RESPONSE ACTION CONTRACT FOR
REMEDIAL, ENFORCEMENT OVERSIGHT, AND
NONTIME-CRITICAL REMOVAL ACTIVITIES
IN REGION 6

FOCUSED ECOLOGICAL RISK ASSESSMENT
LEMON LANE LANDFILL
BLOOMINGTON, MONROE COUNTY, INDIANA

Prepared for

U.S. Environmental Protection Agency
Region 5
Chicago, Illinois

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CONTENTS

Section **Page**

CONTENTS

CONTENTS

Appendix

Attachment

TABLES

Table **Page**

FIGURES

Figure **Page**

ABBREVIATIONS AND ACRONYMS

Ah	Aryl hydrocarbon
AUF	Area use factor
ATSDR	Agency for Toxic Substances and Disease Registry
COPC	Contaminants of potential concern
CSM	Conceptual site model
CTE	Central tendency exposure
CV	Coefficient of variation
DDT	p-p'-Dichlorodipheynltrichloroethane
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
ERA	Ecological risk assessment
FERA	Focused ecological risk assessment
GLI	Great Lakes Initiative
gpm	Gallon per minute
HQ	Hazard quotient
ICS	Illinois Central Spring
IR	Ingestion rate
kg food/kg_{bw}-day	Kilogram food per kilogram bodyweight per day
LOAEC	Lowest-observed-adverse-effect-concentration
LOAEL	Lowest-observed-adverse-effect-level
mg/kg	Milligram per kilogram
NOAEC	No-observed-adverse-effect-concentration
NOAEL	No-observed-adverse-effect-level
PAC	Percent allowable consumption
PADI	Percent allowable daily intake
PCB	Polychlorinated biphenyl
ppm	Part per million
RCRA	Resource Conservation and Recovery Act
RME	Reasonable maximum exposure
TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin
TEQ	Toxic equivalency quotient
Tetra Tech	Tetra Tech EM Inc.
TRV	Toxicity reference value
95UCL	95th-percent upper confidence limit
µg/kg	Microgram per kilogram
Westinghouse	Westinghouse Electric Corporation

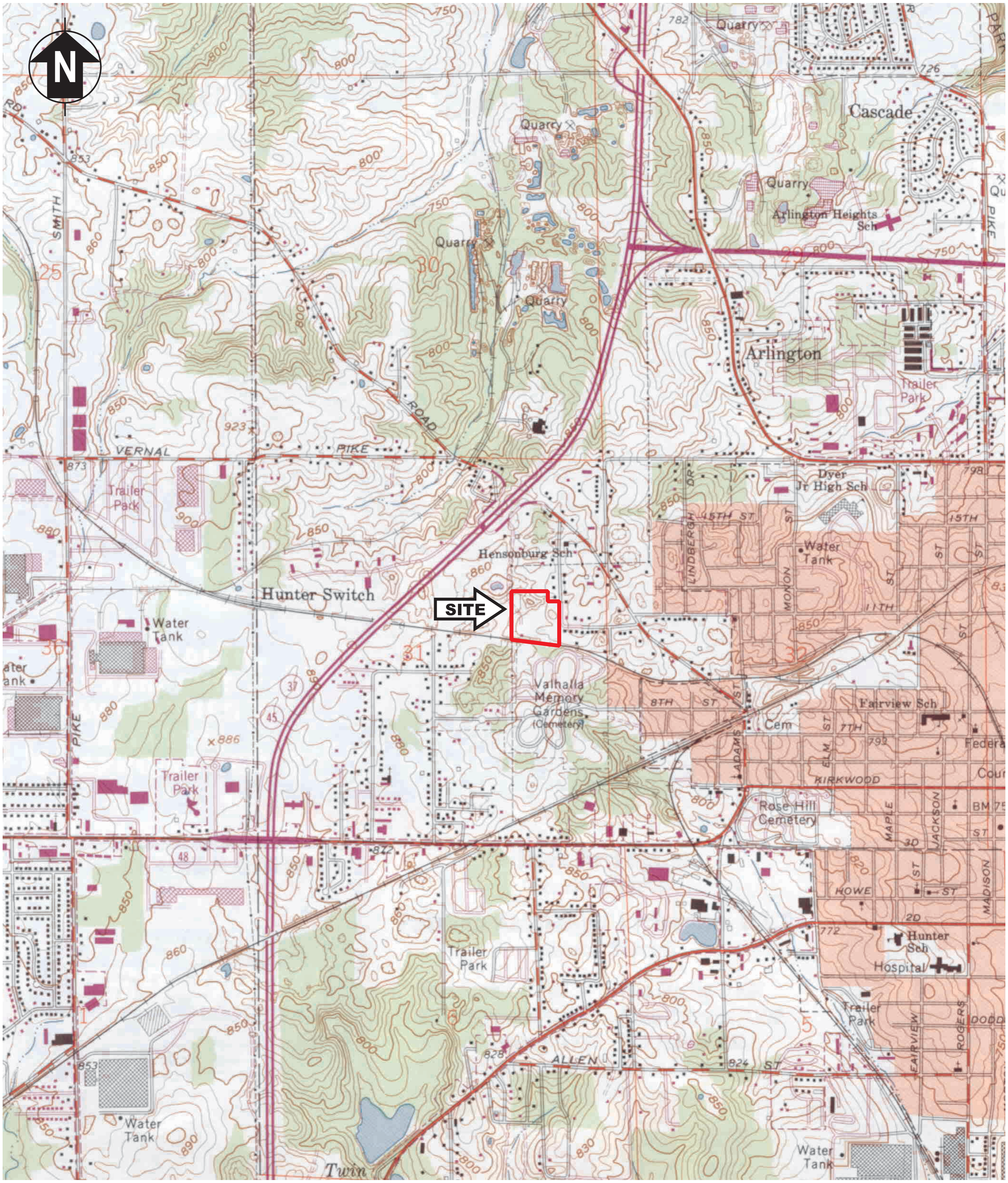
1.0 INTRODUCTION

Tetra Tech EM Inc. (Tetra Tech) has prepared this focused ecological risk assessment (FERA) report for the U.S. Environmental Protection Agency (EPA) in partial fulfillment of the statement of work for Response Action Contract No. 68-W6-0037 for Region 6, Work Assignment No. 941-RSBD-0529. The primary objective of this FERA is to investigate the protectiveness of the remedial activities conducted at the Lemon Lane Landfill site.

The FERA follows the approach developed by EPA for the FERA conducted for the Neal's Landfill site, as detailed in the *Focused Ecological Risk Assessment, PCBs and Mammalian and Avian Piscivores in Conard's Branch and Richland Creek* (EPA 2005). The following sections are included in the report: Section 1.0 describes the site history and ecological risk assessment (ERA) components, Section 2.0 presents the problem formulation, Section 3.0 presents the exposure assessment, Section 4.0 presents the ecological effects assessment, Section 5.0 presents the risk characterization, Section 6.0 presents the uncertainty analysis, and Section 7.0 presents a summary. The references cited in the report are listed in Section 8.0. The report also contains five appendices and an attachment. Appendix A contains the data used in the FERA; Appendices B, C, D, and E contain the risk estimate calculations; and Appendix F contains the summary statistics used in the risk estimates. An evaluation of toxicity values conducted by EPA (EPA 2005) is included in the Attachment.

1.1 SITE HISTORY

Lemon Lane Landfill is located on a 10-acre parcel on the northwest side of Bloomington in Monroe County, Indiana (see Figure 1). The landfill was opened as a refuse dump by a private owner in 1933. After 1950, Lemon Lane Landfill was operated by the City of Bloomington as a municipal waste landfill. The Westinghouse Electric Corporation (Westinghouse; later known as CBS Corporation and now known as Viacom) discarded wastes, including electrical capacitors filled with polychlorinated biphenyl (PCB)-containing oils, at the site between 1957 and 1964. The landfill had no liner or cover, and dumping was not controlled.



BLOOMINGTON QUADRANGLE
INDIANA - MONROE CO.
7.5-MINUTE SERIES (TOPOGRAPHIC)

QUADRANGLE LOCATION

SCALE 1:24 000

SOURCE: MODIFIED FROM USGS 1990

LEMON LANE LANDFILL
BLOOMINGTON, INDIANA

FIGURE 1
SITE LOCATION

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G00AA-0190901 TOPOMAP.DSF 1/2/01 GAS

Lemon Lane Landfill was placed on the National Priorities List in October 1982. In 1985, EPA, the State of Indiana, Monroe County, the City of Bloomington, and Westinghouse (now Viacom) signed a consent decree. Under the terms of the consent decree, Viacom is to remediate six sites in the Bloomington area containing PCBs. Lemon Lane Landfill is one of the six sites covered by the consent decree. Between May and September 1987, a series of interim remedial measures was completed. As part of these measures, the site was cleared of all vegetation; all visible capacitors were removed; and the south slope grade, which had eroded, was stabilized with fill material. The entire site was covered with a temporary cap consisting of 30,000 tons of clean fill overlain by a 488,000-square-foot, 36-mil plastic membrane cover.

During the mid-1980s, site investigations were initiated to further characterize site wastes and develop a remediation plan. The remedial alternative selected by Viacom and the government agencies included excavation and either off-site disposal or on-site consolidation of impacted soil and waste within and adjacent to the landfill. The landfill was to be covered with a cap meeting Resource Conservation and Recovery Act (RCRA) Subtitle C standards.

Viacom also conducted a hydrogeologic investigation to characterize groundwater flow and determine possible impacts to local surface water. Tracer tests in the late 1980s and early 1990s had established that most of the groundwater originating at Lemon Lane Landfill drained through karst solution conduits to Illinois Central Spring (ICS), located 2,500 feet southeast of the site. As early as 1982, the spring resurgence area was known to contain PCB-contaminated sediments resulting from washout.

From 1995 to 1998, Viacom monitored flow rate, conductivity, and PCB concentrations in ICS. Based on early findings, Viacom attempted to reduce infiltration of impacted water into the subsurface by installing an impermeable liner over a sinkhole area in the southwest corner of the landfill. This activity was completed in December 1996.

In May 2000, Viacom began excavation, disposal, and consolidation of soil and fill materials at the site as part of a remedial action overseen by EPA, the State of Indiana, and Monroe County. Excavated material with a PCB concentration greater than 50 parts per million (ppm) was disposed of off site at a

Toxic Substances Control Act-permitted landfill. Excavated material with a PCB concentration less than 50 ppm was consolidated underneath the landfill cap. Excavation activities were completed in October 2000, and installation of the RCRA cap was completed in December 2000. A water treatment plant located at ICS was also completed during this time period. The treatment plant began operating in May 2000, and was designed to collect and treat up to 1,000 gallons per minute (gpm) of PCB-impacted water discharging to ICS.

1.2 ECOLOGICAL RISK ASSESSMENT COMPONENTS

Ecological risk assessments (ERA) generally:

- Characterize the current and potential threats to the environment,
- Establish cleanup levels for the selected remedy that will protect natural resources (i.e., plants and animals), and
- Evaluate the ecological impacts of remediation strategies (EPA 1997).

The process for performing an ERA is described in the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA 1997). One of the first steps in the ERA process is the problem formulation, which includes the following elements:

- **Identification of Contaminants of Potential Concern (COPC; or "stressors"):** identifies those COPCs, attributable to the source (or site) that are likely to present a risk to the ecosystem.
- **Evaluation of Contaminant Release, Migration, and Fate:** describes what is known about the extent of contamination, fate, and transport processes (i.e., transport from soil to surface water via runoff or degradation processes).
- **Identification of Receptors:** Receptors are those individual organisms or animals, populations, or communities that are exposed (or potentially exposed) to a COPC through a complete exposure pathway. A COPC moves from a source to a receptor through an exposure pathway.
- **Identification of Effects:** After the COPCs are identified, possible effects resulting from exposure are reviewed.

- **Selection of Endpoints:** *Assessment* endpoints identify critical effects for the receptor; for example, a decrease in reproductive success can be a critical endpoint as it may impact population/community stability. *Measurement* endpoints represent how the critical effect will be estimated or measured (i.e., comparison of COPC concentrations in a receptors diet to dietary concentrations demonstrated to cause reproductive effects in biological studies).

The end product of the problem formulation step is a conceptual site model (CSM) identifying the (1) environmental receptors at risk (what ecological component needs protecting), (2) data needed, and (3) analyses to be used. The CSM focuses the ERA on those ecological components demonstrating complete exposure pathways and critical effects.

The problem formulation step is followed by the exposure assessment, which quantifies the magnitude and type of exposure. Key elements include (1) quantifying contaminant release, fate, and transport; (2) characterizing receptors, and (3) estimating exposure point concentrations (EPC).

The ecological effects assessment quantitatively links concentrations of COPCs to adverse effects in receptors. The effects assessment identifies how much of a COPC has the potential to cause how much of an effect. The "quantitative link" between COPC concentrations and a potential adverse effect can be provided by literature reviews, field testing, and/or toxicity testing.

The exposure assessment and the effects assessment are combined in the risk characterization step. During risk characterization, the results of the exposure assessment (i.e., the EPC) is compared to the concentration required to produce an adverse effect. A receptor is considered at risk when the EPC (i.e., concentration in diet or dose) exceeds the concentration demonstrated to produce an adverse effect.

As part of the risk characterization, an uncertainty analysis is conducted. During the ERA process, assumptions are made, all of which contribute to uncertainty in risk evaluations. Lacking site-specific information, assumptions are developed based on best estimates of data quality, exposure parameters, and dose-response relationships. The purpose of the uncertainty analysis is to provide a summary of those factors that may influence the risk results, evaluate their variability, and determine their contribution to an over- or underestimation of the overall risk assessment results.

The ERA concludes with a summary regarding the estimated ecosystem risk. If appropriate, preliminary remedial goals may be calculated.

2.0 PROBLEM FORMULATION

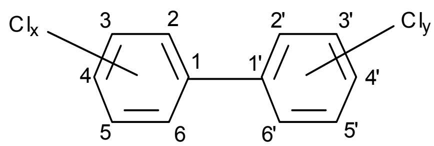
The purpose of this FERA is to investigate the protectiveness of the remedial activities conducted at the Lemon Lane Landfill site. The FERA focuses solely on PCB-related risks to wildlife (specifically, piscivorous [fish-eating] birds and mammals) in Clear Creek, downstream of the Lemon Lane Landfill. PCBs are the only COPCs evaluated in the FERA, as remediation at the Lemon Lane Landfill site focused on the removal of PCB-contaminated soils and waste material. Soil with PCB concentrations less than 50 ppm were consolidated beneath a RCRA landfill cap; therefore, direct contact with PCB-containing soil by terrestrial receptors is unlikely.

Prior to remedial activities at the site, PCB-contaminated sediments from the landfill were likely washed into the bedrock aquifer. Although the RCRA cap now limits migration of water downward through the consolidated fill material, it does not prevent the horizontal movement of groundwater. Groundwater discharging from the Lemon Lane Landfill site percolates through conduits in the karst formations to ICS, which eventually discharges into Clear Creek. A water treatment plant has been built at ICS to address impacted groundwater; however, during periods of high flow (greater than 1,000 gpm), PCB-impacted groundwater may bypass the water treatment system and flow into ICS and eventually into Clear Creek.

The following sections (see Sections 2.1 through 2.4) of the problem formulation discuss the COPCs (PCBs), CSM, assessment endpoint, and measurement endpoint.

2.1 POLYCHLORINATED BIPHENYLS

PCBs are produced by the chlorination of a biphenyl molecule. The general structure of PCBs is shown below.



Up to 209 different compounds (called congeners) can be formed based on the degree and position of the chlorine atoms. Congeners with the same number of chlorine atoms (i.e., three) are called isomers and make up a homolog group (i.e., trichlorobiphenyls).

Monsanto Corporation marketed PCBs under the name Aroclor and was the major producer between 1930 to 1977. PCBs were useful in a variety of applications due to their chemical and thermal stability. The different Aroclors are identified by a four-digit code with the first two digits indicating the type of mixture and the last two digits indicating the approximate amount of chlorination (percent weight), for example, Aroclor 1248. Trade names of PCB mixtures produced in other countries include Clophen, Fenclor, Kaneclor, and Phenoclor. The manufacture, processing, distribution, and use of PCBs was banned in the U.S. in 1977 (Agency for Toxic Substances and Disease Registry [ATSDR] 2000) in part due to their toxicity and persistence in the environment.

2.1.1 Fate and Transport

PCBs are nonpolar, lipophilic compounds. In general, PCBs are relatively insoluble in water, with solubility decreasing with increasing degree of chlorination. PCBs are relatively soluble in nonpolar solvents and lipids. In addition to being more water-soluble, the lower chlorinated congeners are also more volatile and susceptible to degradation processes (such as photolysis and microbial degradation) than the more highly chlorinated congeners.

As PCBs are no longer manufactured or imported in large quantities, uncontrolled releases to the environment are rare. PCBs may be released to the environment from uncontrolled landfills/hazardous waste sites, incineration of PCB-containing material, leakage from electrical equipment, or the improper disposal of PCB-containing material (ATSDR 2000). Once in the environment, PCBs partition between media (i.e., soil to water, water to air, or sediment to water). As the FERA focuses on the aquatic habitat, specifically the release of PCB-impacted groundwater to Clear Creek, the following discussion focuses on the fate and transport of PCBs in the aquatic environment.

At the air-water interface, volatilization of PCBs from water to the atmosphere may occur. For PCBs within the water column, photolysis is the primary degradation process, with the lower chlorinated congers being more susceptible. Due to their relatively low water solubility and high octanol-water partition coefficients (a measure of hydrophobicity), PCBs tend to sorb strongly to suspended solids and sediments. For those PCBs bound to sediment, biodegradation is the principle degradation process. Although sediment may serve as a sink for PCBs in the aquatic environment, it is possible for PCBs in sediment to serve as a continuing source of PCBs to the water column. As PCB concentrations in the water column decrease, PCBs may desorb from the sediment back into the water column.

Dissolved-phase PCBs can also be taken up directly from the water column (bioconcentration) by aquatic organisms. Aquatic organisms bioaccumulate PCBs through combined exposure to PCB-containing food items, water, and sediment; therefore, upper trophic-level aquatic consumers would be expected to have higher PCB concentrations than their prey. In general, the low-chlorinated congeners are more readily metabolized, while the higher chlorinated congeners are slowly metabolized and preferentially retained in the tissues (especially in the lipids). Within the food web, as each trophic level preferentially accumulates the higher-chlorinated congeners, it is expected that the top-level consumers will have the highest levels of the higher-chlorinated congeners. Protection of piscivorous wildlife from risks associated with PCB exposure should be protective of other aquatic organisms (fish, invertebrates, and plants).

2.1.2 Polychlorinated Biphenyl Ecotoxicity

PCBs exhibit a broad spectrum of effects including, effects on the gastrointestinal system, liver, respiratory system, nervous system, immune system, reproductive system, and endocrine system (Hansen 1994). Certain coplanar PCB congeners have a structure similar to 2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD). The mechanism of toxicity for dioxin involves binding to the aryl hydrocarbon (Ah) receptor. Dioxins are potent Ah receptor agonists. PCBs with similar structures can also bind to the Ah receptor and exhibit dioxin-like toxicity but are less potent than dioxins. For the noncoplanar PCBs, mechanisms of toxicity are not as well characterized but include lipid accumulation and vitamin A depletion (which are also associated with Ah receptor activity), enzyme induction, and interference with heme synthesis (Hansen 1994).

PCB-exposure has been related to decreased reproductive success in wildlife populations. Reproductive toxicity in female animals has been established in a number of oral exposure studies; information on the reproductive toxicity in male animals is limited (ATSDR 2000). Effects include decreased conception, complete inhibition of reproduction, and decreased fertility. Mink and monkeys have been demonstrated to be particularly susceptible to the effects of PCBs. Reproductive failure has been shown to occur at concentrations of 2 ppm (Aroclor 1254) (Aulerich and others 1985 as cited in Hansen 1994). Although the adults were not affected, a high death rate of kits resulted. Rhesus monkeys (*Macaca mulatta*) are also sensitive to PCB exposure. Female monkeys have demonstrated increased stillbirths, lowered birth rate, and altered behavioral patterns (Eisler 1986). Exposure to 0.8 milligrams per kilogram (mg/kg) body weight per day Aroclor 1248 for 2 months resulted in a reduced conception rate (Allen and others 1974, as cited in ATSDR 2000).

In birds, PCBs affect normal patterns of growth, reproduction, metabolism, and behavior (Eisler 1986). Fish-eating birds accumulate PCBs through their diet. PCB concentrations in the liver were highest in birds that fed on fish, followed by birds feeding on small birds and mammals, worms and insects, and lowest in plant-eating species (Eisler 1986). PCB exposure in birds has been linked to low reproductive success and deformed chicks. Hormonal and behavioral effects have also been observed in wild bird populations.

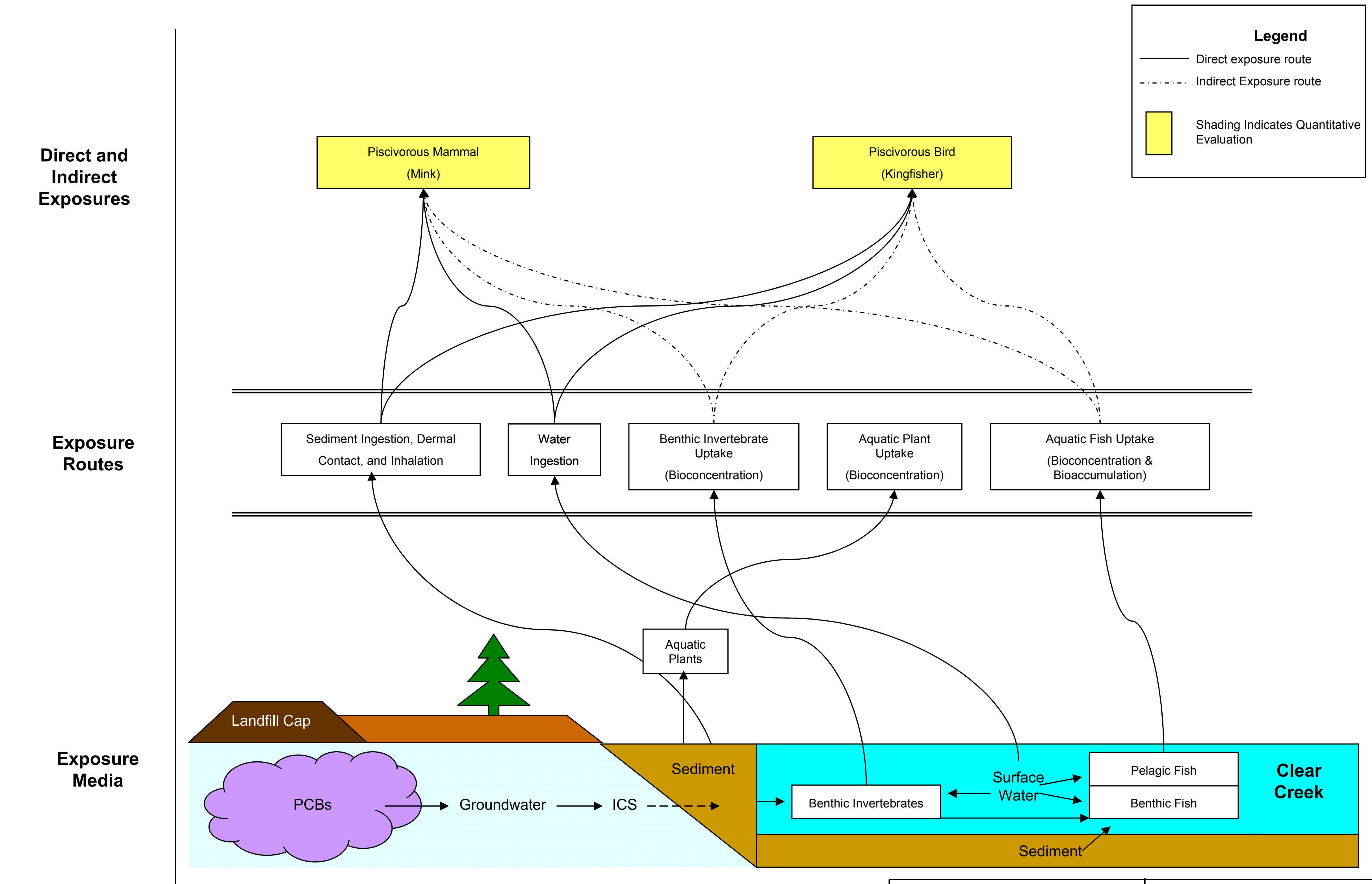
Delayed reproductive impairment has been noted in doves fed Aroclor 1254 in the diet. Although the first clutch was not reduced, the hatchability of the second clutch was reduced. Chromosomal aberrations were noted in the embryos. Doves fed PCBs during the courtship phase demonstrated decreased nest-building and incubation (indirect effect on reproduction). In hens, egg hatchability was decreased in hens fed Aroclors in the diet. Eggshell thinning has been observed in birds with measurable levels of PCB residues; however, the results are confounded due to the presence of other contaminants (i.e., p,p'-dichlorodiphenyltrichloroethane [DDT]).

2.2 CONCEPTUAL SITE MODEL

The CSM illustrating potential exposure pathways for PCB exposure for ecological receptors at the Lemon Lane Landfill site is shown on Figure 2. As PCBs in soil were addressed during the remedial action (through excavation and off-site disposal or consolidation and capping), exposure to PCBs in soil was not considered to represent a significant source of exposure. Therefore, terrestrial exposure pathways are not evaluated in the FERA. The primary release of PCBs from the Lemon Lane Landfill site (post-remediation) is through the infiltration of groundwater, which flows to the ICS and then to Clear Creek.

The PCB exposure routes evaluated in the FERA include direct absorption from water (bioconcentration) by aquatic organisms and dietary exposures through consumption of PCB-contaminated food items. Direct absorption of a chemical from water is called "bioconcentration," exposure through food is known as "trophic transfer" or "biomagnification," and the integrated exposure through all routes is referred to as "bioaccumulation" (in this example, the combined effects of bioconcentration, trophic transfer, and sediment ingestion). Fish are shown as receiving an integrated exposure through all exposure routes (see Figure 2).

The transfer of PCBs from surface water to sediment and from sediment back to surface water is shown as is the direct transfer of PCBs from sediment to aquatic receptors. Although exposure to sediment is a potentially complete exposure pathway for aquatic receptors, either by incidental ingestion of sediment during consumption of prey/food or by direct contact, this pathway was not evaluated in the FERA. The



Notes:

ICS Illinois Central Spring

PCB Polychlorinated biphenyl

LEMON LANE LANDFILL BLOOMINGTON, INDIANA	**FIGURE 2** CONCEPTUAL SITE MODEL

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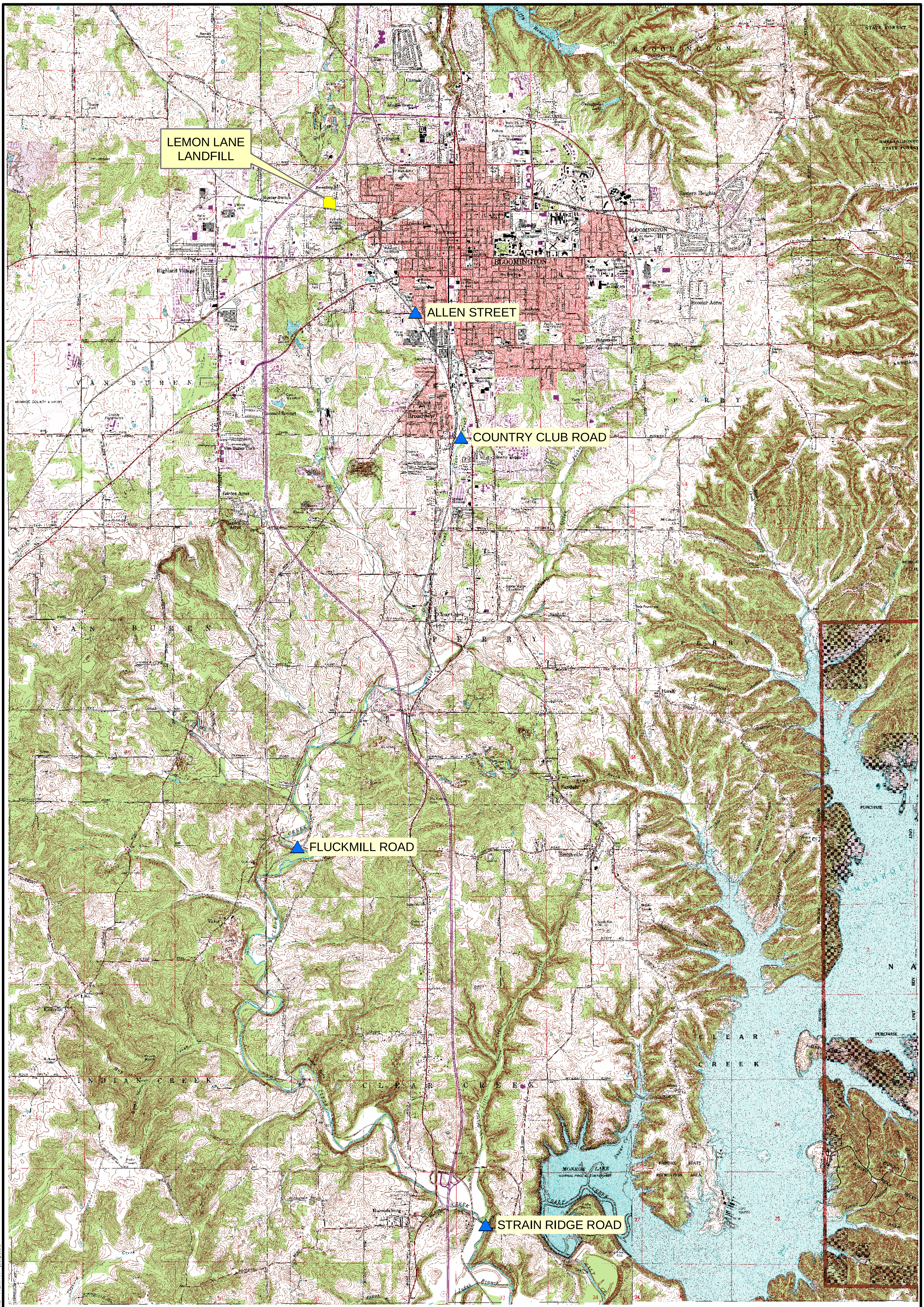
portion of the stream bed from ICS to Station 1 (see Figure 3) is described as silty sand; however below Station 1, the stream bed of Clear Creek is described as being primarily composed of sand, gravel, and exposed bedrock (ChemRisk 1996). For upper trophic levels, exposure to PCBs in sediment during incidental ingestion is expected to be minor (dry weight basis) compared to exposure to PCBs in prey items.

Exposure of piscivorous mammals and birds to PCBs in the diet (i.e., fish and crayfish) was evaluated in the FERA. Although piscivores may be exposed to PCBs through additional exposure routes such as ingestion of PCB-contaminated water or sediments and inhalation of PCBs that volatilize from the water surface, the contribution from these types of exposures was considered minor and were not evaluated in the FERA. For instance, bioconcentration factors for aquatic species can range from 500 to 300,000 (ATSDR 2000), depending on the degree of chlorination. Therefore, the concentration in the prey item (fish or crayfish) may be expected to be 500 to 300,000 times greater than the concentration in the water. An upper level piscivore would need to consume a large amount of surface water to approach the concentrations expected in the piscivorous diet.

Volatilization of PCBs from water to the atmosphere does play a role in influencing global distribution of PCBs; however, the inhalation of PCBs in air above Clear Creek is expected to be a minor contributor and was not evaluated in the FERA.

2.3 ASSESSMENT ENDPOINT

Reproductive effects in seals, mink, and migratory water birds have been associated with PCB exposure. As PCBs bioaccumulate in the food chain, higher trophic level consumers will have a greater exposure to PCBs. Fish would be expected to have a higher level of PCBs than the aquatic invertebrates and aquatic plants they feed on; consequently, fish-eating animals would be expected to have higher PCB levels than the prey (fish) they consume.



LEGEND

- FISH SAMPLING LOCATION
- LEMON LANE LANDFILL

SOURCE: MODIFIED FROM USGS, CLEAR CREEK AND UNIONVILLE, INDIANA QUADRANGLES, 1987, BLOOMINGTON, INDIANA QUADRANGLE, 1990, ALLENS CREEK, INDIANA QUADRANGLE, 1994, AND CAAGIS AT PURDUE UNIVERSITY, 2004.

0 4,000 Feet

LEMON LANE LANDFILL
BLOOMINGTON, INDIANA

FIGURE 3
HISTORICAL FISH SAMPLING LOCATIONS IN CLEAR CREEK

Tetra Tech EM Inc.

Studies also indicate that certain piscivores are sensitive to the effects of PCBs. For this reason, the FERA focused on the protection of piscivorous wildlife from PCB-related risks, which should be protective of lower trophic level aquatic organisms (i.e., fish, invertebrates, and plants).

As discussed in Section 2.1.2, reproductive effects due to PCB exposure have been observed in wildlife. Reproductive success can be adversely impacted by PCB-exposure, including premature births, malformed offspring, and behavioral effects (i.e., inattentiveness or nest abandonment in birds). Adverse impacts on reproduction can affect population stability as the population may not be able to maintain its numbers or the population may become skewed towards the adult-age animals. Due to the potential impact on species populations, any significant reduction in reproductive endpoints is considered to be an ecologically significant adverse effect. The assessment endpoint can be stated as:

- Protection of piscivorous receptors in Clear Creek that may ingest PCB-contaminated food from a reduction in reproductive success.

The testable hypothesis identified for this assessment endpoint is:

- Levels of PCBs in fish and crayfish are sufficient to cause reproductive effects in piscivorous receptors in Clear Creek through dietary exposure.

2.4 MEASUREMENT ENDPOINT

To assess ecological risks, measurement endpoints were identified. A measurement endpoint is defined as a "measureable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint" and measures biological effects (EPA 1997). For each assessment endpoint identified (i.e., reproductive success), one or more measurement endpoints are selected to integrate modeled data or field data with the individual assessment endpoint.

Modeled dietary intake of PCBs were used to evaluate the potential risk to piscivorous mammals and birds that may consume fish and crayfish from Clear Creek. The selected measurement endpoint receptor species for piscivorous mammals is the mink (*Mustela vison*) and for piscivorous birds is the kingfisher (*Ceryle alcyon*). These two receptors were selected because (1) the majority of Clear Creek provides suitable habitat for both receptors; (2) natural history information (i.e., dietary composition and home range) is available; (3) both the mink and kingfisher have dietary compositions that maximize exposure; and (4) mink and avian piscivores (represented by the kingfisher) have been shown to be sensitive to the effects of PCB exposure.

As described in Section 2.1.2, mink have been shown to be sensitive to PCB exposure (Eisler 1986, EPA 1993); they are abundant and widespread, being found in various aquatic habitats, including rivers, streams, lakes, and ditches, as well as swamps and marshes (Linscombe and others 1982, as cited in EPA 1993). Avian piscivores have been shown to be sensitive to the effects of PCB exposure, especially the dioxin-like effects of certain PCB congeners. For the FERA, the kingfisher was selected to represent the avian piscivore guild. Kingfishers are found along rivers and streams and lake and pond edges (EPA 1993). Waters that are relatively shallow (less than 2 feet below ground surface), clear, and free of thick vegetation (which obscures their view of the water) are preferred. Stream riffles are preferred as fish tend to accumulate at riffle edges.

Although the stream reach between ICS and Allen Street is developed, riparian habitat is present. This area is most likely to be impacted by discharges from Lemon Lane Landfill due to its close proximity; ICS is approximately 2,500 feet southeast of the landfill. Downstream of Country Club Road (approximately 3 miles from the site), the amount of riparian habitat increases. The Creek becomes wider and deeper, and provides suitable habitat for fish and invertebrates and other wildlife.

Exposure through the diet was estimated based on site-specific measurements of PCBs in Clear Creek fish and modeled PCB concentrations in crayfish. In addition, for the kingfisher, a dose-related exposure was calculated by adjusting the concentration in the kingfisher diet by its ingestion rate. Dietary studies evaluating exposure to PCBs in the diet have been performed on mink; therefore, dietary concentrations estimated from field data (measured/modeled concentrations in fish/crayfish) can be compared directly to dietary concentrations in controlled studies. No dietary studies on PCBs in the kingfisher were identified; consequently, a direct diet-to-diet comparison cannot be made. Instead, an extrapolation was made to compare the PCB exposure concentration for the kingfisher to the PCB exposure concentrations for other avian species. The interspecies comparison was done on the basis of dose by converting the dietary concentration to a dose (amount of PCBs ingested per body weight per day).

The measures of effects for mink are studies that identify the reproductive effect levels associated with feeding PCB-contaminated fish to mink (see Section 4.1); for the kingfisher, laboratory studies conducted with other avian species, including chicken, pheasant, doves, and cormorants, and a field study of bald eagles, were used to identify the reproductive effect level (dose) for avian receptors (see Section 4.2). The reproductive effect levels were used to evaluate the level of risk associated with exposure to PCBs in the diet.

Exposure was also estimated by modeling the dietary intake of dioxin-like PCB congeners for the mink and kingfisher using the November 2004 data; in addition, accumulation of dioxin-like PCB congeners in kingfisher eggs was modeled. PCB congener data suitable for risk assessment purposes were not available for the 2000 and 2002 sampling events. The assessment of risks associated with exposure to PCB congeners in fish from Clear Creek (November 2004) is included in Appendix E (and discussed in Section 5.0). As only limited PCB congener data is available, the congener-based assessment is not equivalent to the total PCB (as Aroclor) assessment; the methodology for the congener-based risk evaluation is provided in Appendix E.

3.0 EXPOSURE ASSESSMENT

Exposure parameters including dietary composition and home range/site utilization for the mink and kingfisher are discussed in Sections 3.1 and 3.2, respectively.

PCB-contaminated soil was addressed during the removal action. The only complete exposure pathway considered in the FERA is the release of PCBs from the landfill material to groundwater, which flows to ICS, and is subsequently released from ICS to Clear Creek (see Figure 2); a dietary composition was selected to maximize the contribution of aquatic food items. Both the mink and the kingfisher are assumed to feed equally on the various fish species available. The composition of the mink and kingfisher diets used in this FERA are discussed in Sections 3.1.1 and 3.2.1, respectively.

Home ranges are the areas over which animals travel during routine activities, such as foraging for food. The site area use factor (AUF) is that portion of the affected area that falls within a particular animal's home range. The AUFs for the mink and kingfisher used in this FERA are discussed in Sections 3.1.2 and 3.2.2, respectively.

3.1 MINK EXPOSURE PARAMETERS

Dietary composition and home range assumptions for mink inhabiting Clear Creek are discussed in the following sections.

3.1.1 Mink Dietary Composition

Based on observations in 31 mink collected along Michigan streams, the mink diet was found to be 61 percent fish, 5 percent amphibians, 11 percent crustaceans, 2 percent insects, 17 percent bird/mammal prey, and 4 percent unidentified (Alexander 1977, as cited in EPA 1993). Dietary composition is also available for mink along Michigan rivers; however, as Clear Creek more closely resembles a stream, the dietary information for mink collected along streams was determined to be appropriate for use in this FERA.

Using the dietary composition for mink living along Michigan streams, an estimate of dietary exposure for mink along Clear Creek was determined assuming consumption of fish and crayfish only. For this FERA, the percent fish (61 percent) and amphibians (5 percent) from the Michigan stream study were combined to represent the percent total fish consumption (66 percent). The percentages for crustaceans (11 percent) and insects (2 percent) from the Michigan stream study were combined to represent percentage of crayfish consumed (13 percent). The following general equation was used to model the concentration of PCBs in the mink diet for Clear Creek:

$$\mathbf{C_{diet-mink} = (0.66 \times C_{fish}) + (0.13 \times C_{crayfish})}$$

where,

$C_{diet-mink}$ = Concentration of PCBs in mink diet
C_{fish} = Measured concentration of PCBs in Clear Creek fish
$C_{crayfish}$ = Modeled concentration of PCBs in Clear Creek crayfish

Using this approach, 79 percent of the mink diet is modeled. All fish species were assumed to be consumed equally. The remaining 21 percent of the diet, estimated to be terrestrial prey items (mammals and birds), is not accounted for as site-specific PCB data for terrestrial receptors are not available for Lemon Lane Landfill. As PCB-contaminated soil has been addressed by the previous remedial actions (either by off-site disposal or consolidation and capping), terrestrial receptors at the site should have little to no direct contact with PCB-contaminated soil. Therefore, mink exposure to PCBs in the diet may be underestimated by up to 21 percent; however, the actual underestimation may be less than 21 percent as terrestrial prey are expected to have lower PCB tissue concentrations compared to aquatic prey. The potential underestimation of PCBs in the mink diet due to the exclusion of terrestrial prey items is discussed as an uncertainty (see Section 6.0).

3.1.2 Mink Home Range and Area Use Factor

A home range of 1 stream mile was selected for the mink based on the home range of adult female mink along Swedish streams (Gerell 1970, as cited in EPA 2005). In this study, adult female mink were found to range from 0.6 stream miles up to 1.7 stream miles with a mean value of 1.1 stream miles. Mean home ranges for adult male mink were greater; however, since the toxicity endpoint for mink is based on reproductive effects, and reproductive effects in female animals have been observed, the smaller home range of the adult female is considered appropriate.

The shape of the home range is dependent on the habitat type; for riverine habitats, the home range is usually linear in shape, while marsh habitats are more circular (Birks and Linn 1982, Eagle and Whitmann 1987; as cited in EPA 1993). For the FERA, the home range was assumed to be linear in shape, parallel to, and including Clear Creek.

As the home range is 1 stream mile and each of the reaches of Clear Creek evaluated in the FERA are greater than 1 mile apart, the site utilization factor (or AUF) was determined to be 1; therefore, 100 percent of the mink's diet is considered to be food items within a specific reach.

3.2 KINGFISHER EXPOSURE PARAMETERS

Dietary composition and home range assumptions for kingfisher inhabiting Clear Creek are discussed in the following sections.

3.2.1 Kingfisher Dietary Composition

Although the kingfisher diet consists mainly of fish, they also consume crayfish (EPA 1993). The dietary assumptions used in this FERA are based on observations from three studies. For Michigan streams, Alexander (1977, as cited in EPA 2005) reported diets consisting of 86 percent fish, 9 percent amphibians, and 5 percent insects for 17 kingfishers; Salyer (1946, as cited in EPA 1993) reported a diet of 41 percent crayfish with the remainder consisting of various fish species. For Ohio streams (Davis 1982, as cited in EPA 1993), a diet of 13 percent crayfish was reported with the remainder consisting of various fish species. It should be noted that the three dietary composition studies each have a different basis for calculating the percentage of total diet (i.e., mass, volume, and number of prey), which contributes to uncertainty. For the FERA, the percentage of crayfish in the kingfisher diet was estimated by determining the mean value (20 percent) using the percent crayfish in diet reported from the two Michigan stream studies and the Ohio study. The remainder of the diet (80 percent) was assumed to be composed of the fish species available in Clear Creek. The concentration of PCBs in the kingfisher diet was estimated using the general equation below:

$$\mathbf{C_{diet\text{–}kingfisher} = (0.80 \times C_{fish}) + (0.20 \times C_{crayfish})}$$

where,

$C_{diet\text{–}kingfisher}$	= Concentration of PCBs in kingfisher diet
C_{fish}	= Measured concentration of PCBs in Clear Creek fish
$C_{crayfish}$	= Modeled concentration of PCBs in Clear Creek crayfish

3.2.2 Kingfisher Home Range and Area Use Factor

When based on the foraging area during the breeding season, the kingfisher home range may fall between 0.64 miles (Ohio streams) and 1.36 miles (Michigan streams) with a mean value of 1.0 stream mile (Brooks and Davis 1987, as cited in EPA 1993). After the breeding season, the foraging area may be smaller with a mean value of 0.24 stream miles (Davis 1980, as cited in EPA 1993). As the toxicity endpoint for the kingfisher is based on reproductive effects, the home range during breeding season (mean value of 1 stream mile) is appropriate. As the home range is 1 stream mile and each of the reaches of Clear Creek evaluated in the FERA are greater than 1 mile apart, the site utilization factor (or AUF) was determined to be 1; therefore, 100 percent of the kingfisher's diet is considered to be food items within a specific reach.

3.3 DATA COLLECTION AND ANALYSIS

Between November 1996 and November 2004, Viacom conducted five separate fish sampling events near Lemon Lane Landfill (see Figure 3). Viacom collected fish samples from Clear Creek in November 1996, November 1999, November 2000, November 2002, and November 2004. Clear Creek flows along the west side of the City of Bloomington and then to the south.

By November 2000, the majority of the remediation activities were completed. A statistical evaluation of the PCB concentrations in samples collected in November 2000 and November 2002 was conducted to determine if there were any changes in PCB concentrations during the post-remediation period (Tetra Tech 2003). Although slight changes in concentrations were observed between the two sampling periods, due to the high variability in the data, the changes were not determined to be significant. The reader is referred to the *Statistical Analysis of Polychlorinated Biphenyl (PCB) Concentrations in Fish Samples Collected Near the Lemon Lane Landfill Site* report (Tetra Tech 2003) for details on the statistical analysis of Clear Creek fish samples data for the November 2000 and 2002 sampling events.

Data from the 2000, 2002, and 2004 fish sampling events were used to estimate ecological risks associated with post-remediation conditions in Clear Creek. Sampling locations sampled during the November 2000, 2002, and 2004 fish sampling events are presented below and are shown on Figure 3.

Station	Approximate Distance Downstream from Lemon Lane Landfill	Description	Years Sampled
1*	1.5 miles	Allen Street	2002, 2004
2	3 miles	Country Club Road	2000, 2002, 2004
3	10 miles	Fluckmill Road	2000, 2002, 2004
4	20 miles	Strain Ridge Road	2000, 2002, 2004

Notes:

* Location 1 was not sampled during the November 2000 fish sampling event.

Both benthic and pelagic fish species were targeted for collection. Benthic fish live and feed at the bottom of a water body, while pelagic fish live and feed within the water column or at the surface of a water body. Fish species collected during the November 2000, 2002, and 2004 fish sampling events included:

Benthic

Creek chub (*Semotilus atromaculatus*)
White sucker (*Catostomus commersoni*)
Hog sucker (*Hypentelium nigricans*)
Red horse (*Moxostoma duquesnei*)

Pelagic

Green sunfish (*Lepomis cyanellus*)
Longear sunfish (*Lepomis megalotis*)
Rock bass (*Amblopites rupestris*)
Smallmouth bass (*Micropterus dolomieu*)

November 2000. Viacom collected whole fish and fillet samples in November 2000, just after completion of the excavation, consolidation, and disposal remedial activities. Samples were collected from Clear Creek at Stations 2, 3, and 4, at distances of 3, 10, and 20 miles downstream of the landfill, respectively (see Figure 3). Fish samples were analyzed for PCBs (as Aroclors by the 4-peak identification method) using gas chromatography methods. Only the data for the whole fish samples were considered in this FERA as piscivorous wildlife consume whole fish. The number of fish samples collected at each location during the November 2000 sampling event are listed in the table below. PCB data for fish collected during the November 2000 sampling event are presented in Table A-1 of Appendix A.

Species	Number of Samples—November 2000		
	Station 2	Station 3	Station 4
Red horse	—	—	4
Hog sucker	—	—	1
Smallmouth bass	—	2	—
Creek chub	4	3	—
Longear sunfish	2	—	5
White sucker	4	4	—
Rock bass	—	4	—

November 2002. Viacom collected only whole fish samples during this sampling event. Samples were collected from Clear Creek at Stations 1, 2, 3, and 4, at distances of 1.5, 3, 10, and 20 miles downstream of the landfill, respectively. Fish samples were analyzed for PCBs by gas chromatography methods (4-peak and 5-peak identification methods). The number of fish samples collected at each location during the November 2002 sampling event are listed in the table below. Data for fish collected during the November 2002 sampling event are presented in Table A-1 of Appendix A.

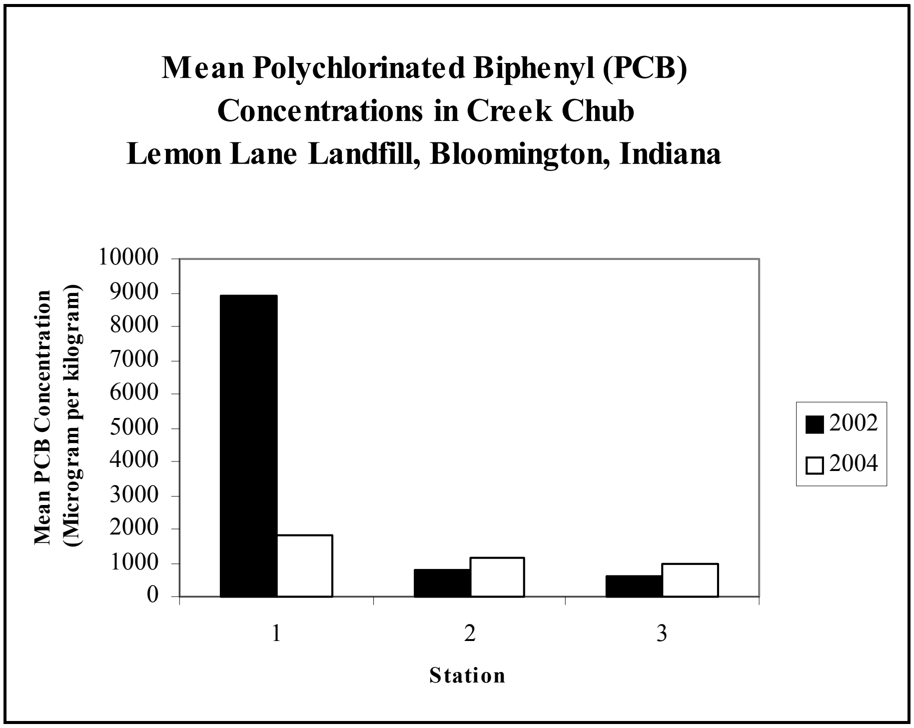
Species	Number of Samples—November 2002			
	Station 1	Station 2	Station 3	Station 4
Creek chub	11	6	6	—
Green sunfish	—	5	5	—
Rock bass	—	—	—	5
Longear sunfish	—	—	—	6

November 2004. Viacom collected both whole fish and fillet samples during this sampling event; however only the data from the whole fish samples were considered for the FERA. Samples were collected from Clear Creek at Stations 1, 2, 3, and 4, at distances of 1.5, 3, 10, and 20 miles downstream of the landfill, respectively. Crayfish samples were collected at Station 1 only. Fish (and crayfish from

Station 1) samples were analyzed for PCBs (as total PCBs) by gas chromatography methods. In addition, selected samples were also submitted for PCB congener-specific analysis. The number of fish samples collected at each location during the November 2004 sampling event are listed in the table below. PCB data (as total PCBs) for fish collected during the November 2004 sampling event are presented in Table A-2 of Appendix A; PCB congener data are presented in Table E-1 of Appendix E.

	Number of Samples—November 2004 Samples Submitted for Aroclor Analysis (Samples Submitted for PCB Congener Analysis)			
Species	**Station 1**	**Station 2**	**Station 3**	**Station 4**
Creek chub	7 (1)	6	6	—
Green sunfish	—	5 (1)	5	—
Rock bass	—	—	—	5
Longear sunfish	—	—	—	6
Red horse	—	—	—	7 (1)
Hog sucker	—	—	—	(1)

Due to the various types of fish collected between the four Clear Creek sampling stations, it is difficult to determine a concentration trend. For the November 2000 fish sampling event, no species of fish was collected at more than two stations. During the November 2002 and 2004 sampling events, creek chub were collected at Stations 1, 2, and 3. The mean PCB concentration in creek chub for Stations 1, 2, and 3 is presented on the graph below. An appreciable decline is noted between the mean sample concentration for fish collected at the station nearest the site (Station 1 at Allen Street, see Figure 3) and those stations further downstream for the 2002 data.



At Station 1 (2002), a mean PCB concentration in creek chub of 8,908 micrograms per kilogram (µg/kg) was calculated. PCB concentrations in creek chub declined sharply downstream, where mean PCB concentrations of 787 µg/kg and 588 µg/kg, respectively, were calculated.

The 2004 data indicates that mean PCB concentrations in creek chub at Station 1 have declined over time; the mean concentration in creek chub at Station 1 in November 2004 was 1,807 µg/kg (with a maximum detected concentration of 3,400 µg/kg); mean PCB concentrations of 1,180 and 986 µg/kg were calculated for downstream Stations 2 and 3, respectively. The November 2004 concentrations at Stations 2 and 3 appear to be increased slightly compared to the 2002 data; although concentrations do appear to decrease at Stations 2 and 3 compared to Station 1 for the November 2004 data, the decrease is slight compared to the decrease observed for the November 2002 data.

3.4 CALCULATION OF EXPOSURE POINT CONCENTRATIONS

Once receptors and exposure parameters have been defined and after the data collection phase of the ERA, an estimate of the concentration of contaminants in the exposure media (i.e., the EPC) can be calculated. EPA risk assessment guidance recommends that exposure be considered under two scenarios: a reasonable maximum exposure (RME) and a central tendency exposure (CTE) scenario. EPA defines the RME scenario as the maximum exposure that is reasonably expected to occur, while the CTE scenario represents the average exposure expected to occur. The 95^{th}-percent upper confidence limit (95UCL) on the arithmetic mean of the data was used as the EPC to evaluate the RME scenario for data sets with four or more samples; the maximum detected concentration was used for data sets with less than four samples. 95UCLs were calculated based on EPA guidance (EPA 2002) using the EPA ProUCL statistical software program. For data sets with less than four results, the maximum detected concentration was used as the EPC for the RME scenario. The mean fish species PCB concentration was used as the EPC to evaluate the CTE scenario.

3.4.1 Calculation of 95^{th}-Percent UCLs for Fish

Two types of RME concentrations were calculated. Species-specific RME PCB concentrations (95UCL or maximum detected concentration) were determined for each fish species at a station. RME concentrations for crayfish were modeled (see Section 3.4.2) using the fish species RME concentration (95UCL or maximum detected concentration) at a specific station, with the exception of Station 1 for the November 2004 sampling event. Crayfish samples were collected during the 2004 event and the crayfish data was used to determine the RME concentration for Station 1 (specifically for the 2004 event). Fish and crayfish concentrations used to evaluate the RME scenario are presented in Table 1.

In addition, an RME dietary PCB concentration was calculated (see Tables 2, 3, and 4). The RME dietary concentration represents the contributions of the RME PCB fish concentration and modeled RME PCB crayfish concentrations towards the total PCB concentration in the piscivore diet. The RME dietary PCB concentration for the mink and kingfisher at a given station were calculated using the general equations describing their dietary compositions as shown below:

TABLE 1

PCB CONCENTRATIONS IN FISH AND CRAYFISH—CLEAR CREEK
STATIONS 1 THROUGH 4
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Fish Species	Sampling Event							
	November 2000		November 2002				November 2004	
	4-Peak Analysis		4-Peak Analysis		5-Peak Analysis		PCB Analysis	
	RME (µg/kg-ww)	CTE (µg/kg-ww)	RME (µg/kg-ww)	CTE (µg/kg-ww)	RME (µg/kg-ww)	CTE (µg/kg-ww)	RME (µg/kg-ww)	CTE (µg/kg-ww)
Station 1 (Allen Street)								
CRC	—	—	12,022	8,908	10,297	7,739	2,562	1,807
CF *	—	—	986.12	731	844.60	635	1,400	913
Station 2 (Country Club Road)								
CRC	2,266	1,675	1,029	787	950	780	1,825	1,180
GS	—	—	2,029	1,418	1,671	1,280	2,094	1,817
LS	2,300 max	1,800	—	—	—	—	—	—
WS	1,900 max	1,833	—	—	—	—	2,457	2,000
CF *	202	150	100	72	85	67	922	596
Station 3 (Fluckmill Road)								
CRC	470 max	433	805	588	665	474	1,148	986
GS	—	—	1,653	1,222	1,350	1,062	2,075	1,302
RB	1,657	1,475	—	—	—	—	—	—

TABLE 1 (Continued)

PCB CONCENTRATIONS IN FISH AND CRAYFISH—CLEAR CREEK
STATIONS 1 THROUGH 4
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Fish Species	Sampling Event							
	November 2000		November 2002				November 2004	
	4-Peak Analysis		4-Peak Analysis		5-Peak Analysis		PCB Analysis	
	RME (µg/kg-ww)	CTE (µg/kg-ww)	RME (µg/kg-ww)	CTE (µg/kg-ww)	RME (µg/kg-ww)	CTE (µg/kg-ww)	RME (µg/kg-ww)	CTE (µg/kg-ww)
Station 3 (Fluckmill Road; Continued)								
SB	3,200 max	2,300	—	—	—	—	—	—
WS	2,227	1,150	—	—	—	—	1,980	1,348
CF *	339	175	438	324	358	281	580	498
Station 4 (Strainridge Road)								
LS	2,149	1,767	3,889	2,457	3,658	2,402	2,985	2,018
RB	—	—	2,199	1,604	2,307	1,544	—	—
RH	3,056	2,125	—	—	—	—	1,837	1,500
HS	—	—	—	—	—	—	—	—
CF *	570	468	1,031	651	969	636	1,509	1,020

TABLE 1 (Continued)

PCB CONCENTRATIONS IN FISH AND CRAYFISH—CLEAR CREEK
STATIONS 1 THROUGH 4
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Notes:

*	PCB concentrations in crayfish were modeled (see Section 3.4.2) with the exception of the November 2004 data for Station 1.
95UCL	95th-percent upper confidence limit
CF	Crayfish
CRC	Creek chub
CTE	Central tendency exposure; for the CTE scenario, the species mean concentration was calculated.
GS	Green sunfish
HS	Northern hogsucker
LS	Longear sunfish
max	Maximum detected concentration
PCB	Polychlorinated biphenyl
ppm	Part per million
RB	Rock bass
RH	Black redhorse
RME	Reasonable maximum exposure; for the RME scenario, the species 95UCL was calculated. For data sets with less than four samples, the maximum detected concentration was used as the RME value.
SB	Smallmouth bass
µg/kg-ww	Microgram per kilogram-wet weight
WS	White sucker

TABLE 2

PCB CONCENTRATIONS IN DIET – NOVEMBER 2000
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Species	Mink		Kingfisher			
	Diet		Diet		Dose	
Station	RME (µg/kg)	CTE (µg/kg)	RME (µg/kg)	CTE (µg/kg)	RME (µg/kg-day)	CTE (µg/kg-day)
Station 1	—	—	—	—	—	—
Station 2	1,470.76	1,187.28	1,791.32	1,445.48	895.66	722.74
Station 3	1,290.47	906.86	1,578.57	1,106.64	798.29	553.32
Station 4	1,791.98	1,345.11	2,196.27	1,650.30	1,098.13	825.15

Notes:

CTE dietary/dose concentration calculated using mean fish and crayfish concentrations.
RME dietary/dose concentration calculated using 95th-percent upper confidence limit fish and crayfish concentrations.

Station Fish sample collection station (see Figure 3)
1 Allen Street
2 Country Club Road
3 Fluckmill Road
4 Strainridge Road

CTE Central tendency exposure
PCB Polychlorinated biphenyl
RME Reasonable maximum exposure
µg/kg Microgram per kilogram diet
µg/kg-day Microgram per kilogram body weight per day
— Not applicable; no fish samples were collected at Station 1 during the November 2000 fish sampling event.

TABLE 3

PCB CONCENTRATIONS IN DIET – NOVEMBER 2002
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Species	Mink				Kingfisher							
Station	Diet (4-Peak Analysis)		Diet (5-Peak Analysis)		Diet (4-Peak Analysis)		Dose (4-Peak Analysis)		Diet (5-Peak Analysis)		Dose (5-Peak Analysis)	
	RME (µg/kg)	CTE (µg/kg)	RME (µg/kg)	CTE (µg/kg)	RME (µg/kg)	CTE (µg/kg)	RME (µg/kg-day)	CTE (µg/kg-day)	RME (µg/kg)	CTE (µg/kg)	RME (µg/kg-day)	CTE (µg/kg-day)
Station 1	8,063.02	5,974.39	6,905.90	5,190.32	9,815.19	7,272.68	4,907.60	3,636.34	8,406.62	6,318.23	4,203.31	3,159.11
Station 2	960.55	736.87	876.34	688.51	1,168.27	896.21	584.14	448.11	1,065.85	837.41	532.92	418.70
Station 3	841.82	639.28	711.35	543.35	1,038.16	788.62	519.08	394.31	877.42	670.54	438.71	335.27
Station 4	2,047.20	1,424.66	2,094.53	1,384.81	2,522.22	1,754.48	1,261.11	877.24	2,579.95	1,705.56	1,289.97	852.78

Notes:

CTE dietary/dose concentration calculated using mean fish and modeled crayfish concentrations.
RME dietary/dose concentration calculated using 95th-percent upper confidence limit (or maximum detected) fish and modeled crayfish concentrations.

Station Fish sample collection station (see Figure 3)
1 Allen Street
2 Country Club Road
3 Fluckmill Road
4 Strainridge Road

CTE Central tendency exposure
PCB Polychlorinated biphenyl
RME Reasonable maximum exposure
µg/kg Microgram per kilogram diet
µg/kg-day Microgram per kilogram body weight per day

TABLE 4

PCB CONCENTRATIONS IN DIET – NOVEMBER 2004
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Species	Mink		Kingfisher			
	Diet		Diet		Dose	
Station	RME (µg/kg)	CTE (µg/kg)	RME (µg/kg)	CTE (µg/kg)	RME (µg/kg-day)	CTE (µg/kg-day)
Station 1	1,872.92	1,311.45	2,329.60	1,628.38	1,164.80	814.19
Station 2	1,522.63	1,1176.80	1,884.74	1,451.72	942.37	725.86
Station 3	1,220.09	846.69	1,503.51	1,069.25	751.75	534.62
Station 4	1,787.38	1,293.66	2,230.52	1,611.35	1,115.26	805.67

Notes:

CTE dietary/dose concentration calculated using mean fish and crayfish concentrations.
RME dietary/dose concentration calculated using 95th-percent upper confidence limit fish and crayfish concentrations.

Station Fish sample collection station (see Figure 3)
1 Allen Street
2 Country Club Road
3 Fluckmill Road
4 Strainridge Road

CTE Central tendency exposure
PCB Polychlorinated biphenyl
RME Reasonable maximum exposure
µg/kg Microgram per kilogram diet
µg/kg-day Microgram per kilogram body weight per day

$$C_{RME\text{-}mink\ diet} = (0.66 \times \text{Mean } C_{RME\text{-}fish}) + (0.13 \times C_{RME\text{-}crayfish})$$

$$C_{RME\text{-}kingfisher\ diet} = (0.80 \times \text{Mean } C_{RME\text{-}fish}) + (0.20 \times C_{RME\text{-}crayfish})$$

where,

$C_{RME\text{-}mink\ diet}$	=	RME concentration of PCBs in the diet of mink
$C_{RME\text{-}kingfisher\ diet}$	=	RME concentration of PCBs in the diet of kingfisher
$C_{RME\text{-}fish}$	=	Mean of the RME PCB concentrations for the fish species at a station. Each fish species at a station contributes equally to the diet.
$C_{RME\text{-}crayfish}$	=	RME PCB concentrations modeled in crayfish at a station using the RME PCB concentration in fish

PCB toxicological studies with dietary exposure have been performed with mink; therefore, the calculated dietary EPCs can be directly compared to the dietary concentrations used in controlled feeding studies to estimate risk. Since PCB toxicological studies with dietary exposure have not been performed with kingfishers, studies using surrogate species were used to determine an effect level and estimate risk. To compare kingfisher exposure to that of the surrogate species, a dose concentration was calculated. After calculating the PCB concentrations in the kingfisher diet, this concentration is then converted to a dose by multiplying the dietary concentration by a kingfisher food ingestion rate (IR) of 0.5-kilogram food per kilogram bodyweight per day (kg food/kg_{BW}-day) (Alexander 1977, as cited in EPA 1993).

$$Dose_{kingfisher} = C_{RME\text{-}kingfisher\ diet} \times IR$$

where,

$Dose_{kingfisher}$	= RME dose of PCBs for kingfisher
$C_{RME\text{-}kingfisher\ diet}$	= RME concentration of PCBs in the diet of kingfisher
IR	= Kingfisher food ingestion rate

For comparison, the calculations detailed above were repeated using the mean fish concentrations and modeled crayfish concentrations to estimate the PCB concentration in the piscivore diet for the CTE scenario (i.e., the average concentration). CTE fish and crayfish PCB concentrations are presented in Table 1.

3.4.2 Modeled PCB Uptake by Crayfish

Site-specific crayfish data were collected in November 1996 at Stations 1, 2, and 3. No crayfish samples were collected during subsequent sampling events until the November 2004 sampling event. During the November 2004 sampling event, crayfish samples were collected at Station 1 only. PCB concentrations in crayfish were modeled for the November 2000 and November 2002 fish sampling events using the 1996 fish and crayfish data; crayfish concentrations were modeled for Stations 2, 3, and 4 for the November 2004 sampling event using the data from Station 1.

Using the fish and crayfish data, station-specific mean fish-to-crayfish PCB ratios were calculated as follows:

- For each station, a species-specific mean fish PCB value was calculated (minimum of three samples).
- For each station, a mean PCB value was calculated for crayfish.
- To determine the mean fish-to-crayfish PCB ratio for each station, the mean fish PCB concentration was divided by the mean crayfish PCB concentration.

To model PCB concentrations in crayfish, the RME fish concentration (or the CTE fish concentration) was divided by the species-specific mean fish-to-crayfish PCB ratio. An example calculation is shown below:

> Station 2: Two mean fish to crayfish PCB ratios are available: one for creek chub (11.20) and one for green sunfish (19.54). To model a RME PCB crayfish concentration for Station 2 for the November 2000 sampling event, the RME PCB concentration for creek chub (2,266 µg/kg) was divided by the mean creek chub-crayfish ratio (11.20), which resulted in a modeled PCB concentration of 202 µg/kg in crayfish.

The 1996 whole fish and crayfish PCB data and the mean fish-crayfish ratios are presented in Table A-3 of Appendix A; the November 2004 fish and crayfish data are presented in Table A-4 of Appendix A. Modeled PCB crayfish concentrations are presented in Tables B-1 and B-2 of Appendix B

(November 2000 data), Tables C-1, C-2, C-5, and C-6 of Appendix C (November 2002 data), and Tables D-1 and D-2 of Appendix D (November 2004 data)

4.0 ECOLOGICAL EFFECTS ASSESSMENT

The objective of the ecological effects assessment is to present the measures of effect that were evaluated in the FERA. The effects assessment determines the potential for PCBs to adversely affect the assessment endpoint identified for the aquatic ecosystem within Clear Creek (in proximity to the Lemon Lane Landfill site). Both field and laboratory studies are available to describe the effects of PCBs on wildlife. Studies are also available that identify toxicity reference values (TRV). TRVs represent a threshold effect-level of a chemical. An exceedance of the TRV (or threshold level) indicates adverse effects may occur but does not, in itself, indicate that an adverse effect has occurred. Concentrations (or doses) below TRVs are not expected to result in an adverse effect; however, the conclusion is subject to uncertainty including interspecies differences in sensitivity, differences in contaminant bioavailability, and differences between effects observed in a laboratory setting compared to those encountered in the field.

TRVs can be statistically determined from study data and represent whether the severity or occurrence of an effect in a treated group is statistically greater than in an unexposed group. TRVs can be based on no-observed-adverse-effect concentrations (NOAEC), no-observed-adverse-effects-levels (NOAEL), lowest-observed-adverse-effect-concentrations (LOAEC), and lowest-observed-adverse-effect levels (LOAEL).

NOAECs/LOAECs represent threshold values expressed as a concentration in food for dietary exposures. TRVs based on NOAECs and LOAECs were identified for the mink. NOAELs/LOAELs represent daily dose levels normalized for body weight. Dose levels can be used to compare toxicity data across species. As no dietary studies specific to the kingfisher were identified, TRVs based on NOAELs and LOAELs in surrogate species (chicken and dove) were identified for the kingfisher.

NOAELs/NOAECs represent the highest concentration (or dose) that did not result in adverse effects in the test animal. LOAELs/LOAECs represent the lowest concentration (or dose) associated with an adverse effect in the test animal.

A "no-effect" level or "low-effect" level may be selected as a TRV by interpolating an appropriate value from a dose-response curve or exposure-response curve derived from multiple studies. In addition to the NOAEL- and LOAEL-based TRVs identified for the kingfisher, no-effect and low-effect TRVs were identified by EPA. A TRV evaluation was conducted by EPA for a similar site (Neal's Landfill; EPA 2005) and is included in the Attachment.

The tables included in the Attachment present the FERA TRVs considered for the mink and kingfisher. The TRVs selected for the FERA to evaluate PCB exposures to mink and kingfisher through the diet are presented below:

Species	Toxicity Reference Values					
	NOAEC ($\mu g/kg_{diet}$)	LOAEC ($\mu g/kg_{diet}$)	NOAEL ($\mu g/kg_{bw}$-day)	LOAEL ($\mu g/kg_{bw}$-day)	No Effect ($\mu g/kg_{bw}$-day)	Low Effect ($\mu g/kg_{bw}$-day)
Mink	500	600	—	—	—	—
Kingfisher	—	—	110	1,120	400	500

Notes:

For mink, TRVs were based on reproductive effects in mink.
For kingfishers, no effect- and low effect-based TRVs were extrapolated from reproductive effects (egg hatchability) in chickens. NOAEL- and LOAEL-based TRVs were extrapolated from behavioral effects (i.e., parental inattentiveness) in doves.

LOAEC; LOAEL	Lowest-observed-adverse-effect concentration; lowest-observed-adverse-effect level
NOAEC; NOAEL	No-observed-adverse-effect concentration; no-observed-adverse-effect level
$\mu g/kg_{diet}$	Microgram per kilogram in the diet
$\mu g/kg_{bw}$-day	Microgram per kilogram-bodyweight per day
—	Not applicable

The evaluation of toxicity values available for the mink and kingfisher are presented in Sections 4.1 and 4.2, respectively. The evaluation is based on the identification of TRVs for the Neal's Landfill FERA (EPA 2005).

4.1 MINK TOXICITY REFERENCE VALUES

The TRVs selected for the evaluation of PCBs in the mink diet for the FERA are 500 µg/kg based on a NOAEC and 600 µg/kg based on a LOAEC. These values are interpolated from an exposure-response plot for the results of three mink feeding studies in which Aroclor 1254 was added to the diet (Aulerich and Ringer 1977; Kihiström and others 1992; Wren and others 1987a, b; as cited in EPA 2005). The reader is directed to Chapman 2003 (as cited in EPA 2005) for a derivation of the TRV. Critical toxicological endpoints noted in the studies were live kit production and kit body weight. The studies were conducted over a single breeding season. In studies conducted over two breeding seasons with Clophen A50 (a PCB mixture similar to Aroclors)-contaminated prey, increased adverse effects were reported compared to studies conducted over just one breeding season. No mink feeding studies using Aroclors that continued beyond one breeding season were identified. Therefore, the single-breeding season TRVs were adjusted for continuous exposure over multiple breeding seasons/generations. The TRVs were adjusted by multiplying by the mean ratio of the interpolated TRV for the two breeding season/generation-contaminated prey studies to their respective single-breeding season TRV (yielding a mean ratio of 0.52 for live kit production, kit body weight, and kit survival endpoints) (EPA 2005).

ERAs for the Great Lakes Initiative (GLI), Housatonic River, and Hudson River were reviewed during the TRV selection process. The LOAEC-based TRV identified for the GLI (2,000 µg/kg) was much higher than the interpolated value selected for the FERA (600 µg/kg). Exposure at a concentration equivalent to the GLI LOAEC-based TRV resulted in a complete suppression of the reproductive processes, which is not an acceptable endpoint; therefore, the GLI LOAEC-based TRV was not considered appropriate.

PCBs (as Aroclor 1260) were released to the Housatonic River (EPA 2005). Aroclor 1260-based TRVs of 1,600 µg/kg (NOAEC basis) and 3,700 µg/kg (LOAEC basis) were determined from a mink feeding study. According to Westinghouse, Aroclor 1260 was not used in the capacitors disposed of at Lemon Lane Landfill. In addition, Aroclor 1260 is less toxic to mammals than other Aroclors (Tillit and others 1992, as cited in EPA 2005); therefore, the Aroclor 1260-based TRVs were not considered sufficiently protective for exposures at the Lemon Lane Landfill site.

The Hudson River ERA used a LOAEC-based TRV of 250 µg/kg based on the Restum and others (1998) study conducted over two breeding seasons and two generations. The Hudson River TRV is lower than the LOAEC-TRV selected for the FERA (600 µg/kg). However, included in the diet were field-contaminated carp from Saginaw Bay, Michigan. It is unknown whether co-contaminants may have interacted with the PCBs to produce additive or synergistic effects (2-breeding season and 2-generation exposure study), but interpretation of the results on an Aroclor basis is complicated by possible additive or multiplicative effects of co-contaminants other than PCBs.

As is shown in the Attachment, most of the NOAEC-based TRVs identified were lower than the value selected for use in the FERA (500 µg/kg). This value is considered sufficiently protective as the values selected for use in the FERA were interpolated from an exposure-response curve, which has a steep slope between the "no effects" and "severe effects" endpoints. In individual experiments, there is often a wide dose spacing; it is not unusual to have doses increasing by an order of magnitude. With wide dose spacing, it may be possible to miss the dose at which effects begin to be observed (i.e., the threshold-effects level).

4.2 KINGFISHER TOXICITY REFERENCE VALUES

An evaluation of avian PCB TRVs (based on dose) performed by EPA (EPA 2005) are presented in the Attachment. Two suitable sets of values were identified for the selection of a dose-related TRV based on TRVs used in the Neal's Landfill FERA (EPA 2005). As there was an appreciable difference between the sets of values, both sets of TRVs were retained for this FERA. The kingfisher dietary TRVs selected for the FERA are 400 µg/kg$_{BW}$-day for a no-effect and 500 µg/kg$_{BW}$-day for a low-effect (EPA 2005), and a NOAEL-based TRV of 110 µg/kg$_{BW}$-day and LOAEL-based TRV of 1,120 µg/kg$_{BW}$-day (based on the Fox and Green Bay ERAs, as cited in EPA 2005).

The no-effect and low-effect TRVs (400 µg/kg_{BW}-day and 500 µg/kg_{BW}-day, respectively) are interpolated from a dose-response plot for the results of three chicken feeding studies conducted with Aroclor 1248 in the diet (Cecil and others 1974; Lillie and others 1974 and 1975; and Scott 1977; as cited in EPA 2005). The reader is directed to Chapman 2003 (as cited in EPA 2005) for a derivation of the TRV. Critical toxicological endpoints noted in the studies were hatchability. Dietary PCB concentrations in the chicken studies were converted to a dose (bodyweight-normalized concentration) by multiplying the dietary concentrations by the study-specific food ingestion rate or by a default leghorn hen food ingestion rate of 0.067 kg feed/kg_{BW}-day (Medway and Kare 1959, as cited in EPA 1995) if no food ingestion rate was available.

The low-effect-based TRV of 500 µg/kg_{BW}-day is between the avian (pheasant) LOAEL-based TRV (600 µg/kg_{BW}-day) for PCBs (as Aroclor 1254) used in the GLI ERA (Dahlgren and others 1972, as cited in EPA 2005) and the LOAEL-based TRV identified for the Sheboygan River and Harbor ERA (400 µg/kg_{BW}-day), which is based on exposure to field-contaminated feed (Summer and others 1996a, b, as cited in EPA 2005). The NOAEL-based TRVs identified for both of these ERAs are appreciably lower than the no-effect-based TRV of 400 µg/kg_{BW}-day selected for the FERA. The FERA value is considered sufficiently protective as the values selected for use in the FERA were interpolated from an exposure-response curve. Interpolation from an exposure-response aids in the identification of a threshold-effect level, which can be missed in the dose-spacing in laboratory studies.

The NOAEL-based TRV (110 µg/kg_{BW}-day) and LOAEL-based TRV (1,120 µg/kg_{BW}-day) are based on impairment of courtship and nesting behaviors in doves (Peakall and Peakall 1973, Tori and Peterle 1983; as cited in EPA 2005). PCB-exposed doves were inattentive parents, which contributed to a decreased survival of offspring. Birds with impaired courtship behavior are less likely to successfully mate, which affects reproduction. Even though the LOAEL-based TRV is two times higher than the interpolated low-effect-based TRV (500 µg/kg_{BW}-day) selected for the FERA, the NOAEL-based TRV is appreciably lower than the no-effect-based interpolated TRV (400 µg/kg_{BW}-day).

The remaining TRVs presented in the Attachment are very high values identified in the Hudson River ERA. These values are up to 10 times greater than the TRVs identified by GLI using the same study due to a difference in toxicological endpoints. Egg production was the critical effect for the Hudson River ERA, while hatchability was identified as the critical effect for the GLI ERA. Also, the Hudson River ERA did not incorporate any modifying factors, while the GLI ERA adjusted the TRVs by a factor of 3. A decline in egg production was not identified as a critical effect for the FERA because studies with chicken, a sensitive species to PCBs, do not exhibit a clear dose response relationship between PCB exposure and a change in egg production (Chapman 2003, as cited in EPA 2005).

4.3 CALCULATION OF HAZARD QUOTIENTS

Potential risks to piscivorous receptors were assessed by a chemical-specific comparison of maximum estimated concentrations (mink) or daily doses (kingfisher). This comparison is expressed as a hazard quotient (HQ). HQs were calculated for each sampling station representing a "reach" of Clear Creek.

For the mink, dietary concentrations were compared to the TRV, and the HQ is expressed as:

$$\mathbf{HQ = C_{diet} / TRV}$$

where,

HQ = Hazard quotient for mink
C_{diet} = Concentration of PCBs in the mink diet
TRV = Toxicity reference value for mink

For the kingfisher, the HQ was calculated in a similar fashion; however, a PCB concentration expressed as a daily dose was substituted for the C_{diet} term in the equation.

A calculated HQ exceeding 1 (i.e., HQ > 1) may indicate that the receptor is at risk of an adverse effect from exposure to PCBs in the diet. HQs were calculated for the RME and CTE scenarios (see Tables B-1 and B-2 of Appendix B; Tables C-1, C-2, C-5, and C-6 of Appendix C; and Tables D-1 and D-2 of Appendix D).

If a NOAEC/NOAEL/no-effect-based TRV is used to calculate the HQ, then an HQ less than 1 indicates that adverse effects would not be expected. For LOAEC/LOAEL/low-effect-based TRVs, an HQ of 1 or more indicates that adverse effects are expected (i.e, the concentration in the diet/dose is greater than a concentration associated with adverse effects). An area of uncertainty exists between the concentration associated with no-adverse-effects and the concentration known to produce adverse effects. Within that area of uncertainty is the threshold effect-level.

4.4 PERCENT ALLOWABLE CONCENTRATION

To address uncertainty in the exposure assumptions for the mink and kingfisher, an additional approach is used as part of the risk characterization. A percent allowable consumption (PAC) for each station was calculated, which represents the percent of the diet an animal can consume within a station area without exceeding the TRV. This approach is modified from the percent allowable daily intake (PADI) approach of Giesy and others (1994). Giesy and others (1994) gives the following equation for PADI:

$$\mathbf{PADI = ((NOAED / C_{fish}) / CR) \times 100} \qquad [1]$$

where,

NOAED	= No-observed-adverse-effects dose
C_{fish}	= PCB concentration in diet (fish and crayfish)
CR	= Food consumption rate

and if, **NOAED = dietary NOAEC x CR**

then equation 1 simplifies to:

$$\mathbf{PAC = (TRV / C_{diet}) \times 100} \qquad [2]$$

Since, $\mathbf{HQ = C_{diet} / TRV}$ and $\mathbf{1 / HQ = TRV / C_{diet}}$

then $$\mathbf{PAC = (1 / HQ) \times 100} \qquad [3]$$

PADI/PAC estimates the percent of an animal's diet that can be consumed from a contaminated source without exceeding the threshold for toxic effects. Equation 3 estimates the percent diet an animal can consume from a contaminated source without exceeding toxic levels assuming that the remainder of the diet has zero contamination. As PCBs are ubiquitous contaminants in the environment, it may be unreasonable to assume that PCBs will not be present in other components of the diet.

Equation 3 above can be modified to account for the contribution of ambient or background levels of PCBs by subtracting out the HQ contributed by background or off-site concentrations of PCBs ($HQ_{off\text{-}site}$). Equation 3 then becomes:

$$\mathbf{PAC = ((1 - HQ_{off\text{-}site}) / HQ_{site}) \times 100} \qquad [4]$$

No background or reference area sample data are available for use in the FERA for Clear Creek. Therefore, Equation 3 was used to calculate the PAC for the FERA. PACs based on RME and CTE PCB concentrations in the diet (or dose) for data collected during November 2000, 2002, and 2004, are presented in Tables B-3 and B-4 of Appendix B; Tables C-3, C-4, C-7, and C-8 of Appendix C; and Tables D-3 and D-4 of Appendix D.

5.0 RISK CHARACTERIZATION RESULTS

This section summarizes the findings of the risk calculations to form conclusions about potential risks posed to the assessment endpoints (piscivorous mammals and birds) identified for the Lemon Lane Landfill study areas (i.e., Clear Creek) in the problem formulation phase.

Risk characterization is the integration of exposure and effects data to determine the likelihood of adverse effects. For the FERA, the HQ (or toxicity quotient) method was used to characterize risk from PCBs (also expressed at toxic equivalency quotients [TEQ] for the November 2004 data; see Appendix E). In addition, a PAC was calculated.

HQs were calculated for both the RME and CTE scenarios (see Tables 5 through 10). For the RME scenario, risks were estimated using RME PCB concentrations in fish; for the CTE scenario, risks were estimated using the CTE PCB concentration in fish. For all of the stations, the CTE HQs were approximately 25 to 30 percent less than those calculated for the RME scenario (see Tables 5, 6, 8, and 9).

HQs were also calculated for the mink and kingfisher using the PCB-congener specific data from the November 2004 sampling event (see Tables 7 and 10, respectively; see also Appendix E).

For the November 2002 data, HQs were also calculated using the 4-peak and 5-peak PCB analysis. For Stations 1 through 3, the 5-peak analysis resulted in HQs that are approximately 6 to 15 percent less than those estimated using the 4-peak analysis. For Station 4, the 5-peak analysis resulted in HQs that were 3 percent greater for the RME scenario (95UCL-based) and 3 percent less for the CTE scenario (mean-based). The differences in PCB concentrations between the 4-peak and 5-peak analysis did not change the risk conclusions. As the remaining data was only analyzed by the 4-peak method, the risk characterization discussion focuses on the 4-peak data. HQs calculated using the 5-peak data are presented for comparison.

TABLE 5

MINK HAZARD QUOTIENTS FOR THE RME SCENARIO—TOTAL PCB-BASED LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	November 2000		November 2002				November 2004	
	4-Peak Analysis		4-Peak Analysis		5-Peak Analysis			
	No Effect	Low Effect	No Effect	Low Effect	No Effect	Low Effect	No Effect	Low Effect
Station 1	—	—	16	13	14	12	4	3
Station 2	3	2	2	2	2	1	3	3
Station 3	3	2	2	1	1	1	2	2
Station 4	4	3	4	3	4	3	4	3

Notes:

Hazard quotients greater than 1 are shown to one significant digit. See also Appendices B, C, and D.

Station — Fish sample collection station (see Figure 3)
1 Allen Street
2 Country Club Road
3 Fluckmill Road
4 Strainridge Road

HQ — Hazard quotient; where HQ = RME concentration of PCBs in mink diet/TRV. For a no-effect-based HQ, an HQ less than 1 indicates that no adverse effect would be expected. For a low-effect-based HQ, an HQ equal to or greater than 1 indicates the potential for adverse effects. An area of uncertainty exists between the concentration associated with no adverse effects and the concentration known to produce adverse effects.

RME — Reasonable maximum exposure; HQs were calculated using the 95th-percent upper confidence limit for PCB concentration in fish.

PCB — Polychlorinated biphenyl

TRV — Toxicity reference value; no-effect-based-TRV = 500 µg/kg and low-effect-based TRV = 600 µg/kg.

µg/kg — Microgram per kilogram

— — Not applicable; no fish samples were collected at Station 1 during the November 2000 fish sampling event.

TABLE 6

MINK HAZARD QUOTIENTS FOR THE CTE SCENARIO—TOTAL PCB-BASED LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	November 2000		November 2002				November 2004	
	4-Peak Analysis		4-Peak Analysis		5-Peak Analysis			
	No Effect	Low Effect	No Effect	Low Effect	No Effect	Low Effect	No Effect	Low Effect
Station 1	—	—	12	10	10	9	3	2
Station 2	2	2	1	1	1	1	2	2
Station 3	2	2	1	1	1	0.9	2	1
Station 4	3	2	3	2	3	2	3	2

Notes:

Hazard quotients greater than 1 are shown to one significant digit. See also Appendices B, C, and D.

Station Fish sample collection station (see Figure 3)
1 Allen Street
2 Country Club Road
3 Fluckmill Road
4 Strainridge Road

CTE Central tendency exposure; HQs were calculated using the mean PCB concentration in fish.
HQ Hazard quotient; where HQ = CTE concentration of PCBs in mink diet/TRV. For a no-effect-based HQ, an HQ less than 1 indicates that no adverse effect would be expected. For a low-effect-based HQ, an HQ equal to or greater than 1 indicates the potential for adverse effects. An area of uncertainty exists between the concentration associated with no adverse effects and the concentration known to produce adverse effects.
PCB Polychlorinated biphenyl
TRV Toxicity reference value; no-effect based-TRV = 500 µg/kg and low-effect-based TRV = 600 µg/kg.
µg/kg Microgram per kilogram
— Not applicable; no fish samples were collected at Station 1 during the November 2000 fish sampling event.

TABLE 7

MINK HAZARD QUOTIENTS—TEQ-BASED
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	November 2004	
	NOAEC	LOAEC
Station 1	19	5
Station 2	5	1
Station 3	4	0.9
Station 4	4	1

Notes:

Hazard quotients greater than 1 are shown to one significant digit. See also Appendix E.

Station Fish sample collection station (see Figure 3)
1 Allen Street
2 Country Club Road
3 Fluckmill Road
4 Strainridge Road

HQ Hazard quotient; where HQ = Concentration of TEQs in mink diet/TRV. For a NOAEC-based HQ, an HQ less than 1 indicates that no adverse effect would be expected. For a LOAEC-based HQ, an HQ equal to or greater than 1 indicates the potential for adverse effects. An area of uncertainty exists between the concentration associated with no adverse effects and the concentration known to produce adverse effects.
LOAEC Lowest-observed-adverse-effect concentration
NOAEC No-observed-adverse-effect concentration
pg/g Picogram per gram
TEQ Toxic equivalency quotient
TRV Toxicity reference value; NOAEC-based TRV = 4.6 pg/g and LOAEC-based TRV = 18 pg/g.

TABLE 8

KINGFISHER HAZARD QUOTIENTS FOR THE RME SCENARIO—TOTAL PCB-BASED
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	November 2000				November 2002								November 2004			
	4-Peak Analysis				4-Peak Analysis				5-Peak Analysis							
	No-Effect	NOAEL	Low-Effect	LOAEL	No-Effect	NOAEL	Low-Effect	LOAEL	No-Effect	NOAEL	Low-Effect	LOAEL	No-Effect	NOAEL	Low-Effect	LOAEL
Station 1	—	—	—	—	12	45	10	4	11	38	8	4	3	11	2	1
Station 2	2	8	2	0.8	1	5	1	0.5	1	5	1	0.5	2	9	2	0.8
Station 3	2	7	2	0.7	1	5	1	0.5	1	4	0.9	0.4	2	7	2	0.7
Station 4	3	10	2	1	3	11	3	1	3	12	3	1	3	10	2	1

Notes:

Hazard quotients greater than 1 are shown to one significant digit. See also Appendices B, C, and D.

Station — Fish sample collection station (see Figure 3)
1 Allen Street
2 Country Club Road
3 Fluckmill Road
4 Strainridge Road

HQ — Hazard quotient; where HQ = RME concentration of PCBs in kingfisher diet (on a dose-basis) / TRV. For a no-effect/NOAEL-based HQ, an HQ greater than 1 indicates that no adverse effect would be expected. For a low-effect/LOAEL-based HQ, and HQ greater than 1 indicates the potential for adverse effects. An area of uncertainty exists between the concentration associated with no adverse effect and the concentration known to produce adverse effects.
RME — Reasonable maximum exposure; HQs were calculated using the RME PCB concentration (95th percent upper confidence limit or maximum detected concentration) in fish.
LOAEL — Lowest-observed-adverse-effect level
NOAEL — No-observed-adverse-effect level
PCB — Polychlorinated biphenyl
TRV — Toxicity reference value; no-effect-based TRV = 400 µg/kg-day and low-effect-based TRV = 500 µg/kg-day; NOAEL-based TRV = 110 µg/kg-day and LOAEL-based TRV = 1,120 µg/kg-day.
µg/kg-day — Microgram per kilogram per day
— — No applicable; no fish samples were collected at Station 1 during the November 2000 fish sampling event.

TABLE 9

KINGFISHER HAZARD QUOTIENTS FOR THE CTE SCENARIO—TOTAL PCB-BASED
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

	November 2000				November 2002								November 2004			
	4-Peak Analysis				4-Peak Analysis				5-Peak Analysis							
Station	**No-Effect**	**NOAEL**	**Low-Effect**	**LOAEL**	**No-Effect**	**NOAEL**	**Low-Effect**	**LOAEL**	**No-Effect**	**NOAEL**	**Low-Effect**	**LOAEL**	**No-Effect**	**NOAEL**	**Low-Effect**	**LOAEL**
Station 1	—	—	—	—	9	33	7	3	8	29	6	3	2	7	2	0.7
Station 2	2	7	1	0.7	1	4	0.9	0.4	1	4	0.8	0.4	2	7	1	0.7
Station 3	1	5	1	0.5	1	4	0.8	0.4	0.8	3	0.7	0.3	1	5	1	0.5
Station 4	2	8	2	0.7	2	8	2	0.8	2	8	2	0.8	2	7	2	0.7

Notes:

Hazard quotients are shown to one significant digit. See also Appendices B and C.

Station — Fish sample collection station (see Figure 3)
1 Allen Street
2 Country Club Road
3 Fluckmill Road
4 Strainridge Road

CTE — Central tendency exposure; HQs were calculated using the mean PCB concentration in fish.
HQ — Hazard quotient; where HQ = CTE concentration of PCBs in kingfisher diet (on a dose-basis) / TRV. For a no-effect/NOAEL-based HQ, an HQ greater than 1 indicates that no adverse effect would be expected. For a low-effect/LOAEL-based HQ, and HQ greater than 1 indicates the potential for adverse effects. An area of uncertainty exists between the concentration associated with no adverse effect and the concentration known to produce adverse effects.
LOAEL — Lowest-observed-adverse-effect level
NOAEL — No-observed-adverse-effect level
PCB — Polychlorinated biphenyl
TRV — Toxicity reference value; no-effect-based TRV = 400 µg/kg-day and low-effect-based TRV = 500 µg/kg-day; NOAEL-based TRV = 110 µg/kg-day and LOAEL-based TRV = 1,120 µg/kg-day.
µg/kg-day — Microgram per kilogram per day
— — No applicable; no fish samples were collected at Station 1 during the November 2000 fish sampling event.

TABLE 10

KINGFISHER HAZARD QUOTIENTS—TEQ-BASED
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Egg-based				Dose-based	
	NOAEC-low	NOAEC-high	LOAEC-low	LOAEC-high	NOAEL	LOAEL
Station 1	106	11	36	3	40	4
Station 2	20	2	7	0.5	9	0.9
Station 3	21	2	7	0.5	7	0.7
Station 4	18	2	6	0.5	9	0.9

Notes:

Hazard quotients greater than 1 are shown to one significant digit. See also Appendix E.

Station — Fish sample collection station (see Figure 3)
1 Allen Street
2 Country Club Road
3 Fluckmill Road
4 Strainridge Road

HQ — Hazard quotient; where HQ = Concentration of TEQs in kingfisher eggs or kingfisher diet/ TRV. For a NOAEC- or NOAEL-based HQ, an HQ less than 1 indicates that no adverse effect would be expected. For a LOAEC- or LOAEL-based HQ, an HQ equal to or greater than 1 indicates the potential for adverse effects. An area of uncertainty exists between the concentration associated with no adverse effects and the concentration known to produce adverse effects.
LOAEC — Lowest-observed-adverse-effect concentration
NOAEC — No-observed-adverse-effect concentration
pg/g-day — Picogram per gram per day
TEQ — Toxic equivalency quotient
TRV — Toxicity reference value; NOAEC-low-based TRV = 1.8 : g/kg lipid and NOAEC-high-based TRV = 17 : g/kg lipid; LOAEC-low based TRV = 5.3 : g/kg lipid and LOAEC-high-based TRV = 68 : g/kg lipid. The NOAEL-based TRV = 1.4 pg/g-day and the LOAEL-based TRV = 14 pg/g-day.
: g/kg lipid — Microgram per kilogram lipid

5.1 MINK HAZARD QUOTIENTS: STATIONS 1 THROUGH 4

HQs for Stations 1 through 4 are discussed in the following sections.

5.1.1 Station 1

Fish samples were collected at Station 1 during the November 2002 and 2004 fish sampling events. Station 1 is located at Allen Street, approximately 1.5 miles from Lemon Lane Landfill (see Figure 3). No samples were collected at Station 1 during the November 2000 sampling activities.

Hazard Quotients Estimated Using Total PCB Concentration Data

Both the November 2002 and November 2004 no-effect-based and low-effect-based mink HQs were greater than 1 for both the RME and CTE scenarios (see Tables 5 and 6). HQs estimated using the November 2004 data were lower than the HQs calculated for November 2002. In November 2002, the RME mink HQs ranged from 13 (low-effect-based) to 16 (no-effect-based) (see Table 5); the CTE mink HQs ranged from 10 (low-effect-based) to 12 (no-effect-based) (see Table 6).

Based on the November 2004 data, mink HQs for Station 1 appear to have decreased (approximately 75 percent lower). The RME mink HQs ranged from 3 (low-effect-based) to 4 (no-effect-based) (see Table 5); the CTE mink HQs ranged from 2 (low-effect-based) to 3 (no-effect-based). Although decreased, the HQs for Station 1 were still greater than 1.

As both the no-effect- and low-effect based HQs are greater than 1, the potential for adverse effects exists for mink with a home range within the Station 1 reach, based on total PCB data.

Hazard Quotients Estimated Using Calculated TEQ Data

HQs were also estimated for Station 1 using the TEQ concentrations calculated from the November 2004 fish data (see Table 7 and also Appendix E). The HQs estimated using the TEQ approach were greater than the HQs calculated based on total PCB data for November 2004 (see Tables 5 through 7). Both the NOAEC- and LOAEC-based HQs were greater than 1. The NOAEC-based HQ was calculated at 19 and the LOAEC-based HQ was calculated at 5. As the LOAEC-based mink HQ exceeds 1, the potential for adverse effects exists for mink with a home range within the Station 1 reach, based on calculated TEQ concentrations.

5.1.2 Station 2

Mink HQs estimated for Station 2 are discussed below. Station 2 is located at Country Club Road, approximately 3 miles from the Lemon Lane Landfill site (see Figure 3).

Hazard Quotients Estimated Using Total PCB Concentration Data

Mink HQs were decreased downstream at Station 2 as compared to the mink HQs estimated for Station 1 (see Tables 5 and 6). This decrease marked for the November 2002 data; only a slight decrease was observed for the November 2004 data. Across the three sampling periods, the HQs were reasonably consistent at Station 2, ranging from 1 to 3 for both the no-effect-based and low-effect based RME HQs. The RME results for the November 2004 data do not differ appreciably from the November 2000 or 2002 results. For the RME scenario, as the low-effect-based mink HQ for the November 2004 data (HQ of 3) exceeds 1, the potential for adverse effects exists for mink with a home range within the Station 2 reach.

For the CTE scenario, both the low-effect- and no-effect-based mink HQs were estimated at 2 for the November 2004 data, which exceeds the threshold of 1. The CTE results for the November 2004 data are greater than the November 2002 results (HQ of 2 versus HQ of 1; see Table 6). For the CTE scenario, as both the no-effect- and low-effect-based mink HQs are greater than 1, the potential for adverse effects exists for mink with a home range within the Station 2 reach.

Hazard Quotients Estimated Using Calculated TEQ Data

HQs were also estimated for Station 2 using the TEQ concentrations calculated from the November 2004 fish data (see Table 7). The NOAEC-based HQs estimated using the TEQ approach were greater than the no-effect based HQs calculated based on total PCB data (see Tables 5 through 7). The NOAEC-based HQ of 5 was greater than the threshold of 1; the LOAEC-based HQ was equivalent to the threshold value of 1, which indicates that exposure is equal to levels shown to cause an adverse effect. The TEQ-based HQs at Station 2 were consistent with the TEQ-based HQs estimated for Stations 3 and 4 (see Table 7).

5.1.3 Station 3

Mink HQs estimated for Station 3 are discussed below. Station 3 is located at Fluckmill Road, approximately 10 miles from the Lemon Lane Landfill site (see Figure 3).

Hazard Quotients Estimated Using Total PCB Concentration Data

Mink HQs were decreased downstream at Station 3 as compared to the mink HQs estimated for Station 1 and similar to those estimated at Station 2 (see Tables 5 and 6). For the RME scenario, both the no-effect- and low-effect-based mink HQs were estimated at 2, which is greater than the threshold of 1. The RME results for the November 2004 data are consistent with the November 2000 and 2002 data (HQ range from 1 to 3). For the RME scenario, as the low-effect-based mink HQ is greater than 1, the potential for adverse effects exists for mink with a home range within the Station 3 reach.

For the CTE scenario, the no-effect-based mink HQ was estimated at 2; the low-effect-based mink HQ was estimated at 1, which indicates that exposure is equal to levels shown to cause an adverse effect.

The CTE results for the November 2004 data are within the range of results estimated for the November 2000 and 2002 data (HQ range of 0.9 to 2; see Table 6). For the CTE scenario, as the low-effect-based mink HQ is equivalent to 1, the potential for adverse effects exists for mink with a home range within the Station 3 reach.

Hazard Quotients Estimated Using Calculated TEQ Data

HQs were also estimated for Station 3 using the TEQ concentrations calculated from the November 2004 fish data (see Table 7). The NOAEC-based HQs estimated using the TEQ approach were greater than the no-effect based HQs estimated based on total PCB data (see Tables 5 through 7). The NOAEC-based HQ of 4 was greater than the threshold of 1; the LOAEC-based HQ was estimated at 0.9, which is below the threshold of 1. Based on the calculated TEQ data, as the LOAEC-based HQ is below the threshold of 1, the potential for adverse effects is low (concentrations are below those shown to produce an adverse effect) for a mink with a home range within the Station 3 reach. The TEQ-based HQs at Station 3 were generally consistent with the TEQ-based HQs estimated for Stations 2 and 4 (see Table 7).

5.1.4 Station 4

Mink HQs estimated for Station 4 are discussed below. Station 4 is located at Strainridge Road, approximately 20 miles from the Lemon Lane Landfill site (see Figure 3).

Hazard Quotients Estimated Using Total PCB Concentration Data

RME and CTE mink HQs at Station 4 were consistent with the HQs observed at Stations 1, 2, and 3 (HQs range from 3 to 4 for RME and 2 to 3 for CTE; see Tables 5 and 6) for the November 2004 data and also consistent across the 2000 and 2002 sampling periods. For the RME scenario, the low-effect-based mink HQ was estimated at 3, which exceeds the threshold value of 1. The RME no-effect-based mink HQ was estimated at 4, which also exceeds the threshold value of 1. The RME results for the November 2004 data do not differ from the November 2000 or 2002 results (see Table 5). For the RME scenario, as both the low-effect-and no-effect-based mink HQs are greater than 1, there is a potential for adverse effects for mink with a home range within the Station 4 reach.

For the CTE scenario, both the low-effect-based and no-effect-based mink HQs exceeded the threshold value of 1. The CTE results for the November 2004 data are equivalent to the November 2000 and 2002 results (see Table 6). For the CTE scenario, the no-effect-based mink HQ is estimated at 3, with a low-effect-based HQ estimated at 2. Both of these values exceed the threshold of 1; therefore, the potential for adverse effects exists for mink with a home range within the Station 4 reach.

Hazard Quotients Estimated Using Calculated TEQ Data

HQs were also estimated for Station 4 using the TEQ concentrations calculated from the November 2004 fish data (see Table 7). The NOAEC-based HQs estimated using the TEQ approach was consistent with the RME no-effect based HQs estimated based on total PCB data (see Tables 5 and 7). The NOAEC-based HQ of 4 was greater than the threshold of 1; the LOAEC-based HQ was estimated at 1, which indicates that exposure is equal to levels shown to cause an adverse effect. Based on the TEQ data, the potential for adverse effects exists for a mink with a home range within the Station 4 reach. The TEQ-based HQs at Station 4 were consistent with the TEQ-based HQs estimated for Stations 2 and 3 (see Table 7).

5.2 KINGFISHER HAZARD QUOTIENTS: STATIONS 1 THROUGH 4

Kingfisher HQs for Stations 1 through 4 are discussed in the following sections.

5.2.1 Station 1

Kingfisher HQs estimated for Station 1 are discussed below. Station 1 is located at Allen Street, approximately 1.5 miles from the Lemon Lane Landfill site (see Figure 3).

Hazard Quotients Estimated Using Total PCB Concentration Data

Both the no-effect- and low-effect-based kingfisher HQs were greater than 1 for both the RME and CTE scenarios (see Tables 8 and 9). For the November 2004 RME scenario, kingfisher HQs estimated using low-effect- or LOAEL-based TRVs ranged from 1 to 2 (see Table 8). RME HQs estimated for the November 2004 data using no-effect- or NOAEL-based TRVs were 3 and 11, respectively. The no-effect- and NOAEL-based CTE HQs were lower than the RME results at 2 and 7, respectively (see Table 9); the LOAEL-based HQ of 0.7 for the CTE scenario was below the threshold value of 1. For the RME and CTE scenarios, as both the low-effect-, no-effect-, and NOAEL-based HQs were greater than 1, there is a potential for adverse effects for kingfisher with a home range within the Station 4 reach. Kingfisher HQs were decreased for the November 2004 data as compared to the November 2002 data by approximately 65 to 75 percent (see Tables 8 and 9).

Egg-Based Hazard Quotients Estimated Using Calculated TEQ Concentrations

HQs were also estimated for Station 1 using the TEQ concentrations calculated from the November 2004 fish data (see Table 10). The NOAEC-low- and NOAEC-high-based HQs for kingfisher eggs were 106 and 11, respectively (see Table 10); the LOAEC-low- and LOAEC-high-based HQs for kingfisher eggs were 36 and 3, respectively. As both the NOAEC- and LOAEC-based HQs exceed the threshold of 1, there is a potential for adverse effects for kingfisher (mortality, deformities, reduced growth) within the Station 1 reach.

Dose-Based Hazard Quotients Estimated Using Calculated TEQ Concentrations

The dose-based HQs for the kingfisher, which were estimated using the TEQs calculated from the November 2004 fish data, were also greater than 1. The kingfisher HQs estimated from TEQ concentrations were greater than those estimated using the total PCB data (see Tables 8 through 10). A NOAEL-based HQ of 40 and LOAEL-based HQ of 4 were estimated for the November 2004 data. As both the NOAEL-based and LOAEL-based HQs exceed the threshold of 1, there is a potential for adverse effects for kingfisher with a home range within the Station 1 reach..

5.2.2 Station 2

Kingfisher HQs estimated for Station 2 are discussed below. Station 2 is located at Country Club Road, approximately 3 miles from the Lemon Lane Landfill site (see Figure 3).

Hazard Quotients Estimated Using Total PCB Concentration Data

Kingfisher HQs were relatively consistent at Station 2 (and the other downstream Stations) compared to the kingfisher HQs estimated for Station 1 (see Tables 8 and 9). The no-effect- and NOAEL-based RME HQs exceeded the threshold of 1 at values of 2 and 9, respectively, which exceeds the threshold of 1. The low-effect-based HQ was equal to 2, which exceed the threshold of 1; however the LOAEL-based HQ was below the threshold value of 1 (HQ of 0.8). As the no-effect-, NOAEL-, and low-effect-based HQs exceed the threshold of 1, the potential for adverse effects exists for kingfisher with a home range within the Station 2 reach.

For the November 2004 CTE scenario, the no-effect- and NOAEL-based HQs ranged from 2 to 7 (see Table 9), which exceed the threshold of 1. The low-effect-based HQ was estimated at 1, which indicates the concentration is equal to levels shown to cause an adverse effect; the LOAEL-based HQ was estimated at 0.7, which is below the threshold value of 1 (see Table 9). For the CTE scenario, as the no-effect-, NOAEL- and low-effect-based HQs exceed or are equivalent to the threshold of 1, the potential for adverse effects exists for kingfisher with a home range within the Station 2 reach.

Egg-Based Hazard Quotients Estimated Using Calculated TEQ Concentrations

HQs were also estimated for Station 2 using the TEQ concentrations calculated from the November 2004 fish data (see Table 10). The NOAEC-low- and NOAEC-high-based HQs for kingfisher eggs were 20 and 2, respectively (see Table 10); the LOAEC-low- and LOAEC-high-based HQs for kingfisher eggs were 7 and 0.5, respectively. As the NOAEC-low, NOAEC-high and LOAEC-low-based HQs exceed the threshold of 1, the potential for adverse exists for kingfisher (mortality, deformities, reduced growth) within the Station 2 reach.

Dose-Based Hazard Quotients Estimated Using Calculated TEQ Concentrations

The NOAEL-based HQ for the kingfisher, which was estimated using TEQ data, was also greater than 1 at 9. The LOAEL-based HQ was estimated at 0.9, which is below the threshold value of 1. As the LOAEL-based HQ is below the threshold of 1, the potential for adverse effects is low (concentrations are below those shown to produce an adverse effect) for a kingfisher with a home range within the Station 2 reach.

5.2.3 Station 3

Kingfisher HQs estimated for Station 3 are discussed below. Station 3 is located at Fluckmill Road, approximately 10 miles from the Lemon Lane Landfill site (see Figure 3).

Hazard Quotients Estimated Using Total PCB Concentration Data

Kingfisher HQs were decreased downstream at Station 3 as compared to the kingfisher HQs estimated for Station 1, but were not appreciably different from the HQs estimated at Station 2 (see Tables 8 and 9). For the RME scenario, the no-effect-, NOAEL-, and low-effect-based HQs exceeded the threshold of 1, ranging from 2 to 7. The RME LOAEL-based HQ was below the threshold value of 1 (HQ = 0.7). For the RME scenario, as the no-effect-, NOAEL-, and low-effect-based HQs exceed the threshold of 1, the potential for adverse effects exists for kingfisher with a home range within the Station 3 reach.

For the CTE scenario, the no-effect- and NOAEL-based HQs ranged from 1 to 5 (see Table 9). The low-effect-based HQ was estimated at 1, which indicates that exposure is equal to levels shown to cause an adverse effect; the LOAEL-based HQ was estimated at 0.5, which is below the threshold value of 1.

For the CTE scenario, as the NOAEL- and low-effect-based HQs exceed, or are equivalent to, the threshold value of 1, the potential for adverse effects exists for kingfisher with a home range within the Station 3 reach.

Egg-Based Hazard Quotients Estimated Using Calculated TEQ Concentrations

HQs were also estimated for Station 3 using the TEQ concentrations calculated from the November 2004 fish data (see Table 10). The NOAEC-low- and NOAEC-high-based HQs for kingfisher eggs were 21 and 2, respectively (see Table 10); the LOAEC-low- and LOAEC-high-based HQs for eggs were 7 and 0.5, respectively. As the NOAEC-low, NOAEC-high and LOAEC-low-based HQs exceed the threshold of 1, there is a potential for adverse effects for piscivorous birds (mortality, deformities, reduced growth) within the Station 3 reach.

Dose-Based Hazard Quotients Estimated Using Calculated TEQ Concentrations

The NOAEL-based HQ for the kingfisher, which was estimated using the November 2004 TEQ data, was also greater than 1 (HQ = 7; see Table 10). The LOAEL-based HQ was estimated at 0.7, which is below the threshold value. As the LOAEL-based HQ is below the threshold of 1, the potential for adverse effects is low (concentrations are below those shown to produce an adverse effect) for a kingfisher with a home range within the Station 3 reach.

5.2.4 Station 4

Kingfisher HQs estimated for Station 4 (November 2002) are discussed below. Station 4 is located at Strainridge Road, approximately 20 miles from the Lemon Lane Landfill site (see Figure 3).

Hazard Quotients Estimated Using Total PCB Concentration Data

HQs were increased slightly at Station 4 as compared to the HQs estimated for Stations 2 and 3, but were generally consistent with the values generated across all four sampling stations for the November 2004 data (see Tables 8 and 9). For the RME scenario, the LOAEL- and low-effect-based HQs were 1 and 2, respectively; the low-effect-based HQ exceeds the threshold value of 1 and the LOAEL-based HQ is equivalent to levels that may cause an adverse effect. The RME no-effect- and NOAEL-based HQs were 3 and 10, respectively; both of which exceeded the threshold value of 1. For the RME scenario, as the LOAEL-based HQ is equivalent to the threshold of 1 and the low-effect-based HQ exceeds the threshold (HQ = 2), the potential for adverse effects exists for kingfisher with a home range within the Station 4 reach.

For the CTE scenario, the LOAEL- and low-effect-based HQs were estimated at 0.7 and 2, respectively. The LOAEL-based HQ is below the threshold value of 1; however, the low-effect based HQ exceeds the threshold value of 1 (HQ = 2), which indicates that the concentration is equivalent to levels that may cause an adverse effect. The no-effect- and NOAEL-based HQs were estimated at 2 and 7, respectively (see Table 9). For the CTE scenario, as the no-effect-, NOAEL-, and low-effect-based HQs exceed the threshold of 1, the potential for adverse effects exists for kingfisher with a home range within the Station 4 reach.

Egg-Based Hazard Quotients Estimated Using Calculated TEQ Concentrations

HQs were also estimated for Station 4 using the TEQ concentrations calculated from the November 2004 fish data (see Table 10). The NOAEC-low- and NOAEC-high-based HQs for eggs were 18 and 2, respectively (see Table 10); the LOAEC-low- and LOAEC-high-based HQs for eggs were 6 and 0.5, respectively. As the NOAEC-low-, NOAEC-high- and LOAEC-low-based HQs exceed the threshold of 1, the potential for adverse effects for piscivorous birds (mortality, deformities, reduced growth) exists within the Station 4 reach.

Dose-Based Hazard Quotients Estimated Using Calculated TEQ Concentrations

The NOAEL-based HQ for the kingfisher, which was estimated using TEQ data, was also greater than 1 at 9. The LOAEL-based HQ was estimated at 0.9, which is below the threshold value. As the LOAEL-based HQ is below the threshold of 1, the potential for adverse effects is low (concentrations are below those shown to produce an adverse effect) for a kingfisher with a home range within the Station 4 reach.

5.3 PERCENT ALLOWABLE CONSUMPTION

The PAC results calculated using total PCB data are summarized in Table 11 for the RME scenario and Table 12 for the CTE scenario.; PAC results calculated using TEQ concentrations are summarized in Table 13. PACs for the November 2004 data are discussed in the following sections as the November 2004 data provides the most recent "snapshot" in time regarding conditions at Clear Creek. PACs for the November 2000 and 2002 data are provided in Tables 11 and 12.

5.3.1 Station 1: Percent Allowable Consumption Based on Total PCBs Data

The Station 1 PAC assumes that the only exposure mink or kingfisher have to PCBs released from Lemon Lane Landfill is through consumption of Clear Creek fish and crayfish. The PAC values therefore, represent the percentage of the mink or kingfisher diet taken from Station 1 that would result in a NOAEC- or LOAEC-based HQ of 1. A NOAEC-based HQ of 1 is not associated with adverse effects, however a LOAEC-based HQ of 1 indicates that the exposure is equivalent to the lowest concentration associated with potential adverse effects.

Using the November 2004 data, the Station 1 NOAEC-based PAC for mink is estimated at 27 percent for the RME scenario to 38 percent for the CTE scenario (see Tables 11 and 12). These values show an increase in the PAC for this reach compared to PACs estimated using the November 2002 data (see Tables 11 and 12). The mink LOAEC-based PAC ranges from 32 percent for the RME scenario to 46 percent for the CTE scenario (see Tables 11 and 12). The results indicate that, to stay within the no-effect dietary concentrations, mink should forage along the Station 1 reach for no more than 25 percent of the total diet, and that potentially adverse effects are possible if greater than approximately 38 percent of the total diet comes from the Station 1 reach.

TABLE 11

PERCENT ALLOWABLE CONSUMPTION FOR THE RME SCENARIO—TOTAL PCB-BASED
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

	November 2000						November 2002						November 2004					
	Mink		Kingfisher				Mink		Kingfisher				Mink		Kingfisher			
Station	NOAEC	LOAEC	No Effect	NOAEL	Low Effect	LOAEL	NOAEC	LOAEC	No Effect	NOAEL	Low Effect	LOAEL	NOAEC	LOAEC	No Effect	NOAEL	Low Effect	LOAEL
Station 1	—	—	—	—	—	—	6	7	8	2	10	23	27	32	34	9	43	96
Station 2	34	41	45	12	56	125	52	62	68	19	86	192	33	39	42	12	53	119
Station 3	39	46	51	14	63	142	59	71	77	21	96	216	41	49	53	15	67	149
Station 4	28.00	33	36	10	46	102	24	29	32	9	40	89	28	34	36	10	45	100

Notes:

PAC represents the percent diet an animal can consume within a station area reach without exceeding the TRV, where PAC = (1 / HQ) x 100.

Station — Fish sample collection station (see Figure 3)
1 Allen Street
2 Country Club Road
3 Fluckmill Road
4 Strainridge Road

HQ — Hazard quotient; where mink HQ = concentration in mink diet / TRV and kingfisher HQ = concentration in kingfisher dose / TRV
LOAEC — Lowest-observed-adverse-effect concentration
LOAEL — Lowest-observed-adverse-effect level
NOAEC — No-observed-adverse-effect concentration
NOAEL — No-observed-adverse-effect level
PAC — Percent allowable consumption
RME — Reasonable maximum exposure
TRV — Toxicity reference value
— — No applicable; no fish samples were collected at Station 1 during the November 2000 fish sampling event.

TABLE 12

PERCENT ALLOWABLE CONSUMPTION FOR THE CTE SCENARIO—TOTAL PCB-BASED
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

	November 2000						November 2002						November 2004					
	Mink		Kingfisher				Mink		Kingfisher				Mink		Kingfisher			
Station	NOAEC	LOAEC	No Effect	NOAEL	Low Effect	LOAEL	NOAEC	LOAEC	No Effect	NOAEL	Low Effect	LOAEL	NOAEC	LOAEC	No Effect	NOAEL	Low Effect	LOAEL
Station 1	—	—	—	—	—	—	8	10	11	3	14	31	38	46	49	14	61	138
Station 2	42	51	55	15	69	155	68	81	89	25	112	250	42	51	55	15	69	154
Station 3	55	66	72	20	90	202	78	94	101	28	127	284	58	69	75	21	94	209
Station 4	37	45	48	13	61	136	35	42	46	13	57	128	39	46	50	14	62	139

Notes:

PAC represents the percent diet an animal can consume within a station area reach without exceeding the TRV, where PAC = (1 / HQ) x 100.

Station — Fish sample collection station (see Figure 3)
1 Allen Street
2 Country Club Road
3 Fluckmill Road
4 Strainridge Road

CTE — Central tendency exposure
HQ — Hazard quotient; where mink HQ = concentration in mink diet / TRV and kingfisher HQ = concentration in kingfisher dose / TRV
LOAEC — Lowest-observed-adverse-effect concentration
LOAEL — Lowest-observed-adverse-effect level
NOAEC — No-observed-adverse-effect concentration
NOAEL — No-observed-adverse-effect level
PAC — Percent allowable consumption
TRV — Toxicity reference value
— — No applicable; no fish samples were collected at Station 1 during the November 2000 fish sampling event.

TABLE 13

PERCENT ALLOWABLE CONSUMPTION—TEQ-BASED
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

	Mink		Kingfisher					
	Dietary Basis		Egg-based				Dose-based	
Station	NOAEC	LOAEC	NOAEC-low	NOAEC-high	LOAEC-low	LOAEC-high	NOAEL	LOAEL
Station 1	5	21	1	9	3	36	3	25
Station 2	22	87	5	48	15	191	11	107
Station 3	28	111	5	45	14	180	14	136
Station 4	23	91	6	52	16	210	11	112

Notes:

PAC represents the percent diet an animal can consume within a station reach without exceeding the TRV, where PAC = (1 / HQ) x 100.

Station — Fish sample collection station (see Figure 3)
1 Allen Street
2 Country Club Road
3 Fluckmill Road
4 Strainridge Road

HQ — Hazard quotient
LOAEC — Lowest-observed-adverse-effect concentration
LOAEL — Lowest-observed-adverse-effect concentration
NOAEC — No-observed-adverse-effect concentration
NOAEL — No-observed-adverse-effect level
PAC — Percent allowable consumption
TRV — Toxicity reference value

Station 1 is located downstream of ICS. It is described as being less than 10 feet wide at bank full with an average depth of less than six inches deep. During roadway construction, culverts have been added. The area within the Station 1 reach may not be as attractive a habitat for wildlife compared to the downstream reaches.

Mink PACs account for 79 percent of the mink diet as 21 percent of the diet was assumed to have no PCB contamination. To calculate the amount of aquatic prey that can be consumed from Station 1 to stay within the PAC amount, the LOAEC-based PAC is multiplied by 79 percent. This results in an adjusted mink PAC of 25 (RME scenario) to 36 percent (CTE scenario). If a typical mink is assumed to have a food ingestion rate of 160 grams per day and a body weight of 1 kilogram (Bleavins and Aulerich 1981, as cited in EPA 1993), this is equivalent to 40 to 58 grams of fish+crayfish from Station 1, with fish comprising 33 to 48 grams and crayfish comprising approximately 7 to 10 grams of the Station 1 diet (diet = 66 percent fish + 13 percent crayfish). The mean weight for fish caught at Station 1 is approximately 38 grams; therefore, about 1 fish caught at Station 1 could be consumed per day (assuming no other exposure to PCBs at the Lemon Lane Landfill site.

The kingfisher has a diet that is composed of 100 percent aquatic prey; therefore, the PAC directly represents the amount of fish and crayfish from the station-reach under consideration. For the RME scenario, kingfisher no effect-/NOAEL-based PACs range from 9 to 34 percent; low-effect-/LOAEL-based PACs range from 43 to 96 percent based on the November 2004 data. Overall, an increase in PAC is observed at Station 1 when the November 2004 and 2002 estimates are compared.

To calculate the amount of fish from Station 1 required to reach the LOAEL, a kingfisher food ingestion rate of 0.5 grams per bodyweight per day (EPA 1993) and a kingfisher body weight of 147 grams were used, resulting in 32 to 71 grams of aquatic prey (or 27 to 57 grams of fish and 6 to 14 grams crayfish) for the November 2004 PAC estimate. The mean weight for fish caught at Station 1 is approximately

38 grams; therefore, less than 1 fish caught at Station 1 could be consumed (assuming no other exposure to PCBs at the Lemon Lane Landfill site)—this is equivalent to approximately 0.7 fish per day for the low-effect endpoint and 1.5 fish per day for the LOAEL-based endpoint (or 3 fish every 2 days).

5.3.2 Station 1: Percent Allowable Consumption Based on TEQs

When the PACs are calculated based on TEQ concentrations, the Station 1 NOAEC-based PAC for mink is estimated at 5 percent; the mink LOAEC-based PAC is estimated at 21 percent (see Table 13). These results indicate that, to stay within no-effect dietary concentrations, mink should forage along the Station 1 reach for no more than a few percent (i.e., 5 percent) of the total diet, and that potentially adverse effects are possible if greater than approximately 21 percent of the total diet comes from the Station 1 reach. The adjusted mink PAC is 17 percent, based on the LOAEC-based PAC. Using a typical mink ingestion rate and body weight (160 grams per day and a body weight of 1 kilogram; Bleavins and Aulerich 1981, as cited in EPA 1993), this is equivalent to 27 grams of fish+crayfish from Station 1, with fish comprising 23 grams and crayfish comprising approximately 4 grams of the Station 1 diet (diet = 66 percent fish + 13 percent crayfish). The mean weight for fish caught at Station 1 is approximately 38 grams; therefore, less than 1 fish caught at Station 1 could be consumed (assuming no other exposure to PCBs at the Lemon Lane Landfill site)—this is equivalent to approximately 3 fish every 5 days (or 0.6 fish per day).

For the kingfisher, PACs based on TEQ concentrations for Station 1 were estimated at 3 percent (NOAEL-based) and 25 percent (LOAEL-based). To stay within the no-effects dietary concentrations, kingfisher should forage along the Station 1 reach for no more than 3 percent of the total diet and adverse effects are possible if more than 25 percent of the diet is consumed within the Station 1 reach. Based on a typical kingfisher body weight and ingestion rate, this is equivalent to 18 grams of aquatic prey, with fish comprising 15 grams. Therefore, less than 1 fish caught at Station 1 could be consumed (assuming no other exposure to PCBs at the Lemon Lane Landfill site—this is equivalent to approximately 0.4 fish per day or 2 fish every 5 days.

5.3.3 Stations 2, 3, and 4: Percent Allowable Consumption

As the PCB concentrations in fish were lower at Stations 2, 3, and 4 than at Station 1, the estimated PACs for Stations 2, 3, and 4 were higher than those estimated at Station 1. That is, more fish may be consumed in the Station 2, 3, and 4 reaches than at the Station 1 reach (see Tables 11 through 13).

Comparing the PACs for these Stations for the years 2002 and 2004, a decrease in PAC is noted at Stations 2 and 3; the PAC at Station 4 remains relatively consistent across the sampling periods (see Tables 11 and 12). Because the November 2004 data represents the most recent "snap shot" in time regarding PCB levels in fish from Clear Creek, discussion of the PACs for these Stations will focus on the November 2004 results.

For the mink, the Station 2 NOAEC- and LOAEC-based PACs (33 and 39 percent, respectively) were approximately 30 percent higher than that estimated for Station 1 for the RME and CTE scenarios (see Tables 11 and 12). The Station 3 NOAEC- and LOAEC-based PACs were approximately 50 percent higher than those reported for Station 1 for the RME and CTE scenarios (see Tables 5 and 6). Using the same approach described above for Station 1 to estimate the amount of fish that could be consumed in the Station 2 reach to equal a LOAEC-based HQ of 1, a fish consumption rate of 41 grams fish/day (or slightly more than 1 fish per day) was estimated for the RME scenario. At Station 3, the LOAEC-based PACs were 49 and 69 percent for the RME and CTE scenarios, respectively, resulting in fish consumption rates of 52 grams fish/day (RME; less than 3 fish over 2 days) and 73 grams fish/day (CTE; slightly less than 2 fish per day).

At Station 4, the PACs for the mink were decreased from those estimated for Stations 2 and 3 and were consistent (albeit slightly higher) with those observed at Station 1 (see Tables 11 and 12). Using the LOAEC-based RME PAC of 33 percent, approximately 35 grams of fish/day could be consumed, which is slightly less than 1 fish/day.

For the kingfisher, the Station 2 no-effect- and NOAEL-based PACs for the RME scenario (42 and 12 percent, respectively) and the CTE scenario (55 and 15 percent, respectively) were approximately

30 percent higher than those estimated for Station 1, as were the low-effect- and LOAEL-based PACs (see Tables 11 and 12). The low-effect-/LOAEL-based PACs ranged from 53 to 119 percent for the RME scenario to 69 to 154 percent for the CTE scenario; the LOAEL-based PACs were greater than 100 percent for both scenarios. At the Station 3 reach, the no-effect-/NOAEL-based PACs for the RME scenario ranged from 15 to 53 percent for the RME scenario and from 21 to 75 percent for the CTE scenario (see Tables 11 and 12); low-effect-/LOAEL-based PACs ranged from 67 to 149 percent for the RME scenario and 94 to 209 percent for the CTE scenario. At Station 3, the LOAEL-based PACs were also greater than 100 percent.

Kingfisher PACs at Station 4 were slightly decreased compared to the PACs estimated for Stations 2 and 3; but were slightly greater than those estimated at Station 1 (see Tables 11 and 12). The no-effect-/NOAEL-based PACs ranged from 10 to 36 percent for the RME scenario and 14 to 50 percent for the CTE scenario; low-effect-/LOAEL-based PACs ranged from 45 to 100 percent for the RME scenario and 62 to 139 percent for the CTE scenario. The LOAEL-based PACs for the Station 4 reach were equivalent to, or greater than, 100 percent for both scenarios.

6.0 UNCERTAINTY ANALYSIS

The purpose of the uncertainty analysis is to (1) provide risk managers with a summary of those factors that significantly influence the risk results and (2) assess the contribution of these factors to the under- or overestimation of risk.

Virtually every step in the ERA process requires numerous assumptions, all of which contribute to uncertainty in the risk evaluation. In the absence of empirical or site-specific data, assumptions are developed based on best estimates of data quality, exposure parameters, and dose-relationships.

6.1 FISH AND CRAYFISH CONTAMINANT DATA

Site-specific PCB concentrations in fish caught at four sampling stations on Clear Creek provided the data for the FERA. Sources of uncertainty associated with the site-specific data include the movement of fish between sampling stations, differences in species accumulation, and changes to the dietary composition.

Both RME and CTE risk estimates were calculated using RME and CTE fish concentrations, respectively. A measure of data variability is the coefficient of variation (CV), which is the standard deviation divided by the mean. For the majority of the fish species data sets with greater than 4 samples, the CV was less than or equal to 0.5 indicating a relatively low sample variability within a fish species collected at a given station. For PCB analysis conducted using the 4-peak method, the CV was large for white suckers collected at Station 3 (November 2000: CV of 1.13; number of samples = 4) and for longear sunfish collected at Station 4 (November 2002: CV of 0.71; number of samples = 6). Using the 5-peak method, CVs were greater than 0.5 for creek chub collected at Station 1 (CV of 0.60; number of samples = 11); longear sunfish collected at Station 4 (CV of 0.78; number of samples = 6); and rock bass collected at Station 4 (CV of 0.67; number of samples = 5). CVs are presented in Appendix F. As noted above, the majority of the "highly variable" data is associated with Stations 3 and 4, which are further downstream of the site (greater than 10 miles). A portion of the variability may be attributable to migration of fish in and out of the sample areas.

For the estimation of TEQ-based HQs, PCB congener data was used. For each fish species sampled, only one sample was submitted for PCB congener analysis. Although at Stations 2, 3, and 4, a sample was analyzed for PCB congeners for each of two to three species collected, at Station 1 (nearest ICS), only one sample was analyzed for PCB congeners; therefore, the TEQ-based risk estimate for Station 1 is based on one fish sample, which may over- or underestimate the actual risk based on the representativeness of this data point.

Data variability is not necessarily considered an "uncertainty", however, as the majority of the data sets have a relatively low variability, variations in individual fish sample concentrations within a species, should not have an appreciable impact on the risk estimate.

The fish component of the piscivore diet was assumed to be composed of equal amounts of each fish present in a given station-reach. This assumption does not account for dietary preferences or seasonal availability. Due to the differences in contaminant levels between species, this could be a source of uncertainty depending on the actual composition of fish in the diet. In November 2000, six different species of fish were sampled; in November 2002, four species were sampled, with creek chub and green sunfish comprising the majority of the fish caught. In 2004, eight species of fish were sampled, with creek chub, white sucker, and green sunfish comprising the majority of the fish caught. Overall, there was not a large difference in mean PCB concentrations between the different species. Downstream of Station 1, mean creek chub PCB concentrations did appear to be slightly lower than the mean PCB concentrations reported for other fish caught at the same station. Preferential feeding on one fish species vs another is not expected to have a large impact on the risk estimate as large differences in concentration were not observed. If creek chub were found to comprise the majority of the diet, the risk estimates for certain stations could be overestimated.

The available fish tissue data for the 2000, 2002, and 2004 sampling events were measured in samples collected in November; therefore, seasonal fluctuations in PCB body burdens could not be evaluated in the FERA. For a similar site (Neal's Landfill; EPA 2005), the lowest PCB levels were reported for a November sampling event and were 1.3 to 3.4 times greater, depending on species, for May and August sampling events. In addition, lipid percentages were lowest in November. Seasonal low PCB lipid concentrations could result in low whole body PCB concentrations. At Clear Creek, historical data indicate lipid percentages may be from 2 to 3 times greater in summer months as compared to November. As this FERA is based exclusively on November data, PCB concentrations may be underestimated by an approximate factor of 2, which results in a proportional underestimation of risk. Underestimation of summer breeding season doses are of particular importance as PCBs affect the reproductive system of both the mink and kingfisher.

No crayfish data were available for the post-remediation sampling events conducted in 2000 and 2002; crayfish samples were collected during the 2004 sampling event at Station 1 only. Therefore, crayfish concentrations used to estimate the dietary intake for the 2000 and 2002 data were modeled using a ratio calculated from fish-crayfish data collected in November 1996. The use of a ratio assumes that uptake factors and contaminant loading are the same over time. Fish:crayfish ratios calculated for creek chub at Stations 1 and 2 using the November 1996 data are approximately four times greater than the ratios calculated for the same species at a nearby site (Neal's Landfill [Conard's Branch/Richland Creek]; see EPA 2005). The green sunfish:crayfish ratio at Station 2 is approximately six to seven times higher than the mean sunfish:crayfish ratio calculated for Neal's Landfill (Conard's Branch/Richland Creek; EPA 2005). The green sunfish:crayfish ratio at Station 3 is within 30 percent of the ratio estimated for Neal's Landfill (Conard's Branch/Richland Creek; EPA 2005). For the November 2004 evaluation, the crayfish ratio for Station 1 was extrapolated to estimate crayfish concentrations at the downstream locations.

At Neal's Landfill, the fish:crayfish ratios were similar across sampling stations, sampling dates, and analytical methods compared to the variability observed in fish:crayfish ratios estimated for the Clear Creek sample locations. For example, PCB concentrations in green sunfish increase by approximately 2.5 times between Station 2 and Station 3, which is consistent with an increased exposure as Station 2 is nearer the source than Station 3. However, PCB concentrations in crayfish are decreased by approximately half at Station 2 as compared to Station 3. A high level of uncertainty is associated with the crayfish modeling for Clear Creek as only limited data was available for extrapolation of crayfish concentrations.

The effect of extrapolated crayfish concentrations on the risk estimates may be tempered as crayfish only contribute 13 to 20 percent of the diet for the mink and kingfisher, respectively. Dependent on the actual concentrations of PCBs in crayfish under current conditions, modeled crayfish concentrations may potentially over- or underestimate risk.

6.2 TOXICITY REFERENCE VALUES

Source of uncertainty associated with the selection of TRVs include: (1) extrapolation of toxicity values across species, (2) extrapolation of laboratory studies to field conditions, (3) differences in toxicity between the compound administered a laboratory study and the compound present in the field, and (4) potential interactions between the primary COPC and other contaminants present in the diet.

6.2.1 Mink TRVs

As the TRVs for mink were selected from studies conducted on mink rather than a surrogate species, interspecies extrapolation was not an issue. Field-contaminated prey were not used in these studies, therefore, the results were not confounded by co-contaminants. Although the toxicological studies were based on captive feeding, there are indications that the effects observed in the laboratory studies are similar to those observed in the field. For instance, changes in the otter population in Sweden have been correlated to the concentration of PCBs in muscle tissue but not to other contaminants. A range of PCB concentrations between 10 ppm to 30 ppm in muscle tissue is associated with a threshold for population effects (Roos and others 2001, as cited in EPA 2005). In mink, PCB concentrations of 40 ppm to 60 ppm have been associated with reduction in litter sizes (Leonards and others, 1995 as cited in EPA 2005). The PCB concentrations associated with reproductive effects in mink are of the same order of magnitude as the concentrations associated with adverse effects in wild populations (otters).

In deriving the TRVs used in the FERA, the toxicity values identified for toxicological studies conducted over one breeding season were extrapolated to account for exposure over several breeding seasons. Studies conducted with Clophen (a European PCB formulation similar to Aroclors) and field-contaminated prey indicated increased effects after two breeding seasons. Although no definite rule is available to account for exposure over time, it is thought that effects are related to both dose and exposure time. For the FERA, the mean difference in toxicity for the long-term Clophen studies (two breeding seasons) was used to adjust the toxicity values identified for the Aroclor studies conducted over one breeding season (Chapman 2003, as cited in EPA 2005). If no adjustment was made in the single-season toxicity values, the TRVs may not be protective for the long-term use of Clear Creek. The adjusted TRVs were still within the range of TRVs identified in other ERAs (see the Attachment).

The mink TEQ TRVs were derived from long-term feeding studies, which mitigates uncertainty associated with extrapolation from a single breeding season. The WHO TEFs (Van den Berg and others 1998), which are consensus-based values, were used to calculate the mink TEQs.

6.2.2 Kingfisher TRVs

No studies evaluating the effects of PCBs in kingfishers were identified. TRVs selected for the kingfisher were based on surrogate species (i.e., chicken and doves). In order to address the interspecies extrapolation, two sets of TRVs were identified. TRVs were identified from a study in which chickens were exposed to PCBs. Chicken have been shown to be sensitive to the effects of PCB exposure (decreased egg hatchability). A second set of TRVs were identified for behavioral effects in doves. Doves are less sensitive to PCB exposure than the chicken. Therefore, with the use of two sets of TRVs, the kingfisher toxicity is "bracketed". Both the chicken and dove studies were controlled feeding studies where the test animals were exposed to Aroclors. The avian TRVs selected for the FERA are representative of the range of TRVs used in other ERAs (see the Attachment).

HQs were calculated using both the chicken TRVs and the dove TRVs (after dose conversion) so that a risk range for possible adverse effects was estimated for both a NOAEL and LOAEL dose.

Two sets of egg-based TEQ TRVs were selected to address uncertainties associated with the toxicity studies and a range of sensitivities. The results of a species sensitivity distribution conducted by EPA (2003) indicate that the egg TRVs selected in the FERA are not overly conservative.

6.3 EXPOSURE ASSUMPTIONS

Uncertainties associated with the exposure assumptions used in the FERA are discussed in the following sections.

6.3.1 Mink Dietary Composition and Foraging Assumptions

For the FERA, the mink was assumed to obtain 79 percent of its diet from aquatic prey in the Clear Creek area. Mink are not limited to a diet composed strictly of aquatic prey. The mink diet will also vary with season and location. Therefore, it is possible that a mink foraging along Clear Creek may consume less or more than 79 percent of their diet from Clear Creek. Assumptions were also made concerning dietary composition. While the mink has a fairly varied diet (including fish, invertebrates, small mammals and birds), a diet of fish and crayfish only, was assumed for the FERA. A mink foraging along Clear Creek may have a lower or greater composition of fish or crayfish (i.e., a different ratio) in their diet.

Selection of a diet with a much lower component of aquatic items is not appropriate for modeling exposure as only those receptors adhering to these dietary assumptions (mainly a terrestrial diet) would be evaluated. No conclusions could be drawn regarding a receptor that did take a larger portion of its prey from Clear Creek. The mink dietary assumptions used in the FERA were not the highest available in the literature, but were selected to provide an evaluation based on a reasonable maximum exposure.

PCB uptake was not modeled for the remaining 21 percent of the mink diet, which was assumed to be composed of terrestrial prey. It was assumed that terrestrial prey at the site would be less exposed to PCBs released from Lemon Lane Landfill as the primary release is to groundwater, which discharges into Clear Creek. If terrestrial prey was contaminated, then the mink diet assumptions would result in an underestimation of up to 21 percent. Without site-specific terrestrial data, the degree of underestimation is unknown.

Home ranges of 1 mile were assumed for both the mink and kingfisher. For mink, the home range assumption was based on the mean home range for female mink along streams. A range of 0.6 to 1.7 stream miles was actually reported. The use of the 1 mile home range may over- or underestimate exposure based on what the actual home range is within the actual distances observed. As all of the stations are greater than 1.5 miles apart, which is slightly less than the upper bound of home ranges reported for female mink, the home range assumption used in the FERA should have little effect on the risk estimate.

6.3.2 Kingfisher Dietary Composition and Foraging Assumptions

The kingfisher diet was assumed to be comprised of 100 percent aquatic prey. This assumption is consistent with dietary information available in the literature (EPA 1993). Although the possibility for non-aquatic items to be consumed does exist, these items constitute a small portion of the total diet (1 to 3 percent [EPA 1993]) and are not estimated to be a significant source of uncertainty.

A dietary composition of 80 percent fish and 20 percent crayfish was assumed for the FERA. The amount of crayfish in the kingfisher diet for the FERA was based on the mean value of crayfish (or crayfish and invertebrates) reported for dietary studies. Two dietary studies reported crayfish/invertebrate intake at 5 percent (based on mass) and 13 percent (based on number of prey). A third study had a higher proportion at 41 percent (percent volume basis). Averaging these three values, resulted in a value of approximately 20 percent. The 41 percent value cited by Salyer and Lagler (1946, as cited in EPA 2005), is much higher than what was reported for the other studies—the incorporation of this value "maximized" the amount of crayfish consumed. Therefore, the kingfisher diet may be composed of a smaller amount of crayfish than what was assumed for the FERA. As fish would be expected to have higher PCB concentrations compared to crayfish, overestimating the amount of crayfish in the diet would potentially underestimate overall risk.

Home ranges of 1 mile were assumed for both the mink and kingfisher. A range of 0.6 to 1.4 stream miles was reported in the literature for the kingfisher. The use of the 1 mile home range may over- or underestimate exposure based on what the actual home range is within the actual distances observed. The kingfisher home range may have been over- or underestimated by 30 to 40 percent. As all of the stations are greater than 1.5 miles apart, which is only slightly greater than the upper bound of home ranges reported for kingfisher, the home range assumption used in the FERA should have little effect on the risk estimate.

7.0 SUMMARY

Remedial actions have been undertaken at the Lemon Lane Landfill site to reduce the release of PCBs to the environment. However, PCB-impacted groundwater discharging from Lemon Lane Landfill has been released to Clear Creek. The FERA evaluated risk to piscivorous mammals (mink) and birds (kingfisher). Mink have been shown to be sensitive to the effects of PCBs. Both species are potentially highly exposed through the piscivorous diet. As PCBs elicit reproductive effects in both species, and as reproductive success is a critical endpoint for population stability, risks were evaluated based on the likelihood of PCB-exposure to cause adverse reproductive effects in the mink or kingfisher. Fish data from four sampling stations on Clear Creek were used to estimate risks to the mink and kingfisher.

Despite the reductions in potential PCB release from Lemon Lane Landfill due to the remedial action, fish in the upper portion of Clear Creek (i.e., near Station 1 at Allen Street, which is approximately 1.5 miles from the site) are accumulating PCBs at concentrations greater than those shown to cause reproductive effects in the mink or kingfisher. Although decreased from the values estimated for the 2002 data, the RME and CTE HQs for both the mink and kingfisher at Station 1 were greater than the threshold value of 1 (see Tables 5 and 6).

Unlike the 2002 data, which show a noticeable decrease in PCB concentrations in Clear Creek fish (for example, creek chub) downstream of Station 1 and the ICS, the 2004 data do not show this marked decrease at the downstream stations. Concentrations at Station 1 do appear to decrease when the November 2002 and 2004 data are compared; however for the November 2004, a potential risk exists for mink or kingfisher that forage within the Station 1, 2, 3, or 4 reaches based on PCB data in fish. The increase in risk observed at Station 4 (approximately 20 miles downstream) for the November 2002 data is not readily apparent in the November 2004 data. In 2002, mink RME low-effect-based HQs of 13 and 3 were estimated for Station 1 and 4, respectively; for the kingfisher, RME low-effect-based HQs of 10 and 3 were estimated, respectively (see Tables 5 and 8). In 2004, both of these stations had mink RME low-effect-based HQs of 3 and kingfisher RME low-effect-based HQs of 2 (see Tables 5 and 8). It should be noted that comparisons with the Station 4 results may be problematic as different species of fish were available for sampling (i.e., no creek chub or green sunfish were sampled) at that location compared to the upstream stations; differences in uptake of PCBs may be reflected in the HQs for Station 4.

Although little difference is noted in the HQs for the station located closest to the ICS and the stations locations downstream (Stations 2, 3, and 4) when the HQs based on total PCB data are compared, a difference is more apparent when the TEQ-based HQs are considered. The mink RME LOAEC-based HQ at Station 1 was estimated at 5; the LOAEC-based HQs at Stations 2, 3, and 4 were all estimated at 1 (or less than 1; see Table 7). The egg-based RME LOAEC-low-based HQ at Station 1 was estimated at 36; downstream LOAEC-low-based HQs were estimated at 6 to 7 (see Table 10). The dose-based kingfisher RME LOAEL-based HQ at Station 1 was estimated at 4; downstream RME LOAEL-based HQs were each below 1 (see Table 10). As discussed earlier, the TEQ-based HQ at Station 1 is based on one fish sample (creek chub) only.

Seasonal data was not available for the Clear Creek evaluation; lipid concentrations appear to be higher in summer months based on data from a similar site (Neal's Landfill; EPA 2005), which could lead to higher whole-body PCB concentrations in summer months. Also, crayfish data were only available for the November 2004 sampling event at Station 1; therefore, the majority of the crayfish concentrations used in the FERA were extrapolated from another Station or sampling event. Both the (1) lack of seasonal data and (2) crayfish extrapolation could result in an up to 2-fold underestimation of risk.

The greatest source of uncertainty in the risk estimate is attributable to the assumptions for the mink diet. Approximately 20 percent of the mink diet is unaccounted for by the dietary composition used to estimate risks. Other sources of uncertainty do not appear to significantly affect the outcome of the risk assessment.

As PCBs are ubiquitous contaminants, it is not surprising that PCBs were detected in fish as far as 20 miles from the site. Based on the November 2004 data, the TEQ-based HQs indicate that a risk may exist to piscivores within the Station 1 reach (i.e., nearest the ICS). The PCB congener concentrations (expressed as TEQ) in fish (creek chub) at Station 1 are approximately 3 to 10 times greater than the PCB congener (expressed as TEQ) concentrations at the downstream stations (dependent on species). The Station 1 location may be impacted by the release of PCB-impacted groundwater from the site, which flows into ICS and then discharges to Clear Creek just upstream of Station 1. Although excess risks were indicated for piscivorous mammals and birds at Station 1, more attractive habitat (due to a greater level of development in the Station 1 reach) may be available in the downstream reaches. The results indicate that risk is associated with consumption of fish/crayfish for the mink or kingfisher downstream of Station 1 (at distances of 3 miles or greater downstream), indicating the downstream reaches may be impacted by the release of PCB-impacted groundwater from Lemon Lane Landfill.

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APPENDIX A

FISH AND CRAYFISH DATA USED IN THE FERA

(Seven Pages)

TABLE A-1

PCB CONCENTRATIONS IN WHOLE FISH SAMPLES: NOVEMBER 2000 AND 2002
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

November 2000			
Station	Species	PCB Concentration (ug/kg)	Percent Lipids
2	CRC	800	1
2	CRC	1400	1.13
2	CRC	2400	2.65
2	CRC	2100	1.08
2	LS	2300	4.24
2	LS	1300	2.69
2	WS	1900	2.11
2	WS	1600	1.42
2	WS	2000	1.5
3	CRC	410	1.79
3	CRC	420	1.36
3	CRC	470	1.27
3	RB	1400	3.72
3	RB	1300	3.61
3	RB	1800	4.35
3	RB	1400	3.7
3	SB	3200	3.22
3	SB	1400	1.99
3	WS	720	1.56
3	WS	3100	6.14
3	WS	410	1.33
3	WS	370	1.62
4	HS	1100	1.68
4	LS	2300	4.54
4	LS	360	1.22
4	LS	1700	4.37
4	LS	1500	4.45
4	LS	2100	4.23
4	RH	1300	2.82
4	RH	1700	2.04
4	RH	3800	2.14
4	RH	1700	1.8

November 2002				
Station	Species	PCB Concentration (4-Peak) (ug/kg)	PCB Concentration (5-Peak) (ug/kg)	Percent Lipids
1	CRC	8300	6600	0.78
1	CRC	3400	3000	0.44
1	CRC	8500	6800	0.68
1	CRC	18000	15000	1.03
1	CRC	4400	4100	0.32
1	CRC	11000	9200	0.51
1	CRC	590	530	0.33
1	CRC	14000	14000	0.39
1	CRC	8100	7900	1.41
1	CRC	5700	5000	0.83
1	CRC	16000	13000	0.81
2	CRC	1200	1000	0.88
2	CRC	790	850	0.6
2	CRC	350	380	0.58
2	CRC	600	560	0.69
2	CRC	800	890	0.56
2	CRC	980	1000	0.71
2	GS	1700	1600	3.61
2	GS	1500	1200	0.54
2	GS	2300	2000	1.49
2	GS	830	950	0.8
2	GS	760	650	0.13
3	CRC	460	360	0.37
3	CRC	1000	830	0.64
3	CRC	210	170	0.48
3	CRC	550	440	0.51
3	CRC	720	600	0.51
3	GS	1200	940	0.74
3	GS	1000	870	1.09
3	GS	840	670	0.89
3	GS	820	690	0.82
3	GS	1670	1600	1.67
3	GS	1800	1600	1.8
4	LS	4500	4800	2.49
4	LS	4000	3800	1.05
4	LS	660	530	0.67
4	LS	480	380	0.32
4	LS	1700	1400	1.45
4	LS	3400	3500	2.04
4	RB	620	500	0.26
4	RB	1000	820	0.37
4	RB	1600	1300	1.12
4	RB	2500	2000	0.6
4	RB	2300	3100	1.04

TABLE A-1

PCB CONCENTRATIONS IN WHOLE FISH SAMPLES: NOVEMBER 2000 AND 2002
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Notes:

Station	Fish sample collection station (see Figure 3 of the main text)	
	1	Allen Street
	2	Country Club Road
	3	Fluckmill Road
	4	Strainridge Road
Species	Sampled fish species	
	CRC	Creek chub
	GS	Green sunfish
	HS	Hog sucker
	LS	Longear sunfish
	RB	Rock bass
	RH	Black red horse
	SB	Smallmouth bass
	WS	White sucker
PCB	Polychlorinated biphenyl	
ug/kg	Microgram per kilogram	

TABLE A-2

PCB CONCENTRATIONS IN WHOLE FISH SAMPLES
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

ID	November 2004					
	Station	Species	Total PCB Concentration (µg/kg)	95UCL Concentration (µg/kg)	Mean PCB Concentration (µg/kg)	Percent Lipids
CC-0026	3	WS	1,900	1,980	1,348	1.68
CC-0027	3	WS	920			1.13
CC-0028	3	WS	2,600			3.73
CC-0029	3	WS	490			0.86
CC-0030	3	WS	980			1.03
CC-0031	3	WS	1,200			1.15
CC-0076	3	CRC	1,400	1,148	986	1.47
CC-0014	3	CRC	1,000			1.23
CC-0015	3	CRC	780			1.08
CC-0016	3	CRC	1,000			1.41
CC-0017	3	CRC	1,100			1.13
CC-0018	3	CRC	860			1.22
TT-XX-0003	3	CRC	760			3
CC-0090	4	LS	4,000	2,985	2,018	4.1
CC-0091	4	LS	2,600			5.04
CC-0092	4	LS	1,400			4.37
CC-0093	4	LS	610			3.32
CC-0094	4	LS	1,500			3.2
CC-0095	4	LS	2,000			6.08
CC-0097	4	RH	1,400	1,837	1,500	2.1
CC-0098	4	RH	1,300			1.36
CC-0100	4	RH	1,200			0.76
CC-0101	4	RH	1,500			2.92
CC-0102	4	RH	2,100			2.28

Notes:

(shaded cell)	Shaded cell indicates data that was not included in the calculation of the 95UCL or mean concentration. This PCB concentration is three times higher than any other fish concentration in the data set and almost five times higher than any other fish concentration at Station 2.
Station	Fish sample collection station 1 Allen Street 2 Country Club Road 3 Fluckmill Road 4 Strainridge Road
Species	Sampled fish species CRC Creek chub GS Green sunfish LS Longear sunfish RH Red horse WS White sucker
95UCL	95 percent upper confidence limit on the arithmetic mean
PCB	Polychlorinated biphenyl
ug/kg	Microgram per kilogram

TABLE A-3

PCB CONCENTRATIONS IN WHOLE FISH AND CRAYFISH SAMPLES
NOVEMBER 1996
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Species	PCB Concentration (ug/kg)	Mean PCB Concentration (ug/kg)
1	CRC	14000	19222.22
1	CRC	14000	
1	CRC	22000	
1	CRC	22000	
1	CRC	21000	
1	CRC	12000	
1	CRC	15000	
1	CRC	11000	
1	CRC	42000	
1	CF	1500	1576.67
1	CF	3200	
1	CF	760	
1	CF	1100	
1	CF	1100	
1	CF	1800	
		CRC/CF Ratio	**12.19**
2	CRC	1200	2037.5
2	CRC	4800	
2	CRC	2200	
2	CRC	1500	
2	CRC	1300	
2	CRC	2200	
2	CRC	2100	
2	CRC	1000	
2	GS	2100	3555.56
2	GS	5000	
2	GS	2900	
2	GS	3400	
2	GS	6700	
2	GS	2300	
2	GS	5300	
2	GS	1700	
2	GS	2600	
2	CF	190	182
2	CF	210	
2	CF	100	
2	CF	200	
2	CF	210	
		CRC/CF Ratio	**11.20**
		GS/CF Ratio	**19.54**
		CRC-GS/CF Ratio	**15.37**

TABLE A-3

PCB CONCENTRATIONS IN WHOLE FISH AND CRAYFISH SAMPLES
NOVEMBER 1996
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Species	PCB Concentration (ug/kg)	Mean PCB Concentration (ug/kg)
3	GS	950	1343.33
3	GS	2220	
3	GS	2400	
3	GS	900	
3	GS	1700	
3	GS	280	
3	GS	620	
3	GS	820	
3	GS	2200	
3	WS	1200	2341.11
3	WS	2000	
3	WS	910	
3	WS	960	
3	WS	1400	
3	WS	6700	
3	WS	3100	
3	WS	2600	
3	WS	2200	
3	CF	540	356
3	CF	370	
3	CF	430	
3	CF	310	
3	CF	130	
		GS/CF Ratio	**3.77**
		WS/CF Ratio	**6.58**
		GS-WS/CF Ratio	**5.17**

Notes:

No crayfish samples were collected at Station 4 during the November 1996 sampling activities

Station	Fish sample collection station (see Figure 3 of the main text)	
	1	Allen Street
	2	Country Club Road
	3	Fluckmill Road
Species	Sampled fish species	
	CF	Crayfish
	CRC	Creek chub
	GS	Green sunfish
	WS	White sucker
PCB	Polychlorinated biphenyl	
ug/kg	Microgram per kilogram	

TABLE A-4

MODELED TOTAL PCB CONCENTRATIONS IN CRAYFISH
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Species	95UCL Concentration (ug/kg)	Mean PCB Concentration (ug/kg)
1	CRC	2,562	1,807
1	CF	1,400	913
		Mean CRC:CF Ratio	**2.0**
2	GS	2,094	1,817
2	WS	2,457	2,000
2	CRC	1,825	1,180
2	CF	922	596
3	GS	2,075	1,302
3	WS	1,980	1,348
3	CRC	1,148	986
3	CF	580	498
4	LS	2,985	2,018
4	RH	1,837	1,500
4	CF	1,509	1,020

Notes:

Measured crayfish data was available for Station 1; crayfish concentrations were modeled for Stations 2, 3, and 4. To calculate the modeled PCB concentration in crayfish, fish:crayfish ratios were calculated for each species using the mean PCB concentration data for Station 1.

For example, Mean CRC:CF Ratio = $\frac{\text{Mean PCB concentration in creek chub at Station 1}}{\text{Mean PCB concentration in crayfish at Station 1}}$

Mean species-specific fish:crayfish ratios were then used to model crayfish concentrations at Stations 2, 3, and 4, where
Modeled crayfish concentration =
(Species-specific PCB concentration / Mean CRC:CF fish:crayfish ratio)

and Species-specific PCB concentration = 95UCL or Mean PCB concentration in fish

Station	Fish sample collection station	
	1	Allen Street
	2	Country Club Road
	3	Fluckmill Road
	4	Strainridge Road
Species	Sampled fish species	
	CRC	Creek chub
	GS	Green sunfish
	LS	Longear sunfish
	RH	Red horse
	WS	White sucker
95UCL	95-percent upper confidence limit on the arithmetic mean	
PCB	Polychlorinated biphenyl	
ug/kg	Microgram per kilogram	

APPENDIX B

MINK AND KINGFISHER RISK ESTIMATES, NOVEMBER 2000

(Four Pages)

TABLE B-1

RME PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK, NOVEMBER 2000 FISH DATA
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

				Mink			Kingfisher					
Station	Species	N	Concentration in Fish and Crayfish (ug/kg)	Concentration in Diet (ug/kg)	HQ No Effect (ratio)	HQ Low Effect (ratio)	Concentration in Diet (ug/kg-diet)	Concentration in Dose (ug/kg-day)	HQ No Effect (ratio)	HQ NOAEL (ratio)	HQ Low Effect (ratio)	HQ LOAEL (ratio)
2	CRC	4	2266	1470.76	2.94	2.45	1791.32	895.66	2.24	8.14	1.79	0.80
2	LS	2	2300									
2	WS	3	2000									
2	CF	--	202									
3	CRC	3	470	1290.47	2.58	2.15	1578.57	789.29	1.97	7.18	1.58	0.70
3	RB	4	1657									
3	SB	2	3200									
3	WS	4	2227									
3	CF	--	339									
4	LS	5	2149	1791.98	3.58	2.99	2196.27	1098.13	2.75	9.98	2.20	0.98
4	RH	4	3056									
4	CF	--	570									

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 2 — Country Club Road
- 3 — Fluckmill Road
- 4 — Strainridge Road

Species — Sampled fish species
- CF — Crayfish
- CRC — Creek chub
- LS — Longear sunfish
- RB — Rock bass
- RH — Black red horse
- SB — Smallmouth bass
- WS — White sucker

Definitions:

HQ	Hazard quotient
IR	Ingestion rate (kingfisher)
kg	Kilogram
LOAEL	Lowest-observed-adverse-effect level
N	Number of samples
NOAEL	No-observed-adverse-effect level
PCB	Polychlorinated biphenyl
RME	Reasonable maximum exposure
TRV	Toxicity reference value
ug/kg	Microgram per kilogram
ug/kg-day	Microgram per kilogram per day
--	Not applicable; crayfish concentration was modeled.

Concentration in Fish & Crayfish:	For the RME scenario, for fish species data sets with more 4 or more samples, the 95-percent upper confidence limit was used as the fish species concentration; for data sets with less than 4 samples, the maximum detected concentration was used as the species concentration. Crayfish concentrations were modeled.
Mink, Concentration in Diet:	Concentration of PCBs in the mink diet = (0.66 x mean concentration of the RME fish species concentration) + (0.13 x modeled crayfish concentration)
Mink, HQ, No Effect:	HQ = Concentration of PCBs in the mink diet / No effect-based TRV, where TRV = 500 ug/kg
Mink, HQ, Low Effect:	HQ = Concentration of PCBs in the mink diet / Low effect-based TRV, where TRV = 600 ug/kg
Kingfisher, Concentration in Diet:	Concentration of PCBs in the kingfisher diet = (0.80 x mean concentration of the RME fish species concentration) + (0.20 x modeled crayfish concentration)
Kingfisher, Concentration in Dose:	Concentration of PCBs in kingfisher diet (expressed as a dose) = (Concentration of PCBs in the kingfisher diet x IR), where IR = 0.5 kg food per kg body weight
Kingfisher, HQ, No Effect:	HQ = Concentration of PCBs in kingfisher dose / No effect-based TRV; where TRV = 400 ug/kg-day
Kingfisher, HQ, NOAEL:	HQ = Concentration of PCBs in kingfisher dose / NOAEL-based TRV; where TRV = 110 ug/kg-day
Kingfisher, HQ, Low Effect:	HQ = Concentration of PCBs in kingfisher dose / Low effect-based TRV; where TRV = 500 ug/kg-day
Kingfisher, HQ, LOAEL:	HQ = Concentration of PCBs in kingfisher dose / LOAEL-based TRV; where TRV = 1,120 ug/kg-day

TABLE B-2

CTE PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK, NOVEMBER 2000 FISH DATA
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Species	N	Concentration in Fish and Crayfish (ug/kg)	Mink			Kingfisher					
				Concentration in Diet (ug/kg)	HQ No Effect (ratio)	HQ Low Effect (ratio)	Concentration in Diet (ug/kg)	Concentration in Dose (ug/kg-day)	HQ No Effect (ratio)	HQ NOAEL (ratio)	HQ Low Effect (ratio)	HQ LOAEL (ratio)
2	CRC	4	1675	1187.28	2.37	1.98	1445.48	722.74	1.81	6.57	1.45	0.65
2	LS	2	1800									
2	WS	3	1833									
2	CF	--	150									
3	CRC	3	433	906.86	1.81	1.51	1106.64	553.32	1.38	5.03	1.11	0.49
3	RB	4	1475									
3	SB	2	2300									
3	WS	4	1150									
3	CF	--	175									
4	LS	5	1767	1345.11	2.69	2.24	1650.30	825.15	2.06	7.50	1.65	0.74
4	RH	4	2125									
4	CF	--	468									

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)

2	Country Club Road
3	Fluckmill Road
4	Strainridge Road

Species — Sampled fish species

CF	Crayfish	RH	Black red horse
CRC	Creek chub	SB	Smallmouth bass
LS	Longear sunfish	WS	White sucker
RB	Rock bass		

Definitions:

CTE	Central tendency exposure
HQ	Hazard quotient
kg	Kilogram
LOAEL	Lowest-observed-adverse-effect level
N	Number of samples
NOAEL	No-observed-adverse-effect level
PCB	Polychlorinated biphenyl
TRV	Toxicity reference value
ug/kg	Microgram per kilogram
ug/kg-day	Microgram per kilogram per day
--	Not applicable; crayfish concentration was modeled.

Concentration in Fish & Crayfish:	For the CTE scenario, the arithmetic mean was used as the fish species concentration; crayfish concentrations were modeled.
Mink, Concentration in Diet:	Concentration of PCBs in the mink diet = (0.66 x mean concentration of the CTE fish species concentration) + (0.13 x modeled crayfish concentration)
Mink, HQ, No Effect:	HQ = Concentration of PCBs in the mink diet / No effect-based TRV, where TRV = 500 ug/kg
Mink, HQ, Low Effect:	HQ = Concentration of PCBs in the mink diet / Low effect-based TRV, where TRV = 600 ug/kg
Kingfisher, Concentration in Diet:	Concentration of PCBs in the kingfisher diet = (0.80 x mean concentration of the CTE fish species concentration) + (0.20 x modeled crayfish concentration)
Kingfisher, Concentration in Dose:	Concentration of PCBs in kingfisher diet (expressed as a dose) = (Concentration of PCBs in the kingfisher diet x IR), where IR = 0.5 kg food per kg body weigh
Kingfisher, HQ, No Effect:	HQ = Concentration of PCBs in kingfisher dose / No effect-based TRV; where TRV = 400 ug/kg-day
Kingfisher, HQ, NOAEL:	HQ = Concentration of PCBs in kingfisher dose / NOAEL-based TRV; where TRV = 110 ug/kg-day
Kingfisher, HQ, Low Effect:	HQ = Concentration of PCBs in kingfisher dose / Low effect-based TRV; where TRV = 500 ug/kg-day
Kingfisher, HQ, LOAEL:	HQ = Concentration of PCBs in kingfisher dose / LOAEL-based TRV; where TRV = 1,120 ug/kg-day

TABLE B-3

RME PERCENT ALLOWABLE CONSUMPTION, NOVEMBER 2000 FISH DATA
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

	Mink		Kingfisher			
	Dietary Basis		Dose Basis			
Station	NOAEC PAC	LOAEC PAC	No Effect PAC	NOAEL PAC	Low Effect PAC	LOAEL PAC
2	34.00	40.80	44.66	12.28	55.82	125.05
3	38.75	46.49	50.68	13.94	63.35	141.90
4	27.90	33.48	36.43	10.02	45.53	101.99
TRV	500 ug/kg	600 ug/kg	400 ug/kg-day	110 ug/kg-day	500 ug/kg-day	1,120 ug/kg-day

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 2 — Country Club Road
- 3 — Fluckmill Road
- 4 — Strainridge Road

PAC (Percent Allowable Consumption, %) = (1 / HQ) x 100; the PAC is the percent of an animals diet that can be consumed within a station reach and not exceed the TRV.

% — Percent
HQ — Hazard quotient; where mink HQ = concentration in mink diet / TRV and kingfisher HQ = concentration in kingfisher dose / TRV
LOAEC — Lowest-observed-adverse-effect concentration
LOAEL — Lowest-observed-adverse-effect level
NOAEC — No-observed-adverse-effect concentration
NOAEL — No-observed-adverse-effect level
RME — Reasonable maximum exposure
TRV — Toxicity reference value; see Section 4.2.2 of the main text.
ug/kg — Microgram per kilogram
ug/kg-day — Microgram per kilogram per day

TABLE B-4

CTE PERCENT ALLOWABLE CONSUMPTION, NOVEMBER 2000 FISH DATA
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

	Mink		Kingfisher			
	Dietary Basis		Dose Basis			
Station	NOAEC PAC	LOAEC PAC	No Effect PAC	NOAEL PAC	Low Effect PAC	LOAEL PAC
2	42.11	50.54	55.34	15.22	69.18	154.97
3	55.14	66.16	72.29	19.88	90.36	202.41
4	37.17	44.61	48.48	13.33	60.59	135.73
TRV	500 ug/kg	600 ug/kg	400 ug/kg-day	110 ug/kg-day	500 ug/kg-day	1,120 ug/kg-day

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 2 — Country Club Road
- 3 — Fluckmill Road
- 4 — Strainridge Road

PAC (Percent Allowable Consumption, %) = (1 / HQ) x 100; the PAC is the percent of an animals diet that can be consumed within a station reach and not exceed the TRV.

%	Percent
CTE	Central tendency exposure
HQ	Hazard quotient; where mink HQ = concentration in mink diet / TRV and kingfisher HQ = concentration in kingfisher dose / TRV
LOAEC	Lowest-observed-adverse-effect concentration
LOAEL	Lowest-observed-adverse-effect level
NOAEC	No-observed-adverse-effect concentration
NOAEL	No-observed-adverse-effect level
TRV	Toxicity reference value; see Section 4.2.2 of the main text.
ug/kg	Microgram per kilogram
ug/kg-day	Microgram per kilogram per day

APPENDIX C

MINK AND KINGFISHER RISK ESTIMATES, NOVEMBER 2002

(18 Pages)

TABLE C-1

RME PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK, NOVEMBER 2002 FISH DATA (4-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

				Mink			Kingfisher					
Station	Species	N	Concentration in Fish and Crayfish (ug/kg)	Concentration in Diet (ug/kg)	HQ No Effect (ratio)	HQ Low Effect (ratio)	Concentration in Diet (ug/kg)	Concentration in Dose (ug/kg-day)	HQ No Effect (ratio)	HQ NOAEL (ratio)	HQ Low Effect (ratio)	HQ LOAEL (ratio)
1	CRC	11	12022	8063.02	16.13	13.44	9815.19	4907.60	12.27	44.61	9.82	4.38
1	CF	--	986.12									
2	CRC	6	984	960.55	1.92	1.60	1168.27	584.14	1.46	5.31	1.17	0.52
2	GS	5	1889									
2	CF	--	94									
3	CRC	5	805	841.82	1.68	1.40	1038.16	519.08	1.30	4.72	1.04	0.46
3	GS	6	1581									
3	CF	--	419									
4	LS	6	3626	2047.20	4.09	3.41	2522.22	1261.11	3.15	11.46	2.52	1.13
4	RB	5	2199									
4	CF	--	961									

Notes:

Station	Fish sample collection station (see Figure 3 of the main text)	
	1	Allen Street
	2	Country Club Road
	3	Fluckmill Road
	4	Strainridge Road
Species	Sampled fish species	
	CF	Crayfish
	GS	Green sunfish
	CRC	Creek chub
	LS	Longear sunfish
	RB	Rock bass

Definitions:

HQ	Hazard quotient
IR	Ingestion rate (kingfisher)
kg	Kilogram
LOAEL	Lowest-observed-adverse-effect level
N	Number of samples
NOAEL	No-observed-adverse-effect level
PCB	Polychlorinated biphenyl
RME	Reasonable maximum exposure
TRV	Toxicity reference value
ug/kg	Microgram per kilogram
ug/kg-day	Microgram per kilogram per day
--	Not applicable; crayfish concentration was modeled

TABLE C-1

RME PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK, NOVEMBER 2002 FISH DATA (4-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Notes (Continued):

Concentration in Fish & Crayfish:	For the RME scenario, for fish species data sets with more 4 or more samples, the 95-percent upper confidence limit was used as the fish species concentration for data sets with less than 4 samples, the maximum detected concentration was used as the species concentration. Crayfish concentrations were modeled
Mink, Concentration in Diet:	Concentration of PCBs in the mink diet = (0.66 x mean concentration of the RME fish species concentration) + (0.13 x modeled crayfish concentration)
Mink, HQ, No Effect:	HQ = Concentration of PCBs in the mink diet / No effect-based TRV, where TRV = 500 ug/kg
Mink, HQ, Low Effect:	HQ = Concentration of PCBs in the mink diet / Low effect-based TRV, where TRV = 600 ug/kg
Kingfisher, Concentration in Diet:	Concentration of PCBs in the kingfisher diet = (0.80 x mean concentration of the RME fish species concentration) + (0.20 x modeled crayfish concentration)
Kingfisher, Concentration in Dose:	Concentration of PCBs in kingfisher diet (expressed as a dose) = (Concentration of PCBs in the kingfisher diet x IR), where IR = 0.5 kg food per kg body weigh
Kingfisher, HQ, No Effect:	HQ = Concentration of PCBs in kingfisher dose / No effect-based TRV; where TRV = 400 ug/kg-day
Kingfisher, HQ, NOAEL:	HQ = Concentration of PCBs in kingfisher dose / NOAEL-based TRV; where TRV = 110 ug/kg-day
Kingfisher, HQ, Low Effect:	HQ = Concentration of PCBs in kingfisher dose / Low effect-based TRV; where TRV = 500 ug/kg-day
Kingfisher, HQ, LOAEL:	HQ = Concentration of PCBs in kingfisher dose / LOAEL-based TRV; where TRV = 1,120 ug/kg-day

TABLE C-2

CTE PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK, NOVEMBER 2002 FISH DATA (4-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

				Mink			Kingfisher					
Station	Species	N	Concentration in Fish and Crayfish (ug/kg)	Concentration in Diet (ug/kg)	HQ No Effect (ratio)	HQ Low Effect (ratio)	Concentration in Diet (ug/kg)	Concentration in Dose (ug/kg-day)	HQ No Effect (ratio)	HQ NOAEL (ratio)	HQ Low Effect (ratio)	HQ LOAEL (ratio)
1	CRC	11	8908	5974.39	11.95	9.96	7272.68	3636.34	9.09	33.06	7.27	3.25
1	CF	--	731									
2	CRC	6	787	736.87	1.47	1.23	896.21	448.11	1.12	4.07	0.90	0.40
2	GS	6	1418									
2	CF	--	72									
3	CRC	5	588	639.28	1.28	1.07	788.62	394.31	0.99	3.58	0.79	0.35
3	GS	6	1222									
3	CF	--	324									
4	LS	6	2457	1424.66	2.85	2.37	1754.48	877.24	2.19	7.97	1.75	0.78
4	RB	5	1604									
4	CF	--	651									

Notes:

Station	Fish sample collection station (see Figure 3 of the main text)	
	1	Allen Street
	2	Country Club Road
	3	Fluckmill Road
	4	Strainridge Road
Species	Sampled fish species	
	CF	Crayfish
	CRC	Creek chub
	GS	Green sunfish
	LS	Longear sunfish
	RB	Rock bass

Definitions:

CTE	Central tendency exposure
HQ	Hazard quotient
IR	Ingestion rate (kingfisher)
kg	Kilogram
LOAEL	Lowest-observed-adverse-effect level
N	Number of samples
NOAEL	No-observed-adverse-effect level
PCB	Polychlorinated biphenyl
TRV	Toxicity reference value
ug/kg	Microgram per kilogram
ug/kg-day	Microgram per kilogram per day
--	Not applicable; crayfish concentration was modeled.

TABLE C-2

CTE PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK, NOVEMBER 2002 FISH DATA (4-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Notes (Continued):

Concentration in Fish & Crayfish:	For the CTE scenario, the arithmetic mean was used as the fish species concentration; crayfish concentrations were modeled.
Mink, Concentration in Diet:	Concentration of PCBs in the mink diet = (0.66 x mean concentration of the CTE fish species concentration) + (0.13 x modeled crayfish concentration)
Mink, HQ, No Effect:	HQ = Concentration of PCBs in the mink diet / No effect-based TRV, where TRV = 500 ug/kg
Mink, HQ, Low Effect:	HQ = Concentration of PCBs in the mink diet / Low effect-based TRV, where TRV = 600 ug/kg
Kingfisher, Concentration in Diet:	Concentration of PCBs in the kingfisher diet = (0.80 x mean concentration of the CTE fish species concentration) + (0.20 x modeled crayfish concentration)
Kingfisher, Concentration in Dose:	Concentration of PCBs in kingfisher diet (expressed as a dose) = (Concentration of PCBs in the kingfisher diet x IR), where IR = 0.5 kg food per kg body weigh
Kingfisher, HQ, No Effect:	HQ = Concentration of PCBs in kingfisher dose / No effect-based TRV; where TRV = 400 ug/kg-day
Kingfisher, HQ, NOAEL:	HQ = Concentration of PCBs in kingfisher dose / NOAEL-based TRV; where TRV = 110 ug/kg-day
Kingfisher, HQ, Low Effect:	HQ = Concentration of PCBs in kingfisher dose / Low effect-based TRV; where TRV = 500 ug/kg-day
Kingfisher, HQ, LOAEL:	HQ = Concentration of PCBs in kingfisher dose / LOAEL-based TRV; where TRV = 1,120 ug/kg-day

TABLE C-3

RME PERCENT ALLOWABLE CONSUMPTION, NOVEMBER 2002 FISH DATA (4-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Mink		Kingfisher			
	Dietary Basis		Dose Basis			
	NOAEC PAC	LOAEC PAC	No Effect PAC	NOAEL PAC	Low Effect PAC	LOAEL PAC
1	6.20	7.44	8.15	2.24	10.19	22.82
2	52.05	62.46	68.48	18.83	85.60	191.74
3	59.40	71.27	77.06	21.19	96.32	215.77
4	24.42	29.31	31.72	8.72	39.65	88.81
TRV	500 ug/kg	600 ug/kg	400 ug/kg-day	110 ug/kg-day	500 ug/kg-day	1,120 ug/kg-day

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 1 — Allen Street
- 2 — Country Club Road
- 3 — Fluckmill Road
- 4 — Strainridge Road

PAC (Percent Allowable Consumption, %) = (1 / HQ) x 100; the PAC is the percent of an animals diet that can be consumed within a station reach and not exceed the TRV.

% — Percent
HQ — Hazard quotient; where mink HQ = concentration in mink diet / TRV and kingfisher HQ = concentration in kingfisher dose / TRV
LOAEC — Lowest-observed-adverse-effect concentration
LOAEL — Lowest-observed-adverse-effect level
NOAEC — No-observed-adverse-effect concentration
NOAEL — No-observed-adverse-effect level
RME — Reasonable maximum exposure
TRV — Toxicity reference value; see Section 4.2.2 of the main text.
ug/kg — Microgram per kilogram
ug/kg-day — Microgram per kilogram per day

TABLE C-4

CTE PERCENT ALLOWABLE CONSUMPTION, NOVEMBER 2002 FISH DATA (4-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Mink		Kingfisher			
	Dietary Basis		Dose Basis			
	NOAEC PAC	LOAEC PAC	No Effect PAC	NOAEL PAC	Low Effect PAC	LOAEL PAC
1	8.37	10.04	11.00	3.03	13.75	30.80
2	67.85	81.43	89.26	24.55	111.58	249.94
3	78.21	93.86	101.44	27.90	126.80	284.04
4	35.10	42.12	45.60	12.54	57.00	127.67
TRV	500 ug/kg	600 ug/kg	400 ug/kg-day	110 ug/kg-day	500 ug/kg-day	1,120 ug/kg-day

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 1 — Allen Street
- 2 — Country Club Road
- 3 — Fluckmill Road
- 4 — Strainridge Road

PAC (Percent Allowable Consumption, %) = (1 / HQ) x 100; the PAC is the percent of an animals diet that can be consumed within a station reach and not exceed the TRV.

% — Percent
CTE — Central tendency exposure
HQ — Hazard quotient; where mink HQ = concentration in mink diet / TRV and kingfisher HQ = concentration in kingfisher dose / TRV
LOAEC — Lowest-observed-adverse-effect concentration
LOAEL — Lowest-observed-adverse-effect level
NOAEC — No-observed-adverse-effect concentration
NOAEL — No-observed-adverse-effect level
TRV — Toxicity reference value; see Section 4.2.2 of the main text.
ug/kg — Microgram per kilogram
ug/kg-day — Microgram per kilogram per day

TABLE C-5

RME PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK, NOVEMBER 2002 FISH DATA (5-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

				Mink			Kingfisher					
Station	Species	N	Concentration in Fish and Crayfish (ug/kg)	Concentration in Diet (ug/kg)	HQ No Effect (ratio)	HQ Low Effect (ratio)	Concentration in Diet (ug/kg)	Concentration in Dose (ug/kg-day)	HQ No Effect (ratio)	HQ NOAEL (ratio)	HQ Low Effect (ratio)	HQ LOAEL (ratio)
1	CRC	11	10297	6905.90	13.81	11.51	8406.62	4203.31	10.51	38.21	8.41	3.75
1	CF	--	844.60									
2	CRC	6	950	876.34	1.75	1.46	1065.85	532.92	1.33	4.84	1.07	0.48
2	GS	5	1671									
2	CF	--	85									
3	CRC	5	665	711.35	1.42	1.19	877.42	438.71	1.10	3.99	0.88	0.39
3	GS	6	1350									
3	CF	--	358									
4	LS	6	3658	2094.53	4.19	3.49	2579.95	1289.97	3.22	11.73	2.58	1.15
4	RB	5	2307									
4	CF	--	969									

Notes:

Station	Fish sample collection station (see Figure 3 of the main text)	
	1	Allen Street
	2	Country Club Road
	3	Fluckmill Road
	4	Strainridge Road
Species	Sampled fish species	
	CF	Crayfish
	CRC	Creek chub
	GS	Green sunfish
	LS	Longear sunfish
	RB	Rock bass

Definitions:

HQ	Hazard quotient
IR	Ingestion rate (kingfisher)
kg	Kilogram
LOAEL	Lowest-observed-adverse-effect level
N	Number of samples
NOAEL	No-observed-adverse-effect level
PCB	Polychlorinated biphenyl
RME	Reasonable maximum exposure
TRV	Toxicity reference value
ug/kg	Microgram per kilogram
ug/kg-day	Microgram per kilogram per day
--	Not applicable; crayfish concentration was modeled.

TABLE C-5

RME PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK, NOVEMBER 2002 FISH DATA (5-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Notes (Continued):

Concentration in Fish & Crayfish:	For the RME scenario, for fish species data sets with more 4 or more samples, the 95-percent upper confidence limit was used as the fish species concentration for data sets with less than 4 samples, the maximum detected concentration was used as the species concentration. Crayfish concentrations were modeled
Mink, Concentration in Diet:	Concentration of PCBs in the mink diet = (0.66 x mean concentration of the RME fish species concentration) + (0.13 x modeled crayfish concentration)
Mink, HQ, No Effect:	HQ = Concentration of PCBs in the mink diet / No effect-based TRV, where TRV = 500 ug/kg
Mink, HQ, Low Effect:	HQ = Concentration of PCBs in the mink diet / Low effect-based TRV, where TRV = 600 ug/kg
Kingfisher, Concentration in Diet:	Concentration of PCBs in the kingfisher diet = (0.80 x mean concentration of the RME fish species concentration) + (0.20 x modeled crayfish concentration)
Kingfisher, Concentration in Dose:	Concentration of PCBs in kingfisher diet (expressed as a dose) = (Concentration of PCBs in the kingfisher diet x IR), where IR = 0.5 kg food per kg body weigh
Kingfisher, HQ, No Effect:	HQ = Concentration of PCBs in kingfisher dose / No effect-based TRV; where TRV = 400 ug/kg-day
Kingfisher, HQ, NOAEL:	HQ = Concentration of PCBs in kingfisher dose / NOAEL-based TRV; where TRV = 110 ug/kg-day
Kingfisher, HQ, Low Effect:	HQ = Concentration of PCBs in kingfisher dose / Low effect-based TRV; where TRV = 500 ug/kg-day
Kingfisher, HQ, LOAEL:	HQ = Concentration of PCBs in kingfisher dose / LOAEL-based TRV; where TRV = 1,120 ug/kg-day

TABLE C-6

CTE PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK, NOVEMBER 2002 FISH DATA (5-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

				Mink			Kingfisher					
Station	Species	N	Concentration in Fish and Crayfish (ug/kg)	Concentration in Diet (ug/kg)	HQ No Effect (ratio)	HQ Low Effect (ratio)	Concentration in Diet (ug/kg)	Concentration in Dose (ug/kg-day)	HQ No Effect (ratio)	HQ NOAEL (ratio)	HQ Low Effect (ratio)	HQ LOAEL (ratio)
1	CRC	11	7739	5190.32	10.38	8.65	6318.23	3159.11	7.90	28.72	6.32	2.82
1	CF	--	635									
2	CRC	6	780	688.51	1.38	1.15	837.41	418.70	1.05	3.81	0.84	0.37
2	GS	6	1280									
2	CF	--	67									
3	CRC	5	474	543.35	1.09	0.91	670.54	335.27	0.84	3.05	0.67	0.30
3	GS	6	1062									
3	CF	--	281									
4	LS	6	2402	1384.81	2.77	2.31	1705.56	852.78	2.13	7.75	1.71	0.76
4	RB	5	1544									
4	CF	--	636									

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 1 Allen Street
- 2 Country Club Road
- 3 Fluckmill Road
- 4 Strainridge Road

Species — Sampled fish species
- CF Crayfish
- CRC Creek chub
- GS Green sunfish
- LS Longear sunfish
- RB Rock bass

Definitions:

CTE	Central tendency exposure
HQ	Hazard quotient
IR	Ingestion rate (kingfisher)
kg	Kilogram
LOAEL	Lowest-observed-adverse-effect level
N	Number of samples
NOAEL	No-observed-adverse-effect level
PCB	Polychlorinated biphenyl
TRV	Toxicity reference value
ug/kg	Microgram per kilogram
ug/kg-day	Microgram per kilogram per day
--	Not applicable; crayfish concentration was modeled.

TABLE C-6

CTE PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK, NOVEMBER 2002 FISH DATA (5-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Notes (Continued):

Concentration in Fish & Crayfish:	For the CTE scenario, the arithmetic mean was used as the fish species concentration; crayfish concentrations were modeled.
Mink, Concentration in Diet:	Concentration of PCBs in the mink diet = (0.66 x mean concentration of the CTE fish species concentration) + (0.13 x modeled crayfish concentration)
Mink, HQ, No Effect:	HQ = Concentration of PCBs in the mink diet / No effect-based TRV, where TRV = 500 ug/kg
Mink, HQ, Low Effect:	HQ = Concentration of PCBs in the mink diet / Low effect-based TRV, where TRV = 600 ug/kg
Kingfisher, Concentration in Diet:	Concentration of PCBs in the kingfisher diet = (0.80 x mean concentration of the CTE fish species concentration) + (0.20 x modeled crayfish concentration)
Kingfisher, Concentration in Dose:	Concentration of PCBs in kingfisher diet (expressed as a dose) = (Concentration of PCBs in the kingfisher diet x IR), where IR = 0.5 kg food per kg body weigh
Kingfisher, HQ, No Effect:	HQ = Concentration of PCBs in kingfisher dose / No effect-based TRV; where TRV = 400 ug/kg-day
Kingfisher, HQ, NOAEL:	HQ = Concentration of PCBs in kingfisher dose / NOAEL-based TRV; where TRV = 110 ug/kg-day
Kingfisher, HQ, Low Effect:	HQ = Concentration of PCBs in kingfisher dose / Low effect-based TRV; where TRV = 500 ug/kg-day
Kingfisher, HQ, LOAEL:	HQ = Concentration of PCBs in kingfisher dose / LOAEL-based TRV; where TRV = 1,120 ug/kg-day

TABLE C-7

RME PERCENT ALLOWABLE CONSUMPTION, NOVEMBER 2002 FISH DATA (5-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

	Mink		Kingfisher			
	Dietary Basis		Dose Basis			
Station	NOAEC PAC	LOAEC PAC	No Effect PAC	NOAEL PAC	Low Effect PAC	LOAEL PAC
1	7.24	8.69	9.52	2.62	11.90	26.65
2	57.06	68.47	75.06	20.64	93.82	210.16
3	70.29	84.35	91.18	25.07	113.97	255.29
4	23.87	28.65	31.01	8.53	38.76	86.82
TRV	500 ug/kg	600 ug/kg	400 ug/kg-day	110 ug/kg-day	500 ug/kg-day	1,120 ug/kg-day

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 1 — Allen Street
- 2 — Country Club Road
- 3 — Fluckmill Road
- 4 — Strainridge Road

PAC (Percent Allowable Consumption, %) = (1 / HQ) x 100; the PAC is the percent of an animals diet that can be consumed within a station reach and not exceed the TRV.

% — Percent
HQ — Hazard quotient; where mink HQ = concentration in mink diet / TRV and kingfisher HQ = concentration in kingfisher dose / TRV
LOAEC — Lowest-observed-adverse-effect concentration
LOAEL — Lowest-observed-adverse-effect level
NOAEC — No-observed-adverse-effect concentration
NOAEL — No-observed-adverse-effect level
RME — Reasonable maximum exposure
TRV — Toxicity reference value; see Section 4.2.2 of the main text.
ug/kg — Microgram per kilogram
ug/kg-day — Microgram per kilogram per day

TABLE C-8

CTE PERCENT ALLOWABLE CONSUMPTION, NOVEMBER 2002 FISH DATA (5-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Mink		Kingfisher			
	Dietary Basis		Dose Basis			
	NOAEC PAC	LOAEC PAC	No Effect PAC	NOAEL PAC	Low Effect PAC	LOAEL PAC
1	9.63	11.56	12.66	3.48	15.83	35.45
2	72.62	87.14	95.53	26.27	119.42	267.49
3	92.02	110.43	119.31	32.81	149.13	334.06
4	36.11	43.33	46.91	12.90	58.63	131.34
TRV	500 ug/kg	600 ug/kg	400 ug/kg-day	110 ug/kg-day	500 ug/kg-day	1,120 ug/kg-day

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 1 Allen Street
- 2 Country Club Road
- 3 Fluckmill Road
- 4 Strainridge Road

PAC (Percent Allowable Consumption, %) = (1 / HQ) x 100; the PAC is the percent of an animals diet that can be consumed within a station reach and not exceed the TRV.

% — Percent

CTE — Central tendency exposure

HQ — Hazard quotient; where mink HQ = concentration in mink diet / TRV and kingfisher HQ = concentration in kingfisher dose / TRV

LOAEC — Lowest-observed-adverse-effect concentration

LOAEL — Lowest-observed-adverse-effect level

NOAEC — No-observed-adverse-effect concentration

NOAEL — No-observed-adverse-effect level

TRV — Toxicity reference value; see Section 4.2.2 of the main text.

ug/kg — Microgram per kilogram

ug/kg-day — Microgram per kilogram per day

TABLE C-9

RME PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK USING FISH:CRAYFISH RATIOS FROM THE NEAL'S LANDFILL FERA, NOVEMBER 2002 FISH DATA (4-PEAK) LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

				Mink			Kingfisher					
Station	Species	N	Concentration in Fish and Crayfish (ug/kg)	Concentration in Diet (ug/kg)	HQ No Effect (ratio)	HQ Low Effect (ratio)	Concentration in Diet (ug/kg)	Concentration in Dose (ug/kg-day)	HQ No Effect (ratio)	HQ NOAEL (ratio)	HQ Low Effect (ratio)	HQ LOAEL (ratio)
1	CRC	11	12022	8524.60	17.05	14.21	10525.32	5262.66	13.16	47.84	10.53	4.70
1	CF	--	4536.78									
2	CRC	6	984	1010.87	2.02	1.68	1245.68	622.84	1.56	5.66	1.25	0.56
2	GS	5	1889									
2	CF	--	481									
3	CRC	5	805	839.22	1.68	1.40	1034.16	517.08	1.29	4.70	1.03	0.46
3	GS	6	1581									
3	CF	--	399									
4	LS	6	3626	2064.26	4.13	3.44	2548.46	1274.23	3.19	11.58	2.55	1.14
4	RB	5	2199									
4	CF	--	1092									

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 1 Allen Street
- 2 Country Club Road
- 3 Fluckmill Road
- 4 Strainridge Road

Species — Sampled fish species
- CF Crayfish
- GS Green sunfish
- CRC Creek chub
- LS Longear sunfish
- RB Rock bass

Definitions:

HQ	Hazard quotient
IR	Ingestion rate (kingfisher)
kg	Kilogram
LOAEL	Lowest-observed-adverse-effect level
N	Number of samples
NOAEL	No-observed-adverse-effect level
PCB	Polychlorinated biphenyl
RME	Reasonable maximum exposure
TRV	Toxicity reference value
ug/kg	Microgram per kilogram
ug/kg-day	Microgram per kilogram per day
--	Not applicable; crayfish concentration was modeled

TABLE C-9

RME PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK USING FISH:CRAYFISH RATIOS FROM THE NEAL'S LANDFILL FERA, NOVEMBER 2002 FISH DATA (4-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Notes (Continued):

Concentration in Fish & Crayfish:	For the RME scenario, for fish species data sets with more 4 or more samples, the 95-percent upper confidence limit was used as the fish species concentration for data sets with less than 4 samples, the maximum detected concentration was used as the species concentration. Crayfish concentrations were modeled using fish:crayfish ratios from the Neal's Landfill focused ecological risk assessment (EPA 2003)
Mink, Concentration in Diet:	Concentration of PCBs in the mink diet = (0.66 x mean concentration of the RME fish species concentration) + (0.13 x modeled crayfish concentration)
Mink, HQ, No Effect:	HQ = Concentration of PCBs in the mink diet / No effect-based TRV, where TRV = 500 ug/kg
Mink, HQ, Low Effect:	HQ = Concentration of PCBs in the mink diet / Low effect-based TRV, where TRV = 600 ug/kg
Kingfisher, Concentration in Diet:	Concentration of PCBs in the kingfisher diet = (0.80 x mean concentration of the RME fish species concentration) + (0.20 x modeled crayfish concentration)
Kingfisher, Concentration in Dose:	Concentration of PCBs in kingfisher diet (expressed as a dose) = (Concentration of PCBs in the kingfisher diet x IR), where IR = 0.5 kg food per kg body weigh
Kingfisher, HQ, No Effect:	HQ = Concentration of PCBs in kingfisher dose / No effect-based TRV; where TRV = 400 ug/kg-day
Kingfisher, HQ, NOAEL:	HQ = Concentration of PCBs in kingfisher dose / NOAEL-based TRV; where TRV = 110 ug/kg-day
Kingfisher, HQ, Low Effect:	HQ = Concentration of PCBs in kingfisher dose / Low effect-based TRV; where TRV = 500 ug/kg-day
Kingfisher, HQ, LOAEL:	HQ = Concentration of PCBs in kingfisher dose / LOAEL-based TRV; where TRV = 1,120 ug/kg-day

TABLE C-10

RME PERCENT ALLOWABLE CONSUMPTION, NOVEMBER 2002 FISH DATA (4-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Mink		Kingfisher			
	Dietary Basis		Dose Basis			
	NOAEC PAC	LOAEC PAC	No Effect PAC	NOAEL PAC	Low Effect PAC	LOAEL PAC
1	5.87	7.04	7.60	2.09	9.50	21.28
2	49.46	59.35	64.22	17.66	80.28	179.82
3	59.58	71.50	77.36	21.27	96.70	216.60
4	24.22	29.07	31.39	8.63	39.24	87.90
TRV	500 ug/kg	600 ug/kg	400 ug/kg-day	110 ug/kg-day	500 ug/kg-day	1,120 ug/kg-day

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 1 — Allen Street
- 2 — Country Club Road
- 3 — Fluckmill Road
- 4 — Strainridge Road

PAC (Percent Allowable Consumption, %) = (1 / HQ) x 100; the PAC is the percent of an animals diet that can be consumed within a station reach and not exceed the TRV.

% — Percent
HQ — Hazard quotient; where mink HQ = concentration in mink diet / TRV and kingfisher HQ = concentration in kingfisher dose / TRV
LOAEC — Lowest-observed-adverse-effect concentration
LOAEL — Lowest-observed-adverse-effect level
NOAEC — No-observed-adverse-effect concentration
NOAEL — No-observed-adverse-effect level
RME — Reasonable maximum exposure
TRV — Toxicity reference value; see Section 4.2.2 of the main text.
ug/kg — Microgram per kilogram
ug/kg-day — Microgram per kilogram per day

TABLE C-11

RME PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK FOR STATION 1&2 COMBINED, NOVEMBER 2002 FISH DATA (4-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

				Mink			Kingfisher					
Station	Species	N	Concentration in Fish and Crayfish (ug/kg)	Concentration in Diet (ug/kg)	HQ No Effect (ratio)	HQ Low Effect (ratio)	Concentration in Diet (ug/kg)	Concentration in Dose (ug/kg-day)	HQ No Effect (ratio)	HQ NOAEL (ratio)	HQ Low Effect (ratio)	HQ LOAEL (ratio)
1	CRC	11	12022	8063.02	16.13	13.44	9815.19	4907.60	12.27	44.61	9.82	4.38
1	CF	--	986.12									
2	CRC	6	984	960.55	1.92	1.60	1168.27	584.14	1.46	5.31	1.17	0.52
2	GS	5	1889									
2	CF	--	94									
1&2	--	--	--	1670.80	3.34	2.78	2032.96	1016.48	2.54	9.24	2.03	0.91

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 1 — Allen Street
- 2 — Country Club Road
- 1&2 — Combined; assumes receptor forages 10 percent at Station 1 reach and 90 percent at Station 2 reach

Species — Sampled fish species
- CF — Crayfish
- GS — Green sunfish
- CRC — Creek chub

Definitions:

HQ	Hazard quotient
IR	Ingestion rate (kingfisher)
kg	Kilogram
LOAEL	Lowest-observed-adverse-effect level
N	Number of samples
NOAEL	No-observed-adverse-effect level
PCB	Polychlorinated biphenyl
RME	Reasonable maximum exposure
TRV	Toxicity reference value
ug/kg	Microgram per kilogram
ug/kg-day	Microgram per kilogram per day
--	Not applicable; crayfish concentration was modeled

TABLE C-11

RME PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK FOR STATION 1&2 COMBINED, NOVEMBER 2002 FISH DATA (4-PEAK)
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Notes (Continued):

Concentration in Fish & Crayfish:	For the RME scenario, for fish species data sets with more 4 or more samples, the 95-percent upper confidence limit was used as the fish species concentration for data sets with less than 4 samples, the maximum detected concentration was used as the species concentration. Crayfish concentrations were modeled
Mink, Concentration in Diet:	Concentration of PCBs in the mink diet = (0.66 x mean concentration of the RME fish species concentration) + (0.13 x modeled crayfish concentration)
Mink, HQ, No Effect:	HQ = Concentration of PCBs in the mink diet / No effect-based TRV, where TRV = 500 ug/kg
Mink, HQ, Low Effect:	HQ = Concentration of PCBs in the mink diet / Low effect-based TRV, where TRV = 600 ug/kg
Kingfisher, Concentration in Diet:	Concentration of PCBs in the kingfisher diet = (0.80 x mean concentration of the RME fish species concentration) + (0.20 x modeled crayfish concentration)
Kingfisher, Concentration in Dose:	Concentration of PCBs in kingfisher diet (expressed as a dose) = (Concentration of PCBs in the kingfisher diet x IR), where IR = 0.5 kg food per kg body weigh
Kingfisher, HQ, No Effect:	HQ = Concentration of PCBs in kingfisher dose / No effect-based TRV; where TRV = 400 ug/kg-day
Kingfisher, HQ, NOAEL:	HQ = Concentration of PCBs in kingfisher dose / NOAEL-based TRV; where TRV = 110 ug/kg-day
Kingfisher, HQ, Low Effect:	HQ = Concentration of PCBs in kingfisher dose / Low effect-based TRV; where TRV = 500 ug/kg-day
Kingfisher, HQ, LOAEL:	HQ = Concentration of PCBs in kingfisher dose / LOAEL-based TRV; where TRV = 1,120 ug/kg-day
Station 1&2 Concentration in Diet:	HQ = (Concentration of PCBs in diet/dose at Station 1 x 0.1 + Concentration of PCBs in diet/dose at Station 2 x 0.9) / TRV

TABLE C-12

RME PERCENT ALLOWABLE CONSUMPTION FOR STATION 1&2 COMBINED
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

	Mink		Kingfisher			
	Dietary Basis		Dose Basis			
Station	NOAEC PAC	LOAEC PAC	No Effect PAC	NOAEL PAC	Low Effect PAC	LOAEL PAC
1&2	29.93	35.91	39.35	10.82	49.19	110.18
TRV	500 ug/kg	600 ug/kg	400 ug/kg-day	110 ug/kg-day	500 ug/kg-day	1,120 ug/kg-day

Notes:

Station Fish sample collection station (see Figure 3 of the main text)
1 Allen Street
2 Country Club Road

PAC (Percent Allowable Consumption, %) was calculated for an receptors that make partial use of the Station 1 reach. For comparison purposes, a receptor was assumed to forage within the Station 2 reach 90 percent of the time and within the Station 1 reach 10 percent of the time.

PAC = (1 / Station 1&2 HQ) x 100; the PAC is the percent of an animals diet that can be consumed within the combined Station 1 and Station 2 reach and not exceed the TRV.

% Percent
HQ Hazard quotient; where mink HQ = concentration in mink diet / TRV and kingfisher HQ = concentration in kingfisher dose / TRV
LOAEC Lowest-observed-adverse-effect concentration
LOAEL Lowest-observed-adverse-effect level
NOAEC No-observed-adverse-effect concentration
NOAEL No-observed-adverse-effect level
RME Reasonable maximum exposure
TRV Toxicity reference value; see Section 4.2.2 of the main text.
ug/kg Microgram per kilogram
ug/kg-day Microgram per kilogram per day

TABLE A-2

PCB CONCENTRATIONS IN WHOLE FISH SAMPLES
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

ID	November 2004					
	Station	Species	Total PCB Concentration (µg/kg)	95UCL Concentration (µg/kg)	Mean PCB Concentration (µg/kg)	Percent Lipids
CC-0045	1	CRC	1,900	2,562	1,807	1.14
CC-0046	1	CRC	1,200			1.51
CC-0047	1	CRC	650			1.09
CC-0048	1	CRC	3,400			1.7
CC-0049	1	CRC	1,100			1.21
CC-0050	1	CRC	1,400			2.3
CC-0051	1	CRC	3,000			1.96
CC-0077	1	CF	720	1,400	913	2.58
CC-0078	1	CF	1,400			3.54
CC-0079	1	CF	620			1.7
CC-0062	2	GS	1,900	2,094	1,817	2.61
CC-0063	2	GS	1,800			2.75
CC-0064	2	GS	2,400			2.52
CC-0065	2	GS	1,600			2.92
CC-0066	2	GS	1,400			2.46
CC-0067	2	GS	1,800			3.02
CC-0069	2	WS	2,600	2,457	2,000	2.25
CC-0070	2	WS	2,700			2.78
CC-0071	2	WS	2,100			1.26
CC-0072	2	WS	1,600			1.02
CC-0073	2	WS	1,400			1.1
CC-0074	2	WS	1,600			1.4
CC-0055	2	CRC	980	1,825	1,180	0.93
CC-0056	2	CRC	1,300			1.78
CC-0057	2	CRC	300			0.93
CC-0058	2	CRC	2,600			1.05
CC-0059	2	CRC	700			0.99
CC-0060	2	CRC	1,200			1.13
CC-0054	3	GS	890	2,075	1,302	1.4
CC-0020	3	GS	12,000			5.25
CC-0021	3	GS	1,700			2.35
CC-0022	3	GS	420			1.92
CC-0023	3	GS	1,000			1.77
CC-0024	3	GS	2,500			3.32

APPENDIX D

MINK AND KINGFISHER RISK ESTIMATES, NOVEMBER 2004

(Four Pages)

TABLE D-1

RME TOTAL PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK, NOVEMBER 2004 FISH DATA
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

				Mink			Kingfisher					
Station	Species	N	Concentration in Fish and Crayfish (µg/kg)	Concentration in Diet (µg/kg)	HQ No Effect (ratio)	HQ Low Effect (ratio)	Concentration in Diet (µg/kg-diet)	Concentration in Dose (µg/kg-day)	HQ No Effect (ratio)	HQ NOAEL (ratio)	HQ Low Effect (ratio)	HQ LOAEL (ratio)
1	CRC	7	2562	1872.92	3.75	3.12	2329.60	1164.80	2.91	10.59	2.33	1.04
1	CF	3	1400									
2	GS	6	2094	1522.63	3.05	2.54	1884.74	942.37	2.36	8.57	1.88	0.84
2	WS	6	2457									
2	CRC	6	1825									
2	CF	--	922									
3	GS	5	2075	1220.09	2.44	2.03	1503.51	751.75	1.88	6.83	1.50	0.67
3	WS	6	1980									
3	CRC	7	1148									
3	CF	--	580									
4	LS	6	2985	1787.38	3.57	2.98	2230.52	1115.26	2.79	10.14	2.23	1.00
4	RH	5	1837									
4	CF	--	1509									

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 1 Allen Street
- 2 Country Club Road
- 3 Fluckmill Road
- 4 Strainridge Road

Species — Sampled fish species
- CF Crayfish
- CRC Creek chub
- GS Green sunfish
- LS Longear sunfish
- RH Black red horse
- WS White sucker

Definitions:

HQ	Hazard quotient
IR	Ingestion rate (kingfisher)
kg	Kilogram
LOAEL	Lowest-observed-adverse-effect level
N	Number of samples
NOAEL	No-observed-adverse-effect level
PCB	Polychlorinated biphenyl
RME	Reasonable maximum exposure
TRV	Toxicity reference value
ug/kg	Microgram per kilogram
ug/kg-day	Microgram per kilogram per day
--	Not applicable; crayfish concentration was modeled.

Concentration in Fish & Crayfish:	For the RME scenario, for fish species data sets with more 4 or more samples, the 95-percent upper confidence limit was used as the fish species concentration; for data sets with less than 4 samples, the maximum detected concentration was used as the species concentration. Crayfish concentrations were modeled.
Mink, Concentration in Diet:	Concentration of PCBs in the mink diet = (0.66 x mean concentration of the RME fish species concentration) + (0.13 x modeled crayfish concentration)
Mink, HQ, No Effect:	HQ = Concentration of PCBs in the mink diet / No effect-based TRV, where TRV = 500 µg/kg
Mink, HQ, Low Effect:	HQ = Concentration of PCBs in the mink diet / Low effect-based TRV, where TRV = 600 µg/kg
Kingfisher, Concentration in Diet:	Concentration of PCBs in the kingfisher diet = (0.80 x mean concentration of the RME fish species concentration) + (0.20 x modeled crayfish concentration)
Kingfisher, Concentration in Dose:	Concentration of PCBs in kingfisher diet (expressed as a dose) = (Concentration of PCBs in the kingfisher diet x IR), where IR = 0.5 kg food per kg body weight
Kingfisher, HQ, No Effect:	HQ = Concentration of PCBs in kingfisher dose / No effect-based TRV; where TRV = 400 µg/kg-day
Kingfisher, HQ, NOAEL:	HQ = Concentration of PCBs in kingfisher dose / NOAEL-based TRV; where TRV = 110 µg/kg-day
Kingfisher, HQ, Low Effect:	HQ = Concentration of PCBs in kingfisher dose / Low effect-based TRV; where TRV = 500 µg/kg-day
Kingfisher, HQ, LOAEL:	HQ = Concentration of PCBs in kingfisher dose / LOAEL-based TRV; where TRV = 1,120 µg/kg-day

TABLE D-2

CTE TOTAL PCB CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK, NOVEMBER 2004 FISH DATA
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Species	N	Concentration in Fish and Crayfish (µg/kg)	Mink			Kingfisher					
				Concentration in Diet (µg/kg)	HQ No Effect (ratio)	HQ Low Effect (ratio)	Concentration in Diet (µg/kg)	Concentration in Dose (µg/kg-day)	HQ No Effect (ratio)	HQ NOAEL (ratio)	HQ Low Effect (ratio)	HQ LOAEL (ratio)
1	CRC	7	1807	1311.45	2.62	2.19	1628.38	814.19	2.04	7.40	1.63	0.73
1	CF	3	913									
2	GS	6	1817	1176.80	2.35	1.96	1451.72	725.86	1.81	6.60	1.45	0.65
2	WS	6	2000									
2	CRC	6	1180									
2	CF	--	596									
3	GS	5	1302	864.69	1.73	1.44	1069.25	534.62	1.34	4.86	1.07	0.48
3	WS	6	1348									
3	CRC	7	986									
3	CF	--	498									
4	LS	6	2018	1293.66	2.59	2.16	1611.35	805.67	2.01	7.32	1.61	0.72
4	RH	5	1500									
4	CF	--	1020									

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 1 — Allen Street
- 2 — Country Club Road
- 3 — Fluckmill Road
- 4 — Strainridge Road

Species — Sampled fish species
- CF — Crayfish
- CRC — Creek chub
- GS — Green sunfish
- LS — Longear sunfish
- RH — Black red horse
- WS — White sucker

Definitions:

CTE	Central tendency exposure
HQ	Hazard quotient
kg	Kilogram
LOAEL	Lowest-observed-adverse-effect level
N	Number of samples
NOAEL	No-observed-adverse-effect level
PCB	Polychlorinated biphenyl
TRV	Toxicity reference value
ug/kg	Microgram per kilogram
ug/kg-day	Microgram per kilogram per day
--	Not applicable; crayfish concentration was modeled.

Concentration in Fish & Crayfish: For the CTE scenario, the arithmetic mean was used as the fish species concentration; crayfish concentrations were modeled.
Mink, Concentration in Diet: Concentration of PCBs in the mink diet = (0.66 x mean concentration of the CTE fish species concentration) + (0.13 x modeled crayfish concentration)
Mink, HQ, No Effect: HQ = Concentration of PCBs in the mink diet / No effect-based TRV, where TRV = 500 µg/kg
Mink, HQ, Low Effect: HQ = Concentration of PCBs in the mink diet / Low effect-based TRV, where TRV = 600 µg/kg
Kingfisher, Concentration in Diet: Concentration of PCBs in the kingfisher diet = (0.80 x mean concentration of the CTE fish species concentration) + (0.20 x modeled crayfish concentration)
Kingfisher, Concentration in Dose: Concentration of PCBs in kingfisher diet (expressed as a dose) = (Concentration of PCBs in the kingfisher diet x IR), where IR = 0.5 kg food per kg body weight
Kingfisher, HQ, No Effect: HQ = Concentration of PCBs in kingfisher dose / No effect-based TRV; where TRV = 400 µg/kg-day
Kingfisher, HQ, NOAEL: HQ = Concentration of PCBs in kingfisher dose / NOAEL-based TRV; where TRV = 110 µg/kg-day
Kingfisher, HQ, Low Effect: HQ = Concentration of PCBs in kingfisher dose / Low effect-based TRV; where TRV = 500 µg/kg-day
Kingfisher, HQ, LOAEL: HQ = Concentration of PCBs in kingfisher dose / LOAEL-based TRV; where TRV = 1,120 µg/kg-day

TABLE D-3

RME PERCENT ALLOWABLE CONSUMPTION, NOVEMBER 2004 FISH DATA
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Mink		Kingfisher			
	Dietary Basis		Dose Basis			
	NOAEC PAC	LOAEC PAC	No Effect PAC	NOAEL PAC	Low Effect PAC	LOAEL PAC
1	26.70	32.04	34.34	9.44	42.93	96.15
2	32.84	39.41	42.45	11.67	53.06	118.85
3	40.98	49.18	53.21	14.63	66.51	148.99
4	27.97	33.57	35.87	9.86	44.83	100.42
TRV	500 µg/kg	600 µg/kg	400 µg/kg-day	110 µg/kg-day	500 µg/kg-day	1,120 µg/kg-day

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 1 — Allen Street
- 2 — Country Club Road
- 3 — Fluckmill Road
- 4 — Strainridge Road

PAC (Percent Allowable Consumption, %) = (1 / HQ) x 100; the PAC is the percent of an animals diet that can be consumed within a station reach and not exceed the TRV.

% — Percent
HQ — Hazard quotient; where mink HQ = concentration in mink diet / TRV and kingfisher HQ = concentration in kingfisher dose / TRV
LOAEC — Lowest-observed-adverse-effect concentration
LOAEL — Lowest-observed-adverse-effect level
NOAEC — No-observed-adverse-effect concentration
NOAEL — No-observed-adverse-effect level
RME — Reasonable maximum exposure
TRV — Toxicity reference value
µg/kg — Microgram per kilogram
µg/kg-day — Microgram per kilogram per day

TABLE D-4

CTE PERCENT ALLOWABLE CONSUMPTION, NOVEMBER 2004 FISH DATA
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

	Mink		Kingfisher			
	Dietary Basis		Dose Basis			
Station	**NOAEC PAC**	**LOAEC PAC**	**No Effect PAC**	**NOAEL PAC**	**Low Effect PAC**	**LOAEL PAC**
1	38.13	45.75	49.13	13.51	61.41	137.56
2	42.49	50.99	55.11	15.15	68.88	154.30
3	57.82	69.39	74.82	20.58	93.52	209.49
4	38.65	46.38	49.65	13.65	62.06	139.01
TRV	500 µg/kg	600 µg/kg	400 µg/kg-day	110 µg/kg-day	500 µg/kg-day	1,120 µg/kg-day

Notes:

Station — Fish sample collection station (see Figure 3 of the main text)
- 1 Allen Street
- 2 Country Club Road
- 3 Fluckmill Road
- 4 Strainridge Road

PAC (Percent Allowable Consumption, %) = (1 / HQ) x 100; the PAC is the percent of an animals diet that can be consumed within a station reach and not exceed the TRV.

% — Percent
CTE — Central tendency exposure
HQ — Hazard quotient; where mink HQ = concentration in mink diet / TRV and kingfisher HQ = concentration in kingfisher dose / TRV
LOAEC — Lowest-observed-adverse-effect concentration
LOAEL — Lowest-observed-adverse-effect level
NOAEC — No-observed-adverse-effect concentration
NOAEL — No-observed-adverse-effect level
TRV — Toxicity reference value
µg/kg — Microgram per kilogram
µg/kg-day — Microgram per kilogram per day

APPENDIX E

MINK AND KINGFISHER RISK ESTIMATES BASED ON PCB CONGENER TOXIC EQUIVALENCY QUOTIENTS (NOVEMBER 2004)

(13 Pages)

APPENDIX E

MINK AND KINGFISHER RISK ESTIMATES BASED ON PCB CONGENER TOXIC EQUIVALENCY QUOTIENTS (NOVEMBER 2004)

The main text of the focused ecological risk assessment (FERA) for the Lemon Lane Landfill site evaluates risk to piscivorous wildlife (i.e., mink and kingfisher) associated with exposure to total polychlorinated biphenyls (PCB) as Aroclors and as PCB congeners. As PCB congener data suitable for use in the FERA was only available for the November 2004 sampling event, the main text focuses on the results of the risk analysis using total PCB data for the November 2000, 2002, and 2004 sampling events.

This appendix presents the methodology used to evaluate risk to piscivorous wildlife associated with exposure to dioxin-like PCB congeners and follows the approach developed by U.S. Environmental Protection Agency (EPA) for the FERA conducted for the Neal's Landfill site, as detailed in the *Focused Ecological Risk Assessment, PCBs and Mammalian and Avian Piscivores in Conard's Branch and Richland Creek* (EPA 2005).

The following sections describe the process for evaluating risk associated with dioxin-like congeners at the Lemon Lane Landfill site; accompanying tables follow the text.

E.1 PROBLEM FORMULATION

The purpose of this FERA is to investigate the protectiveness of the remedial activities conducted at the Lemon Lane Landfill site. The assessment presented in this appendix focuses solely on dioxin-like PCB-related risks to wildlife (specifically, piscivorous [fish-eating] birds and mammals) in Clear Creek, downstream of the Lemon Lane Landfill site.

Components of the problem formulation, including the conceptual site model, assessment endpoint, and measurement endpoint are the same as detailed in Section 2.0 of the main text, except as noted below.

Assessment Endpoints. Assessment endpoints are as described in Section 2.3 of the main text, that is, the reproductive conditions of piscivorous mammals and birds that inhabit or potentially inhabit Clear Creek are the assessment endpoints.

Measurement Endpoints. As discussed in Section 2.4 of the main text, two piscivorous measurement endpoints are assessed: mink to represent mammalian piscivores and kingfisher to represent avian piscivores. The measures of effects for mink are studies that identify the reproductive effect levels associated with feeding PCB-contaminated fish to mink (see Section 5.1 of the main text); for the kingfisher, accumulation of dioxin-like PCB congeners in kingfisher eggs was modeled to identify the reproductive effect level (dose) for avian receptors. In addition, the effects of dioxin-like PCB congeners (expressed as a dose) on avian fertility and embryo mortality were also evaluated for the kingfisher. The reproductive effect levels were used to evaluate the level of risk associated with exposure to dioxin-like PCB congeners in the diet.

E.2 EXPOSURE ASSESSMENT

Exposure Assumptions. The assumptions for assessing exposure were as described in Section 3.0 of the main text, with the following exception:

- As no PCB congener analysis was conducted for crayfish samples, no data were available to extrapolate the contribution of crayfish to the dietary composition; therefore, the concentration of PCB congeners in crayfish was assumed to equal the PCB congener concentration in fish. The mink diet was assumed to be composed of 79 percent fish (based on a dietary assumption of 66 percent fish and 13 percent crayfish); the kingfisher diet was assumed to be composed of 100 percent fish (based on a dietary assumption of 80 percent fish and 20 percent crayfish).

Data Collection and Analysis. As discussed in Section 3.3 of the main text, fish tissue samples were collected at four sampling stations in Clear Creek downgradient of the Lemon Lane Landfill site (see Figure 3 of the main text). Fish tissue samples were analyzed for total PCBs as Aroclors. Split samples were collected from a subset of the fish tissue samples and analyzed for dioxin-like PCB congeners.

At Station 1, only one species (creek chub) were collected; at Stations 2 and 3 three species of fish were collected. At Station 4 two species of fish were collected. One split sample representing each species was submitted for PCB congener analysis at each station; the sample identifications and species submitted for congener analysis are presented below.

Station	Species	Number of Samples
1	Creek chub	1
2	Green sunfish	1
2	White sucker	1
2	Creek chub	1
3	Longear sunfish	1
3	White sucker	1
3	Creek chub	1
4	Longear sunfish	1
4	Northern Hogsucker	1 + duplicate

Total PCB results for these split samples are presented in Table A-2 of Appendix A; results of the congener analyses are presented in Table D-1. This appendix presents an evaluation of risk associated with exposure to dioxin-like PCB congeners in fish tissue collected from Clear Creek Creek.

<u>Calculation of Exposure Point Concentrations.</u> As only one sample was submitted for congener analysis per species at each station, no summary statistics could be calculated; that is, a mean or 95-percent upper confidence limit (95UCL) on the arithmetic mean could not be calculated.

In order the assess exposure to the dioxin-like PCB congeners, the PCB congener data was transformed to dioxin equivalent concentrations. The congener data for each fish sample were converted to World Health Organization (WHO) toxic equivalent concentrations (TEC) for mammals and birds according to Van den Berg and others 1998.

To calculate the TEC for mammals (i.e., mink), the dioxin-like PCB congener concentration was multiplied by its corresponding mammalian toxic equivalency factor (TEF), which is the relative potency of that congener relative to the dioxin congener 2,3,7,8-tetrachloro-dibenzo-p-dioxin (or TCDD). After each congener was multiplied by its respective TEF, the products were summed to derive the TEC for the sample. Mammalian TEFs and TECs are presented in Table E-1.

A similar process was followed to convert modeled dioxin-like congener concentrations in kingfisher eggs to TECs for birds, where the TEFs are based on relative toxicity in bird eggs. Prior to calculating the TECs for bird eggs, the PCB congener data was lipid-normalized. PCB congener concentrations were divided by the percent lipid in the sample, which results in the concentration of individual congeners in the fat tissues of the animal that was sampled. Lipid-normalized PCB congener concentrations are presented in Table E-2. After the data was lipid normalized, the lipid-normalized congener concentrations were multiplied by a diet-to-egg biomagnification factor (BMF) to derive the lipid-normalized concentration in eggs; the concentration in eggs were then multiplied by their respective avian TEFs to calculate the TEC for each sample. Lipid-normalized diet-to-egg BMFs are available for dioxin-like congeners 77, 105, 118, 126, and 169 (Blankenship and Geisy 2002, as cited in EPA 2005); therefore, congeners 81, 114, 123, 156/157, 167, and 189 were not modeled. However, these congeners have very small TEFs and would contribute only a small portion of the total TEC. Diet-to-egg BMFs, avian TEFs, and TECs are presented in Table E-3.

To calculate the TEC for avian receptors (i.e., kingfisher), the dioxin-like PCB congener concentration was multiplied by its corresponding mammalian toxic equivalency factor (TEF). The available avian TEFs (i.e., those listed in Van den Berg and others 1998) are based on toxicological studies in which eggs were dosed via injection; therefore, the WHO mammalian TEFs were used to calculate a toxic equivalency quotient (TEQ) ingestion dose for kingfisher. Mammalian TEFs have been used historically to estimate TEQ ingestion doses for avian receptors. Relative potencies for ethoxyresorufin-O-deethylase (EROD) induction for non-ortho PCBs (and also dioxins/furans) in birds have been found to be in the same order of magnitude as those reported from mammalian systems (Van den Berg and others 1998). As described above for the mink, each congener was multiplied by its respective TEF and the products were summed to derive the TEC for the sample. The mammalian TEFs and TECs, which were used to calculate an exposure point concentration for the kingfisher, are presented in Table E-1.

E.3 ECOLOGICAL EFFECTS ASSESSMENT

Mink TEC-based toxicity reference values (TRV) and their derivations are presented in the Attachment, both on a dose and dietary basis. The dietary TRVs selected for this FERA are a no-observed-adverse-effect-concentration (NOAEC)-based TRV of 4.6 picograms per gram (pg/g) and lowest-observed-adverse-effect-concentration (LOAEC)-based TRV of 18 pg/g; these TRVs are multiple season or multiple generation TRVs. Both TRVs were calculated as the geometric means of the TRVs presented in Brunström and others (2001, as cited in EPA 2005) and Restum and others (1998, as cited in EPA 2005) mink feeding studies, as detailed in Section 4.2.2.2 of EPA 2003.

Two sets of kingfisher egg TEC-based TRVs were selected for use in the FERA as they cluster around two different values (EPA 2005). Derivation of the kingfisher egg TRVs is detailed in Section 4.2.2.5 of EPA 2005. One set of kingfisher egg TRVs (lipid-normalized) were a NOAEC-based TRV of 1.8 microgram per kilogram (: g/kg) lipid and LOAEC-based TRV of 5.3 : g/kg lipid (Blankenship and Geisy 2002, as cited in EPA 2005); the basis of the Blankenship and Geisy (2002) TRVs was a field study of bald eagle eggs (Elliot and others 1996, as cited in EPA 2005). A second set of kingfisher egg TRVs (lipid-normalized) were a NOAEC-based TRV of 17 : g/kg lipid and a LOAEC-based TRV of 68 : g/kg lipid selected from the Hudson River ERA. The Hudson River TRVs are an order of magnitude greater (i.e., 10 times greater) than other available TRVs (see the Attachment) and are based on embryo mortalilty in double-crested cormorant eggs injected with TCDD (Powell and others 1977, as cited in EPA 2005), hatchability of bald eagle eggs (Elliot and others 1996, as cited in EPA 2005), and embryo mortality of kestrel eggs injected with PCB congener 77 (Hoffman and others 1998, as cited in EPA 2005).

Avian dose-based TEC TRVs and their derivations are presented in the Attachment (see also Section 4.2.2.4 of EPA 2005). The dose-based TRVs selected for this FERA are a no-observed-adverse-effect-level (NOAEL)-based TRV of 1.4 nanogram per kilogram body weight per day (ng/kg-day) and a lowest-observed-adverse-effect-level (LOAEL)-based TRV of 14 ng/kg-day. These TRVs are based on a study of dioxin in pheasant (Nosek and others 1992 as cited in EPA 2005); the toxicological endpoints are fertility and embryo mortality. The original TRVs from Nosek and others (1992) was adjusted downward by a factor of 10 to account for extrapolation from subchronic exposure (i.e., 10 weeks in the Nosek and others [1992] study) to chronic exposure.

E.4 RISK CHARACTERIZATION RESULTS

For the FERA, the hazard quotient (HQ; or toxicity quotient) method was used to characterize risk from dioxin-like PCB congeners. In addition, a percent allowable consumption (PAC) estimate was calculated. Calculation of HQ and PAC risk estimates followed the same procedure as described in Sections 4.3 and 4.4 of the main text. HQ risk estimates and the PACs are presented in Tables E-4 and E-5, respectively. The risk characterizations results are discussed in Section 5.0 of the main text.

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APPENDIX E TABLES

TABLE E-1

PCB CONGENER CONCENTRATIONS IN WHOLE FISH SAMPLES
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Species	November 2004 - Concentrations in pg/g											Mammalian WHO TEQ (pg/g)
		77 TeCB	81 TeCB	105 PeCB	114 PeCB	118 PeCB	123 PeCB	126 PeCB	167HxCB	156/157 HxCB	169 HxCB	189 HpCB	
1	CRC	44,800	3,190	135,000	11,400	217,000	8,630	601	2,210	7,360	23	235	110.62
2	GS	5,690	511	41,100	3,190	78,500	2,590	213	1,950	4,950	17	279	38.43
2	WS	5,020	627	27,600	2,060	54,700	1,850	164	1,230	3,000	15	180	28.09
2	CRC	3,450	188	14,700	1,090	28,900	969	59.7	716	1,680	14.1	118	12.34
3	GS	12,700	524	43,600	3,020	95,700	2,720	193	977	2,560	18.2	110	37.82
3	WS	5,800	324	23,200	1,710	49,200	1,640	10.7	822	2,140	14	93.7	11.17
3	CRC	3,350	173	16,000	1,200	35,900	1,160	56.3	639	1,570	10	75.9	12.79
4	LS	9,520	490	59,700	4,400	133,000	3,730	37	1,840	4,240	15	166	28.85
4	HS	7,680	453	41,800	3,250	96,500	2,690	27.8	1,260	3,330	14	143	21.15
Mammalian TEF		**0.0001**	**0.0001**	**0.0001**	**0.0005**	**0.0001**	**0.0001**	**0.1**	**0.00001**	**0.0005**	**0.01**	**0.0001**	--

Notes:

Station — Fish sample collection station
- 1 Allen Street
- 2 Country Club Road
- 3 Fluckmill Road
- 4 Strain Ridge Road

Species — Sampled fish species
- CRC Creek chub
- GS Green sunfish (Station 1 and 2 only)
- HS Northern Hogsucker
- LS Longear sunfish (Station 3 only)
- WS White sucker

TEQ = 3 n [PCB_i x TEF_i]

where,

PCB_i = Concentration of the ith PCB congener

TEF_i = Mammalian toxic equivalency factor for the ith PCB congener

Mammalian TEFs as listed in Van den Berg and others 1998.

Definitions:

HpCB	Heptachlorobiphenyl
HxCB	Hexachlorobiphenyl
PCB	Polychlorinated biphenyl
PeCB	Pentachlorobiphenyl
pg/g	Picogram per gram
TeCB	Tetrachlorobiphenyl
TEF	Toxic equivalency factor
TEQ	Toxic equivalency quotient
WHO	World Health Organization

TABLE E-2

LIPID-NORMALIZED PCB CONGENER CONCENTRATIONS IN WHOLE FISH SAMPLES
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Species	Percent Lipid	November 2004 - Concentrations in ug/kg Lipid										
			77 TeCB	81 TeCB	105 PeCB	114 PeCB	118 PeCB	123 PeCB	126 PeCB	167HxCB	156/157 HxCB	169 HxCB	189 HpCB
1	CRC	2.06	2,174.76	154.85	6,553.40	553.40	10,533.98	418.93	29.17	107.28	357.28	1.12	11.41
2	GS	2.26	251.77	22.61	1,818.58	141.15	3,473.45	114.60	9.42	86.28	219.03	0.75	12.35
2	WS	1.86	269.89	33.71	1,483.87	110.75	2,940.86	99.46	8.82	66.13	161.29	0.81	9.68
2	CRC	1.41	244.68	13.33	1,042.55	77.30	2,049.65	68.72	4.23	50.78	119.15	1.00	8.37
3	GS	1.98	641.41	26.46	2,202.02	152.53	4,833.33	137.37	9.75	49.34	129.29	0.92	5.56
3	WS	1.14	508.77	28.42	2,035.09	150.00	4,315.79	143.86	0.94	72.11	187.72	1.23	8.22
3	CRC	1.38	242.75	12.54	1,159.42	86.96	2,601.45	84.06	4.08	46.30	113.77	0.72	5.50
4	LS	1.43	665.73	34.27	4,174.83	307.69	9,300.70	260.84	2.59	128.67	296.50	1.05	11.61
4	HS	2.22	345.95	20.41	1,882.88	146.40	4,346.85	121.17	1.25	56.76	150.00	0.63	6.44

Notes:

Station — Fish sample collection station
- 1 — Allen Street
- 2 — Country Club Road
- 3 — Fluckmill Road
- 4 — Strain Ridge Road

Species — Sampled fish species
- CRC — Creek chub
- GS — Green sunfish (Station 1 and 2 only)
- HS — Northern Hogsucker
- LS — Longear sunfish (Station 3 only)
- WS — White sucker

Lipid-normalized PCB congener concentration (ug/kg) = PCB concentration (pg/g) / (Percent lipids x 10)

Definitions:

- HpCB — Heptachlorobiphenyl
- HxCB — Hexachlorobiphenyl
- PCB — Polychlorinated biphenyl
- PeCB — Pentachlorobiphenyl
- pg/g — Picogram per gram
- TeCB — Tetrachlorobiphenyl
- ug/kg — Microgram per kilogram

TABLE E-3

MODELED (LIPID-NORMALIZED) PCB CONGENER CONCENTRATIONS IN KINGFISHER EGGS
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Species	November 2004 - Concentrations in ug/kg-lipid											Avian WHO TEQ
		77 TeCB	81 TeCB	105 PeCB	114 PeCB	118 PeCB	123 PeCB	126 PeCB	167HxCB	156/157 HxCB	169 HxCB	189 HpCB	
1	GS	1,935.53	--	52,099.51	--	275,463.59	--	867.66	--	--	34.89	--	191.54
2	WS	224.08	--	14,457.74	--	90,830.75	--	280.29	--	--	23.51	--	41.61
2	CRC	240.20	--	11,796.77	--	76,903.49	--	262.22	--	--	25.20	--	40.21
2	GS	217.77	--	8,288.30	--	53,598.23	--	125.92	--	--	31.25	--	24.88
3	WS	570.86	--	17,506.06	--	126,391.67	--	289.89	--	--	28.72	--	60.58
3	CRC	452.81	--	16,178.95	--	112,857.89	--	27.91	--	--	38.38	--	28.22
3	LS	216.05	--	9,217.39	--	68,027.90	--	121.33	--	--	22.64	--	24.56
4	WS	592.50	--	33,189.86	--	243,213.29	--	76.95	--	--	32.78	--	43.10
4	CRC	307.89	--	14,968.92	--	113,670.05	--	37.24	--	--	19.71	--	21.77
Diet-Egg BMF		**0.89**	**--**	**7.95**	**--**	**26.15**	**--**	**29.74**	**--**	**--**	**31.25**	**--**	--
Avian TEF		**0.05**		**0.0001**		**0.00001**		**0.1**			**0.001**		

Notes:

Station — Fish sample collection station
- 1 — Allen Street
- 2 — Country Club Road
- 3 — Fluckmill Road
- 4 — Strain Ridge Road

Species — Sampled fish species
- CRC — Creek chub
- GS — Green sunfish (Station 1 and 2 only)
- HS — Hogsucker
- LS — Longear sunfish (Station 3 only)
- WS — White sucker

Definitions:

BMF	Biomagnification factor
HpCB	Heptachlorobiphenyl
HxCB	Hexachlorobiphenyl
PCB	Polychlorinated biphenyl
PeCB	Pentachlorobiphenyl
TeCB	Tetrachlorobiphenyl
TEF	Toxic equivalency factor
TEQ	Toxic equivalency quotient
WHO	World Health Organization
ug/kg	Microgram per kilogram

Lipid-normalized concentration in egg = Lipid-normalized fish tissue concentration x Diet-Egg BMF

TEQ = 3 n [PCB_i x TEF_i]

where,

PCB_i = Concentration of the ith PCB congener and TEF_i = Avian toxic equivalency factor for the *i* th PCB congener

Avian TEFs as listed in Van den Berg and others 1998.

TABLE E-4

TEQ CONCENTRATIONS IN DIET AND STATION-SPECIFIC RISK, NOVEMBER 2004 FISH DATA
LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

				Mink			Lipid-normalized	Kingfisher: Egg-based				Kingfisher: Dose-based			
Station	Species	N	TEQ Concentration in Fish (pg/g)	Concentration in Diet (pg/g)	HQ NOAEC (ratio)	HQ LOAEC (ratio)	TEQ Concentration in Eggs (ug/kg Lipid)	HQ NOAEC-low (ratio)	HQ NOAEC-high (ratio)	HQ LOAEC-low (ratio)	HQ LOAEC-high (ratio)	TEQ Concentration in Diet (pg/g)	TEQ Concentration in Dose (pg/g-day)	HQ NOAEL (ratio)	HQ LOAEL (ratio)
1	GS	1	110.62	87.39	19.00	4.85	191.54	106.41	11.27	36.14	2.82	110.62	55.31	39.51	3.95
2	WS	1	38.43	20.76	4.51	1.15	41.61	19.76	2.09	6.71	0.52	26.28	13.14	9.39	0.94
2	CRC	1	28.09				40.21								
2	GS	1	12.34				24.88								
3	WS	1	37.82	16.27	3.54	0.90	60.58	20.99	2.22	7.13	0.56	20.59	10.30	7.35	0.74
3	CRC	1	11.17				28.22								
3	LS	1	12.79				24.56								
4	WS	1	28.85	19.75	4.29	1.10	43.10	18.02	1.91	6.12	0.48	25.00	12.50	8.93	0.89
4	CRC	1	21.15				21.77								

Notes:

Station — Fish sample collection station
- 1 — Allen Street
- 2 — Country Club Road
- 3 — Fluckmill Road
- 4 — Strain Ridge Road

Species — Sampled fish species
- CRC — Creek chub
- GS — Green sunfish
- LS — Longear sunfish
- WS — White sucker

TEQ Concentration in Fish: As n = 1 for each species, the fish TEQ concentration, which was calcualated using mammalian TEFs, was used.
Lipid-normalized TEQ Concentration in Eggs: As n = 1 for each species, the lipid-normalized TEQ concentration, which was calculated using avian TEFs, was used.
No PCB congener data was available for crayfish samples collected in November 2004; therefore, the TEQ concentration in crayfish was assumed to equal the TEQ concentration in fish.

Mink, Concentration in Diet:	Concentration of TEQs in the mink diet = 0.79 x mean of the fish species concentration (assumes crayfish TEQ = fish tissue TEQ)
Mink, HQ, NOAEC:	HQ = Concentration of TEQs in the mink diet / NOAEC-based TRV, where TRV = 4.6 pg/g
Mink, HQ, LOAEC:	HQ = Concentration of TEQs in the mink diet / LOAEC-based TRV, where TRV = 18 pg/g
Kingfisher, Egg-based HQ, NOAEC-low:	HQ = Mean Concentration of TEQs in kingfisher egg / NOAEC-low-based TRV; where TRV = 1.8 ug/kg lipid-day
Kingfisher, Egg-based HQ, NOAEC-high:	HQ = Mean Concentration of TEQs in kingfisher egg / NOAEC-high-based TRV; where TRV = 17 ug/kg lipid-day
Kingfisher, Egg-based HQ, LOAEC-low:	HQ = Mean Concentration of TEQs in kingfisher egg / LOAEC-low-based TRV; where TRV = 5.3 ug/kg lipid-day
Kingfisher, Egg-based HQ, LOAEC-high:	HQ = Mean Concentration of TEQs in kingfisher egg / LOAEC-high-based TRV; where TRV = 68 ug/kg lipid-day
Kingfisher, Concentration in Diet:	Concentration of TEQs in the kingfisher diet = Mean fish species concentration (assumes crayfish TEQ = fish tissue TEQ)
Kingfisher, Concentration in Dose:	Concentration of TEQs in kingfisher diet (expressed as a dose) = (Concentration of TEQs in the kingfisher diet x IR), where IR = 0.5 kg food per kg body weight
Kingfisher, Dose-based HQ, NOAEL:	HQ = Concentration of TEQs in kingfisher dose / NOAEL-based TRV; where TRV = 1.4 ng/kg-day (or 1.4 pg/g-day)
Kingfisher, Dose-based HQ, LOAEL:	HQ = Concentration of TEQs in kingfisher d / LOAEL-based TRV; where TRV = 14 ng/kg lipid-day (or 14 pg/g-day)

Definitions:

HQ	Hazard quotient
IR	Ingestion rate (kingfisher)
kg	Kilogram
LOAEC	Lowest-observed-adverse-effect concentration
LOAEL	Lowest-observed-adverse-effect level
N	Number of samples
NOAEC	No-observed-adverse-effect concentration
NOAEL	No-observed-adverse-effect level
PCB	Polychlorinated biphenyl
pg/g	Picogram per gram
pg/g-day	Picogram per gram per day
TEF	Toxic equivalency factor
TEQ	Toxic equivalency quotient
TRV	Toxicity reference value
ug/kg Lipid	Microgram per kilogram lipid
ug/kg Lipid-day	Microgram per kilogram lipid per day

TABLE E-5

PERCENT ALLOWABLE CONSUMPTION FOR PCB CONGENERS (EXPRESSED AS TEQs), NOVEMBER 2004 FISH DATA LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Station	Mink		Kingfisher					
	Dietary Basis		Egg-based				Dose-based	
	NOAEC PAC	LOAEC PAC	NOAEC-low PAC	NOAEC-high PAC	LOAEC-low PAC	LOAEC-high PAC	NOAEL PAC	LOAEL PAC
1	5.26	20.60	0.94	8.88	2.77	35.50	2.53	25.31
2	22.15	86.69	5.06	47.80	14.90	191.20	10.65	106.53
3	28.28	110.65	4.76	44.99	14.03	179.97	13.60	135.98
4	23.29	91.14	5.55	52.41	16.34	209.63	11.20	112.00
TRV	4.6 pg/g	18 pg/g	1.8 ug/kg lipid	17 ug/kg lipid	5.3 ug/kg lipid	68 ug/kg lipid	1.4 pg/g-day	14 pg/g-day

Notes:

Station — Fish sample collection station
- 1 — Allen Street
- 2 — Country Club Road
- 3 — Fluckmill Road
- 4 — Strain Ridge Road

PAC (Percent Allowable Consumption, %) = (1 / HQ) x 100; the PAC is the percent of an animal's diet that can be consumed within a station reach and not exceed the TRV.

% — Percent

HQ — Hazard quotient; where,
- mink HQ = TEQ concentration in mink diet / TRV
- kingfisher egg-based HQ = lipid-normalized TEQ concentration in kingfisher egg / TRV
- kingfisher dose-based HQ = TEQ concentration in kingfisher dose / TRV

LOAEC — Lowest-observed-adverse-effect concentration
LOAEL — Lowest-observed-adverse-effect level
NOAEC — No-observed-adverse-effect concentration
NOAEL — No-observed-adverse-effect level
PCB — Polychlorinated biphenyl
pg/g — Picogram per gram
pg/g-day — Picogram per gram per day
TRV — Toxicity reference value
ug/kg lipid — Microgram per kilogram lipid

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT

(29 Pages)

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for November 2000, Station 2: Creek Chub	
Number of Samples	4
Minimum	0.8
Maximum	2.4
Mean	1.675
Median	1.75
Standard Deviation	0.718215381
Variance	0.515833333
Coefficient of Variation	0.428785302
Skewness	-0.419051601
Shapiro-Wilk Test Statisitic	0.956943424
Shapiro-Wilk 5% Critical Value	0.748
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	2.520110845
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	2.185282072
Modified-t	2.507570457
95 % Non-parametric UCL	
CLT	**2.265679587**
Jackknife	2.520110845
Standard Bootstrap	2.189187994
Bootstrap-t	2.8671528
Chebyshev (Mean, Std)	3.240314132

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for November 2000, Station 3: Rock Bass	
Number of Samples	4
Minimum	1.3
Maximum	1.8
Mean	1.475
Median	1.4
Standard Deviation	0.221735578
Variance	0.049166667
Coefficient of Variation	0.150329206
Skewness	1.71986803
Shapiro-Wilk Test Statisitic	0.800413288
Shapiro-Wilk 5% Critical Value	0.748
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	1.735912182
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	1.75923237
Modified-t	1.751802012
95 % Non-parametric UCL	
CLT	**1.657361285**
Jackknife	1.735912182
Standard Bootstrap	1.634867102
Bootstrap-t	1.#INF
Chebyshev (Mean, Std)	1.958261489

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for November 2000, Station 3: White Sucker	
Number of Samples	4
Minimum	0.37
Maximum	3.1
Mean	1.15
Median	0.565
Standard Deviation	1.309376442
Variance	1.714466667
Coefficient of Variation	1.13858821
Skewness	1.917128604
Shapiro-Wilk Test Statisitic	0.722741729
Shapiro-Wilk 5% Critical Value	0.748
Data not Normal at 5% Significance Level	
Data are Lognormal: Try Lognormal UCLs	
95 % UCL (Assuming Normal Data)	
Student's-t	2.690719206
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	2.897424055
Modified-t	2.795312665
95 % Non-parametric UCL	
CLT	**2.226866295**
Jackknife	2.690719206
Standard Bootstrap	2.049985191
Bootstrap-t	44.24022395
Chebyshev (Mean, Std)	4.003719795

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for November 2000, Station 4: Longear Sunfish	
Number of Samples	5
Minimum	0.36
Maximum	2.3
Mean	1.592
Median	1.7
Standard Deviation	0.757839033
Variance	0.57432
Coefficient of Variation	0.476029543
Skewness	-1.324441689
Shapiro-Wilk Test Statisitic	0.895256252
Shapiro-Wilk 5% Critical Value	0.762
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	2.314516523
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	1.934970572
Modified-t	2.281059403
95 % Non-parametric UCL	
CLT	**2.149467079**
Jackknife	2.314516523
Standard Bootstrap	2.090587973
Bootstrap-t	2.137828809
Chebyshev (Mean, Std)	3.06930024

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for November 2000, Station 4: Red Horse	
Number of Samples	4
Minimum	1.3
Maximum	3.8
Mean	2.125
Median	1.7
Standard Deviation	1.132475165
Variance	1.2825
Coefficient of Variation	0.53292949
Skewness	1.828870214
Shapiro-Wilk Test Statisitic	0.767127745
Shapiro-Wilk 5% Critical Value	0.748
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	3.457562723
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	3.609641412
Modified-t	3.543860644
95 % Non-parametric UCL	
CLT	**3.056377942**
Jackknife	3.457562723
Standard Bootstrap	2.932294289
Bootstrap-t	1.#INF
Chebyshev (Mean, Std)	4.593172401

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for	**(4-Peak)**
November 2002, Station 1: Creek Chub	
Number of Samples	11
Minimum	3.4
Maximum	18
Mean	9.390909091
Median	8.3
Standard Deviation	4.815486382
Variance	23.18890909
Coefficient of Variation	0.512781706
Skewness	0.64853751
Shapiro-Wilk Test Statisitic	0.926202918
Shapiro-Wilk 5% Critical Value	0.85
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	**12.02246442**
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	12.08247444
Modified-t	12.06978296
95 % Non-parametric UCL	
CLT	11.77911118
Jackknife	12.02246442
Standard Bootstrap	11.72276777
Bootstrap-t	12.46612393
Chebyshev (Mean, Std)	15.71969809

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for	**(4-Peak)**
November 2002, Station 2: Creek Chub	
Number of Samples	6
Minimum	0.35
Maximum	1.2
Mean	0.786666667
Median	0.795
Standard Deviation	0.294595768
Variance	0.086786667
Coefficient of Variation	0.374486146
Skewness	-0.139896565
Shapiro-Wilk Test Statisitic	0.986088162
Shapiro-Wilk 5% Critical Value	0.788
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	1.029012928
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	0.977150846
Modified-t	1.027868125
95 % Non-parametric UCL	
CLT	**0.984490283**
Jackknife	1.029012928
Standard Bootstrap	0.968471023
Bootstrap-t	1.021638035
Chebyshev (Mean, Std)	1.310903678

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for	**(4-Peak)**
November 2002, Station 2: Green Sunfish	
Number of Samples	5
Minimum	0.76
Maximum	2.3
Mean	1.418
Median	1.5
Standard Deviation	0.640874403
Variance	0.41072
Coefficient of Variation	0.45195656
Skewness	0.349704897
Shapiro-Wilk Test Statisitic	0.926003459
Shapiro-Wilk 5% Critical Value	0.762
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	2.029003558
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	1.937322225
Modified-t	2.036474121
95 % Non-parametric UCL	
CLT	**1.889427791**
Jackknife	2.029003558
Standard Bootstrap	1.846731405
Bootstrap-t	2.115290495
Chebyshev (Mean, Std)	2.667294201

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for	**(4-Peak)**
November 2002, Station 3: Green Sunfish	
Number of Samples	6
Minimum	0.82
Maximum	1.9
Mean	1.26
Median	1.1
Standard Deviation	0.477995816
Variance	0.22848
Coefficient of Variation	0.379361759
Skewness	0.666253503
Shapiro-Wilk Test Statisitic	0.843131187
Shapiro-Wilk 5% Critical Value	0.788
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	1.653218476
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	1.637692665
Modified-t	1.662064765
95 % Non-parametric UCL	
CLT	**1.58097834**
Jackknife	1.653218476
Standard Bootstrap	1.559259878
Bootstrap-t	2.026353678
Chebyshev (Mean, Std)	2.110599788

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for	**(4-Peak)**
November 2002, Station 3: Creek Chub	
Number of Samples	5
Minimum	0.21
Maximum	1
Mean	0.588
Median	0.55
Standard Deviation	0.294906765
Variance	0.08697
Coefficient of Variation	0.501542117
Skewness	0.261103759
Shapiro-Wilk Test Statisitic	0.993089353
Shapiro-Wilk 5% Critical Value	0.762
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	0.869161304
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	0.821389077
Modified-t	0.871728012
95 % Non-parametric UCL	
CLT	**0.804933683**
Jackknife	0.869161304
Standard Bootstrap	0.777572802
Bootstrap-t	0.913931508
Chebyshev (Mean, Std)	1.162879118

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for (4-Peak)	
November 2002, Station 4: Longear Sunfish	
Number of Samples	6
Minimum	0.48
Maximum	4.5
Mean	2.456666667
Median	2.55
Standard Deviation	1.74096142
Variance	3.030946667
Coefficient of Variation	0.708668149
Skewness	-0.051696964
Shapiro-Wilk Test Statisitic	0.889347679
Shapiro-Wilk 5% Critical Value	0.788
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	3.888851163
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	3.609709227
Modified-t	3.886351096
95 % Non-parametric UCL	
CLT	**3.625737375**
Jackknife	3.888851163
Standard Bootstrap	3.522336115
Bootstrap-t	3.87960291
Chebyshev (Mean, Std)	5.55473022

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for	**(4-Peak)**
November 2002, Station 4: Rock Bass	
Number of Samples	5
Minimum	0.62
Maximum	2.5
Mean	1.604
Median	1.6
Standard Deviation	0.809370126
Variance	0.65508
Coefficient of Variation	0.504594841
Skewness	-0.091660128
Shapiro-Wilk Test Statisitic	0.932481684
Shapiro-Wilk 5% Critical Value	0.762
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	2.375645776
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	2.183519426
Modified-t	2.373172877
95 % Non-parametric UCL	
CLT	**2.199373397**
Jackknife	2.375645776
Standard Bootstrap	2.138575586
Bootstrap-t	2.496651982
Chebyshev (Mean, Std)	3.181752832

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for	**(5-Peak)**
November 2002, Station 1: Creek Chub	
Number of Samples	**11**
Minimum	0.53
Maximum	15
Mean	7.739090909
Median	6.8
Standard Deviation	4.680941048
Variance	21.91120909
Coefficient of Variation	0.604843786
Skewness	0.267888477
Shapiro-Wilk Test Statisitic	0.953354212
Shapiro-Wilk 5% Critical Value	0.85
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	**10.29712023**
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	10.18237406
Modified-t	10.31611978
95 % Non-parametric UCL	
CLT	10.06056631
Jackknife	10.29712023
Standard Bootstrap	9.922829673
Bootstrap-t	10.57225837
Chebyshev (Mean, Std)	13.8910527

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for	**(5-Peak)**
November 2002, Station 2: Green Sunfish	
Number of Samples	**5**
Minimum	0.65
Maximum	2
Mean	1.28
Median	1.2
Standard Deviation	0.532212364
Variance	0.28325
Coefficient of Variation	0.415790909
Skewness	0.330350117
Shapiro-Wilk Test Statisitic	0.980610718
Shapiro-Wilk 5% Critical Value	0.762
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	1.787406203
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	1.709068374
Modified-t	1.793266751
95 % Non-parametric UCL	
CLT	**1.671495896**
Jackknife	1.787406203
Standard Bootstrap	1.63316679
Bootstrap-t	1.958465518
Chebyshev (Mean, Std)	2.317472891

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for	**(5-Peak)**
November 2002, Station 2: Creek Chub	
Number of Samples	6
Minimum	0.38
Maximum	1
Mean	0.78
Median	0.87
Standard Deviation	0.25385035
Variance	0.06444
Coefficient of Variation	0.325449166
Skewness	-0.947749698
Shapiro-Wilk Test Statisitic	0.857683956
Shapiro-Wilk 5% Critical Value	0.788
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	0.988827451
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	0.907617671
Modified-t	0.98214449
95 % Non-parametric UCL	
CLT	**0.950462714**
Jackknife	0.988827451
Standard Bootstrap	0.935427542
Bootstrap-t	0.943859696
Chebyshev (Mean, Std)	1.231730008

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for	**(5-Peak)**
November 2002, Station 3: Green Sunfish	
Number of Samples	6
Minimum	0.67
Maximum	1.6
Mean	1.061666667
Median	0.905
Standard Deviation	0.429577312
Variance	0.184536667
Coefficient of Variation	0.404625411
Skewness	0.725680081
Shapiro-Wilk Test Statisitic	0.800743931
Shapiro-Wilk 5% Critical Value	0.788
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	1.415054145
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	1.405647246
Modified-t	1.42371347
95 % Non-parametric UCL	
CLT	**1.350131561**
Jackknife	1.415054145
Standard Bootstrap	1.330450856
Bootstrap-t	2.038622582
Chebyshev (Mean, Std)	1.826105095

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for	**(5-Peak)**
November 2002, Station 3: Creek Chub	
Number of Samples	5
Minimum	0.14
Maximum	0.83
Mean	0.474
Median	0.44
Standard Deviation	0.25899807
Variance	0.06708
Coefficient of Variation	0.546409429
Skewness	0.199964423
Shapiro-Wilk Test Statisitic	0.994177803
Shapiro-Wilk 5% Critical Value	0.762
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	0.720926295
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	0.675586973
Modified-t	0.722652642
95 % Non-parametric UCL	
CLT	**0.664519214**
Jackknife	0.720926295
Standard Bootstrap	0.647324477
Bootstrap-t	0.778676574
Chebyshev (Mean, Std)	0.978880184

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for	**(5-Peak)**
November 2002, Station 4: Longear Sunfish	
Number of Samples	6
Minimum	0.38
Maximum	4.8
Mean	2.401666667
Median	2.45
Standard Deviation	1.871217963
Variance	3.501456667
Coefficient of Variation	0.779133087
Skewness	0.092942128
Shapiro-Wilk Test Statisitic	0.88841133
Shapiro-Wilk 5% Critical Value	0.788
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	3.941005405
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	3.689177554
Modified-t	3.945836377
95 % Non-parametric UCL	
CLT	**3.658205774**
Jackknife	3.941005405
Standard Bootstrap	3.552521273
Bootstrap-t	4.115961915
Chebyshev (Mean, Std)	5.731523437

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for	**(5-Peak)**
November 2002, Station 4: Rock Bass	
Number of Samples	5
Minimum	0.5
Maximum	3.1
Mean	1.544
Median	1.3
Standard Deviation	1.037149941
Variance	1.07568
Coefficient of Variation	0.671729236
Skewness	0.870270284
Shapiro-Wilk Test Statisitic	0.941482862
Shapiro-Wilk 5% Critical Value	0.762
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	2.532808885
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	2.499816835
Modified-t	2.562895578
95 % Non-parametric UCL	
CLT	**2.306928435**
Jackknife	2.532808885
Standard Bootstrap	2.244501888
Bootstrap-t	3.326045938
Chebyshev (Mean, Std)	3.565777436

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for
November 2004, Station 1: Creek Chub

Variable:

Raw Statistics		Normal Distribution Test	
Number of Valid Samples	7	Shapiro-Wilk Test Statisitic	0.899177343
Number of Unique Samples	7	Shapiro-Wilk 5% Critical Value	0.803
Minimum	650	Data are normal at 5% significance level	
Maximum	3400		
Mean	1807.142857	95% UCL (Assuming Normal Distribution)	
Median	1400	Student's-t UCL	**2562.246047**
Standard Deviation	1028.116632		
Variance	1057023.81	Gamma Distribution Test	
Coefficient of Variation	0.568918295	A-D Test Statistic	0.277930848
Skewness	0.761189425	A-D 5% Critical Value	0.710486899
		K-S Test Statistic	0.186032018
Gamma Statistics		K-S 5% Critical Value	0.313151224
k hat	3.677114872	Data follow gamma distribution	
k star (bias corrected)	2.196446593	at 5% significance level	
Theta hat	491.4567318		
Theta star	822.7574769	95% UCLs (Assuming Gamma Distribution)	
nu hat	51.4796082	Approximate Gamma UCL	2912.240561
nu star	30.75025231	Adjusted Gamma UCL	3395.042688
Approx.Chi Square Value (.05)	19.08156199		
Adjusted Level of Significance	0.01584	Lognormal Distribution Test	
Adjusted Chi Square Value	16.36801181	Shapiro-Wilk Test Statisitic	0.959356834
		Shapiro-Wilk 5% Critical Value	0.803
Log-transformed Statistics		Data are lognormal at 5% significance level	
Minimum of log data	6.476972363		
Maximum of log data	8.131530711	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	7.357407088	95% H-UCL	3483.011273
Standard Deviation of log data	0.583431958	95% Chebyshev (MVUE) UCL	3558.717804
Variance of log data	0.34039285	97.5% Chebyshev (MVUE) UCL	4315.666458
		99% Chebyshev (MVUE) UCL	5802.545512
		95% Non-parametric UCLs	
		CLT UCL	2446.319096
		Adj-CLT UCL (Adjusted for skewness)	2565.777719
		Mod-t UCL (Adjusted for skewness)	2580.879178
		Jackknife UCL	2562.246047
		Standard Bootstrap UCL	2387.759959
		Bootstrap-t UCL	3275.179446
RECOMMENDATION		Hall's Bootstrap UCL	3477.927054
Data are normal (0.05)		Percentile Bootstrap UCL	2414.285714
		BCA Bootstrap UCL	2335.714286
Use Student's-t UCL		95% Chebyshev (Mean, Sd) UCL	3500.974202
		97.5% Chebyshev (Mean, Sd) UCL	4233.896378
		99% Chebyshev (Mean, Sd) UCL	5673.580072

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for
November 2004, Station 2: Green Sunfish

		Variable:	
Raw Statistics		Normal Distribution Test	
Number of Valid Samples	6	Shapiro-Wilk Test Statisitic	0.930679528
Number of Unique Samples	5	Shapiro-Wilk 5% Critical Value	0.788
Minimum	1400	Data are normal at 5% significance level	
Maximum	2400		
Mean	1816.666667	95% UCL (Assuming Normal Distribution)	
Median	1800	Student's-t UCL	**2094.015525**
Standard Deviation	337.1448749		
Variance	113666.6667	Gamma Distribution Test	
Coefficient of Variation	0.185584335	A-D Test Statistic	0.289533324
Skewness	0.912440486	A-D 5% Critical Value	0.696974749
		K-S Test Statistic	0.20482607
Gamma Statistics		K-S 5% Critical Value	0.331773905
k hat	36.46437067	Data follow gamma distribution	
k star (bias corrected)	18.34329644	at 5% significance level	
Theta hat	49.82032141		
Theta star	99.03708813	95% UCLs (Assuming Gamma Distribution)	
nu hat	437.572448	Approximate Gamma UCL	2140.997362
nu star	220.1195573	Adjusted Gamma UCL	2276.867212
Approx.Chi Square Value (.05)	186.7745704		
Adjusted Level of Significance	0.01222	Lognormal Distribution Test	
Adjusted Chi Square Value	175.6289784	Shapiro-Wilk Test Statisitic	0.958884772
		Shapiro-Wilk 5% Critical Value	0.788
Log-transformed Statistics		Data are lognormal at 5% significance level	
Minimum of log data	7.244227516		
Maximum of log data	7.783224016	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	7.490983916	95% H-UCL	2151.336246
Standard Deviation of log data	0.18032824	95% Chebyshev (MVUE) UCL	2399.010545
Variance of log data	0.032518274	97.5% Chebyshev (MVUE) UCL	2651.188898
		99% Chebyshev (MVUE) UCL	3146.54444
		95% Non-parametric UCLs	
		CLT UCL	2043.062377
		Adj-CLT UCL (Adjusted for skewness)	2097.84594
		Mod-t UCL (Adjusted for skewness)	2102.560654
		Jackknife UCL	2094.015525
		Standard Bootstrap UCL	2025.691359
		Bootstrap-t UCL	2146.999832
RECOMMENDATION		Hall's Bootstrap UCL	2705.857999
Data are normal (0.05)		Percentile Bootstrap UCL	2033.333333
		BCA Bootstrap UCL	2116.666667
Use Student's-t UCL		95% Chebyshev (Mean, Sd) UCL	2416.620369
		97.5% Chebyshev (Mean, Sd) UCL	2676.220815
		99% Chebyshev (Mean, Sd) UCL	3186.155622

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for
November 2004, Station 2: White Sucker

Raw Statistics		Normal Distribution Test	
Number of Valid Samples	6	Shapiro-Wilk Test Statisitic	0.874338795
Number of Unique Samples	5	Shapiro-Wilk 5% Critical Value	0.788
Minimum	1400	Data are normal at 5% significance level	
Maximum	2700		
Mean	2000	95% UCL (Assuming Normal Distribution)	
Median	1850	Student's-t UCL	**2456.54667**
Standard Deviation	554.977477		
Variance	308000	Gamma Distribution Test	
Coefficient of Variation	0.277488739	A-D Test Statistic	0.445468947
Skewness	0.379095764	A-D 5% Critical Value	0.697609056
		K-S Test Statistic	0.279390463
Gamma Statistics		K-S 5% Critical Value	0.332043945
k hat	15.81406861	Data follow gamma distribution	
k star (bias corrected)	8.018145418	at 5% significance level	
Theta hat	126.4696675		
Theta star	249.4342389	95% UCLs (Assuming Gamma Distribution)	
nu hat	189.7688234	Approximate Gamma UCL	2579.971792
nu star	96.21774501	Adjusted Gamma UCL	2840.919623
Approx.Chi Square Value (.05)	74.58821473		
Adjusted Level of Significance	0.01222	Lognormal Distribution Test	
Adjusted Chi Square Value	67.73704137	Shapiro-Wilk Test Statisitic	0.88804075
		Shapiro-Wilk 5% Critical Value	0.788
Log-transformed Statistics		Data are lognormal at 5% significance level	
Minimum of log data	7.244227516		
Maximum of log data	7.901007052	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	7.568951955	95% H-UCL	2648.189887
Standard Deviation of log data	0.276389707	95% Chebyshev (MVUE) UCL	2982.757095
Variance of log data	0.07639127	97.5% Chebyshev (MVUE) UCL	3408.225477
		99% Chebyshev (MVUE) UCL	4243.975726
		95% Non-parametric UCLs	
		CLT UCL	2372.672194
		Adj-CLT UCL (Adjusted for skewness)	2410.139585
		Mod-t UCL (Adjusted for skewness)	2462.390826
		Jackknife UCL	2456.54667
		Standard Bootstrap UCL	2344.576483
		Bootstrap-t UCL	2828.25117
RECOMMENDATION		Hall's Bootstrap UCL	2340.598817
Data are normal (0.05)		Percentile Bootstrap UCL	2333.333333
		BCA Bootstrap UCL	2466.666667
Use Student's-t UCL		95% Chebyshev (Mean, Sd) UCL	2987.589658
		97.5% Chebyshev (Mean, Sd) UCL	3414.920492
		99% Chebyshev (Mean, Sd) UCL	4254.329169

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for
November 2004, Station 2: Creek Chub

Raw Statistics		Normal Distribution Test	
Number of Valid Samples	6	Shapiro-Wilk Test Statisitic	0.903128162
Number of Unique Samples	6	Shapiro-Wilk 5% Critical Value	0.788
Minimum	300	Data are normal at 5% significance level	
Maximum	2600		
Mean	1180	95% UCL (Assuming Normal Distribution)	
Median	1090	Student's-t UCL	**1825.2351**
Standard Deviation	784.346862		
Variance	615200	Gamma Distribution Test	
Coefficient of Variation	0.664700731	A-D Test Statistic	0.223429713
Skewness	1.283832625	A-D 5% Critical Value	0.702162182
		K-S Test Statistic	0.191110205
Gamma Statistics		K-S 5% Critical Value	0.334919859
k hat	2.711047863	Data follow gamma distribution	
k star (bias corrected)	1.466635043	at 5% significance level	
Theta hat	435.2560557		
Theta star	804.5628023	95% UCLs (Assuming Gamma Distribution)	
nu hat	32.53257436	Approximate Gamma UCL	2281.948053
nu star	17.59962051	Adjusted Gamma UCL	2963.882225
Approx.Chi Square Value (.05)	9.100799721		
Adjusted Level of Significance	0.01222	Lognormal Distribution Test	
Adjusted Chi Square Value	7.00687498	Shapiro-Wilk Test Statisitic	0.965277042
		Shapiro-Wilk 5% Critical Value	0.788
Log-transformed Statistics		Data are lognormal at 5% significance level	
Minimum of log data	5.703782475		
Maximum of log data	7.863266724	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	6.877646414	95% H-UCL	3684.900476
Standard Deviation of log data	0.719279458	95% Chebyshev (MVUE) UCL	2719.433004
Variance of log data	0.517362939	97.5% Chebyshev (MVUE) UCL	3378.503863
		99% Chebyshev (MVUE) UCL	4673.120944
		95% Non-parametric UCLs	
		CLT UCL	1706.695727
		Adj-CLT UCL (Adjusted for skewness)	1886.022749
		Mod-t UCL (Adjusted for skewness)	1853.206491
		Jackknife UCL	1825.2351
		Standard Bootstrap UCL	1673.886416
		Bootstrap-t UCL	2103.08888
RECOMMENDATION		Hall's Bootstrap UCL	4370.851206
Data are normal (0.05)		Percentile Bootstrap UCL	1676.666667
		BCA Bootstrap UCL	1850
Use Student's-t UCL		95% Chebyshev (Mean, Sd) UCL	2575.75547
		97.5% Chebyshev (Mean, Sd) UCL	3179.699977
		99% Chebyshev (Mean, Sd) UCL	4366.032015

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for
November 2004, Station 3: Green Sunfish

Raw Statistics	
Number of Valid Samples	6
Number of Unique Samples	6
Minimum	420
Maximum	12000
Mean	3085
Median	1350
Standard Deviation	4427.305049
Variance	19601030
Coefficient of Variation	1.435106985
Skewness	2.30623726

Gamma Statistics	
k hat	0.918025261
k star (bias corrected)	0.570123742
Theta hat	3360.473976
Theta star	5411.106
nu hat	11.01630314
nu star	6.841484901
Approx.Chi Square Value (.05)	2.083395917
Adjusted Level of Significance	0.01222
Adjusted Chi Square Value	1.267723374

Log-transformed Statistics	
Minimum of log data	6.040254711
Maximum of log data	9.392661929
Mean of log data	7.39905382
Standard Deviation of log data	1.150113727
Variance of log data	1.322761586

RECOMMENDATION

Data follow gamma distribution (0.05)

Use Approximate Gamma UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.646531482
Shapiro-Wilk 5% Critical Value	0.788
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	6727.07821

Gamma Distribution Test	
A-D Test Statistic	0.543759555
A-D 5% Critical Value	0.717031325
K-S Test Statistic	0.268790182
K-S 5% Critical Value	0.341702537
Data follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	**10130.56652**
Adjusted Gamma UCL	16648.72744

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.939085233
Shapiro-Wilk 5% Critical Value	0.788
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	38248.11453
95% Chebyshev (MVUE) UCL	8175.820705
97.5% Chebyshev (MVUE) UCL	10531.42836
99% Chebyshev (MVUE) UCL	15158.56347

95% Non-parametric UCLs	
CLT UCL	6057.973777
Adj-CLT UCL (Adjusted for skewness)	7876.30332
Mod-t UCL (Adjusted for skewness)	7010.700873
Jackknife UCL	6727.07821
Standard Bootstrap UCL	5804.551643
Bootstrap-t UCL	23315.00516
Hall's Bootstrap UCL	19268.10035
Percentile Bootstrap UCL	6385
BCA Bootstrap UCL	8353.333333
95% Chebyshev (Mean, Sd) UCL	10963.44708
97.5% Chebyshev (Mean, Sd) UCL	14372.45742
99% Chebyshev (Mean, Sd) UCL	21068.79812

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for
November 2004, Station 3: White Sucker

Raw Statistics		Normal Distribution Test	
Number of Valid Samples	6	Shapiro-Wilk Test Statisitic	0.92455068
Number of Unique Samples	6	Shapiro-Wilk 5% Critical Value	0.788
Minimum	490	Data are normal at 5% significance level	
Maximum	2600		
Mean	1348.333333	95% UCL (Assuming Normal Distribution)	
Median	1090	Student's-t UCL	**1980.0955**
Standard Deviation	767.9691834		
Variance	589776.6667	Gamma Distribution Test	
Coefficient of Variation	0.569569234	A-D Test Statistic	0.231615153
Skewness	0.903883067	A-D 5% Critical Value	0.700289131
		K-S Test Statistic	0.185742304
Gamma Statistics		K-S 5% Critical Value	0.333771276
k hat	3.771013932	Data follow gamma distribution	
k star (bias corrected)	1.996618077	at 5% significance level	
Theta hat	357.5519364		
Theta star	675.3085875	95% UCLs (Assuming Gamma Distribution)	
nu hat	45.25216718	Approximate Gamma UCL	2338.237032
nu star	23.95941692	Adjusted Gamma UCL	2900.675125
Approx.Chi Square Value (.05)	13.81608453		
Adjusted Level of Significance	0.01222	Lognormal Distribution Test	
Adjusted Chi Square Value	11.13715914	Shapiro-Wilk Test Statisitic	0.974230721
		Shapiro-Wilk 5% Critical Value	0.788
Log-transformed Statistics		Data are lognormal at 5% significance level	
Minimum of log data	6.194405391		
Maximum of log data	7.863266724	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	7.06821406	95% H-UCL	3015.817132
Standard Deviation of log data	0.58650938	95% Chebyshev (MVUE) UCL	2757.906518
Variance of log data	0.343993253	97.5% Chebyshev (MVUE) UCL	3366.601274
		99% Chebyshev (MVUE) UCL	4562.264256
		95% Non-parametric UCLs	
		CLT UCL	1864.031307
		Adj-CLT UCL (Adjusted for skewness)	1987.650302
		Mod-t UCL (Adjusted for skewness)	1999.377565
		Jackknife UCL	1980.0955
		Standard Bootstrap UCL	1812.111651
		Bootstrap-t UCL	2735.028946
RECOMMENDATION		Hall's Bootstrap UCL	6439.754436
Data are normal (0.05)		Percentile Bootstrap UCL	1861.666667
		BCA Bootstrap UCL	2096.666667
Use Student's-t UCL		95% Chebyshev (Mean, Sd) UCL	2714.944511
		97.5% Chebyshev (Mean, Sd) UCL	3306.278259
		99% Chebyshev (Mean, Sd) UCL	4467.838903

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for
November 2004, Station 3: Creek Chub

Raw Statistics		Normal Distribution Test	
Number of Valid Samples	7	Shapiro-Wilk Test Statisitic	0.903414753
Number of Unique Samples	6	Shapiro-Wilk 5% Critical Value	0.803
Minimum	760	Data are normal at 5% significance level	
Maximum	1400		
Mean	985.7142857	95% UCL (Assuming Normal Distribution)	
Median	1000	Student's-t UCL	**1148.339746**
Standard Deviation	221.4239631		
Variance	49028.57143	Gamma Distribution Test	
Coefficient of Variation	0.224633006	A-D Test Statistic	0.303416242
Skewness	1.083514542	A-D 5% Critical Value	0.70684335
		K-S Test Statistic	0.159105152
Gamma Statistics		K-S 5% Critical Value	0.3114501
k hat	24.94999517	Data follow gamma distribution	
k star (bias corrected)	14.35237819	at 5% significance level	
Theta hat	39.50759426		
Theta star	68.67950891	95% UCLs (Assuming Gamma Distribution)	
nu hat	349.2999323	Approximate Gamma UCL	1171.077486
nu star	200.9332947	Adjusted Gamma UCL	1235.62353
Approx.Chi Square Value (.05)	169.1287053		
Adjusted Level of Significance	0.01584	Lognormal Distribution Test	
Adjusted Chi Square Value	160.2938227	Shapiro-Wilk Test Statisitic	0.935749662
		Shapiro-Wilk 5% Critical Value	0.803
Log-transformed Statistics		Data are lognormal at 5% significance level	
Minimum of log data	6.633318433		
Maximum of log data	7.244227516	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	6.873192611	95% H-UCL	1177.492074
Standard Deviation of log data	0.213592963	95% Chebyshev (MVUE) UCL	1332.09312
Variance of log data	0.045621954	97.5% Chebyshev (MVUE) UCL	1482.256851
		99% Chebyshev (MVUE) UCL	1777.224423
		95% Non-parametric UCLs	
		CLT UCL	1123.37273
		Adj-CLT UCL (Adjusted for skewness)	1159.994703
		Mod-t UCL (Adjusted for skewness)	1154.052034
		Jackknife UCL	1148.339746
		Standard Bootstrap UCL	1119.422814
		Bootstrap-t UCL	1245.378238
RECOMMENDATION		Hall's Bootstrap UCL	1344.157903
Data are normal (0.05)		Percentile Bootstrap UCL	1120
		BCA Bootstrap UCL	1191.428571
Use Student's-t UCL		95% Chebyshev (Mean, Sd) UCL	1350.512245
		97.5% Chebyshev (Mean, Sd) UCL	1508.360613
		99% Chebyshev (Mean, Sd) UCL	1818.423167

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for
November 2004, Station 4: Longear Sunfish

Raw Statistics	
Number of Valid Samples	6
Number of Unique Samples	6
Minimum	610
Maximum	4000
Mean	2018.333333
Median	1750
Standard Deviation	1174.741106
Variance	1380016.667
Coefficient of Variation	0.58203523
Skewness	0.890072406

Gamma Statistics	
k hat	3.379767494
k star (bias corrected)	1.800994858
Theta hat	597.1811188
Theta star	1120.676899
nu hat	40.55720993
nu star	21.6119383
Approx.Chi Square Value (.05)	12.04623242
Adjusted Level of Significance	0.01222
Adjusted Chi Square Value	9.573588219

Log-transformed Statistics	
Minimum of log data	6.413458957
Maximum of log data	8.29404964
Mean of log data	7.454854281
Standard Deviation of log data	0.638953466
Variance of log data	0.408261532

RECOMMENDATION
Data are normal (0.05)

Use Student's-t UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.950215309
Shapiro-Wilk 5% Critical Value	0.788
Data are normal at 5% significance level	
95% UCL (Assuming Normal Distribution)	
Student's-t UCL	**2984.722353**
Gamma Distribution Test	
A-D Test Statistic	0.18437007
A-D 5% Critical Value	0.700817314
K-S Test Statistic	0.16093922
K-S 5% Critical Value	0.334166435
Data follow gamma distribution at 5% significance level	
95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	3621.057103
Adjusted Gamma UCL	4556.295348
Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.97156323
Shapiro-Wilk 5% Critical Value	0.788
Data are lognormal at 5% significance level	
95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	5132.034539
95% Chebyshev (MVUE) UCL	4353.039647
97.5% Chebyshev (MVUE) UCL	5353.610636
99% Chebyshev (MVUE) UCL	7319.038596
95% Non-parametric UCLs	
CLT UCL	2807.182185
Adj-CLT UCL (Adjusted for skewness)	2993.389469
Mod-t UCL (Adjusted for skewness)	3013.766926
Jackknife UCL	2984.722353
Standard Bootstrap UCL	2737.67297
Bootstrap-t UCL	3584.977196
Hall's Bootstrap UCL	7356.62257
Percentile Bootstrap UCL	2768.333333
BCA Bootstrap UCL	3101.666667
95% Chebyshev (Mean, Sd) UCL	4108.800453
97.5% Chebyshev (Mean, Sd) UCL	5013.347245
99% Chebyshev (Mean, Sd) UCL	6790.154265

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for
November 2004, Station 4: Red Horse

Raw Statistics		Normal Distribution Test	
Number of Valid Samples	5	Shapiro-Wilk Test Statisitic	0.83566592
Number of Unique Samples	5	Shapiro-Wilk 5% Critical Value	0.762
Minimum	1200	Data are normal at 5% significance level	
Maximum	2100		
Mean	1500	95% UCL (Assuming Normal Distribution)	
Median	1400	Student's-t UCL	**1837.074438**
Standard Deviation	353.5533906		
Variance	125000	Gamma Distribution Test	
Coefficient of Variation	0.23570226	A-D Test Statistic	0.437237196
Skewness	1.697056275	A-D 5% Critical Value	0.67861148
		K-S Test Statistic	0.27364937
Gamma Statistics		K-S 5% Critical Value	0.357105218
k hat	25.47816127	Data follow gamma distribution	
k star (bias corrected)	10.32459784	at 5% significance level	
Theta hat	58.87395029		
Theta star	145.2841092	95% UCLs (Assuming Gamma Distribution)	
nu hat	254.7816127	Approximate Gamma UCL	1916.796302
nu star	103.2459784	Adjusted Gamma UCL	2146.730221
Approx.Chi Square Value (.05)	80.79573582		
Adjusted Level of Significance	0.0086	Lognormal Distribution Test	
Adjusted Chi Square Value	72.14179319	Shapiro-Wilk Test Statisitic	0.88678488
		Shapiro-Wilk 5% Critical Value	0.762
Log-transformed Statistics		Data are lognormal at 5% significance level	
Minimum of log data	7.090076836		
Maximum of log data	7.649692624	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	7.293467381	95% H-UCL	1914.311503
Standard Deviation of log data	0.215808695	95% Chebyshev (MVUE) UCL	2127.52179
Variance of log data	0.046573393	97.5% Chebyshev (MVUE) UCL	2399.817134
		99% Chebyshev (MVUE) UCL	2934.688611
		95% Non-parametric UCLs	
		CLT UCL	1760.074194
		Adj-CLT UCL (Adjusted for skewness)	1888.295932
		Mod-t UCL (Adjusted for skewness)	1857.074438
		Jackknife UCL	1837.074438
		Standard Bootstrap UCL	1731.572808
		Bootstrap-t UCL	2260.638829
RECOMMENDATION		Hall's Bootstrap UCL	2972.13575
Data are normal (0.05)		Percentile Bootstrap UCL	1740
		BCA Bootstrap UCL	1680
Use Student's-t UCL		95% Chebyshev (Mean, Sd) UCL	2189.202438
		97.5% Chebyshev (Mean, Sd) UCL	2487.420883
		99% Chebyshev (Mean, Sd) UCL	3073.213272

APPENDIX F

ProUCL Version 2.1 MODEL OUTPUT FOR DETERMINATION OF 95-PERCENT UPPER CONFIDENCE LIMIT LEMON LANE LANDFILL, BLOOMINGTON, INDIANA

Summary Statistics for
November 2004, Station 4: Green Sunfish (adjusted for high concentration)

Raw Statistics	
Number of Valid Samples	5
Number of Unique Samples	5
Minimum	420
Maximum	2500
Mean	1302
Median	1000
Standard Deviation	811.2459553
Variance	658120
Coefficient of Variation	0.623076771
Skewness	0.779497831

Gamma Statistics	
k hat	3.075019577
k star (bias corrected)	1.363341164
Theta hat	423.4119385
Theta star	955.0067395
nu hat	30.75019577
nu star	13.63341164
Approx.Chi Square Value (.05)	6.320038021
Adjusted Level of Significance	0.0086
Adjusted Chi Square Value	4.323780173

Log-transformed Statistics	
Minimum of log data	6.040254711
Maximum of log data	7.824046011
Mean of log data	7.000332199
Standard Deviation of log data	0.679050805
Variance of log data	0.461109995

RECOMMENDATION
Data are normal (0.05)

Use Student's-t UCL

Normal Distribution Test	
Shapiro-Wilk Test Statisitic	0.945693456
Shapiro-Wilk 5% Critical Value	0.762
Data are normal at 5% significance level	

95% UCL (Assuming Normal Distribution)	
Student's-t UCL	**2075.434175**

Gamma Distribution Test	
A-D Test Statistic	0.209481161
A-D 5% Critical Value	0.682525723
K-S Test Statistic	0.197992709
K-S 5% Critical Value	0.359347231
Data follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)	
Approximate Gamma UCL	2808.638476
Adjusted Gamma UCL	4105.366427

Lognormal Distribution Test	
Shapiro-Wilk Test Statisitic	0.975945428
Shapiro-Wilk 5% Critical Value	0.762
Data are lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)	
95% H-UCL	4659.075444
95% Chebyshev (MVUE) UCL	3018.619775
97.5% Chebyshev (MVUE) UCL	3757.005644
99% Chebyshev (MVUE) UCL	5207.421703

95% Non-parametric UCLs	
CLT UCL	1898.753259
Adj-CLT UCL (Adjusted for skewness)	2033.891377
Mod-t UCL (Adjusted for skewness)	2096.51299
Jackknife UCL	2075.434175
Standard Bootstrap UCL	1837.184776
Bootstrap-t UCL	2856.24565
Hall's Bootstrap UCL	7521.078363
Percentile Bootstrap UCL	1880
BCA Bootstrap UCL	2040
95% Chebyshev (Mean, Sd) UCL	2883.409498
97.5% Chebyshev (Mean, Sd) UCL	3567.686651
99% Chebyshev (Mean, Sd) UCL	4911.816616

ATTACHMENT

APPENDIX E OF *FOCUSED ECOLOGICAL RISK ASSESSMENT, PCBs AND MAMMALIAN AND AVIAN PISCIVORES IN CONARD'S BRANCH AND RICHLAND CREEK* (EPA 2005)

(13 Pages)

Appendix E

Comparison of PCB Toxicity Reference Values in Recent Ecological Risk Assessments

Appendix E1. Mink PCB Toxicity Reference Values (TRV) in Recent Ecological Risk Assessments

Site or Application	NOAEL–NOAEC [a]		LOAEL–LOAEC [b]		Endpoint	UF [d]	Contam Source [e]	Study Exposure Duration	Reference
	Dose	Diet [c]	Dose	Diet [c]				number of breeding seasons or generations	
	mg/kg_{BW}-d	mg/kg	mg/kg_{BW}-d	mg/kg					
Fox River, WI	0.05	0.25	0.1	0.5 - 0.7	kit survival	none	field	1 (NOAEL); 2 (LOAEL)	Heaton et al 1995; Restum et al 1998
Great Lakes Initiative (GLI) Water Quality Criteria	0.03	0.2	0.3 [f]	2 [f]	whelping rate; kit production and BW [g]	0.1 (LOAEL-to-NOAEL)	product (A1254)	1	Aulerich and Ringer 1977
Housatonic River, MA, CT	0.169	1.6	0.414	3.7	kit survival	none	field	1	Bursian et al 2003
Hudson River, NY	0.004	0.025	0.04	0.25	kit BW	none	field	2	Restum et al 1998
Kalamazoo River, WI	0.08 [h]	0.5 [i]	0.1 [h]	0.6 [j]	live kit production and BW	0.52 (single-to-multiple season or generation exposure) [k]	product (A1254)	1	Aurlerich and Ringer 1977; Kihiström et al 1992; Wren, et al 1987
Sheboygan River and Harbor, WI, aquatic ERA	0.004	0.015	0.146	0.72	gestation duration; kit BW and survival	none	field	1	Heaton et al 1995
Upper Green Bay, WI	0.004	0.015	0.134	0.72	kit survival	none	field	1	Heaton et al 1995

a) NOAEL – no observed adverse effect level (dose); NOAEC – no observed adverse effect concentration (diet).
b) LOAEL – lowest observed adverse effect level (dose); LOAEC – lowest observed adverse effect concentration (diet).
c) Dietary concentration on a fresh-weight (fw) basis.
d) Uncertainty factor expressed as a multiplier.
e) Contaminant source of the study used for TRVs: product – Aroclor added to feed; field – field-contaminated prey.
f) The GLI calculated water quality criteria solely on a NOAEL basis, so did not evaluate the appropriateness of using the LOAEL by itself for decision making. In this case, the LOAEL served as a starting point for calculating the NOAEL.
g) BW – bodyweight
h) Farm-raised female mink food ingestion rate of 0.16 kg/kg_{BW}-d (Bleavins and Aulerich 1981 as cited in USEPA 1993).
i) Interpolated 10 % effective concentration (EC_{10}), the dietary concentration associated with a 10 % decrement in reproductive endpoints compared to control values based on combined exposure-response data, adjusted for continuous exposure over multiple breeding seasons or generations (Appendix D of the Kalamazoo ERA).
j) Interpolated 25 % effective concentration (EC_{25}), the dietary concentration associated with a 25 % decrement in reproductive endpoints compared to control values based on combined exposure-response data, adjusted for continuous exposure over multiple breeding seasons or generations (Appendix D of the Kalamazoo ERA).

k) Based on the mean difference in interpolated EC_{25} for continuous exposures over 1 versus 2 breeding seasons and 1 versus 2 generations of females in mink feeding studies with Clophen A50 (Brunström, et al. 2001; Kihiström, et al. 1992) and field-contaminated prey (Restum, et al. 1998).

Appendix E2. Mink Dioxin Toxic Equivalent Concentration (TEC) Toxicity Reference Values (TRVs) (µg/kg$_{BW}$-d) **in Recent Ecological Risk Assessments**

Site or Application	NOAEL/NOAEC		LOAEL/LOAEC		Endpoint	Test Species	UF	Contam Source	TEF/TEC [a]	Exposure Duration	Reference
	Dose	Diet	Dose	Diet						no. breeding seasons or generations	
	µg/kg$_{BW}$-d	µg/kg ww	µg/kg$_{BW}$-d	µg/kg ww							
Great Lakes Initiative (GLI) Water Quality Criteria	0.0001	0.0005 [b]	0.001 [c]	0.0045 [b c]	fertility; litter size; stillbirth rate	rat	0.1 (inter-specific [d])	TCDD [e]	1 (by definition)	3	Murray, et al. 1979
Housatonic River, MA, CT	0.0017	0.0161	0.0077	0.0685	kit survival	mink	none	field	Van den Berg et al 1998	1	Bursian, et al. 2003
Hudson River, NY	0.00008	0.0003	0.00224	0.0126	kit BW and survival	mink	none	field	Ahlborg et al 1992, 1994	2	Tillitt et al 1996
Sheboygan River and Harbor, WI, aquatic ERA	0.0002	0.0009	0.004	0.022	gestation duration; kit BW and survival	mink	none	field	recalculated with TEFs from Ahlborg et al 1994 [f]	1	Heaton et al 1995
Single-season exposure TRV	0.001 [g]	0.007 [h]	0.004 [g]	0.028 [i]	kit BW, survival, and abnormality	mink	none	field (Heaton, Restum, Bursian); Clophen A50 (Brunström)	Van den Berg et al 1998 (Brunström, Bursian); recalculated with TEFs from Van den Berg et al 1998 (Heaton, Restum)	1	Heaton et al 1995; Restum et al 1996; Brunström et al 2001; Bursian, et al. 2003
Multiple-season or generation exposure TRV	0.0008 [g]	0.0046 [j]	0.003 [g]	0.018 [k]	whelping rate, live kits/mated female, kit BW and survival	mink	none	field (Restum); Clophen A50 (Brunström)		2	Restum et al 1996; Brunström et al 2001

a) TEF – dioxin toxic equivalency factor; TEC – dioxin toxic equivalent concentration .

b) Mink food ingestion: 0.22 kg/kg_{BW}-d = (0.159 + 0.0177 kg/d) / 0.8 kg_{BW} (USEPA 1995)
c) The GLI calculated water quality criteria solely on a NOAEL basis, so did not evaluate the appropriateness of using the LOAEL by itself for decision making.
d) Interspecific extrapolation of toxicity data between species.
e) TCDD – 2,3,7,8-tetrachlorinated dibenzo-*p*-dioxin.
f) The recalculated TEC is identical to the value obtained with the mammalian WHO-TEFs (Van den Berg, et al. 1998).
g) Farm-raised female mink food ingestion rate of 0.16 kg/kg_{BW}-d (Bleavins and Aulerich 1981as cited in USEPA 1993)
h) Geometric mean NOAEC–1 breeding season or generation exposure: 3.2 pg/g (Brunström, et al. 2001), 0.89 pg/g (Heaton, et al. 1995; Restum, et al. 1998), and 16.1 pg/g (Bursian, et al. 2003). Brunström, et al. (2001) dietary concentration calculated by dividing the reported TEC/mink/d by the reported daily feed consumption of 130 g/d. Restum, et al. (1998) TEC is calculated from the following regression of total PCB (mg/kg) and TEC (pg/g) (data from Tillitt, et al. 1996 recalculated with mammalian WHO-TEFs): TEC = (32.594 * PCB) - 1.577 $r^2 = 0.99$, p = 0.005, for a PCB range 0.015–2.56 mg/kg. The Restum, et al. (1998) and Heaton, et al. (1995) studies were performed with the same collection of field-contaminated prey (homogenized and frozen in large batches for multiple feeding studies), so the PCB-TEC regression for the feed used by Heaton, et al. (1995), as reported by Tillitt, et al. (1996), applies to the Restum, et al. (1998) treatments as well.
i) Geometric mean LOAEC–1 breeding season or generation exposure: 64.6 pg/g (Brunström, et al. 2001), 22 pg/g (Heaton, et al. 1995), 6.6 pg/g (Restum, et al. 1998), and 68.5 pg/g (Bursian, et al. 2003).
j) Geometric mean NOAEC–2 breeding seasons or generations exposure: 3.2 pg/g (Brunström, et al. 2001) and 6.6 pg/g (Restum, et al. 1998).
k) Geometric mean LOAEC–2 breeding seasons or generations exposure: 22.3 pg/g (Brunström, et al. 2001) and 14.7 pg/g (Restum, et al. 1998).
Other definitions as in Appendix E1.

Appendix E3. Avian PCB Dose Toxicity Reference Values (TRVs) (mg/kg$_{BW}$-d) **in Recent Ecological Risk Assessments**

Site or Application - Receptor	NOAEL	LOAEL	Endpoint	Contaminant Source	Test Species	UF	Reference
Great Lakes Initiative (GLI) Water Quality Criteria - belted kingfisher, bald eagle, herring gull	0.2	0.6 [a]	hatchability	product (A1254)	pheasant	0.33 (inter-specific); 0.33 (LOAEL-to-NOAEL)	Dahlgren et al 1972
Fox River, WI - piscivorous and carnivorous birds	0.11	1.12	courtship and nesting behaviors	product (A1254)	ring dove; mourning dove	0.1 (LOAEL-to-NOAEL)	Peakall and Peakall 1973; Tori and Peterle 1983
Hudson River, NY - belted kingfisher, great blue heron, bald eagle	1.8	7.1	egg production	product (A1254)	pheasant	none	Dahlgren et al 1972
Kalamazoo River, MI	0.4 [b]	0.5 [c]	hatchability	product (A1248)	chicken	none	Lillie et al 1974, 1975; Cecil et al 1974; Scott 1977
Sheboygan River and Harbor, WI, aquatic ERA - great blue heron	0.046	0.4	hatchability; deformity	field	chicken	none	Summer et al 1996
Sheboygan River and Harbor, WI, terrestrial ERA - robin	0.042	0.36	hatchability; deformity	field	chicken	none	Summer et al 1996
Upper Green Bay, WI - caspian tern, double-crested cormorant	0.11	1.12	courtship and nesting behaviors	product (A1254)	ring dove; mourning dove	0.1 (LOAEL-to-NOAEL)	Peakall and Peakall 1973; Tori and Peterle 1983

a) The GLI calculated water quality criteria solely on a NOAEL basis, so did not evaluate the appropriateness of using the LOAEL by itself for decision making. In this case, the LOAEL served as a starting point for calculating the NOAEL.

b) Interpolated 10 % effective dose (ED_{10}), the dose associated with a 10 % decrement in reproductive endpoints compared to control values based on combined dose-response data (Appendix D of the Kalamazoo ERA).

c) Interpolated 25 % effective dose (ED_{25}), the dose associated with a 25 % decrement in reproductive endpoints compared to control values based on combined dose-response data (Appendix D of the Kalamazoo ERA).

Other definitions as in Appendix E1

Appendix E4. Avian Dioxin Toxic Equivalent Concentration (TEC) Dose Toxicity Reference Values (TRVs) ($\mu g/kg_{BW}$-d) **in Recent Ecological Risk Assessments**

Site or Application - Receptor	NOAEL	LOAEL	Endpoint	Contam Source	Test Species	UF	TEF/TEC	Reference
GLI Water Quality Criteria - belted kingfisher, bald eagle, herring gull	0.0014	0.014	fertility; embryo mortality	TCDD	pheasant	0.1 (subchronic-to-chronic)	1 (by definition)	Nosek et al 1992a
Hudson River, NY - belted kingfisher, great blue heron, bald eagle	0.0014	0.014	fertility; embryo mortality	TCDD	pheasant	0.1 (subchronic-to-chronic)	1 (by definition)	Nosek et al 1992a
Sheboygan River and Harbor, WI, aquatic ERA - great blue heron	0.0029	0.028	hatchability; deformity	field	chicken	none	recalculated with TEFs from Kennedy et al 1996	Summer et al 1996
Sheboygan River and Harbor, WI, terrestrial ERA - robin	0.00144	0.00323	hatchability; deformity	field	chicken	none	HII4E bioassay [a]	Summer et al 1996
	0.014	0.14	hen and embryo mortality	TCDD	pheasant	none	1 (by definition)	Nosek et al 1992a
Revised Summer, et al. (1996) TRVs	0.0014	0.012	hatchability; deformity	field	chicken	none	recalculated with mammalian TEFs from Van den Berg et al. 1998 [b]	Summer et al 1996

a) TEC as measured by the H4IIE rat hepatoma cell line bioassay (Tillitt, et al. 1996).

b) TEC is calculated from the following regression of total PCB (mg/kg) and TEC (pg/g) (data from Tillitt, et al. 1996 recalculated with mammalian WHO-TEFs): TEC = (32.594 * PCB) - 1.577 $r^2 = 0.99$, p = 0.005, for a PCB range 0.015–2.56 mg/kg. The Heaton, et al. (1995) and Summer, et al. (1996) studies were performed with the same collection of field-contaminated prey (homogenized and frozen in large batches for multiple feeding studies), so the PCB-TEC regression for the feed used by Heaton, et al. (1995), as reported by Tillitt, et al. (1996), applies to the Summer, et al. (1996) treatments as well. The avian TEFs reported by Van den Berg, et al. (1998) are not used for recalculating the Summer, et al. (1996) TECs because the avian TEFs are based on egg studies, which means that congeners should be modeled or measured in eggs to apply the avian TEFs. Summer, et al. (1996) did not report egg TECs, only the dietary TECs as determined by the HII4E bioassay performed with a rat hepatoma cell line. Since Summer, et al. (1996) originally reported the dietary TECs on a mammalian basis, and because ingestion-based avian TEFs are unavailable, the dietary TEC is recalculated with the updated mammalian TEFs. Dietary TEC is converted to dose by converting to µg/kg and multiplying by the mean daily food consumption over the exposure period (weeks 3–10): 0.0548 kg/kg-d (high-dose treatment) and 0.0553 kg/kg-d (low-dose treatment). An additional uncertainty for the high-dose treatment is that the dietary PCB concentration (6.6 mg/kg) is greater than the highest PCB concentration (2.56 mg/kg) reported by Tillitt, et al. (1996) in the data used to develop the PCB-TEC regression.

Other definitions as in Appendices E1 and E2

Appendix E5. Avian PCB Egg Toxicity Reference Values (TRVs) in Recent Ecological Risk Assessments

Site or Application - Receptor	NOAEC		LOAEC		Endpoint	Contam Source	Test Species	UF	Reference
	mg/kg	mg/kg lipid	mg/kg	mg/kg lipid					
Fox River, WI - all birds	4.7	49 [a]	7.6	80 [a]	hatchability	field	common tern	none	Hoffman et al 1993
Fox River, WI - all birds	0.8	14 [b]	8	136 [b]	deformity	field	double-crested cormorant	10 (NOAEC-to-LOAEC)	Ludwig et al 1996
Hudson River, NY - belted kingfisher	4.7	49 [a]	7.6	80 [a]	hatchability	field	common tern	none	Hoffman et al 1993
Hudson River, NY - great blue heron	2	32 [c]	7.6	80 [a]	hatchability	field	GBH (NOAEC); common tern (LOAEC)	none	Halbrook et al 1999 (NOAEC); Hoffman et al 1993 (LOAEC)
Hudson River, NY - bald eagle	5.5	73 [d]	8.7	116 [d]	nest success	field	bald eagle	none	Wiemeyer et al 1993
Kalamazoo River, MI - general	1	8.9 [e]	1.5	13.4 [e]	hatchability	product (A1242)	chicken	none	Britton and Huston 1973
Kalamazoo River, MI - great blue heron	5.8 [f]	61 [a]	20.6 [g]	217 [a]	hatchability, population size or reproductive success	field	Forster's tern	none	Barron et al 1995
Kalamazoo River, MI - bald eagle	1.5	20 [d]	7.7 [h]	103 [d]	hatchability, nesting success, population size or reproductive success	field	bald eagle	0.2 (LOAEC-to-NOAEC) [i]	Wiemeyer et al 1984; various secondary sources [h]

Appendix E5. Avian PCB Egg Toxicity Reference Values (TRVs) in Recent Ecological Risk Assessments

Site or Application - Receptor	NOAEC		LOAEC		Endpoint	Contam Source	Test Species	UF	Reference
	mg/kg	mg/kg lipid	mg/kg	mg/kg lipid					
Kalamazoo River, MI - robin	2.8 [j]	25 [e]	6.2 [k]	55 [e]	hatchability, egg production, fertility, deformity	product (A1242, A1248, A1254) (Barron); field (Summer)	chicken	none	Barron et al 1995; Summer et al 1996
Sheboygan River and Harbor, WI, terrestrial ERA - robin	5	45 [e]	24	214 [e]	hatchability; deformity	field	chicken	none	Summer et al 1996
Upper Green Bay, WI - caspian tern, double-crested cormorant	4.7	49 [a]	7.6	80 [a]	hatchability, deformity	field	common tern	none	Hoffman et al 1993
USEPA Region 5 proposed	0.7	6 [e]	1.3	12 [e]	hatchability	product (A1248)	chicken	none	Lillie et al 1974; Cecil et al 1974; Scott 1977

a) Tern egg lipid content of 9.5 % (semi-precocial) (Carey, et al. 1980)
b) Cormorant egg lipid content of 5.9 % (altricial) (Carey, et al. 1980)
c) Heron egg lipid content of 6.3 % (semi-altricial) (Carey, et al. 1980)
d) Bald eagle egg lipid content of 7.5 % (Blankenship and Giesy 2002)
e) Chicken egg fat content of 11.2 % (5.6 g fat in 50 g egg - Pennington and Church 1985)
f) Arithmetic mean NOAEC: 4.5 mg/kg (Kubiak, et al. 1989 as cited in Barron, et al. 1995) and 7.0 mg/kg (Bosveld and Van den Berg, in press as cited in Barron, et al. 1995). Note: the article as published by Bosveld and Van den Berg (1994) show an egg PCB NOAEC of 2.3 mg/kg for Forster's tern hatching success based on King, et al. (1991).
g) Arithmetic mean LOAEC: 22.2 mg/kg (Kubiak, et al. 1989 as cited in Barron, et al. 1995) and 19 mg/kg (Bosveld and Van den Berg, in press as cited in Barron, et al. 1995). Note: the published article by Bosveld and Van den Berg (1994) show an egg PCB LOAEC of 19.2 mg/kg for Forster's tern hatching success based on Kubiak, et al. (1989).
h) Arithmetic mean LOAEC: 4.0 mg/kg (Wiemeyer, et al. 1984 as derived by Ludwig, et al. 1993 as cited by Stratus 1999), 4.0 mg/kg (Wiemeyer, et al. 1984 as derived by Ludwig, et al. 1993 as cited by Barron, et al. 1995), 4.5 mg/kg (40 % decrement in productivity, Wiemeyer, et al. 1984), 13 mg/kg (unsuccessful nests, Wiemeyer, et al. 1984), 13 mg/kg (reproductive success, Wiemeyer, et al. 1984 as cited by Bosveld and Van den Berg 1994). Note: all of the values are estimates of the LOAEC of the same study.
i) Table 4-9 of the Kalamazoo ERA mistakenly states that the NOAEC is "est. from mean LOAEC/10", but the actual divisor was 5.
j) Arithmetic mean NOAEC: 0.36 mg/kg (Scott 1977 as cited by Barron, et al. 1995), 0.95 mg/kg (Britton and Huston 1973 as cited by Barron, et al. 1995), <5 (entered as 5) mg/kg (Platanow and Reinhart 1973 as cited by Barron, et al. 1995), and 5 mg/kg (Summer, et al. 1996).

k) Arithmetic mean LOAEC: 1.5 mg/kg (Britton and Huston 1973 as cited by Barron, et al. 1995) [note: Table 4-9 of the Kalamazoo ERA mistakenly cites this as "Britton 1973"], 2.5 mg/kg (Scott 1977 as cited by Barron, et al. 1995), 3 mg/kg (RCB/Hagler, Bailly, Inc 1994), 4 mg/kg (Tumasonis, et al. 1973 as cited by Barron, et al. 1995), 4.8 mg/kg (RCB/Hagler, Bailly, Inc 1994), 5 mg/kg (Platanow and Reinhart 1973 as cited by Barron, et al. 1995), and 24 mg/kg (Summer, et al. 1996).

Appendix E6. Avian Dioxin Toxic Equivalent Concentration (TEC) Egg Toxicity Reference Values (TRVs) in Recent Ecological Risk Assessments										
Site or Application - Receptor	NOAEC		LOAEC		Endpoint	Contam Source	Test Species	UF	TEFs	Reference
	µg/kg	µg/kg lipid	µg/kg	µg/kg lipid						
Blankenship & Giesy 2002 - bald eagle	0.134	1.79 [a]	0.4	5.33 [a]	P4501A induction	field	bald eagle	none	Recalculated with TEFs from Van den Berg et al 1998	Elliott et al. 1996
Fox River, WI - all birds	0.007	0.04 [b]	0.19 - 0.31 [c]	2.5 - 4.1 [d]	egg lethality	field	wood duck (NOAEC), double-crested cormorant, caspian tern (LOAEC) [e]	unknown (treatment-to-LC_{50}) [f], 0.1 (LC_{50} -to-NOAEC); none [g] (LOAEC)	USEPA 1989 (NOAEC); H4IIE bioassay (LOAEC) [h]	Giesy et al 1995 (NOAEC), Giesy et al 1994a (LOAEC)
Fox River, WI - all birds	0.038	0.6 [i]	0.38	6.4 [i]	deformity	field	double-crested cormorant	10 (NOAEC-to-LOAEC)	H4IIE bioassay	Ludwig et al 1996
Hudson River, NY - belted kingfisher	1	17 [i]	4	68 [i]	embryo mortality	TCDD injection	double-crested cormorant	none	1 (by definition)	Powell et al 1997
Hudson River, NY - great blue heron	0.3	4.8 [j]	0.5	7.9 [j]	chick BW	field	great blue heron	none	Safe et al 1990	Sanderson et al 1994
Hudson River, NY - bald eagle	0.214 [k]	12.8 [l]	5	79 [m]	hatch rate (NOAEC); embryo mortality (LOAEC)	field (NOAEC); PCB 77 injection (LOAEC)	bald eagle (NOAEC); kestrel (LOAEC)	none	Ahlborg et al 1994 (NOAEC); Van den Berg et al 1998 (LOAEC)	Elliot et al 1996 (NOAEC); Hoffman et al 1998 (LOAEC)
Sheboygan River and Harbor, WI, terrestrial ERA - robin	0.08	0.7 [n]	0.16	1.4 [n]	embryo mortality	TCDD injection	chicken	none	1 (by definition)	Powell et al 1996

a) Bald eagle egg lipid content of 7.5 % (Blankenship and Giesy 2002)
b) Wood duck egg lipid content of 18 % (White and Seginak 1994)

c) Lethal concentration to 20 % (LC_{20}) and 30 % (LC_{30}) of eggs based on a linear regression of data on field-exposed double-crested cormorant and caspian tern colonies (Table 9 in Giesy, et al. 1994a) and the NOAEC from Giesy, et al. (1995). Note–the data are incorrectly attributed in the Fox River ERA Figure 6-4 (Giesy and Tillitt are transposed), Table 6-7 (should read "Giesy, et al. 1994b"), and Table 6-5 (should read "derived from Giesy, et al. 1994b and 1995", the regression based on Tillitt, et al. 1992 data was not used in the derivation).

d) Based on the following regression: egg LC_n = 0.006 lipid-normalized TEC (pg/g) + 5.282, $r^2 = 0.99$, $p < 0.01$, where LC_n is the lethal concentration in eggs associated with mortality in n % of eggs. Each egg TEC datum in Table 6-7 of the Fox River ERA was lipid-normalized by species: wood duck (see b), cormorant (see g), and caspian tern (semi-precocial–egg lipid content of 9.5 %, Carey, et al. 1980).

e) The regression includes the wood duck NOAEC value in addition to the cormorant and tern data.

f) Giesy, et al. (1995) wrote: "The LC-50 for wood ducks (*Aix sponsa*) has been reported to be approximately 70 ng TCDD-EQ/kg in the eggs of wood ducks (White and Setinak [*sic*] 1994). If this value is divided by an application factor of 10, the estimated NOAEC for eggs is estimated to be approximately 7 ng TCDD-EQ/kg.". However, LC_{50} values are not presented in White and Seginak (1994) or the companion paper by White and Hoffman (1995). The nearest datum to a LC_{50} is 55 % eggs hatched at >50 ppt TEC (Table 4 in White and Seginak 1994). Giesy, et al. (1995) do not discuss the procedure for deriving a LC_{50} of 70 ppt from White and Seginak (1994).

g) The cormorant and tern data were used without UFs (6 data points). One data point in the regression was derived with UFs (the wood duck NOAEC).

h) Six of the 7 TEC data points used in the regression are based on the HII4E bioassay (Giesy, et al. 1994a), but one datum (the Giesy, et al. 1995 NOAEC derived from White and Seginak 1994) is based on USEPA 1989 TEFs.

i) Cormorant egg lipid content of 5.9 % (altricial) (Carey, et al. 1980)

j) Heron egg lipid content of 6.3 % (semi-altricial) (Carey, et al. 1980)

k) Average of whole egg TECs at Powell River (210 ng/kg) and East Vancouver (217 ng/kg – calculated from 13,000 ng TEC/kg lipid ÷ 60 [yolk lipid concentration-to-whole egg concentration reported by Elliott, et al. 1996]).

l) Average of lipid-normalized egg yolk TECs at Powell River (12,600 ng/kg lipid) and East Vancouver (13,000 ng/kg lipid – estimated from Figure 4 of Elliott, et al. 1996).

m) Falcon egg lipid content of 6.3 % (semi-altricial) (Carey, et al. 1980)

n) Chicken egg fat content of 11.2 % based on 5.6 g fat in a 50-g egg (Pennington and Church 1985)

Appendix E7. Ecological Risk Assessment Sources

Fox - Final Baseline Human Health and Ecological Risk Assessment, Lower Fox River and Green Bay, Wisconsin, Remedial Investigation and Feasibility Study, 12/2002, prepared by The RETEC Group for Wisconsin Dept. of Natural Resources. http://www.dnr.state.wi.us/org/water/wm/lowerfox/rifs/riskassessment.html

Great Lakes Initiative - USEPA. 1995. Great Lakes Water Quality Initiative Criteria Documents for the Protection of Wildlife: DDT, Mercury, 2,3,7,8-TCDD, PCBs. Office of Water. EPA-820-B-95-008.

Hudson - Hudson River PCB Reassessment, Phase 2 Report, Further Characterization and Analysis, 11/2000, prepared by TAMS Consultants and Menzie-Cura Assoc. for USEPA Region 2 and USACE, Kansas City District. http://www.epa.gov/hudson/reports.htm

Housatonic - Bursian, S., R. Aulerich, B. Yamini, and D. Tillitt. 2003. Dietary Exposure of Mink to Fish from the Housatonic River: Effects on Reproduction and Survival. 6/10/03 Revised Final Report. submitted to Weston Solutions, Inc. http://www.epa.gov/ne/ge/thesite/restofriver-reports.html

Kalamazoo - Final (Revised) Baseline Ecological Risk Assessment. Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. 2003. prepared by CDM for Michigan Department of Environmental Quality., and Appendix D. Toxicity Reference Values (TRVs) for Mammals and Birds Based on Selected Aroclors. 3/6/03. memo from James Chapman, ecologist, USEPA Region 5 to Shari Kolak, RPM. USEPA Region 5, Chicago.

Sheboygan aquatic ERA - Sheboygan River and Harbor Aquatic Ecological Risk Assessment, 11/98, prepared by EVS and NOAA for USEPA Region 5. http://response.restoration.noaa.gov/cpr/library/publications.html

Sheboygan terrestrial ERA - Sheyboygan River and Harbor Floodplain Terrestrial Ecological Risk Assessment, Sheboygan, Wisconsin, 11/99, prepared by James Chapman, USEPA ecologist, for USEPA Region 5.

Upper Green Bay - Focused Ecological Risk Assessment. Upper Green Bay Portion of the Fox River Site, Green Bay, WI. 2000. prepared by Mark Sprenger, Nancy Beckham and Karen Kracko, USEPA Environmental Response Team Center, NJ. Appendix C in Final Baseline Human Health and Ecological Risk Assessment, Lower Fox River and Green Bay, Wisconsin Remedial Investigation and Feasibility Study, 2002, Volume 2.

See Section 8 for all other references.