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Toxicological Benchmarks for Wildlife: 1995 Revision

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Toxicological Benchmarks for Wildlife: 1995 Revision

D. M. Opresko
B. E. Sample
G. W. Suter II

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PREFACE

The purpose of this report is to present toxicological benchmarks for assessment of effects of certain chemicals on mammalian and avian wildlife species. This work was performed under Work Breakdown Structure 1.4.12.2.3.04.07.02 (Activity Data Sheet 8304, "Technical Integration"). Publication of this document meets a milestone for the Environmental Restoration (ER) Risk Assessment Program. This document provides the ER Program with toxicological benchmarks that may be used as comparative tools in screening assessments as well as lines of evidence to support or refute the presence of ecological effects in ecological risk assessments. The chemicals considered in this report are some that occur at U.S. Department of Energy waste sites, and the wildlife species evaluated herein were chosen because they are widely distributed and represent a range of body sizes and diets.

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TABLES

ACRONYMS

BAF	bioaccumulation factor
BCF	bioconcentration factor
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FCM	food chain multiplier
FEL	frank effects level
HQ	hazard quotient
LD_{50}	lethal dose to 50% of the population
LC_{50}	lethal concentration to 50% of the population
LOAEL	lowest observed adverse effects level
NOAEL	no observed adverse effects level
P_{oct}	Octanol/Water Partition Coefficient
PCB	polychlorinated biphenyl
RfD	reference dose
RTECS	Registry of Toxic Effects of Chemical Substances
TCDD	tetrachlorodibenzodioxin
TCDF	tetrachlorodibenzofuran
TWA	time weighted average

EXECUTIVE SUMMARY

The process of evaluating ecological risks of environmental contaminants comprises two tiers. The first tier is a screening assessment where concentrations of contaminants in the environment are compared to no observed adverse effects level (NOAEL)-based toxicological benchmarks that represent concentrations of chemicals in environmental media (water, sediment, soil, food, etc.); these concentrations are presumed to be nonhazardous to the surrounding biota. The second tier is a baseline ecological risk assessment where toxicological benchmarks are one of several lines of evidence used to support or refute the presence of ecological effects.

This report presents NOAEL- and lowest observed adverse effects level (LOAEL)-based toxicological benchmarks for assessment of effects of 85 chemicals on 8 representative mammalian wildlife species or 11 avian wildlife species. The chemicals are some of those that occur at U.S. Department of Energy waste sites; the wildlife species were chosen because they are widely distributed and provide a representative range of body sizes and diets. Further descriptions of the chosen wildlife species and chemicals are also provided in this report. The NOAEL-based benchmarks represent values believed to be nonhazardous for the listed wildlife species; LOAEL-based benchmarks represent threshold levels at which adverse effects are likely to become evident. These benchmarks consider contaminant exposure through oral ingestion of contaminated media; however, exposure through inhalation and/or direct dermal exposure are not considered in this report.

1. INTRODUCTION

Ecological risks of environmental contaminants are evaluated by using a two-tiered process. In the first tier, a screening assessment is performed where concentrations of contaminants in the environment are compared to no observed adverse effects level (NOAEL)-based toxicological benchmarks. These benchmarks represent concentrations of chemicals (i.e., concentrations presumed to be nonhazardous to the biota) in environmental media (water, sediment, soil, food, etc.). While exceedance of these benchmarks does not indicate any particular level or type of risk, concentrations below the benchmarks should not result in significant effects. In practice, when contaminant concentrations in food or water resources are less than these toxicological benchmarks, the contaminants may be excluded from further consideration. However, if the concentration of a contaminant exceeds a benchmark, that contaminant should be retained as a contaminant of potential concern (COPC) and investigated further.

The second tier in ecological risk assessment, the baseline ecological risk assessment, may use toxicological benchmarks as part of a weight-of-evidence approach (Suter 1993). Under this approach, based toxicological benchmarks are one of several lines of evidence used to support or refute the presence of ecological effects. Other sources of evidence include media toxicity tests, surveys of biota (abundance and diversity), measures of contaminant body burdens, and biomarkers.

This report presents NOAEL- and lowest observed adverse effects level (LOAEL)-based toxicological benchmarks for assessment of effects of 85 chemicals on 8 representative mammalian wildlife species (short-tailed shrew, little brown bat, meadow vole, white-footed mouse, cottontail rabbit, mink, red fox, and whitetail deer) or 11 avian wildlife species (American robin, rough-winged swallow, American woodcock, wild turkey, belted kingfisher, great blue heron, barred owl, barn owl, Cooper's hawk, and red-tailed hawk, osprey) (scientific names for both the mammalian and avian species are presented in Appendix B). [In this document, NOAEL refers to both dose (mg contaminant per kg animal body weight per day) and concentration (mg contaminant per kg of food or L of drinking water)].

The 19 wildlife species were chosen because they are widely distributed and provide a representative range of body sizes and diets. The chemicals are some of those that occur at U.S. Department of Energy (DOE) waste sites. The NOAEL-based benchmarks presented in this report represent values believed to be nonhazardous for the listed wildlife species; LOAEL-based benchmarks represent threshold levels at which adverse effects are likely to become evident. These benchmarks consider contaminant exposure through oral ingestion of contaminated media only. Exposure through inhalation and/or direct dermal exposure are not considered in this report.

2. AVAILABILITY AND LIMITATIONS OF TOXICITY DATA

Information on the toxicity of environmental contaminants to terrestrial wildlife can be obtained from several sources including the U.S. Environmental Protection Agency (EPA) Terrestrial Toxicity Data Base (TERRE-TOX; Meyers and Schiller 1986), U. S. Fish and Wildlife Service reports, EPA assessment and criteria documents, and Public Health Service toxicity profiles. In addition, many refereed journals (e.g., Environmental Toxicology and Chemistry, Archives of Environmental Contamination and Toxicology, Journal of Wildlife Management, etc.) regularly publish studies concerning contaminant effects on wildlife. Selected data from these sources are presented in tabular form in Appendix C.

Pesticides were excluded from this compilation except for those considered to be likely contaminants on DOE reservations, such as the persistent organochlorine compounds (e.g., chlordane, DDT, endrin, etc.). Most of the available information on the effects of environmental contaminants on wildlife pertains to agricultural pesticides and little to industrial and laboratory chemicals of concern to DOE. Furthermore, the toxicity data that are available are often limited to severe effects of acute exposures [e.g., concentration or dose levels causing 50% mortality to a test population (LC_{50} and LD_{50})].

Relatively few studies have determined safe exposure levels (NOAELs) for situations in which wildlife have been exposed over an entire lifetime or several generations. Consequently, for nearly all wildlife species, a NOAEL for chronic exposures to a particular chemical must be estimated from toxicity studies of the same chemical conducted on a different species of wildlife or on domestic or laboratory animals or from less than ideal data (e.g., LD_{50} values). In many cases, the only available information is from studies on laboratory species (primarily rats and mice). These studies may be of short-term or subchronic duration and may identify a lowest-observed-adverse-effect-level (LOAEL) only and not a NOAEL. Estimating a NOAEL for a chronic exposure from such data can introduce varying levels of uncertainty into the calculation (Sect. 3.2); however, such laboratory studies represent a valuable resource whose use should be maximized.

Wildlife NOAELs estimated from data on laboratory animals must be evaluated carefully while considering the possible limitations of the data. Variations in physiological or biochemical factors may exist among species; these factors may include uptake, metabolism, and disposition, which can alter the potential toxicity of a contaminant to a particular species. Inbred laboratory strains may have an unusual sensitivity or resistance to the tested compound. Behavioral and ecological parameters (e.g., stress factors such as competition, seasonal changes in temperature or food availability, diseased states, or exposure to other contaminants) may make a wildlife species' sensitivity to an environmental contaminant different from that of a laboratory or domestic species.

Available studies on wildlife or laboratory species may not include evaluations of all significant endpoints for determining long-term effects on natural populations. Important data that may be lacking are potential effects on reproduction, development, and population dynamics following multigeneration exposures. In this report, endpoints such as reproductive and developmental toxicity and reduced survival were used whenever possible; however, for some contaminants, limitations in the available data necessitated the use of endpoints such as organ-specific toxic effects. It should be emphasized that in such cases the resulting benchmarks represent conservative values whose relationships to potential population level effects are uncertain. These benchmarks will be recalculated if and when more appropriate toxicity data become available.

If fewer steps are involved in the extrapolation process, then the uncertainty in estimating the wildlife NOAEL will be lower. For example, extrapolating from a NOAEL for an appropriate toxic endpoint (i.e., reproductive or population effects) for white laboratory mice to white-footed mice that are relatively closely related and of comparable body size would have a high level of reliability. Conversely, extrapolating from a LOAEL for organ-specific toxicity (e.g., liver or kidney damage) in laboratory mice to a nonrodent wildlife species such as mink or fox would have a low level of reliability in predicting population effects among these species. Because of the differences in avian and mammalian physiology and to reduce extrapolation uncertainty, studies performed on mammalian test species are used exclusively to estimate NOAELs for mammalian wildlife, and studies performed on avian test species are used exclusively to estimate NOAELs for avian wildlife; interclass extrapolations were not performed for this document.

In this report, benchmarks for mammalian species of wildlife have been estimated from studies conducted primarily on laboratory rodents, and benchmarks for avian species have been estimated from studies on domestic and wild birds. Few experimental toxicity data are available for other groups of wildlife such as reptiles and amphibians, and it is not considered appropriate to apply benchmarks across different groups. Models for such wildlife extrapolations have not been developed as they have for aquatic biota (Suter 1993).

3. METHODOLOGY

The general method used in this report is one based on EPA methodology for deriving human toxicity values (e.g., reference values, reportable quantities, and unit risks for carcinogenicity) from animal data (EPA 1986a, 1986b, 1988b, 1989). For this report, experimentally derived NOAELs or LOAELs were used to estimate NOAELs for wildlife by adjusting the dose according to differences in body size. The concentrations of the contaminant in the wildlife species' food or drinking water that would be equivalent to the NOAEL were then estimated from the species' rate of food consumption and water intake. For wildlife species that feed primarily on aquatic organisms, a benchmark that combines exposure through both food and water is calculated based on the potential of the contaminant to bioconcentrate and bioaccumulate through the food chain.

NOAELs and LOAELs for mammals and domestic and wild birds were obtained from the primary literature, EPA review documents, and secondary sources such as the Registry of Toxic Effects of Chemical Substances and the Integrated Risk Information System (IRIS) (EPA 1994). Appendix A provides a brief description of these studies and discusses the rationale for their use in deriving benchmarks. The selection of a particular study and a particular toxicity endpoint and the identification of NOAELs and LOAELs was based on an evaluation of the data. Emphasis was placed on those studies in which reproductive and developmental endpoints were considered (endpoints that may be directly related to potential population-level effects), multiple exposure levels were investigated, and the reported results were evaluated statistically to identify significant differences from control values. It is recognized that other interpretations of the same data may be possible and that future research may provide more comprehensive data from which benchmarks might be derived. Therefore, it is anticipated that the development of these screening benchmarks will be an ongoing process, and consequently, the values presented in this report are subject to change.

3.1 ESTIMATING NOAELS FOR WILDLIFE

NOAELs and LOAELs are daily dose levels normalized to the body weight of the test animals (e.g., milligrams of chemical per kilogram body weight per day). The presentation of toxicity data on a mg/kg/day basis allows comparisons across tests and across species with appropriate consideration for differences in body size. Studies have shown that numerous physiological functions such as metabolic rates, as well as responses to toxic chemicals, are a function of body size. Smaller animals have higher metabolic rates and usually are more resistant to toxic chemicals because of more rapid rates of detoxification. (However, this may not be true if the toxic effects of the compound are produced primarily by a metabolite). It has been shown that the best measure of differences in body size is one based on body surface area which, for lack of direct measurements, can be expressed in terms of body weight (bw) raised to the 2/3 power ($bw^{2/3}$) (EPA 1980a). If the dose (d) has been calculated in terms of unit body weight (i.e., mg/kg), then the dose per unit body surface area (D) equates to:

$$D = \frac{d \; x \; bw}{bw^{2/3}} = d \; x \; bw^{1/3}. \qquad (1)$$

The assumption is that the dose per body surface area (Eq. 1) for species "a" and "b" would be equivalent:

$$d_a \; x \; bw_a^{1/3} = d_b \; x \; bw_b^{1/3}. \qquad (2)$$

Therefore, knowing the body weights of two species and the dose (d_b) producing a given effect in species "b," the dose (d_a) producing the same effect in species "a" can be determined:

$$d_a = d_b \; x \; \frac{bw_b^{1/3}}{bw_a^{1/3}} = d_b \; x \left(\frac{bw_b}{bw_a} \right)^{1/3}. \qquad (3)$$

EPA uses this methodology in carcinogenicity assessments and reportable quantity documents for adjusting from animal data to an equivalent human dose (EPA 1985a, 1988b). The same approach has been proposed for use in extrapolating from one animal species to another. However, it should be noted that EPA has not applied this method to wildlife and that wildlife toxicologists commonly scale dose to body weight without incorporating the exponential factor of 2/3. The exponent has been retained for this report because no reason exists why different methods should be used to extrapolate from mice to humans and mice to foxes. The issue of appropriate scaling models for wildlife should be investigated.

For developing reference doses (RfDs), EPA uses a default factor of 0.1 to adjust an animal dose to an equivalent human dose. Using the body size scaling method outlined previously results in an adjustment factor of about 0.07 when deriving an equivalent human dose from data for mice (using the standard body weight of 0.03 kg for mice and 70 kg for humans) and a factor of about 0.17 when deriving an equivalent human dose from data for rats (standard body weight 0.35 kg).

The ideal data set to use in the calculation would be the actual average body weights of the test animals used in the bioassay. When this information is not available, standard reference body weights for laboratory species can be used as indicated previously (EPA 1985a; see Table 1). Body weight data for wildlife species are available from several secondary sources [i.e., the Mammalian Species series, published by the American Society of Mammalogists; Burt and Grosseneider 1976; Dunning 1984; Dunning 1993; Silva and Downing 1995; Whitaker 1980]. Often, only a range of adult body weight values is available for a species, in which case an average value must be estimated. A time-weighted average body weight for the entire life span of a species would be the most appropriate data set to use for chronic exposure situations; however, such data usually are not available. Body weight of a species can vary geographically, as well as by sex. Sex-specific data may be needed depending on the toxicity endpoints used. Body weight data for the mammalian wildlife species considered in this report are given in Table 1.

Table 1. Reference values for mammalian species

Species	Body weight (kg)	Food intake (kg/day)	Food factor[a] f	Water intake (L/day)[19]	Water factor[b] ω
rat	0.35[c]	0.028[d]	0.08	0.046[e]	0.13
mouse	0.03[c]	0.0055[d]	0.18	0.0075[e]	0.25
rabbit	3.8[c]	0.135[d]	0.034	0.268[e]	0.070
dog	12.7[c]	0.301[d]	0.024	0.652[e]	0.051
short-tailed shrew	0.015[f]	0.009[f]	0.6	0.0033[f]	0.22
meadow vole	0.044[f]	0.005[f]	0.114	0.006[g]	0.136
white-footed mouse	0.022[f]	0.0034[f]	0.155	0.0066[f]	0.3
cotton rat	0.15	0.010[h]	0.07	0.018[g]	0.12
cottontail rabbit	1.2[f]	0.237[f]	0.198	0.116[g]	0.013
mink	1.0[f]	0.137[f]	0.137	0.099[g]	0.099
red fox	4.5[f]	0.45[f]	0.1	0.38[g]	0.084
whitetail deer	56.5[f]	1.74[f]	0.031	3.7[g]	0.065

[a] The food factor is the daily food intake divided by the body weight.
[b] The water factor is the daily water intake divided by the body weight.
[c] EPA reference values (EPA 1985a).
[d] Calculated using reference body weight and Eq. 10.
[e] Calculated using reference body weight and Eq. 21.
[f] See Appendix B for data source.
[g] Calculated according to Calder and Braun, 1983; see Eq. 24.
[h] Calculated using Eq. 14.

If a NOAEL (or LOAEL) is available for the test species ($NOAEL_t$), then the equivalent NOAEL (or LOAEL) for a species of wildlife ($NOAEL_w$) can be calculated by using the adjustment factor for differences in body size:

$$NOAEL_w = NOAEL_t \left(\frac{bw_t}{bw_w} \right)^{1/4} . \tag{4}$$

3.2 DERIVING A CHRONIC NOAEL FROM OTHER ENDPOINTS

In cases where a NOAEL for a specific chemical is not available for either wildlife or laboratory species, but a LOAEL has been determined experimentally, the NOAEL can be estimated by applying an uncertainty factor (UF) to the LOAEL. In the EPA methodology, the LOAEL can be reduced by a factor of up to 10 to derive the NOAEL.

$$NOAEL = \frac{LOAEL}{\leq 10}. \tag{5}$$

Although a factor of 10 is usually used in the calculation, the true NOAEL may be only slightly lower than the experimental LOAEL, particularly if the observed effect is of low severity. A thorough analysis of the available data for the dose-response function may reveal whether a LOAEL to NOAEL uncertainty factor of <10 should be used. No data were found for any of the contaminants considered suggesting the use of a LOAEL-NOAEL adjustment factor of <10.

If the only available data consist of a NOAEL (or a LOAEL) for a subchronic exposure, then the equivalent NOAEL or LOAEL for a chronic exposure can be estimated by applying a UF of ≤ 10:

$$chronic\ NOAEL = \frac{subchronic\ NOAEL}{\leq 10}. \tag{6}$$

EPA has no clear guidance on the dividing line between a subchronic exposure and a chronic exposure. For studies on laboratory rodents, EPA generally accepts a 90-day exposure duration as a standard for a subchronic exposure. In the guidance for the proposed Great Lakes Water Quality Criteria, EPA (1993d) indicates that a chronic exposure would be equivalent to at least 50% of a species' lifespan. Since most of the NOAELS and LOAELS available for calculated benchmarks for mammalian wildlife are from studies on laboratory rodents (with lifespans of approximately 2 years), 1 year has been selected as the minimum required exposure duration for a chronic exposure (approximately one-half of the lifespan). Little information is available concerning the lifespans of birds used in toxicity tests, and little standardization of study duration for avian toxicity tests has been conducted. In addition, few long-term, multigeneration avian toxicity tests have been performed. Therefore, avian studies where exposure duration was 10 weeks or less were considered to be subchronic, and those where the exposure duration was greater than 10 weeks were considered chronic studies.

In addition to duration of exposure, the time when contaminant exposure occurs is critical. Reproduction is a particularly sensitive lifestage due to the stressed condition of the adults and the rapid growth and differentiation occurring within the embryo. For many species, contaminant exposure of a few days to as little as a few hours during gestation and embryo development may produce severe adverse effects. Because these benchmarks are intended to evaluate the potential for adverse effects on wildlife populations and impaired reproduction is likely to affect populations, contaminant exposures that are less than one year or 10 weeks, but occur during reproduction, were considered to represent chronic exposures.

If the available data are limited to acute toxicity endpoints [frank-effects level (FEL)] or to exposure levels associated with lethal effects (LD_{50}s), the estimation of NOAELs for chronic exposures are likely to have a wide margin of error because no standardized mathematical correlation exists between FEL or LD_{50} values and NOAELs that can routinely be applied to all chemicals (i.e., exposure levels associated with NOAELs may range from 1/10 to 1/10,000 of the acutely toxic dose, depending on the chemical and species). However, if both an LD_{50} and a NOAEL have been determined for a related chemical *a*, then this ratio could be used to estimate a $NOAEL_w$ using the $(LD_{50})_w$ for the compound of interest.

$$NOAEL_w = (LD_{50})_w \frac{NOAEL_a}{(LD_{50})_a}. \tag{7}$$

3.3 NOAEL EQUIVALENT CONCENTRATION IN FOOD

The dietary level or concentration in food (C_f, in mg/kg food) of a contaminant that would result in a dose equivalent to the NOAEL or LOAEL (assuming no exposure through other environmental media) can be calculated from the food factor f:

$$C_f = \frac{NOAEL_w}{f}. \tag{8}$$

The food factor, f, is the amount of food consumed (F, in g/day or kg/day) per unit body weight (bw, in g or kg):

$$f = \frac{F}{bw}. \tag{9}$$

In the absence of empirical data, rates of food consumption (F, in kg/day) for laboratory mammals can be estimated from allometric regression models based on body weight (in kg) (EPA 1988a):

$$F = 0.056(bw)^{0.6611} \quad (laboratory\ mammals). \tag{10}$$

$$F = 0.054(bw)^{0.9451} \quad (moist\ diet). \tag{11}$$

$$F = 0.049(bw)^{0.6087} \quad (dry\ diet). \tag{12}$$

In the absence of specific information on the body weights of the test animals, EPA (1985a) uses default values (see Table 1). In this report, F was estimated using Eq. 10 and the default body weights. Reference body weights for particular strains of laboratory animals and for specific age groups corresponding to subchronic or chronic exposures are available (EPA 1988a), and these can also be used in the equations. Default values for food consumption and food factors for common laboratory species (rats, mice, dogs, rabbits, etc.) have also been used by EPA (1988b) for estimating equivalent dose levels for laboratory studies in which the exposure is reported only as a dietary concentration. Generally, the rates of food consumption for laboratory species, as derived from Eqs. 10–12, are higher then the EPA default values.

Food consumption rates are available for some species of wildlife (EPA 1993a, 1993b; Table 1). In the absence of experimental data, F values (g/day) can be estimated from allometric regression models based on metabolic rate and expressed in terms of body weight (g) (Nagy 1987):

$$F = 0.235(bw)^{0.822} \quad (placental\ mammals). \tag{13}$$

$$F = 0.621(bw)^{0.564} \quad (rodents). \tag{14}$$

$$F = 0.577(bw)^{0.727} \quad (herbivores). \tag{15}$$

$$F = 0.492(bw)^{0.673} \quad (marsupials). \tag{16}$$

$$F = 0.648(bw)^{0.651} \quad (birds). \tag{17}$$

$$F = 0.398(bw)^{0.850} \quad (passerine\ birds). \tag{18}$$

It should be noted that F values estimated using these allometric equations are expressed as g/day dry *weight*. Because wildlife do not consume dry food, these estimates must be adjusted to account for the water content of food. Water contents of selected wildlife foods are given in the *Wildlife Exposures Factors Handbook* (EPA 1993a).

3.4 NOAEL EQUIVALENT CONCENTRATION IN DRINKING WATER

The concentration of the contaminant in the drinking water of an animal (C_w, in mg/L) resulting in a dose equivalent to a $NOAEL_w$ or $LOAEL_w$ can be calculated from the daily water consumption rate (W, in L/day) and the average body weight (bw_w) for the species:

$$C_w = \frac{NOAEL_w\ x\ bw_w}{W}. \tag{19}$$

If known, the water factor ω [= the rate of water consumption per unit body weight (W/bw)] can be used in a manner identical to that for the food factor:

$$C_w = \frac{NOAEL_w}{\omega}. \tag{20}$$

If empirical data are not available, W (in L/day) can be estimated from allometric regression models based on body weight (in kg) (EPA 1988a):

$$W = 0.10(bw)^{0.7377} \quad (laboratory\ mammals). \tag{21}$$

$$W = 0.009(bw)^{1.2044} \quad (mammals,\ moist\ diet). \tag{22}$$

$$W = 0.093(bw)^{0.7584} \quad (mammals,\ dry\ diet). \tag{23}$$

In the absence of specific information on the body weights of the test animals, EPA (1985a) uses default values (see Table 1). In this report, W was estimated using Eq. 21 and the default body weights. Reference body weights for particular strains of laboratory animals and for specific age groups corresponding to subchronic or chronic exposures are available (EPA 1988a), and these can also be used in the equations. Default values for water consumption and ω for common laboratory species have been used by EPA (1988b) for estimating equivalent dose levels for laboratory studies in which the exposure was given only as a concentration in the animals' drinking water. Generally, the rates of water consumption for laboratory species, as derived from Eqs. 21–23, are higher than the EPA default values.

Water consumption rates are available for some species of mammalian wildlife (Table 1). Water consumption rates (in L/day) can also be estimated from allometric regression models based on body weight (in kg) (Calder and Braun 1983):

$$W = 0.099(bw)^{0.90} \tag{24}$$

A similar model has also been developed for birds (Calder and Braun 1983):

$$W = 0.059(bw)^{0.67} \tag{25}$$

3.5 COMBINED FOOD AND WATER BENCHMARKS FOR PISCIVOROUS WILDLIFE

If a wildlife species (such as mink, belted kingfisher, or great blue heron) feeds primarily on aquatic organisms and the concentration of the contaminant in the food is proportional to the concentration in the water, then the food consumption rate (F, in kg/day) and the aquatic life bioaccumulation factor can be used to derive a C_w value that incorporates both water and food consumption (EPA 1993c, 1993d, 1993e):

$$C_w = \frac{NOAEL_w \ x \ bw_w}{W + (F \ x \ BAF)} \tag{26}$$

The bioaccumulation factor (BAF) is the ratio of the concentration of a contaminant in tissue (mg/kg) to its concentration in water (mg/L), where both the organism and its prey are exposed, and is expressed as L/kg. BAFs may be predicted by multiplying the bioconcentration factor for the contaminant [bioconcentration factor (BCF), ratio of concentration in food to concentration in water; i.e., (mg/kg)/(mg/L) = L/kg] by the appropriate food chain multiplying factor (FCM) (see Table 2). For most inorganic compounds, BCFs and BAFs are assumed to equal; however, an FCM may be applicable for some metals if the organometallic form biomagnifies (EPA 1993c).

Table 2. Aquatic food chain multiplying factors[a]

Log P_{oct}	Prey Trophic Level[b]		
	2	3	4
≤3.9	1.0	1.0	1.0
4.0	1.1	1.0	1.0
4.1	1.1	1.1	1.1
4.2	1.1	1.1	1.1
4.3	1.1	1.1	1.1
4.4	1.2	1.1	1.1
4.5	1.2	1.2	1.2
4.6	1.2	1.3	1.3
4.7	1.3	1.4	1.4
4.8	1.4	1.5	1.6
4.9	1.5	1.8	2.0
5.0	1.6	2.1	2.6
5.1	1.7	2.5	3.2
5.2	1.9	3.0	4.3
5.3	2.2	3.7	5.8
5.4	2.4	4.6	8.0
5.5	2.8	5.9	11.0
5.6	3.3	7.5	16.0

Table 2. (continued)

Log P_{oct}	Prey Trophic Level[b] 2	3	4
≤3.9	1.0	1.0	1.0
5.7	3.9	9.8	23.0
5.8	4.6	13.0	33.0
5.9	5.6	17.0	47.0
6.0	6.8	21.0	67.0
6.1	8.2	25.0	75.0
6.2	10.0	29.0	84.0
6.3	13.0	34.0	92.0
6.4	15.0	39.0	98.0
6.5	19.0	45.0	100.0
>6.5	([c])	([c])	([c])

[a]From EPA 1993c.
[b]Trophic level: 2 = zooplankton; 3 = small fish; 4 = piscivorous fish, including top predators.
[c]For chemicals with log P_{oct}>6.5, FCM can range from 0.1-100. Such chemicals should be evaluated individually. Without chemical-specific data, an FCM of 1.0 should be used (EPA 1993c).

In cases where the BCF for a particular compound is not available, it can be estimated from the octanol-water partition coefficient of the compound by the following relationship (Lyman et al. 1982):

$$\log BCF = 0.76 \log P_{oct} - 0.23. \tag{27}$$

The BCF can also be estimated from the water solubility of a compound by the following regression equation (Lyman et al. 1982):

$$\log BCF = 2.791 - 0.564 \log WS. \tag{28}$$

where WS is the water solubility in mg/L water.

Log P_{oct} values, reported or calculated BCF values, and estimated BAF values for chemicals for which benchmarks have been derived are included on Table 3. Reported BCFs represent the maximum value listed for fish. An FCM of 1 was applied to all reported BCFs for inorganic compounds (EPA 1993c). Because all wildlife (mink, belted kingfisher, great blue heron, osprey) for which combined food and water benchmarks were calculated consume small fish, the trophic level 3 FCM appropriate for the log P_{oct} of the chemical was applied to all calculated BCFs (EPA 1993c).

Table 3. Octanol-water partition coefficients, bioconcentration factors, and bioaccumulation factors for selected chemicals

Chemical and Form	Log P_{oct}	BCF	Trophic Level 3 FCM	Trophic Level 3 BAF	Source
Acetone	-0.24	0.39[a]	1.0	0.39	USAF 1989
Aluminum		231	1.0	231.00	EPA 1988c
Antimony		1	1.0	1.00	EPA 1980b
Aroclor 1016	5.6	10,616.9[a]	7.5	79,627.17	ATSDR 1989
Aroclor 1242	5.6	10,616.9[a]	7.5	79,627.17	ATSDR 1989
Aroclor 1248	6.2	30,338.9[a]	29.0	879,828.44	ATSDR 1989
Aroclor 1254	6.5	51,286.1[a]	45.0	2,307,876.23	ATSDR 1989
Arsenic (arsenite)		17.00	1.0	17.00	EPA 1985g
Benzene	2.13	24.48[a]	1.0	24.48	EPA 1992
BHC-mixed isomers	5.31	6,391.46[a]	3.7	23,648.40	EPA 1992
Benzo(a)pyrene	6.1	25468.3[a]	25.0	636,707.56	EPA 1992
Beryllium		19.00	1.0	19.00	EPA 1980c
Bis(2-ethylhexyl)phthalate	5.11	4,504.0[a]	2.5	11,260.04	EPA 1992
Cadmium		12,400.00	1.0	12,400.00	EPA 1985f
Carbon Tetrachloride	2.83	83.33[a]	1.0	83.33	EPA 1992
Chlordane	5.54	9,558.73[a]	5.9	56,396.48	EPA 1992
Chloroform	1.97	18.5[a]	1.0	18.50	EPA 1992
Chromium (Cr+6)		3.00	1.0	3.00	EPA 1985d
Copper		290.00	1.0	290.00	EPA 1985e
o-Cresol	1.95	17.86[a]	1.0	17.86	EPA 1992
Cyanide		0.00	1.0	0.00	EPA 1985c
DDT (and metabolites)	6.36	4,0142.1[a]	39.0	1,565,541.58	EPA 1992
1,2-Dichloroethane	1.48	7.85[a]	1.0	7.85	EPA 1992
1,1-Dichloroethylene	2.13	24.48[a]	1.0	24.48	EPA 1992
1,2-Dichloroethylene	1.86	15.26[a]	1.0	15.26	EPA 1992
Dieldrin	4.56	1720.28[a]	1.3	2,236.37	EPA 1992
Diethylphthalate	2.47	44.38[a]	1.0	44.38	EPA 1992
Di-n-butyl phthalate	4.13	810.59[a]	1.1	891.65	EPA 1992
1,4-Dioxane	-0.27	0.37[a]	1.0	0.37	EPA 1992
Endrin	4.56	1,720.28[a]	1.3	2,236.37	EPA 1992
Ethanol	-0.31	0.34[a]	1.0	0.34	EPA 1992
Formaldehyde	0.35	1.09[a]	1.0	1.09	EPA 1992

Table 3. (continued)

Chemical and Form	Log P_{oct}	BCF	Trophic Level 3 FCM	Trophic Level 3 BAF	Source
Heptachlor	4.27	1,035.62[a]	1.1	1,139.18	EPA 1992
Lead		45.00	1.0	45.00	EPA 1985b
Lindane (Gamma-BHC)	3.72	395.55[a]	1.0	395.55	EPA 1992
Mercury (Methyl Mercury Chloride)				60,000.00	EPA 1993e
Methanol	-0.77	0.15[a]	1.0	0.15	EPA 1992
Methylene Chloride	1.25	5.25[a]	1.0	5.25	EPA 1992
Methyl Ethyl Ketone	0.29	0.98[a]	1.0	0.98	EPA 1992
4-Methyl 2-Pentanone	1.19	4.72[a]	1.0	4.72	EPA 1992
Nickel		106.00	1.0		EPA 1986f
Pentachloronitrobenzene	4.64	1,978.79[a]	1.3	2,572.43	EPA 1992
Pentachlorophenol		438	1.0	438	EPA 1986g
Selenium				2,600.00	Peterson and Nebeker 1992
2,3,7,8-Tetrachloro Dibenzodioxin	6.8	86,696.2[a]	1.0	86,696.19	EPA 1992
1,1,2,2-Tetrachloroethylene	3.4	225.94[a]	1.0	225.94	EPA 1992
Thallium		34.00	1.0	34.00	EPA 1980d
Toluene	2.73	69.95[a]	1.0	69.95	EPA 1992
Toxaphene	4.82	2,711.44[a]	1.5	4,067.16	EPA 1992
1,1,1-Trichloroethane	2.49	45.96[a]	1.0	45.96	EPA 1992
Trichloroethylene	2.42	40.66[a]	1.0	40.66	EPA 1992
Vinyl Chloride	1.36	6.36[a]	1.0	6.36	EPA 1992
Xylene (mixed isomers)	3.2	159.22[a]	1.0	159.22	EPA 1992
Zinc		966.00	1	966.00	EPA 1987

[a] Values estimated using Eq. 27

4. APPLICATION OF THE METHODOLOGY

This chapter will present two examples that illustrate the application of the methodology for deriving NOAELs and screening benchmarks. In one example (inorganic trivalent arsenic), the estimated values were derived primarily from data on laboratory species. In the second example [Aroclor 1254, a polychlorinated biphenyl (PCB)], experimental data were available for two species of mammalian wildlife. While the examples focus on mammals, derivation of NOAELs and screening benchmarks for birds is performed in an identical manner.

4.1 INORGANIC TRIVALENT ARSENIC

The toxicity of inorganic compounds containing arsenic depends on the valence or oxidation state of the arsenic as well as on the physical and chemical properties of the compound in which it occurs. Trivalent (As^{+3}) compounds such as arsenic trioxide (As_2O_3), arsenic trisulfide (As_2S_3), and sodium arsenite ($NaAsO_2$), are generally more toxic than pentavalent (As^{+5}) compounds such as arsenic pentoxide (As_2O_5), sodium arsenate (Na_2HAsO_4), and calcium arsenate [$Ca_3(AsO_4)_2$]. The relative toxicity of the trivalent and pentavalent forms may also be affected by factors such as water solubility; the more toxic compounds are generally more water soluble. In this analysis, the effects of the trivalent form of arsenic in water soluble inorganic compounds will be evaluated. In many cases, only total arsenic concentrations are reported so the assessor must assume conservatively that it is all trivalent.

4.1.1 Toxicity to Wildlife

The only wildlife toxicity information available for trivalent inorganic arsenic compounds pertains to acute exposures (Table 4; the values listed are those reported in the literature except where noted).

For whitetail deer, the estimated lethal dose is 34 mg sodium arsenite/kg or 19.5 mg arsenic/kg (NAS 1977). For birds, estimated LD_{50} values for sodium arsenite range from 47.6 to 386 mg/kg body weight. Median lethality was also reported at a dietary level of 500 mg/kg food for mallard ducks. No information was found in the available literature regarding chronic toxicity or reproductive or developmental effects.

4.1.2 Toxicity to Domestic Animals

The toxicity of inorganic trivalent arsenic to domestic animals is summarized in Table 5 (the values listed are those given in the source). For assessment purposes, the most useful study is the one identifying a dietary NOAEL of 50 ppm arsenic in dogs following a 2-year exposure to sodium arsenite. This dietary concentration was estimated to be equivalent to 1.2 mg/kg bw/day.

4.1.3 Toxicity to Laboratory Animals (Rodents)

Selected acute and chronic toxicity data for trivalent arsenic in rats and mice are summarized in Table 6 (dietary or drinking water concentrations were converted to daily dose levels using reference body weights and Eqs. 8 and 20). For assessment purposes, the studies of Byron et al. (1967) and Schroeder and Mitchener (1971) provide the most useful data. In the study of Bryon et al. (1967), a dietary concentration of 62.5 ppm arsenic for 2 years caused no adverse effects in rats other than a slight reduction in growth of females. This dietary level, which can be considered a NOAEL, is equivalent to a daily dose of 5 mg arsenic/kg bw/day. In the Schroeder and Mitchener study (1971), a concentration of 5 mg arsenic/L in the drinking water of mice over three generations was associated with a decrease in litter size and therefore is considered a potential population level LOAEL. The equivalent dose was estimated to be 1.26 mg/kg bw/day; therefore, using Eq. 5, the NOAEL is estimated to be 0.126 mg/kg bw/day.

Table 4. Toxicity of trivalent arsenic compounds to wildlife[a]

Species	Chemical	Conc. in Diet (mg/kg food)	Dose (mg/kg)	Effect	Reference
Whitetail deer *(Odocoileus virginianus)*	sodium arsenite	NR	34	Lethal dose	NAS 1977
Mallard duck *(Anas platyrhynchos)*	sodium arsenite	NR	323	LD_{50} (single dose)	NAS 1977
	sodium arsenite	500	NR	32-day LD_{50}	NAS 1977
California quail *(Callipepla californica)*	sodium arsenite	NR	47.6	LD_{50}	Hudson et al. 1984
Ring-necked pheasant *(Phasianus colchicus)*	sodium arsenite	NR	386	LD_{50} (single dose)	Hudson et al. 1984

[a] Source of data and references: Eisler 1988.
NR. Not reported.

Table 5. Toxicity of trivalent arsenic compounds to domestic animals[a]

Species	Chemical	Conc. in Diet[b] or Water[c]	Dose[d]	Effect	Reference
Cattle	arsenic trioxide	NR	33–55 mg/kg (single dose)	toxic	Robertson et al. 1984
	sodium arsenite	NR	1–4 g/animal	lethal	NRCC 1978
Sheep	sodium arsenite	NR	5–12 mg/kg (single dose)	acutely toxic	NRCC 1978
	"total arsenic"	58 mg As/kg food (3 wk)	NR	no adverse effects	Woolson 1975
Horse	sodium arsenite	NR	2–6 mg/kg/day (14 wk)	lethal	NRCC 1978
Pig	sodium arsenite	500 mg As/L	100–200 mg/kg	lethal	NAS 1977
Cat	arsenite	NR	1.5 mg/kg/day	chronic toxic effects	Pershagen and Vahter 1979
Dog	sodium arsenite	NR	50–150 mg/animal	lethal	NRCC 1978
	sodium arsenite	125 mg As/kg food (2 year)	3.0 mg As/kg/day[e]	reduced survival	Byron et al. 1967
	sodium arsenite	50 mg As/kg food (2 year)	1.2 mg As/kg/day[e]	NOAEL	Byron et al. 1967
	sodium arsenite	NR	4 mg/kg/day (58 days) + 8 mg/kg (125 days)	LOAEL; liver enzyme changes	Neiger and Osweiler 1989

Table 5. (continued)

Species	Chemical	Conc. in Diet[b] or Water[c]	Dose[d]	Effect	Reference
Mammals	arsenic trioxide	NR	3–250 mg/kg	lethal	NAS 1977
Mammals	sodium arsenite	NR	1–25 mg/kg	lethal	NAS 1977
Chicken *(Gallus gallus)*	arsenite	NR	0.01–1.0 μg As/embryo	≤34% dead	NRCC 1978
	arsenite	NR	0.03–0.3 μg As/embryo	malform.	NRCC 1978

[a] Sources of data and references: USAF 1990; Eisler 1988. NR

[b] Dietary level given as mg/kg food.

[c] Concentration in water given as mg/L.

[d] Dose, in mg/kg bw/day, refers to compound unless otherwise stated.

[e] Calculated using body weight of 12.7 kg and Eqs. 8, 9, and 10.

Not reported.

Table 6. Toxicity of trivalent arsenic compounds to laboratory animals

Species	Chemical	Conc. in Diet[a] or Water[b]	Dose (mg As/kg)	Effect	Reference
Rat	arsenic trioxide	NR	15.1 (1 dose)	LD_{50}	Harrison et al. 1958
	sodium arsenite	125 mg As/kg food (2 year)	10[c]	FEL, bile duct enlargement	Byron et al. 1967
	sodium arsenite	62.5 mg As/kg food (2 year)	5[c]	reduced growth in females; no effect on survival	Byron et al. 1967
	sodium arsenite	31.25 mg As/kg food (2 year)	2.5[c]	NOAEL	Byron et al. 1967
	sodium arsenite	5 mg As/L (lifetime)	0.65[d]	NOAEL	Schroeder et al. 1968a
Mouse	arsenic trioxide	NR	39.4 (1 dose)	LD_{50}	Harrison et al. 1958
	sodium arsenite	NR	a. 23 (1 dose) b. 11.5 (1 dose)	a. Fetal mortality b. NOAEL	Baxley et al. 1981
	arsenic trioxide	75.8 mg As/L (lifetime)	18.95[d]	LOAEL; mild hyperkeratosis/epidermal hyperplasia	Baroni et al. 1963
	soluble arsenite	5 mg As/L + 0.06 mg As/kg food (3 generations)	1.26[c,d]	LOAEL; incr. in male to female ratio; decr. in litter size	Schroeder and Mitchener 1971

Table 6. (continued)

Species	Chemical	Conc. in Diet[a] or Water[b]	Dose (mg As/kg)	Effect	Reference
	sodium arsenite	5 mg As/L + 0.46 mg As/kg food (lifetime)	0.44[c,d]	LOAEL; slight decr. in median life span; no effect on growth	Schroeder and Balassa, 1967
	sodium arsenite	0.5 mg As/L (3 weeks)	0.125[d]	LOAEL; immunosuppressive effects	Blakely et al. 1980

[a] Dietary level in mg/kg food.
[b] Concentration in water given as mg/L.
[c] Estimated using reference body weight (see Table 1) and Eqs. 8, 9, and 10.
[d] Estimated using reference body weight (see Table 1) and Eqs. 19, 20 and 21.

4.1.4 Extrapolations to Wildlife Species

Estimates of benchmarks for wildlife are shown in Table 7, and the values derived from laboratory studies are shaded. The NOAELs for dose (mg/kg bw/day) were estimated using Eq. 4. Concentrations in food (C_f) equivalent to the NOAEL were calculated using the food factors listed in Table 1 and Eq. 8. Similarly, concentrations in water (C_w) equivalent to the NOAELs were estimated from the water factors given in Table 1 and Eq. 20.

Three of the toxicity values listed in Tables 5 and 6 were used to estimate benchmarks for wildlife, the drinking water LOAEL of 5 mg/L for mice (Schroeder and Mitchener 1971), the dietary NOAEL of 62.5 ppm for rats (Byron et al. 1967), and a dietary NOAEL of 50 ppm for dogs (Bryon et al. 1967). These values were used to estimate NOAELs, C_f, and C_w for the white-footed mouse, cotton rat, red fox, and whitetail deer (Table 7).

As expected, benchmarks derived from related species are similar because of similarities in body weight and food and water consumption. Wildlife benchmarks derived from the mouse study are substantially lower than the corresponding NOAELs, C_fs, and C_ws derived from the rat or dog studies. These differences may be have several explanations. For example, mice may be unusually sensitive to trivalent arsenic; however, the LD_{50} data for rats and mice suggest a similar level of tolerance. The mouse study was a three-generation bioassay in which reproductive effects (reduced litter size) were identified. Although both the rat and dog studies involved chronic exposure durations, neither evaluated potential reproductive effects. Therefore, it is possible that reproductive effects similar to those seen in mice might occur in rats and dogs at or below the experimental NOAELs for these species if multigeneration studies were conducted. Another possibility is that trivalent arsenic may be relatively more toxic in drinking water than food, which might be the case if there were significant differences in rates of gastrointestinal absorption. If this can be shown to be the case, then benchmarks based on media-specific studies would be appropriate. Because there is insufficient information to determine which of these factors is responsible, the conservative approach would be to use the mouse data to estimate the benchmarks for the wildlife species.

Table 7. Selected wildlife toxicity values for trivalent inorganic arsenic[a,b]

Species	BW (kg)	Food factor f^c	Water factor ω^c	LOAEL	NOAEL (as arsenic) Dose (mg/kg)	$C_f^{(9)}$ (mg/kg)	$C_w^{(20)}$ (mg/L)	LD_{50} (mg As/kg)	NOAEL/LD_{50}
Mouse	0.030	0.18	0.25	5.0 mg/L + 0.06 mg/kg	0.126[(20)]	0.7	0.5[(5)]	39.4	0.002
White-footed mouse	0.022	0.155	0.3						
	Extrapolated from data for laboratory mice →				0.14[(4)]	0.9	0.47		
Rat	0.35	0.05	0.13		5[(8)]	62.5	38.5	15.1	0.21
Cotton rat	0.15	0.070[(14,9)]	0.12[(21)]						
	Extrapolated from data for laboratory rat →				6.6[(4)]	95	55		
	Extrapolated from data for laboratory mouse →				0.07[(4)]	1.0	0.6		
Dog	12.7	0.024	0.051		1.2[(8)]	50	26		
Red fox	4.5	0.1	0.084						
	Extrapolated from data for dog →				1.7[(4)]	17	20		
	Extrapolated from data for laboratory mouse →				0.024[(4)]	0.24	0.28		
Whitetail deer	56.5	0.031	0.065					>19.5	
	Extrapolated from data for laboratory rat →				0.9[(4)]	29	13.8		
	Extrapolated from data for dog →				0.73[(4)]	23.5	11.2		
	Extrapolated from data for laboratory mice →				0.01[(4)]	0.32	0.15		

[a] Numbers in parentheses refer to equations in text used to derive the values.
[b] Shaded values are experimentally derived.
[c] see Table 1.

4.2 POLYCHLORINATED BIPHENYLS

PCBs occur in a variety of different formulations consisting of mixtures of individual compounds. The most well-known of these formulations is the Aroclor series (i.e., Aroclor 1016, Aroclor 1242, Aroclor 1248, Aroclor 1254, etc.). The Aroclor formulations vary in the percent chlorine, and generally, the higher the chlorine content the greater the toxicity. This analysis will focus on Aroclor 1254 for which chronic toxicity data are available for three species of wildlife.

4.2.1 Toxicity to Wildlife

Toxicity data for Aroclor 1254 are available for three species of wildlife: white-footed mice, oldfield mice (*Peromyscus poliontus*), and mink (Table 8). In these species, the reproductive system and developing embryos are adversely affected by both acute and chronic exposures. A dietary LOAEL of 10 ppm was reported for white-footed mice (Linzey 1987). Using Eq. 5, a body weight of 0.22 kg (Table 1) and a food consumption rate of 3.4 g/day (Table 1), the estimated NOAEL for this species would be ≥0.155 mg/kg bw/day. A dietary LOAEL of 5 ppm was reported for oldfield mice (McCoy et al. 1995). Using Eq. 5, a body weight of 0.014 kg (see Appendix A) and a food consumption rate of 1.9 g/day (Appendix A), the estimated NOAEL for this species would be ≥0.068 mg/kg bw/day. A dietary NOAEL of 1 ppm was reported for mink (Aulerich and Ringer, 1977). Using a time-weighted average body weight of 0.8 kg (Bleavins et al. 1980) and a food consumption rate of 110 g/day (137 g/kg bw/day × 0.8 kg bw; Bleavins and Aulerich 1981), the NOAEL is 0.137 mg/kg/day.

4.2.2 Toxicity to Domestic Animals

No information was found in the available literature on the toxicity of Aroclor 1254 to domestic animals.

4.2.3 Toxicity to Laboratory Animals

As shown in Table 9, laboratory studies have identified a dietary NOAEL of 5 ppm (= 0.4 mg/kg bw/day) for rats exposed to Aroclor 1254 over two generations (Linder et al. 1974). Reported LOAELs are 4–10 times higher than the NOAEL, and the single-dose LD_{50} is about 4000-fold higher than the NOAEL. As shown by the dose levels that produce fetotoxicity during gestation, rabbits appear to be less sensitive than rats.

4.2.4 Extrapolations to Wildlife Species

Experimentally derived and extrapolated toxicity values for Aroclor 1254 for representative wildlife species are shown in Table 10. Empirical data are available for four species: laboratory rat (Linder et al. 1974), white-footed mouse (Linzey 1987), oldfield mouse (McCoy et al. 1995) and mink (Aulerich and Ringer 1977). Reproductive and/or developmental changes were the endpoints evaluated in each of these studies. The calculated NOAELs are 0.4 mg/kg bw/day for the rat, 0.155 mg/kg bw/day for the white-footed mouse, 0.068 mg/kg bw/day for the oldfield mouse, and 0.137 mg/kg bw/day for mink. These data indicate that the laboratory rat is less sensitive to the toxicity of Aroclor 1254 than white-footed or oldfield mice or mink.

Table 8. Toxicity of Aroclor 1254 to wildlife

Species	Concentration in Food	Daily Dose (mg/kg)	Expos. Period	Effect	Reference
White-footed mouse	400 ppm	62[a]	2-3 wk	FEL, reprod.	Sanders and Kirkpatrick 1975
	200 ppm	31[a]	60 d	LOAEL, reproduction	Merson and Kirkpatrick 1976
	10 ppm	1.55[a]	18 mo	LOAEL, reproduction	Linzey 1987
Oldfield mouse	5 ppm	0.68[b]	12 mo.	LOAEL, reproduction	McCoy et al. 1995
Mink	6.5 ppm	0.89[c]	9 mo	LC_{50}	Ringer et al. 1981; ATSDR 1989
	2 ppm	0.38[c] 0.28[d]	9 mo	FEL/LOAEL, fetotoxicity	Aulerich and Ringer 1977
	1 ppm	0.137[d]	5 mo	NOAEL	Aulerich and Ringer, 1977

[a] Estimated from Eq. 8 using a food factor of 0.155.
[b] See Appendix A for estimation procedure.
[c] Reported by ATSDR (1989); based on food intake of 150 g/day and mean body weight of 0.8 kg
[d] Estimated a food consumption rate of 110 g/day and a body weight of 0.8 kg (as reported by Bleavins et al. 1980).

Table 9. Toxicity of Aroclor 1254 to laboratory animals

Species	Concentration in Diet	Daily Dose (mg/kg)	Exposure Period	Effect	Reference
Rat		1010	1 day	LD_{50}	Garthoff et al. 1981
	50 ppm	4[a]	During gestation	LOAEL, for fetotoxicity	Collins and Capen 1980
	25 ppm	2[a]	104 week	LOAEL, reduced survival	NCI 1978, ATSDR 1989a
	20 ppm	1.6[a]	2 generations	FEL/LOAEL, reduced litter size	Linder et al. 1974
	5 ppm	0.4[a]	2 generations	NOAEL	Linder et al. 1974
Rabbit		10.0	During gestation (28 days)	NOAEL for fetoxicity	Villeneuve et al. 1971
		12.5	During gestation (28 days)	FEL, fetal deaths	Villeneuve et al. 1971

[a] Calculated using a food factor of 0.08 (see Table 1) and Eq. 8.

Table 10. Selected wildlife toxicity values for Aroclor 1254[a,b]

Species	bw (kg)	Food factor f	Water factor ω	LOAEL (ppm diet)	NOAEL (mg/kg/d)	Benchmarks C_f (mg/kg food)	Benchmarks C_w (mg/L)	LD_{50} (mg/kg)	NOAEL/LD_{50}
Rat (lab)	0.35	0.08	0.13		0.4[(8)]	5.0	3.1	1,010	0.0004
Oldfield Mouse	0.014			5	≥0.068[(8)]				
White-footed mouse	0.022	0.155	0.3	10	≥0.155[(8)]	1.0	0.52		
	Extrapolated from oldfield mouse data →				0.059[(4)]	0.379[(8)]	0.195[(20)]		
	Extrapolated from rat data →				1.01[(4)]	6.5[(8)]	3.35[(20)]		
	Extrapolated from mink data →				0.45[(4)]	2.9[(8)]	1.50[(20)]		
Mink	0.80[c]	0.137	0.099		0.137[(8)]	1	0.71	1.25	0.06
	Extrapolated from white-footed mouse data →				0.18[(4)]	0.104[(8)]	0.145[(20)]		
	Extrapolated from oldfield mouse data →				≥0.05[(4)]	0.34[(8)]	0.47[(20)]		
	Extrapolated from rat data →				0.30[(4)]	2.22[(8)]	3.08[(20)]		
Cotton rat	0.15	0.07	0.12						
	Extrapolated from white-footed mouse data →				≥0.08[(4)]	1.17[(8)]	0.68[(20)]		
	Extrapolated from oldfield mouse data →				0.031[(4)]	0.444[(8)]	0.259[(20)]		
	Extrapolated from rat data →				0.53[(4)]	7.56[(8)]	4.41[(20)]		
	Extrapolated from mink data →				0.24[(4)]	3.4[(8)]	1.98[(20)]		
Whitetail deer	56.5	0.031	0.065						
	Extrapolated from white-footed mouse data →				≥0.012[(4)]	0.37[(8)]	0.17[(20)]		
	Extrapolated from oldfield mouse data →				0.004[(4)]	0.143[(8)]	0.067[(20)]		
	Extrapolated from rat data →				0.075[(4)]	2.43[(8)]	1.14[(20)]		
	Extrapolated from mink data →				0.034[(4)]	1.09[(8)]	0.51[(20)]		

[a] Numbers in parentheses refer to equations in text.
[b] Shaded values are experimentally derived.
[c] TWA bw for females to 10 mo (reproductive maturity) (EPA 1988a).

The most conservative benchmark for Aroclor 1254 would be the NOAEL for whitetail deer (0.012 mg/kg bw/day) extrapolated from the data for the oldfield mouse. The NOAEL derived from the mink data (0.034 mg/kg) may be more reliable because it was based on an experimentally derived NOAEL whereas the white-footed mouse value was based on an experimentally derived LOAEL. However, because metabolism and physiology are more likely to be similar between an omnivore (mouse) and an herbivore (deer) than between a carnivore (mink) and herbivore, the oldfield mouse NOAEL may be a better estimate of toxicity to whitetail deer than the mink NOAEL.

For mink, a combined water quality benchmark for Aroclor 1254 can be derived from Eq. 26. Using a log P_{oct} of 6.5 (ATSDR 1989), the BCF for Aroclor 1254 was estimated from Eq. 27 to be 51,286. Conservatively, the diet of mink is assumed to consist entirely of small fish (trophic level 3, FCM = 45.0; Table 2); therefore, the BAF was estimated to be 2,307,876. For mink weighing 0.8 kg and having a NOAEL of 0.137 mg/kg, the combined food and water benchmark for Aroclor 1254 is calculated to be 0.43 ng/L.

5. SITE-SPECIFIC CONSIDERATIONS

The examples given in this report for trivalent inorganic arsenic and Aroclor 1254 illustrate the extent of the analysis that is required for an understanding of the toxicity of environmental contaminants to wildlife and for the development of benchmark values. For a complete risk assessment at a particular site, similar analyses would be needed for all the chemicals present, as well as information on their physical and chemical state, their concentration in various environmental media, and their bioavailability. The last factor is especially important in estimating environmental impacts. For example, insoluble substances tightly bound to soil particles are unlikely to be taken up by organisms even if ingested. In addition, the chemical or valence state of a contaminant may alter its toxicity such that the different chemical or valence states may have to be treated separately as in the case of trivalent arsenic. Similar problems can be encountered with formulations consisting of mixtures of compounds such as the Aroclors, and each may have to be evaluated separately, unless the relative potency of each of the components can be determined.

For a site-specific assessment, information on the types of wildlife species present, their average body size, and food and water consumption rates would also be needed for calculating NOAELs and environmental criteria. Use of observed values for food and water consumption (if available) are recommended over rates estimated by allometric equations. A list of pertinent exposure parameters (body weights, food and water consumption rates) for selected avian and mammalian species for the DOE Oak Ridge site is given in Appendix B. Exposure information for additional wildlife species may be found in the *Wildlife Exposure Factors Handbook* (EPA 1993a, 1993b). Because body size of some species can vary geographically, the more specific the data are to the local population, the more reliable will be the estimates. Data on body size are especially important in the extrapolation procedure, particularly if calculations of the NOAEL and environmental concentrations are based solely on the adjustment factor as shown in Eq. 4. In such cases the lowest NOAEL will be derived from the species with the largest body size. Estimates of average body weights for wildlife species used herein were obtained from the available literature (Appendix B, see also Table 1). These estimates were used to calculate body surface area scaling factors from Eq. 4 (Table 11) and also to derive food factors from Eq. 10 and water factors from Eq. 21 (see Table 1).

Table 11. Body size scaling factors

Experimental Animals		Wildlife		
Species	Body Weight[a] (bw_t, in kg)	Species	Body weight[b] (bw_w in kg)	Scaling factor $(bw_t/bw_w)^{1/3}$
rat	0.35	short-tailed shrew	0.015	2.86
rat	0.35	white-footed mouse	0.022	2.52
rat	0.35	meadow vole	0.044	2.00
rat	0.35	cottontail rabbit	1.2	0.66
rat	0.35	mink	1.0	0.70
rat	0.35	red fox	4.5	0.43
rat	0.35	whitetail deer	56.5	0.18
mouse	0.03	short-tailed shrew	0.015	1.26
mouse	0.03	white-footed mouse	0.022	1.11
mouse	0.03	meadow vole	0.004	0.88
mouse	0.03	cottontail rabbit	1.2	0.29
mouse	0.03	mink	1.0	0.31
mouse	0.03	red fox	4.5	0.19
mouse	0.03	whitetail deer	56.5	0.08

[a] Standard reference values used by EPA.
[b] From Appendix B.

Information on physiological, behavioral, or ecological characteristics of these species can also be of special importance in determining if certain species are particularly sensitive to a particular chemical or groups of chemicals. If one species occurring at a site is known to be unusually sensitive to a particular contaminant, then the criteria should be based on data for that species (with exceptions noted in the following paragraphs). Similarly, extrapolations from studies on laboratory animals should be based on the most sensitive species unless there is evidence that this species is unusually sensitive to the chemical.

Physiological and biochemical data may be important in determining the mechanism whereby a species' sensitivity to a chemical may be enhanced or diminished. Such information would aid in determining whether data for that species would be appropriate for developing criteria for other species.

For example, if the toxic effects of a chemical are related to the induction of a specific enzyme system, as is the case with PCBs, then it would be valuable to know whether physiological factors (enzyme activity levels per unit mass of tissue or rates of synthesis of the hormones affected by the induced enzymes) in the most sensitive species are significantly different from those of other species of wildlife. Furthermore, if the most sensitive species, or closely related species, do not occur at a particular site, then a less stringent criterion might be acceptable.

Physiological data may also reveal how rates of absorption and bioavailability vary with exposure routes and/or exposure conditions. Gastrointestinal absorption may be substantially different depending on whether the chemical is ingested in the diet or in drinking water. Therefore, a NOAEL based on a laboratory drinking water study may be inappropriate to use in extrapolating to natural populations that would only be exposed to the same chemical in their diet. The diet itself may affect gastrointestinal absorption rates. In the case of the mink exposed to PCBs, a diet consisting primarily of contaminated fish in which the PCBs are likely to be concentrated in fatty tissues may result in a different rate of gastrointestinal absorption than that occurring in laboratory rodents dosed with PCBs in dry chow.

Behavioral and ecological data might also explain differences in sensitivity between species. Certain species of wildlife may be more sensitive because of higher levels of environmental stress to which they are subjected. This may be especially true of populations occurring at the periphery of their normal geographic range. Conversely, laboratory animals maintained under stable environmental conditions of low stress may have higher levels of resistance to toxic chemicals.

As a first step in developing wildlife criteria for chemicals of concern at DOE sites, relevant toxicity data for wildlife and laboratory animals have been compiled (Appendixes A and C). These data consist primarily of NOAELs, LOAELs, and LD_{50}s for avian and mammalian species. No methodology is currently available for extrapolating from avian or mammalian studies to reptiles and amphibians, and no attempt has been made to do so in this report. No pertinent data on nonpesticide chemicals were found for amphibians, reptiles, or terrestrial invertebrates. Additional chronic exposure studies are needed before toxicological benchmarks can be developed for these groups.

6. RESULTS

The results of the analyses are presented in Tables 12 (NOAELs) and 13 (LOAELs) **(these tables are presented in Appendix D)**. Because of the consistency of the body weight differences for the selected mammalian wildlife species, the calculated NOAELs and LOAELs exhibit about a 15-fold range between the species of smallest body size (little brown bat) and that of the largest body size (whitetail deer). In terms of dietary intake, the range in values is much less (2–3 fold) thereby indicating that equivalent dietary levels of a chemical result in nearly equivalent doses between species because food intake is a function of metabolic rate which, in turn, is a function of body size. However, according to EPA (1980a), the correlation is not exact because food intake also varies with moisture and caloric content of the food, and it should be noted that in laboratory feeding experiments, the test animals are usually dosed with the chemical in a dry chow. Therefore, it would be expected that the food factor for a species of wildlife would be relatively higher than that of a related laboratory species of comparable body size, resulting in a lower dietary benchmark for wildlife species as compared to that for the related laboratory species.

7. APPLICATION OF THE BENCHMARKS

As stated in Sect. 1, ecological risk assessment is a tiered process. As part of the first tier or screening assessment, toxicological benchmarks are used to identify COPCs and focus future data collection. In the second tier or baseline assessment, toxicological benchmarks are one of several lines of evidence used to determine if environmental contaminant concentrations are resulting in ecological effects. In a screening assessment, general, conservative assumptions are made so that all chemicals that may be present at potentially hazardous levels in the environment are retained for future consideration. In contrast, in a baseline assessment, more specific assumptions are made so that an accurate estimate of the contaminant exposure that an individual may experience and potential effects that may result from that exposure may be made.

7.1 SCREENING ASSESSMENT

Screening assessments serve to identify those contaminants whose concentrations are sufficiently high such that they may be hazardous to wildlife. The primary emphasis of a screening assessment is to include all potential hazards while eliminating clearly insignificant hazards. To prevent any potential hazards from being overlooked, assumptions made in a screening assessment are conservative. NOAEL-based benchmarks are used in screening assessments because they are conservative and represent maximum concentrations that are believed to be nonhazardous. Exceedance of a NOAEL-based benchmark does not suggest that adverse effects are likely; it simply indicates contamination is sufficiently high to warrant further investigation.

Questions that drive a screening assessment include (1) which media (water, soil, etc.) are contaminated such that they may be toxic?, (2) what chemicals are involved? (which contaminants are COPCs)?, (3) what are the concentrations and spatial and temporal distributions of these contaminants?, and (4) what organisms are expected to be significantly exposed to the chemicals? To answer these questions, diet, water, and combined food and water (for aquatic feeding species) benchmark values are compared to the contaminant concentrations observed in the media from the site. If the concentration of a contaminant exceeds the benchmark, it should be retained as a COPC. By comparing contaminant concentrations from several locations within a site to benchmarks for several endpoint species, the spatial extent of potentially hazardous contamination, which media are contaminated, and the species potentially at risk from contamination may be identified.

In a screening assessment, it is generally assumed that wildlife species reside and therefore forage and drink exclusively from the contaminated site. That is, approximately 100% of the food and water they consume is contaminated. While this assumption simplifies the assessment, due to the mobility and the diverse diets of most wildlife, it is likely to overestimate the actual exposure experienced. It should be remembered, however, that the purpose of the screening assessment is to identify potential risks and data gaps to be filled. Once these data gaps are filled, a definitive evaluation of risk may be made as part of the baseline assessment.

In most screening assessments, because they rely on existing data, available data are likely to be restricted to contaminant concentration in abiotic media (e.g., soil and water). Contaminant concentrations in wildlife foods may need to be estimated using contaminant uptake models such as those described in Baes et al. (1984), Travis and Arms (1988), or Menzies et al. (1992).

Table 14 provides a simplified example of the use of NOAEL-based benchmarks in a screening assessment. The purpose of the assessment in this example is to identify the contaminants and media with concentrations sufficiently high to present a hazard to a representative endpoint species (meadow vole). This information will be used to identify gaps in data needed for the baseline assessment. Data consists of the concentrations of four metals in soil and water. These data were compared to values observed at a representative background location and found to be higher. (Screening contaminant concentrations against background helps provide a context for the data and aids in the identification of anthropogenic contamination. This is particularly important in areas where metal concentrations in native soils are naturally high.) Because dietary exposure cannot be evaluated directly from soil concentrations, metal concentrations in the voles' food (plant foliage) was estimated using plant uptake factors for foliage from Baes et al. (1984). To determine which contaminants pose a risk, an HQ was calculated, where HQ = media concentration/benchmark. If the HQ ≥ 1, contaminant concentrations are sufficiently high that they may produce adverse effects. Contaminants with HQs ≥ 1 should be retained as COPCs. In this example, while metal concentrations in water did not exceed any water benchmarks, estimated concentrations of arsenic and mercury in plant foliage exceeded dietary benchmarks. These metals should therefore be retained as COPCs in food but not in water. Because contaminant concentrations in plant foliage were estimated, one data need for the baseline assessment consists of actual, measured concentrations in plants. In addition, the form of the metals (i.e., inorganic vs. methyl mercury) should be identified so the most appropriate benchmark may be used in the baseline assessment.

Table 14. Use of benchmarks in a screening assessment

Analyte	Contaminant Concentrations in Media			NOAEL-based Benchmarks for Meadow Vole		Comparison of Media Concentrations to Benchmarks			
						Water		Diet	
	Water (mg/L)	Soil (mg/kg)	Estimated in Plants[a] (mg/kg)	Water (mg/L)	Diet (mg/kg)	HQ[b]	Retain as COPC	HQ[b]	Retain as COPC
Arsenic	0.038	131	5.24	0.814	0.977	0.047	NO	5.36	YES
Lead	0.069	18.8	0.85	116.3	139.6	0.0006	NO	0.006	NO
Mercury[c]	0.005	0.71	0.64	0.465	0.558	0.011	NO	1.15	YES
Selenium	0.02	14.8	0.37	0.491	0.589	0.041	NO	0.63	NO

[a] Estimates using plant uptake factors for foliage from Baes et al. (1984).
[b] HQ = Hazard Quotient = Media Concentration/Benchmark.
[c] Mercury assumed to be in the form of methyl mercury.

7.2 BASELINE ASSESSMENT

In contrast to the screening assessment that defines the scope of the assessment, the baseline assessment uses new and existing data to evaluate the risk of leaving the site unremediated. The purposes of the baseline assessment are to determine (1) if significant ecological effects are occurring at the site, (2) the causes of these effects, (3) the source of the causal agents, and (4) the consequences of leaving the system unremediated. The baseline assessment provides the ecological basis for determining the need for remediation.

Because the baseline assessment focuses on a smaller number of contaminants and species than the screening assessment, it can provide a higher level of characterization of toxicity to the species and communities at the site. In the baseline ecological risk assessment, a weight-of-evidence approach (Suter 1993) is employed to determine if and to what degree ecological effects are occurring or may occur. The lines of evidence used in a baseline assessment consist of (1) toxicity tests using ambient media from the site, (2) biological survey data from the site, and (3) the comparison of contaminant exposure experienced by endpoint species at the site to wildlife LOAELs.

Estimating the contaminant exposure experienced by wildlife at a waste site consists of summing the exposure received from each separate source. While wildlife may be exposed to contaminants through oral ingestion, inhalation, and dermal absorption, the benchmarks in this document are only applicable to the most common exposure route—oral ingestion. Exposure through inhalation and dermal absorption are special cases that must be considered independently.

The primary routes of oral exposure for terrestrial wildlife are through ingestion of food (either plant or animal) and surface water. In addition, some species may ingest soil incidentally while foraging or purposefully to meet nutrient needs. The total exposure experienced by terrestrial wildlife is represented by the sum of the exposures from each individual source. Total exposure may be represented by the following generalized equation:

$$E_{total} = E_{food} + E_{water} + E_{soil}, \qquad (29)$$

where

E_{total} = exposure from all sources
E_{food} = exposure from food consumption
E_{water} = exposure from water consumption
E_{soil} = exposure through consumption of soil (either incidental or deliberate)

Building on the screening assessment example, Table 15 provides an example of the use of benchmarks in a baseline assessment. The purpose of the assessment in this example is to ascertain the level of exposure and risk experienced by a representative endpoint species (meadow vole). In addition to soil and water contaminant data, concentrations of arsenic, lead, mercury, and selenium were measured in plants on which meadow voles forage. Exposure parameters for each medium were calculated according to the following equation:

$$E_{medium} = \frac{\text{Medium Consumption Rate (kg or L/d) x Analyte Concentration in Medium (mg/kg or mg/L}}{\text{Body Weight (kg)}} \qquad (30)$$

where E_{medium} = estimated exposure (mg analyte/kg body weight/day) for each medium (e.g., food, water, and soil). Body weight (0.044 kg), food (0.005 kg/day) and water (0.006 L/day) consumption rates for meadow voles were obtained from Appendix B. Beyer et al. (1992) states that soil consumption by meadow voles is 2% of food consumption. Therefore, soil consumption was estimated to be 2% of 0.005 k/day or 0.0001 kg/day. As in the screening assessment, an HQ was calculated in which total exposure was compared to the LOAEL for each contaminant. Total exposure from all sources exceeded the LOAELs for selenium only.

Table 15. Use of benchmarks in a baseline assessment

Analyte	Contaminant Concentrations in Media			Contaminant Exposure (mg/kg bw/d)				LOAEL for Meadow Vole	HQ[a]
	Water (mg/L)	Soil (mg/kg)	Plants (mg/kg)	Water	Soil	Diet	Total		
Arsenic	0.038	131	1.77	0.0052	0.298	0.201	0.504	1.11	0.45
Lead	0.069	18.8	1.07	0.0094	0.043	0.122	0.174	159	0.001
Mercury[b]	0.005	0.71	0.06	0.0007	0.0016	0.007	0.0093	0.32	0.03
Selenium	0.02	14.8	23.61	0.003	0.034	2.68	2.717	0.67	4.06

[a] HQ = Hazard Quotient = Total Exposure/Benchmark.
[b] Mercury assumed to be in the form of methyl mercury.

By comparing the exposure from each source (e.g., water, soil, diet) to the LOAEL, the relative contribution of each to the total can be determined. For example, virtually all selenium exposure (98.6%) was obtained through food consumption; selenium exposures from soil and water were both less then the LOAEL. This information serves not only to identify contaminants that present a risk, but by identifying the media that account for the majority of exposure, these data may be used to guide remediation.

In the preceding example, the species used has a small home range (< 1 ha) and a diet restricted to grassy and herbaceous plant material (Reich 1981). Therefore, it was assumed that voles would reside and forage exclusively on the hypothetical waste site and that 100% of the food, water, and soil consumed would be contaminated. Because most wildlife are mobile and many species have varied diets, it is not likely that all food, water, or soil ingested by individuals of other wildlife endpoint species would be obtained from contaminated sources. In the case of species with large home ranges, because they may spend only a portion of their time on a contaminated site (and may receive exposure from multiple, spatially separate locations), their exposure should be represented by the proportion of food, water, or soil obtained from contaminated sources. For species with diverse diets, the contaminant concentrations in the different food types consumed is likely to differ. Dietary exposure for these species would be represented by the sum of the contaminant concentrations in each food type multiplied by the proportion of each food type in the species diet.

Ideally, site-specific information on home ranges, diet composition, and use of waste sites by endpoint species should be collected. In the absence of site specific data, information to estimate exposure for selected wildlife species may be found in the *Wildlife Exposure Factors Handbook* (EPA 1993a and 1993b)or in other published literature.

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Appendix A

DESCRIPTIONS OF STUDIES USED TO CALCULATE BENCHMARKS

A. DESCRIPTIONS OF STUDIES USED TO CALCULATE BENCHMARKS

Compound: Acetone
Form: not applicable
Reference: EPA 1986c
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Study Duration: 90 days (<1 yr and not during a critical lifestage=subchronic).
Endpoint: Liver and kidney damage
Exposure Route: oral intubation
Dosage: three dose levels:
100, 500, and 2500 mg/kg/d;
NOAEL = 100 mg/kg/d
LOAEL = 500 mg/kg/d
Calculations: not applicable
Comments: Significant tubular degeneration of the kidneys and increases in kidney weights were observed at the 500 and 2500 mg/kg/d dose levels; liver weights were increased at the 2500 mg/kg/d level. Because no significant differences were observed at the 100 mg/kg/d dose level and the study considered exposure for 90 days and did not include critical lifestages (reproduction), this dose was considered to be a subchronic NOAEL. The 500 mg/kg/d dose was considered to be a subchronic LOAEL. Chronic NOAEL and LOAEL values were estimated by multiplying the subchronic NOAEL and LOAEL by a subchronic to chronic uncertainty factor of 0.1.
Final NOAEL: 10 mg/kg/d
Final LOAEL: 50 mg/kg/d

Compound: Aldrin
Form: not applicable
Reference: Treon and Cleveland 1955
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 3 generations (>1 yr and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
2.5, 12.5, and 25.0 ppm; NOAEL = 2.5 ppm
Calculations:

$$NOAEL: \left(\frac{2.5\,mg\ Aldrin}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.35\ kg\ BW = 0.2\ mg/kg/d$$

$$LOAEL: \left(\frac{12.5\,mg\ Aldrin}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.35\ kg\ BW = 1\ mg/kg/d$$

Comments: While the number of litters and offspring mortality were not significantly reduced among rats receiving the 2.5 ppm dose level, these parameters were reduced at the 12.5 ppm dose level. Because the study considered exposure throughout 3 generations including critical lifestages (reproduction), the 2.5 ppm dose was considered to be a chronic NOAEL and the 12.5 ppm dose was considered a subchronic LOAEL.

Final NOAEL: 0.2 mg/kg/d

Final LOAEL: 1 mg/kg/d

Compound: Aluminum

Form: $AlCl_3$

Reference: Ondreicka et al. 1966

Test Species: Mouse

Body weight: 0.03 kg (EPA 1988a)

Exposure Duration: 3 generations (>1 yr and during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in water

Dosage: one dose level:

19.3 mg Al /kg/d = LOAEL

Calculations: not applicable

Comments: While there were no effects on the number of litters or number of offspring per litter, growth of generations 2 and 3 was significantly reduced. Therefore, this dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.

Final NOAEL: 1.93 mg/kg/d

Final LOAEL: 19.3 mg/kg/d

Compound: Aluminum

Form: $Al_2(SO_4)_3$

Reference: Carriere et al. 1986

Test Species: Ringed Dove

Body weight: 0.155 kg (Terres 1980)

Food Consumption: 0.017 kg/d (calculated using allometric equation from Nagy 1987)

Exposure Duration: 4 months (>10 wk and during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: one dose level:

1000 ppm Al (as $Al_2(SO_4)_3$)= NOAEL

Calculations:

$$NOAEL: \left(\frac{1000\,mg\ Al}{kg\ food} \ x\ \frac{17\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.155\ kg\ BW\ =\ 109.7\ mg/kg/d$$

Comments: Because no significant differences were observed at the 1000 ppm dose level and the study considered exposure over 4 months including critical lifestages (reproduction), this dose was considered to be a chronic NOAEL.

Final NOAEL: 109.7 mg/kg/d

Compound: Aluminum
Form: Aluminum Chloride
Reference: Storer and Nelson 1968
Test Species: day-old white leghorn chicks
Body weight: 0.08 kg (mean weight 1 to 14 days; EPA 1988)
Food Consumption: 0.0089 kg/d (calculated using allometric equation for chickens from EPA 1988)
Exposure Duration: 2 weeks
(<10 wk and not during a critical lifestage = subchronic).
Endpoint: mortality
Exposure Route: oral in diet
Dosage: four dose levels:
0.05%, 0.1%, 0.2%, and 0.4% Al (as $AlCl_3$); 0.4%= LOAEL
Calculations:

$$LOAEL: \left(\frac{4000\,mg\ Al}{kg\ food} \ x\ \frac{8.9\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.08\ kg\ BW\ =\ 445\ mg/kg/d$$

Comments: While no adverse effects were observed among the 0.05%, 0.1%, and 0.2% dose levels, 25% mortality was observed at the 0.4% dose level. Because the study considered exposure over 2 weeks and did not include critical lifestages (reproduction), this dose was considered to be a subchronic LOAEL. A chronic LOAEL was estimated by multiplying the subchronic LOAEL by a subchronic-chronic uncertainty factor of 0.1.

Final LOAEL: 44.5 mg/kg/d

Compound: Antimony
Form: Antimony Potassium Tartrate
Reference: Schroeder et al. 1968b
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)
Water Consumption: 0.0075 L/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: lifetime (>1 yr = chronic).
Endpoint: lifespan, longevity
Exposure Route: oral in water
Dosage: one dose level:

5 ppm Sb = LOAEL

Calculations:

$$LOAEL: \left(\frac{5\,mg\ Sb}{L\ water} \ x\ \frac{7.5\,mL\ water}{day} \ x\ \frac{1\,L}{1000\,mL} \right) \ /\ 0.03\ kg\ BW\ =\ 1.25\ mg/kg/d$$

Comments: Because median lifespan was reduced among female mice exposed to the 5 ppm dose level and the study considered exposure throughout the entire lifespan, this dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.

Final NOAEL: 0.125 mg/kg/d

Final LOAEL: 1.25 mg/kg/d

Compound: Aroclor 1016

Form: not applicable

Reference: Aulerich and Ringer 1980

Test Species: Mink

Body weight: 1.0 kg (EPA 1993)

food consumption: 0.137 kg/d (Bleavins and Aulerich 1981)

Exposure Duration: 18 months (>1 yr and during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: three dose levels:

2, 10, and 25 ppm; 10 ppm = NOAEL

Calculations:

$$NOAEL: \left(\frac{10\,mg\ Aroclor\ 1016}{kg\ food} \ x\ \frac{137\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 1\ kg\ BW\ =\ 1.37\ mg/kg/d$$

$$LOAEL: \left(\frac{25\,mg\ Aroclor\ 1016}{kg\ food} \ x\ \frac{137\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 1\ kg\ BW\ =\ 3.425\ mg/kg/d$$

Comments: While kit mortality was greater for all dose levels, these differences were not significant. Because Aroclor 1016 at 25 ppm in the diet reduced kit growth, and the study considered exposure over 18 months including critical lifestages (reproduction), this dose was considered a chronic LOAEL; the 10 ppm dose was considered to be a chronic NOAEL.

Final NOAEL: 1.37 mg/kg/d

Final LOAEL: 3.43 mg/kg/d

Compound: Aroclor 1242

Form: not applicable

Reference: Bleavins et al. 1980

Test Species: Mink
Body weight: 1.0 kg (EPA 1993)
food consumption: 0.137 kg/d (Bleavins and Aulerich 1981)
Exposure Duration: 7 months (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: four dose levels:
5, 10, 20, and 40 ppm; 5 ppm = LOAEL
Calculations:

$$LOAEL: \left(\frac{5\,mg\ Aroclor\ 1254}{kg\ food}\ x\ \frac{137\,g\ food}{day}\ x\ \frac{1\,kg}{1000\,g} \right)\ /\ 1\ kg\ BW\ =\ 0.685\ mg/kg/d$$

Comments: Because all Aroclor 1242 dose levels produced total reproductive failure, and the study considered exposure over 7 months including critical lifestages (reproduction), the lowest dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 0.069 mg/kg/d
Final LOAEL: 0.69 mg/kg/d

Compound: Aroclor 1242
Form: not applicable
Reference: McLane and Hughes 1980
Test Species: Screech Owl
Body weight: 0.181 kg (Dunning 1984)
food consumption: 1300-1700 g/month/pair (Pattee et al. 1988)
Daily food consumption was estimated as follows:
median food consumption/month/pair = 1500 g;
1 month = 30 d;
Males and females consume equal amounts of food = 750 g/month
750 g/month ÷ 30 d = 25 g/ d
Exposure Duration: 2 generations(during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: one dose level:
3 ppm = NOAEL
Calculations:

$$NOAEL: \left(\frac{3\,mg\ Aroclor1242}{kg\ food}\ x\ \frac{25\,g\ food}{day}\ x\ \frac{1\,kg}{1000\,g} \right)\ /\ 0.181\ kg\ BW\ =\ 0.41\ mg/kg/d$$

Comments: Fertility and hatching success was not significantly reduced by 3 ppm Aroclor 1242 in the diet. Because the study considered exposure during reproduction, this dose was considered to be a chronic NOAEL.
Final NOAEL: 0.41 mg/kg/d

Compound: Aroclor 1248
Form: not applicable
Reference: Barsotti et al. 1976
Test Species: Rhesus Monkey
Body weight: 5.0 kg (from study)
food consumption: 0.2 kg/d (EPA 1988a)
Exposure Duration: 14 months (>1 yr and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: two dose levels:
2.5 and 5 ppm; 2.5 ppm = LOAEL
Calculations:

$$LOAEL: \left(\frac{2.5\,mg\ Aroclor\ 1248}{kg\ food} \ x\ \frac{200\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) /\ 5\ kg\ BW = 0.1\ mg/kg/d$$

Comments: Pregnancy and live birth rates were reduced by both dose levels. Because the study considered exposure over 14 months including critical lifestages (reproduction), the 2.5 ppm dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 0.01 mg/kg/d
Final LOAEL: 0.1 mg/kg/d

Compound: Aroclor 1254
Form: not applicable
Reference: Dahlgren et al. 1972
Test Species: Ring-necked Pheasant
Body weight: 1 kg (EPA 1993e)
Exposure Duration: 17 weeks (>10 wks and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: weekly oral dose via gelatin capsule
Dosage: two dose levels:
12.5 and 50 mg/bird/week; LOAEL = 12.5 mg/bird/week
Calculations: 12.5 mg/bird/week = 1.8 mg/kg/d
Comments: Significantly reduced egg hatchability was observed in both treatment groups. Therefore, because the study considered exposure throughout a critical lifestage (reproduction), the 12.5 mg/bird/week dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 0.18 mg/kg/d
Final LOAEL: 1.8 mg/kg/d

Compound: Aroclor 1254
Form: not applicable
Reference: McCoy et al. 1995
Test Species: Oldfield mouse (*Permyscus poliontus*)

Body weight: 0.014 kg (from Silva and Downing 1995)
food consumption: assumed comparable to that reported by Linzy (1987) for white-footed mice (*Peromyscus leucopus*): 0.135 g food/g BW/d or 1.9 g/animal/d

Exposure Duration: 12 months (>1 yr and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: one dose level:
5 ppm = LOAEL
Calculations:

$$LOAEL: \left(\frac{5\,mg\ Aroclor\ 1254}{kg\ food} \times \frac{1.9\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.014\ kg\ BW = 0.68\ mg/kg/d$$

Comments: Aroclor 1254 at 5 ppm in the diet reduced the number of litters, offspring weights, and offspring survival. Because and the study considered exposure over 12 months including critical lifestages (reproduction), this dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 0.068 mg/kg/d
Final LOAEL: 0.68 mg/kg/d

Compound: Aroclor 1254
Form: not applicable
Reference: Aulerich and Ringer 1977
Test Species: Mink
Body weight: 1.0 kg (EPA 1993e)
food consumption: 0.137 kg/d (Bleavins and Aulerich 1981)
Exposure Duration: 4.5 month (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
1, 5, and 15 ppm; NOAEL = 1 ppm.
Calculations:

$$NOAEL: \left(\frac{1\,mg\ Aroclor\ 1254}{kg\ food} \times \frac{137\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 1\ kg\ BW = 0.137\ mg/kg/d$$

$$LOAEL: \left(\frac{5\,mg\ Aroclor\ 1254}{kg\ food} \times \frac{137\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 1\ kg\ BW = 0.685\ mg/kg/d$$

Comments: Because Aroclor 1254 at 5 and 15 ppm in the diet reduced the number of offspring born alive and the study considered exposure over 4.5 months days including critical lifestages (reproduction), the 5 ppm dose was considered to be a chronic LOAEL and the 1 ppm dose was considered to be a chronic NOAEL.
Final NOAEL: 0.14 mg/kg/d
Final LOAEL: 0.69 mg/kg/d

Compound: Arsenic
Form: Arsenite (As^{+3})
Reference: Schroeder and Mitchner 1971
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)
Water Consumption: 0.0075 L/d
Food Consumption: 0.0055 kg/d
(calculated using allometric equation from EPA 1988a)
Exposure Duration: 3 generations (> 1 yr and during critical lifestage=chronic)
Endpoint: reproduction
Exposure Route: oral in water (+ incidental in food; As species in food not stated, assumed to be As^{+3})
Dosage: one dose level:
5 mg As/L (in water) + 0.06 mg/kg As (in food) = LOAEL
Calculations:

$$NOAEL: \left(\frac{5\,mg\ As^{+3}}{L\ water} \times \frac{7.5\,mL\ water}{day} \times \frac{1\,L}{1000\,mL} \right) / 0.03\ kg\ BW = 1.25\ mg/kg/d$$

$$LOAEL: \left(\frac{0.06\,mg\ As^{+3}}{kg\ food} \times \frac{5.5\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / 0.03\ kg\ BW = 0.011\ mg/kg/d$$

Total Exposure = 1.25 mg/kg/d + 0.011 mg/kg/d = 1.261 mg/kg/d

Comments: Because mice exposed to As^{+3} displayed declining litter sizes with each successive generation and the study considered exposure over 3 generations, this dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 0.126 mg/kg/d
Final LOAEL: 1.26 mg/kg/d

Compound: Arsenic
Form: Paris Green; Copper Acetoarsenite (44.34% As^{+3})
Reference: USFWS 1969
Test Species: Brown-headed Cowbird (Males only)
Body weight: 0.049 kg (Dunning 1984)
Food Consumption: 0.01087 kg/d
(calculated using allometric equation from Nagy 1987)
Exposure Duration: 7 months (> 10 wk=chronic)
Endpoint: mortality
Exposure Route: oral in diet
Dosage: four dose level:
25, 75, 225, and 675 ppm Paris Green; NOAEL = 25 ppm
mg/kg As^{+3} = 0.4434 x 25 mg/kg = 11.09 mg/kg

Calculations:

$$NOAEL: \left(\frac{11.09\,mg\ As^{+3}}{kg\ food} \times \frac{10.87\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.049\ kg\ BW = 2.46\ mg/kg/d$$

$$LOAEL: \left(\frac{33.26\,mg\ As^{+3}}{kg\ food} \times \frac{10.87\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.049\ kg\ BW = 7.38\ mg/kg/d$$

Comments: Cowbirds in the 675 and 225 ppm groups experienced 100% mortality. Those in the 75 and 25 ppm groups experienced 20% and 0% mortality, respectively. Because the study considered exposure over 7 months, the 75 ppm Paris green (33.26 mg/kg As^{+3}) and the 25 ppm Paris green (11.09 mg/kg As^{+3}) doses were considered to be chronic LOAELs and NOAELs, respectively.

Final NOAEL: 2.46 mg/kg/d
Final LOAEL: 7.38 mg/kg/d

Compound: Arsenic
Form: Sodium Arsenite (51.35% As^{+3})
Reference: USFWS 1964
Test Species: Mallard Ducks
Body weight: 1 kg (Heinz et al. 1989)
Food Consumption: 0.100 kg/d (Heinz et al. 1989)
Exposure Duration: 128 d (> 10 wk=chronic)
Endpoint: mortality
Exposure Route: oral in diet
Dosage: four dose level:
100, 250, 500, and 1000 ppm Sodium Arsenite;
NOAEL = 100 ppm
mg/kg As^{+3} = 0.5135 x 100 mg/kg = 51.35 mg/kg

Calculations:

$$NOAEL: \left(\frac{51.35\,mg\ As^{+3}}{kg\ food} \times \frac{100\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 1\ kg\ BW = 5.135\ mg/kg/d$$

$$LOAEL: \left(\frac{128.375\,mg\ As^{+3}}{kg\ food} \times \frac{100\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 1\ kg\ BW = 12.8375\ mg/kg/d$$

Comments: Mallards in the 1000, 500, and 250 ppm groups experienced 92%, 60%, and 12% mortality, respectively. Because those in the 100 ppm group experienced 0% mortality, and the study considered exposure over 128 days, the 100 ppm Sodium Arsenite (51.35 mg/kg As^{+3}) dose was considered to be a chronic NOAEL. The 250 ppm Sodium Arsenite (128.375 mg/kg As^{+3}) dose was considered to be a chronic LOAEL.

Final NOAEL: 5.14 mg/kg/d
Final LOAEL: 12.84 mg/kg/d

Compound: Barium
Form: Barium Chloride
Reference: Perry et al. 1983
Test Species: Rat
Body weight: 0.435 kg (from study)
Water Consumption: 0.022 L/d (from study)
Exposure Duration: 16 months (> 1yr = chronic)
Endpoint: growth, hypertension
Exposure Route: oral in water
Dosage: three dose level:
1, 10, and 100, ppm Ba (as Barium Chloride);
NOAEL = 100 ppm
Calculations:

$$NOAEL: \left(\frac{100\,mg\ Ba}{L\ water} \ x \ \frac{22\,mL\ water}{day} \ x \ \frac{1\,L}{1000\,mL} \right) / \ 0.435\ kg\ BW = 5.06\ mg/kg/d$$

Comments: While none of the three dose levels had any affect on food or water consumption or on growth, cardiovascular hypertension was observed among rats exposed to 10 or 100 ppm Ba. Because the significance of hypertension in wild populations is unclear, the maximum dose that did not affect growth, food or water consumption (100 ppm) was considered to be a chronic NOAEL.
Final NOAEL: 5.1 mg/kg/d

Compound: Barium
Form: Barium Chloride (66% Ba)
Reference: Borzelleca et al. 1988
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Exposure Duration: 10 days (< 1yr = subchronic)
Endpoint: mortality
Exposure Route: oral gavage in water
Dosage: four dose levels:
100, 145, 209, and 300 mg Barium Chloride /kg/d
LOAEL = (300x0.66)=198 mg Ba /kg/d
Calculations: not applicable
Comments: Exposure of rats to 300 mg/kg/d $BaCl_2$ for 10 days resulted in 30% mortality to female rats. No adverse effects were observed at any other dose levels. The 300 mg/kg/d dose was considered to be a subchronic LOAEL. A chronic LOAEL was estimated by multiplying the subchronic LOAEL by a subchronic to chronic uncertainty factor of 0.1. **Final LOAEL:** 19.8 mg/kg/d

Compound: Barium
Form: Barium Hydroxide
Reference: Johnson et al. 1960
Test Species: 1-day old chicks
Body weight: 0.121 kg (mean$_{♂+♀}$ at 14 d; EPA 1988a)

Food Consumption: 0.0126 kg/d (calculated using allometric equation from EPA 1988a)

Exposure Duration: 4 wk (< 10 wk = subchronic)
Endpoint: mortality
Exposure Route: oral in diet
Dosage: eight dose level:
250, 500, 1000, 2000, 4000, 8000, 16000, and 32000 ppm
Ba (as Barium Hydroxide)
NOAEL = 2000 ppm
Calculations:

$$NOAEL: \left(\frac{2000\,mg\ Ba}{kg\ food}\ x\ \frac{12.6\,g\ food}{day}\ x\ \frac{1\,kg}{1000\,g} \right)\ /\ 0.121\ kg\ BW\ =\ 208.26\ mg/kg/d$$

$$LOAEL: \left(\frac{4000\,mg\ Ba}{kg\ food}\ x\ \frac{12.6\,g\ food}{day}\ x\ \frac{1\,kg}{1000\,g} \right)\ /\ 0.121\ kg\ BW\ =\ 416.53\ mg/kg/d$$

Comments: To estimate daily Ba intake throughout the 4 week study period, food consumption of 2-week-old chicks was calculated. While this value will over- and underestimate food consumption by younger and older chicks, it was assumed to approximate food consumption throughout the entire 4 week study. While Barium exposures up to 2000 ppm produced no mortality, chicks in the 4000 to 32000 ppm groups experienced 5% to 100% mortality. Because 2000 ppm was the highest nonlethal dose, this dose was considered to be a subchronic NOAEL. The 4000 ppm dose was considered to be a subchronic LOAEL. Chronic NOAELs and LOAELs were estimated by multiplying the subchronic NOAELs and LOAELs by a subchronic to chronic uncertainty factor of 0.1.

Final NOAEL: 20.8 mg/kg/d
Final LOAEL: 41.7 mg/kg/d

Compound: Benzene
Form: not applicable
Reference: Nawrot and Staples 1979
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)
Exposure Duration: days 6-12 of gestation
(during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral gavage
Dosage: three dose levels:
0.3, 0.5, and 1 mL/kg/d; LOAEL = 0.3 mL/kg/d
Calculations: density of benzene=0.8787 g/mL (Merck 1976)

$$LOAEL: \left(\frac{0.3\,mL\ Benzene}{kg\ BW}\ x\ \frac{0.8787\,g\ Benzene}{mL\ Benzene}\ x\ \frac{1000\,mg}{1\,g} \right)\ =\ 263.6\ mg/kg/d$$

Comments: Benzene exposure of 0.5 and 1.0 mL/kg/d significantly increased maternal mortality and embryonic resorption. Fetal weights were significantly reduced by all three dose levels. While the benzene exposures evaluated in this study were of a short duration, they occurred during a critical lifestage. Therefore, the 0.3 mL/kg/d dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.

Final NOAEL: 26.36 mg/kg/d
Final LOAEL: 263.6 mg/kg/d

Compound: β-Benzene Hexachloride (β-BHC)
Form: not applicable
Reference: Van Velsen et al. 1986
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 13 weeks
(<1 yr and not during a critical lifestage = subchronic).
Endpoint: growth, blood chemistry, organ histology
Exposure Route: oral in diet
Dosage: four dose levels:
2, 10, 50, and 250 ppm; NOAEL = 50 ppm
Calculations:

$$NOAEL: \left(\frac{50 mg\ \beta\text{-}BHC}{kg\ food} \ x\ \frac{28 g\ food}{day} \ x\ \frac{1 kg}{1000 g} \right) / \ 0.35\ kg\ BW = 4\ mg/kg/d$$

$$LOAEL: \left(\frac{250 mg\ \beta\text{-}BHC}{kg\ food} \ x\ \frac{28 g\ food}{day} \ x\ \frac{1 kg}{1000 g} \right) / \ 0.35\ kg\ BW = 20\ mg/kg/d$$

Comments: Consumption of 250 ppm β-BHC in the diet caused gonadal atrophy in both male and female rats. Because no significant effects were observed in groups consuming 50 ppm β-BHC or less, this dose was considered to be a subchronic NOAEL; the 250 ppm dose was considered to be a subchronic LOAEL. Chronic NOAELs and LOAELs were estimated by multiplying the subchronic values by a subchronic-chronic uncertainty factor of 0.1.

Final NOAEL: 0.4 mg/kg/d
Final LOAEL: 2 mg/kg/d

Compound: Benzene Hexachloride (BHC mixed isomers)
Form: not applicable
Reference: Bleavins et al. 1984
Test Species: Mink
Body weight: 1.0 kg (EPA 1993e)
food consumption: 0.137 kg/d (Bleavins and Aulerich 1981)

Exposure Duration: 331 d (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
1, 5, and 25 ppm; 1 ppm = LOAEL
Calculations:

$$LOAEL: \left(\frac{1\,mg\ BHC}{kg\ food} \ x\ \frac{137\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 1\ kg\ BW\ =\ 0.137\ mg/kg/d$$

Comments: All dose levels produced increased kit mortality and decreased kit body weight. Because the study considered exposure over 331 days including critical lifestages (reproduction), this dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 0.014 mg/kg/d
Final LOAEL: 0.14 mg/kg/d

Compound: Benzene Hexachloride (BHC mixed isomers)
Form: not applicable
Reference: Grant et al. 1977
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 4 generations (>1 yr and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: seven dose levels:
10, 20, 40, 80, 160, 320, and 640 ppm; NOAEL = 20 ppm
Calculations:

$$NOAEL: \left(\frac{20\,mg\ BHC}{kg\ food} \ x\ \frac{28\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.35\ kg\ BW\ =\ 1.6\ mg/kg/d$$

$$LOAEL: \left(\frac{40\,mg\ BHC}{kg\ food} \ x\ \frac{28\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.35\ kg\ BW\ =\ 3.2\ mg/kg/d$$

Comments: Consumption of 320 ppm and 640 ppm BHC in the diet increased maternal mortality, 80 - 640 ppm BHC reduced litter sizes, and 40 - 320 ppm BHC reduced birthweights. Because no significant effects were observed in groups consuming 10 or 20 ppm BHC in their diet and the study considered exposure throughout four generations including critical lifestages (reproduction), the 20 ppm dose was considered to be a chronic NOAEL. The lowest dose to produce an adverse effect (40 ppm) was considered a chronic LOAEL.
Final NOAEL: 1.6 mg/kg/d
Final LOAEL: 3.2 mg/kg/d

Compound: Benzene Hexachloride (BHC mixed isomers)
Form: not applicable
Reference: Vos et al. 1971
Test Species: Japanese Quail
Body weight: 0.150 kg (from study)
Food Consumption: 0.0169 kg/d (calculated using allometric equation from Nagy 1987)
Exposure Duration: 90 d (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: seven dose levels:
1, 5, 20, and 80 ppm; NOAEL = 5 ppm
Calculations:

$$NOAEL: \left(\frac{5\,mg\ BHC}{kg\ food} \times \frac{16.9\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.15\ kg\ BW = 0.563\ mg/kg/d$$

$$LOAEL: \left(\frac{20\,mg\ BHC}{kg\ food} \times \frac{16.9\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.15\ kg\ BW = 2.25\ mg/kg/d$$

Comments: Consumption of 20 ppm and 80 ppm BHC in the diet reduced egg hatchability and egg volume. Because no significant effects were observed in groups consuming 1 or 5 ppm BHC in their diet and the study considered exposure throughout a critical lifestage (reproduction), the 5 ppm dose was considered to be a chronic NOAEL. The 20 ppm dose was considered to be a chronic LOAEL.
Final NOAEL: 0.56 mg/kg/d
Final LOAEL: 2.25 mg/kg/d

Compound: Benzo(a)pyrene (BaP)
Form: not applicable
Reference: Mackenzie and Angevine 1981
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)
Exposure Duration: days 7-16 of gestation (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral intubation
Dosage: three dose levels:
10, 40, and 160 mg/kg/d; LOAEL = 10 mg/kg/d
Calculations: not applicable
Comments: BaP exposure 160 mg/kg/d significantly reduced pregnancy rates and percentage of viable litters. Pup weights were significantly reduced by all three dose levels. Total sterility was observed in 97% of offspring in the 40 and 160 mg/kg/d groups and fertility was impaired among offspring in the 10 mg/kg/d group. While the BaP exposures evaluated in this study were of a short duration, they occurred during a critical lifestage. Therefore, the 10 mg/kg/d dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 1 mg/kg/d

Final LOAEL: 10 mg/kg/d

Compound: Beryllium
Form: Beryllium Sulfate
Reference: Schroeder and Mitchner 1975
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Water Consumption: 0.046 L/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: lifetime (> 1yr = chronic)
Endpoint: longevity, weight loss
Exposure Route: oral in water
Dosage: one dose level:
5 ppm Be = NOAEL
Calculations:

$$NOAEL: \left(\frac{5\, mg\ Be}{L\ water} \times \frac{46\, mL\ water}{day} \times \frac{1\, L}{1000\, mL} \right) / \ 0.35\ kg\ BW = 0.66\ mg/kg/d$$

Comments: While exposure to 5 ppm Be in water did not reduce longevity, weight loss by males was observed in months 2 - 6. Because the weight loss was not considered to be an adverse effect, the 5 ppm dose level was considered to be a chronic NOAEL.
Final NOAEL: 0.66 mg/kg/d

Compound: Bis(2-ethylhexyl)Phthalate (BEHP)
Form: not applicable
Reference: Lamb et al. 1987
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)
Food Consumption: 0.0055 kg/d
(calculated using allometric equation from EPA 1988a)
Exposure Duration: 105 d (during critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
0.01%, 0.1% and 0.3% of diet;
NOAEL = 0.01% = 100 mg/kg
LOAEL = 0.1% = 1000 mg/kg
Calculations:

$$NOAEL: \left(\frac{100\, mg\ BEHP}{kg\ food} \times \frac{5.5\, g\ food}{day} \times \frac{1\, kg}{1000\, g} \right) / \ 0.03\ kg\ BW = 18.33\ mg/kg/d$$

$$LOAEL: \left(\frac{1000\, mg\ BEHP}{kg\ food} \times \frac{5.5\, g\ food}{day} \times \frac{1\, kg}{1000\, g} \right) / \ 0.03\ kg\ BW = 183.3\ mg/kg/d$$

Comments: While significant reproductive effects were observed among mice on diets containing 0.1% and 0.3% Bis(2-ethylhexyl)Phthalate, no adverse effects were observed among the

0.01% dose group. Because the study considered exposure during critical lifestage, the 0.01% dose was considered to be a chronic NOAEL. The 0.1% dose was considered to be a chronic LOAEL.

Final NOAEL: 18.3 mg/kg/d

Final LOAEL: 183 mg/kg/d

Compound: Bis(2-ethylhexyl)Phthalate (BEHP)

Form: not applicable

Reference: Peakall 1974

Test Species: Ringed Dove

Body weight: 0.155 kg (Terres 1980)

Food Consumption: 0.01727 kg/d (calculated using allometric equation from Nagy 1987)

Exposure Duration: 4 weeks (during critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: one dose level:

10 ppm = NOAEL

Calculations:

$$NOAEL: \left(\frac{10\,mg\ BEHP}{kg\ food} \times \frac{17.27\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) /\ 0.155\ kg\ BW\ =\ 1.11\ mg/kg/d$$

Comments: No significant reproductive effects were observed among doves on diets containing 10 ppm Bis(2-ethylhexyl)Phthalate, and the study considered exposure over 4 weeks and during a critical lifestage, the 10 ppm dose was considered to be a chronic NOAEL..

Final NOAEL: 1.1 mg/kg/d

Compound: Boron

Form: Boric acid or Borax

Reference: Weir and Fisher 1972

Test Species: Rat

Body weight: 0.35 kg (EPA 1988a)

Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)

Exposure Duration: 3 generations (>1 yr and during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: three dose levels:

117, 350, and 1170 ppm B; NOAEL = 350 ppm

Calculations:

$$NOAEL: \left(\frac{350\,mg\ B}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) /\ 0.35\ kg\ BW\ =\ 28\ mg/kg/d$$

$$LOAEL: \left(\frac{1170\, mg\ B}{kg\ food} \times \frac{28\, g\ food}{day} \times \frac{1\, kg}{1000\, g} \right) / \ 0.35\ kg\ BW = 93.6\ mg/kg/d$$

Comments: While consumption of 1170 ppm B as either boric acid or borax resulted in sterility, no adverse reproductive effects were observed among rats consuming 117 or 350 ppm B. Because the study considered exposure throughout 3 generations including critical lifestages (reproduction), the 350 ppm dose was considered to be a chronic NOAEL and the 1170 ppm dose was considered a chronic LOAEL.

Final NOAEL: 28 mg/kg/d
Final LOAEL: 93.6 mg/kg/d

Compound: Boron
Form: Boric acid
Reference: Smith and Anders 1989
Test Species: Mallard Ducks
Body weight: 1 kg (Heinz et al. 1989)
Food Consumption: 0.1 kg/d (Heinz et al. 1989)
Exposure Duration: 3 wks prior to, during, and 3 wks post reproduction (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: four dose levels:
8, 35, 288, and 1000 ppm B; NOAEL = 288 ppm
Calculations:

$$NOAEL: \left(\frac{288\, mg\ B}{kg\ food} \times \frac{100\, g\ food}{day} \times \frac{1\, kg}{1000\, g} \right) / \ 1\ kg\ BW = 28.8\ mg/kg/d$$

$$LOAEL: \left(\frac{1000\, mg\ B}{kg\ food} \times \frac{100 g\ food}{day} \times \frac{1\, kg}{1000\, g} \right) / \ 1\ kg\ BW = 100\ mg/kg/d$$

Comments: While consumption of 1000 ppm B resulted in reduced egg fertility and duckling growth and increased embryo and duckling mortality, no adverse reproductive effects were observed among the other dose levels. Because the study considered exposure throughout reproduction, the 288 ppm dose was considered to be a chronic NOAEL and the 1000 ppm dose was considered a chronic LOAEL.

Final NOAEL: 28.8 mg/kg/d
Final LOAEL: 100 mg/kg/d

Compound: Cadmium
Form: $CdCl_2$
Reference: Wills et al. 1981
Test Species: Rat

Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation

Exposure Duration: 4 generations (>1 yr and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels: 0.08, 0.1, and 0.125 ppm Cd;
0.1 ppm = NOAEL

Calculations:

$$NOAEL: \left(\frac{0.1\, mg\ Cd}{kg\ food} \ x\ \frac{28\, g\ food}{day} \ x\ \frac{1\, kg}{1000\, g} \right) \ /\ 0.35\ kg\ BW\ =\ 0.008\ mg/kg/d$$

$$LOAEL: \left(\frac{0.125\, mg\ Cd}{kg\ food} \ x\ \frac{28\, g\ food}{day} \ x\ \frac{1\, kg}{1000\, g} \right) \ /\ 0.35\ kg\ BW\ =\ 0.01\ mg/kg/d$$

Comments: While no reduction in the growth or survivorship of offspring was observed at any dose level, fertility (no. litters/no. females) was reduced by 63% in rats receiving the 0.125 ppm Cd diet; fertility was not reduced in the 0.1 ppm Cd diet. Because the study considered multigeneration exposure and was long term, the 0.1 ppm and 0.125 ppm doses were considered to be a chronic NOAELs and LOAELs, respectively.

Final NOAEL: 0.008 mg/kg/d
Final LOAEL: 0.01 mg/kg/d

Compound: Cadmium
Form: Cadmium Chloride
Reference: White and Finley 1978
Test Species: Mallard Ducks
Body weight: 1.153 kg (from study)
Food Consumption: 0.110 kg/d (from study)

Exposure Duration: 90 d (> 10 wk and during a critical lifestage =chronic)
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose level:
1.6, 15.2, and 210 ppm Cd
NOAEL = 15.2 ppm

Calculations:

$$NOAEL: \left(\frac{15.2\, mg\ Cd}{kg\ food} \ x\ \frac{110\, g\ food}{day} \ x\ \frac{1\, kg}{1000\, g} \right) \ /\ 1.153\ kg\ BW\ =\ 1.45\ mg/kg/d$$

$$LOAEL: \left(\frac{210\, mg\ Cd}{kg\ food} \ x\ \frac{110\, g\ food}{day} \ x\ \frac{1\, kg}{1000\, g} \right) \ /\ 1.153\ kg\ BW\ =\ 20.03\ mg/kg/d$$

Comments: Mallards in the 210 ppm group produced significantly fewer eggs than those in the other groups. Because the study considered exposure over 90 days, the 15.2 ppm Cd dose was considered to be a chronic NOAEL and the 210 ppm does was considered to be a chronic LOAEL.

Final NOAEL: 1.45 mg/kg/d

Final LOAEL: 20 mg/kg/d

Compound: Carbon Tetrachloride

Form: not applicable

Reference: Alumot et al. 1976a

Test Species: Rat

Body weight: 0.35 kg (EPA 1988a)

Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)

Exposure Duration: 2 yr (>1 yr and during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: two dose levels:

80 and 200 ppm;

No effects observed at either dose level.

Calculations:

$$NOAEL: \left(\frac{200\, mg\ CCl_4}{kg\ food} \times \frac{28\, g\ food}{day} \times \frac{1\, kg}{1000\, g} \right) / \ 0.35\ kg\ BW = 16\ mg/kg/d$$

Comments: Because no significant differences were observed at either dose level and the study considered exposure throughout 2 years including critical lifestages (reproduction), the maximum dose was considered to be a chronic NOAEL.

Final NOAEL: 16 mg/kg/d

Compound: Chlordane

Form: not applicable

Reference: WHO 1984 (secondary source; Primary citation: Keplinger, M.L., W.B. Deichman, and F. Sala. 1968. Effects of pesticides on reproduction in mice. Ind. Med. Surg. 37: 525.)

Test Species: Mouse

Body weight: 0.03 kg (EPA 1988a)

Food Consumption: 0.0055 kg/d

(calculated using allometric equation from EPA 1988a)

Exposure Duration: 6 generations (>1 yr and during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: three dose levels:

25, 50, and 100 mg/kg; NOAEL = 25 mg/kg

Calculations:

$$NOAEL: \left(\frac{25\,mg\ Chlordane}{kg\ food} \times \frac{5.5\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.03\ kg\ BW = 4.58\ mg/kg/d$$

$$LOAEL: \left(\frac{50\,mg\ Chlordane}{kg\ food} \times \frac{5.5\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.03\ kg\ BW = 9.16\ mg/kg/d$$

Comments: While significant effects were observed among mice on diets containing 50 and 100 mg/kg Chlordane (decreased viability and reduced abundance of offspring), no adverse effects were observed among the 25 mg/kg dose group. Because the study considered exposure over six generations and through reproduction, the 25 mg/kg dose was considered to be a chronic NOAEL. The 50 mg/kg dose was considered to be a chronic LOAEL.

Final NOAEL: 4.6 mg/kg/d
Final LOAEL: 9.2 mg/kg/d

Compound: Chlordane
Form: not applicable
Reference: Stickel et al. 1983
Test Species: Red-winged Blackbird
Body weight: 0.064 kg (from study)
Food Consumption: 0.0137 kg/d
(calculated using allometric equation from Nagy 1987)
Exposure Duration: 84 days (>10 weeks = chronic).
Endpoint: mortality
Exposure Route: oral in diet
Dosage: three dose levels:
10, 50, and 100 ppm; NOAEL = 10 ppm
Calculations:

$$NOAEL: \left(\frac{10\,mg\ Chlordane}{kg\ food} \times \frac{13.7\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.064\ kg\ BW = 2.14\ mg/kg/d$$

$$LOAEL: \left(\frac{50\,mg\ Chlordane}{kg\ food} \times \frac{13.7\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.064\ kg\ BW = 10.7\ mg/kg/d$$

Comments: While 26% and 24% mortality was observed among birds on diets containing 50 and 100 mg/kg Chlordane, no adverse effects were observed among the 10 mg/kg dose group. Because the study considered exposure over 84 days, the 10 mg/kg dose was considered to be a chronic NOAEL. The 50 mg/kg dose was considered to be a chronic LOAEL.

Final NOAEL: 2.14 mg/kg/d
Final LOAEL: 10.7 mg/kg/d

Compound: Chlordecone (Kepone)
Form: not applicable
Reference: Larson et al. 1979
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 2 yr (>1 yr and during a critical lifestage = chronic).
Endpoint: mortality, growth, kidney damage
Exposure Route: oral in diet
Dosage: five dose levels:
1, 5, 10, 25, and 80 ppm; NOAEL = 1 ppm
Calculations:

$$NOAEL: \left(\frac{1\,mg\ Chlordecone}{kg\ food} \ x\ \frac{28\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.35\ kg\ BW\ =\ 0.08\ mg/kg/d$$

$$LOAEL: \left(\frac{5\,mg\ Chlordecone}{kg\ food} \ x\ \frac{28\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.35\ kg\ BW\ =\ 0.4\ mg/kg/d$$

Comments: Chlordecone at 25 and 80 ppm in the diet produced 100% mortality in 6 months. Growth was depressed by 10 and 25 ppm and kidney damage was observed at doses as low as 5 ppm. Because the study considered exposure throughout 2 years, the 1 ppm dose was considered to be a chronic NOAEL. The 5 ppm dose was considered to be a chronic LOAEL.
Final NOAEL: 0.08 mg/kg/d
Final LOAEL: 0.4 mg/kg/d

Compound: Chloroform
Form: not applicable
Reference: Palmer et al. 1979
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Exposure Duration: 13 wk (<1 yr and not during a critical lifestage = subchronic).
Endpoint: liver, kidney, gonad condition
Exposure Route: oral intubation
Dosage: four dose levels:
15, 30, 150, and 410 mg/kg/d; NOAEL = 150 mg/kg/d
Calculations: not applicable
Comments: Gonadal atrophy was observed among male and female rats receiving 410 mg/kg/d; therefore 150 mg/kg/d was considered to be a subchronic NOAEL. The 410 mg/kg/d dose was considered to be a subchronic LOAEL. To estimate the chronic NOAEL and LOAEL, the subchronic values was multiplied by a subchronic-chronic uncertainty factor of 0.1.
Final NOAEL: 15 mg/kg/d
Final LOAEL: 41 mg/kg/d

Compound: Chromium

Form: Cr^{+3} as Cr_2O_3 (68.42% Cr)

Reference: Ivankovic and Preussmann 1975

Test Species: Rat

Body weight: 0.35 kg (EPA 1988a)

Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)

Exposure Duration: 90 d and 2 yr

Endpoint: reproduction, longevity

Exposure Route: oral in diet

Dosage: three dose levels:

Cr_2O_3 as 1%, 2% or 5% of diet

No effects observed at any dose level

Calculations:

$$NOAEL: \left(\frac{50{,}000\,mg\ Cr_2O_3}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.35\ kg\ BW = 4000\ mg/kg/d$$

0.6842 x 4000 mg Cr_2O_3 /kg/d or 2737 mg Cr^{+3}/kg/d.

Comments: Reproductive effects were evaluated among rats fed 2% or 5% Cr_2O_3 for 90 d; carcinogenicity and longevity were evaluated among rats fed 1%, 2% or 5% Cr_2O_3 for 2 years. Because no significant differences were observed at any dose level in either study and both studies considered exposure throughout 2 years or a critical lifestage (reproduction), the maximum dose was considered to be a chronic NOAEL.

Final NOAEL: 2737 mg/kg/d

Compound: Chromium

Form: Cr^{+6} as $K_2Cr_2O_4$

Reference: MacKenzie et al. 1958

Test Species: Rat

Body weight: 0.35 kg (EPA 1988a)

Water Consumption: 0.046 L/d (calculated using allometric equation from EPA 1988a)

Exposure Duration: 1 yr

Endpoint: body weight and food consumption

Exposure Route: oral in water

Dosage: six dose levels:

0.45, 2.2, 4.5, 7.7, 11.2, and 25 ppm Cr^{+6} in water

No effects observed at any dose level

Calculations:

$$NOAEL: \left(\frac{25\,mg\ Cr^{+6}}{L\ water} \times \frac{0.046\,L\ water}{day} \right) / \ 0.35\ kg\ BW = 3.28\ mg/kg/d$$

Comments: Because no significant differences were observed at any dose level studied and the study considered exposure over 1 year, the maximum dose was considered to be a chronic NOAEL.

Final NOAEL: 3.28 mg/kg/d

Compound: Chromium
Form: Cr^{+6}
Reference: Steven et al. 1976 (cited in Eisler 1986)
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Water Consumption: 0.046 L/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 3 months (<1 yr = subchronic)
Endpoint: mortality
Exposure Route: oral in water
Dosage: two dose levels:
134 and 1000 ppm Cr^{+6} in water; 1000 ppm = LOAEL
Calculations:

$$LOAEL: \left(\frac{1000\,mg\ Cr^{+6}}{L\ water}\ x\ \frac{0.046\,L\ water}{day} \right)\ /\ 0.35\ kg\ BW\ =\ 131.4\ mg/kg/d$$

Comments: Because the 1000 ppm dose was identified as the toxicity threshold, this dose was considered to be a subchronic LOAEL. A chronic LOAEL was estimated by multiplying the subchronic LOAEL by a subchronic-chronic uncertainty factor of 0.1.
Final LOAEL: 13.14 mg/kg/d

Compound: Chromium
Form: Cr^{+3} as $CrK(SO_4)_2$
Reference: Haseltine et al., unpubl. data
Test Species: Black duck
Body weight: 1.25 kg ($mean_{♂+♀}$; Dunning 1984)
Food Consumption: Congeneric Mallard ducks, weighing 1 kg consume 100 g food/d (Heinz et al.1989). Therefore, it was assumed that a 1.25 kg black duck would consume 125 g food/d.
Exposure Duration: 10 mo. (>10 weeks and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: two dose levels:
10 and 50 ppm Cr^{+3} in diet; NOAEL = 10 ppm
Calculations:

$$NOAEL: \left(\frac{10\,mg\ Cr^{+3}}{kg\ food}\ x\ \frac{125\,g\ food}{day}\ x\ \frac{1\,kg}{1000\,g} \right)\ /\ 1.25\ kg\ BW\ =\ 1\ mg/kg/d$$

$$LOAEL: \left(\frac{50\,mg\ Cr^{+3}}{kg\ food}\ x\ \frac{125\,g\ food}{day}\ x\ \frac{1\,kg}{1000\,g} \right)\ /\ 1.25\ kg\ BW\ =\ 5\ mg/kg/d$$

Comments: While duckling survival was reduced at the 50 ppm dose level, no significant differences were observed at the 10 ppm Cr^{+3} dose level. Because the study considered exposure throughout a critical lifestage (reproduction), the dose 50 ppm dose was considered to be a chronic LOAEL and the dose 10 ppm dose was considered to be a chronic NOAEL.

Final NOAEL: 1 mg/kg/d

Final LOAEL: 5 mg/kg/d

Compound: Copper

Form: Copper Sulfate

Reference: Aulerich et al. 1982

Test Species: Mink

Body weight: 1.0 kg (EPA 1993e)

food consumption: 0.137 kg/d (Bleavins and Aulerich 1981)

Exposure Duration: 357 d (during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: four dose levels:

25, 50, 100, and 200 ppm Cu supplemental + 60.5 ppm Cu in base feed; NOAEL = 85.5 ppm Cu (supplement + base)

Calculations:

$$NOAEL: \left(\frac{85.5\,mg\ Cu}{kg\ food} \ x \ \frac{137\,g\ food}{day} \ x \ \frac{1\,kg}{1000\,g} \right) / \ 1\ kg\ BW \ = \ 11.71\ mg/kg/d$$

$$LOAEL: \left(\frac{110.5\,mg\ Cu}{kg\ food} \ x \ \frac{137\,g\ food}{day} \ x \ \frac{1\,kg}{1000\,g} \right) / \ 1\ kg\ BW \ = \ 15.14\ mg/kg/d$$

Comments: Consumption of 50, 100, and 200 ppm supplemental Cu increased the percentage mortality of mink kits. Kit survivorship among the 25 ppm supplemental Cu group was actual greater than the controls. Because this study was approximately one year in duration and considered exposure during reproduction, the 25 ppm supplemental Cu (85.5 ppm total Cu) dose was considered to be a chronic NOAEL and the 50 ppm supplemental Cu (110.5 ppm total Cu) dose was considered to be a chronic NOAEL

Final NOAEL: 11.7 mg/kg/d

Final LOAEL: 15.14 mg/kg/d

Compound: Copper

Form: Copper Oxide

Reference: Mehring et al. 1960

Test Species: 1 day old chicks

Body weight: 0.534 kg ($mean_{♂+♀}$ at 5 weeks; EPA 1988a)

food consumption: 0.044 kg/d (calculated using allometric equation from EPA 1988a)

Exposure Duration: 10 weeks (10 weeks = chronic).

Endpoint: growth, mortality
Exposure Route: oral in diet
Dosage: eleven dose levels:
36.8, 52.0, 73.5, 104.0, 147.1, 208.0, 294.1, 403, 570, 749, and 1180 ppm total Cu; NOAEL = 570 ppm total Cu
Calculations:

$$NOAEL: \left(\frac{570\,mg\ Cu}{kg\ food} \ x\ \frac{44\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.534\ kg\ BW\ =\ 46.97\ mg/kg/d$$

$$LOAEL: \left(\frac{749\,mg\ Cu}{kg\ food} \ x\ \frac{44\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.534\ kg\ BW\ =\ 61.72\ mg/kg/d$$

Comments: While consumption of Cu up to 570 ppm had no effect of growth of chicks, 749 ppm Cu in the diet reduced growth by over 30% and produced 15% mortality. Because this study was 10 weeks in duration, the 570 and 749 ppm Cu doses were considered to be a chronic NOAEL and LOAEL, respectively. To estimate daily Cu intake throughout the 10 week study period, food consumption of 5-week-old chicks was calculated. While this value will over- and underestimate food consumption by younger and older chicks, it was assumed to approximate food consumption throughout the entire 10 week study.
Final NOAEL: 47 mg/kg/d
Final LOAEL: 61.7 mg/kg/d

Compound: *o*-Cresol
Form: not applicable
Reference: Hornshaw et al. 1986
Test Species: Mink
Body weight: 1.0 kg (EPA 1993e)
food consumption: 0.137 kg/d (Bleavins and Aulerich 1981)
Exposure Duration: 6 months (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
100, 400, and 1600 ppm ; NOAEL = 1600 ppm
Calculations:

$$NOAEL: \left(\frac{1600\,mg\ o\text{-}Cresol}{kg\ food} \ x\ \frac{137\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 1\ kg\ BW\ =\ 219.2\ mg/kg/d$$

Comments: No adverse effects were observed at any dose level. Because this study considered exposure during reproduction, the maximum dose was considered to be a chronic NOAEL.
Final NOAEL: 219.2 mg/kg/d

Compound: Cyanide

Form: Potassium Cyanide
Reference: Tewe and Maner 1981
Test Species: Rat
Body weight: 0.273 kg (from study)
Food Consumption: 0.0375 kg/d (from study)
Exposure Duration: gestation and lactation (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: one dose level:
500 ppm CN = NOAEL
Calculations:

$$NOAEL: \left(\frac{500\,mg\ CN}{kg\ food} \ x \ \frac{37.5\,g\ food}{day} \ x \ \frac{1\,kg}{1000\,g} \right) \ / \ 0.273\ kg\ BW \ = \ 68.7\ mg/kg/d$$

Comments: Consumption of 500 ppm CN significantly reduced offspring growth and food consumption, however values for treated individuals were only marginally less than controls (reductions were 7% or less). While the effects of 500 ppm Cn in the diet were statistically significant, they were not considered to be biologically significant. Because the study considered exposure throughout a critical lifestage (reproduction), this dose was considered to be a chronic NOAEL.
Final NOAEL: 68.7 mg/kg/d

Compound: DDT
Form: not applicable
Reference: Fitzhugh 1948
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 2 yr (> 1 yr and during a critical lifestage = chronic)
Endpoint: reproduction,
Exposure Route: oral in diet
Dosage: four dose levels:
10, 50, 100, and 600 ppm; NOAEL = 10 ppm
Calculations:

$$NOAEL: \left(\frac{10\,mg\ DDT}{kg\ food} \ x \ \frac{28\,g\ food}{day} \ x \ \frac{1\,kg}{1000\,g} \right) \ / \ 0.35\ kg\ BW \ = \ 0.8\ mg/kg/d$$

$$LOAEL: \left(\frac{50\,mg\ DDT}{kg\ food} \ x \ \frac{28\,g\ food}{day} \ x \ \frac{1\,kg}{1000\,g} \right) \ / \ 0.35\ kg\ BW \ = \ 4\ mg/kg/d$$

Comments: While consumption of 50 ppm or more DDT in the diet reduced the number of young produced, no adverse effects were observed at the 10 ppm DDT dose level. Because the study considered exposure throughout 2 years and reproduction, the 10 and 50 ppm DDT doses were considered to be chronic NOAELs and LOAELs, respectively.

Final NOAEL: 0.8 mg/kg/d
Final LOAEL: 4 mg/kg/d

Compound: DDT
Form: not applicable
Reference: Anderson et al. 1975
Test Species: Brown Pelican
Body weight: 3.5 kg (Dunning 1984)
Food Consumption: 0.66 kg/d (EPA 1993e)
Exposure Duration: 5 yr (> 1 yr and during a critical lifestage = chronic)
Endpoint: reproduction,
Exposure Route: oral in diet
Dosage: one dose level:
0.15 ppm DDT; LOAEL = 0.15 ppm

Calculations:

$$LOAEL: \left(\frac{0.15\,mg\ DDT}{kg\ food}\ x\ \frac{660\,g\ food}{day}\ x\ \frac{1\,kg}{1000\,g} \right)\ /\ 3.5\ kg\ BW\ =\ 0.028\ mg/kg/d$$

Comments: Anderson et al. (1975) studied the reproductive success of pelicans from 1969 through 1974. During this time, DDT residues in anchovies, their primary food, declined from 4.27 ppm (wet weight) to 0.15 ppm (wet weight). While reproductive success improved from 1969 to 1974, in 1974 the fledgling rate was still 30% below that needed to maintain a stable population. Because this study was long-term and considered reproductive effects in a wildlife species, EPA (1993) judged this study to be the most appropriate to evaluate DDT effects to avian wildlife. Therefore the 0.15 ppm DDT value was considered to be a chronic LOAEL. To estimate the chronic NOAEL, the chronic NOAEL was multiplied by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 0.0028 mg/kg/d
Final LOAEL: 0.028 mg/kg/d

Compound: 1,2,-Dichloroethane
Form: not applicable
Reference: Lane et al. 1982
Test Species: Mouse
Body weight: 0.035 kg (from study)
Water Consumption: 6 mL/d (from study)
Exposure Duration: 2 generations (>1 yr and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in water
Dosage: three dose levels:
5, 15, and 50 mg/kg/d
No effects observed at any dose level.
Calculations: not applicable

Comments: Because no significant differences were observed at any dose level and the study considered exposure throughout 2 generations including critical lifestages (reproduction), the maximum dose was considered to be a chronic NOAEL.

Final NOAEL: 50 mg/kg/d.

Compound: 1,2,-Dichloroethane

Form: not applicable

Reference: Alumot at al. 1976b

Test Species: Chicken

Body weight: 1.6 kg ($mean_{♂+♀}$ from study)

Food Consumption: 0.11 kg/d (calculated using allometric equation from EPA 1988a)

Exposure Duration: 2 yr (>10 wk and during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: two dose levels:

250 and 500 ppm; NOAEL = 250 ppm

Calculations:

$$NOAEL: \left(\frac{250\,mg\ 1,2\,Dichloroethane}{kg\ food} \ x\ \frac{0.11\,kg\ food}{day} \right) / \ 1.6\ kg\ BW\ =\ 17.2\ mg/kg/d$$

$$LOAEL: \left(\frac{500\,mg\ 1,2\,Dichloroethane}{kg\ food} \ x\ \frac{0.11\,kg\ food}{day} \right) / \ 1.6\ kg\ BW\ =\ 34.4\ mg/kg/d$$

Comments: While egg production was reduced at the 500 ppm dose level, no significant differences were observed at the 250 ppm dose level. Because the study considered exposure throughout 2 years including critical lifestages (reproduction), these doses were considered to be chronic NOAELs and LOAELs.

Final NOAEL: 17.2 mg/kg/d

Final LOAEL: 34.4 mg/kg/d

Compound: 1,1-Dichloroethylene
Form: not applicable
Reference: Quast et al. 1983
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Exposure Duration: 2 years (>1 yr = chronic).
Endpoint: mortality, body weight, blood chemistry, liver histology
Exposure Route: oral in water
Dosage: three dose levels:
7, 10, and 20 mg/kg/d (males) and
9, 14, and 30 mg/kg/d (females); NOAEL = 30 mg/kg/d
Calculations: not applicable
Comments: The only treatment-related effect observed were microscopic hepatic lesions. These were evident among females at all dose levels and among males only at the highest dose level. No other treatment effects were observed. Because the relationship of hepatic lesions to potential population effects is unknown and no other effects were observed, the maximum dose, 30 mg/kg/d was considered a chronic NOAEL.
Final NOAEL: 30 mg/kg/d

Compound: 1,1-Dichloroethylene
Form: not applicable
Reference: Quast et al. 1983
Test Species: dog (beagle)
Body weight: 10 kg (EPA 1988a)
Exposure Duration: 97 d (<1 yr and not during a critical lifestage = subchronic).
Endpoint: mortality, body weight, blood chemistry, liver histology
Exposure Route: daily oral capsules
Dosage: three dose levels:
6.25, 12.5, and 25 mg/kg/d; NOAEL = 25 mg/kg/d
Calculations: not applicable
Comments: No adverse effects were observed among any of the treatments, therefore the maximum dose, 25 mg/kg/d was considered a subchronic NOAEL. A chronic NOAEL was estimated by multiplying the subchronic NOAEL by a subchronic-chronic uncertainty factor of 0.1.
Final NOAEL: 2.5 mg/kg/d

Compound: 1,2-Dichloroethylene
Form: not applicable
Reference: Palmer et al. 1979
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)
Exposure Duration: 90 d (<1 yr and not during a critical lifestage = subchronic).
Endpoint: body and organ weights, blood chemistry, hepatic function
Exposure Route: oral in water
Dosage: three dose levels:
16.8, 175, and 387 mg/kg/d (Males)
22.6, 224, and 452 mg/kg/d (Females)
NOAEL = 452 mg/kg/d

Calculations: not applicable

Comments: Exposure to 387 mg/kg/d 1,2-Dichloroethylene reduced glutathione levels in males and all dose levels reduced aniline hydroxylase activity in females. No other treatment effects were observed. Because the relationship of enzyme levels to potential population effects is unknown and no other effects were observed, the maximum dose, 452 mg/kg/d was considered a subchronic NOAEL. To estimate the chronic NOAEL, the subchronic NOAEL was multiplied by a subchronic-chronic uncertainty factor of 0.1.

Final NOAEL: 45.2 mg/kg/d

Compound: Dieldrin
Form: not applicable
Reference: Treon and Cleveland 1955
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 3 generations (>1 yr and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
2.5, 12.5, and 25.0 ppm; LOAEL = 2.5 ppm
Calculations:

$$LOAEL: \left(\frac{2.5\,mg\ Dieldrin}{kg\ food} \; x \; \frac{28\,g\ food}{day} \; x \; \frac{1\,kg}{1000\,g} \right) \,/\, 0.35\ kg\ BW \,=\, 0.2\ mg/kg/d$$

Comments: Because Dieldrin at 2.5 ppm in the diet reduced the number of pregnancies in rats and the study considered exposure throughout 3 generations including critical lifestages (reproduction), this dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.

Final NOAEL: 0.02 mg/kg/d
Final LOAEL: 0.2 mg/kg/d

Compound: Dieldrin
Form: not applicable
Reference: Mendenhall et al. 1983
Test Species: Barn Owl
Body weight (BW): 0.466 kg ($mean_{♂+♀}$; Johnsgard 1988)
Food Consumption: wild birds 100-150 g/d ; 50-75 g/d captive (Johnsgard 1988). Used median captive food consumption value: 62.5 g/d
Exposure Duration: 2 yrs (>10 weeks and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: Only 1 dose level applied: 0.58 ppm NOAEL

Calculations:

$$NOAEL: \left(\frac{0.58\,mg\ Dieldrin}{kg\ food} \times \frac{62.5\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) /\ 0.466\ kg\ BW = 0.077\ mg/kg/d$$

Comments: While 0.58 ppm Dieldrin in the diet produced a slight but significant reduction in eggshell thickness, no significant effect on no. eggs laid/pair, no. eggs hatched/pair, % eggs broken, embryo or nestling mortality was observed. Therefore this dose was considered to be a chronic NOAEL.

Final NOAEL: 0.077 mg/kg/d

Compound: Diethylphthalate (DEP)
Form: not applicable
Reference: Lamb et al. 1987
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)
Food Consumption: 0.0055 kg/d
(calculated using allometric equation from EPA 1988a)
Exposure Duration: 105 d (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
0.25%, 1.25% and 2.5% of diet;
NOAEL = 2.5% = 25000 mg/kg
Calculations:

$$NOAEL: \left(\frac{25000\,mg\ DEP}{kg\ food} \times \frac{5.5\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) /\ 0.03\ kg\ BW = 4583\ mg/kg/d$$

Comments: No significant reproductive effects were observed among mice in any of the treatment groups. Because the study considered exposure during a critical lifestage, the maximum dose was considered to be a chronic NOAEL.

Final NOAEL: 4583 mg/kg/d

Compound: Di-n-butyl phthalate (DBP)
Form: not applicable
Reference: Lamb et al. 1987
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)
Food Consumption: 0.0055 kg/d
(calculated using allometric equation from EPA 1988a)
Exposure Duration: 105 d (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:

0.03%, 0.3% and 1% of diet;
NOAEL = 0.3% = 3000 mg/kg

Calculations:

$$NOAEL: \left(\frac{3000\,mg\ DBP}{kg\ food} \times \frac{5.5\,g\ food}{day} \times \frac{1\,kg}{1000\,g}\right) / 0.03\ kg\ BW = 550\ mg/kg/d$$

$$LOAEL: \left(\frac{10000\,mg\ DBP}{kg\ food} \times \frac{5.5\,g\ food}{day} \times \frac{1\,kg}{1000\,g}\right) / 0.03\ kg\ BW = 1833\ mg/kg/d$$

Comments: While significant reproductive effects (reduced litters/pair, live pups/litter, etc.) were observed among mice on diet containing 1% DBP, no adverse effects were observed among either the 0.03% or 0.3% dose groups. Because the study considered exposure during a critical lifestage, these doses were considered to be chronic NOAELs and LOAELs.

Final NOAEL: 550 mg/kg/d
Final LOAEL: 1833 mg/kg/d

Compound: Di-n-butyl phthalate (DBP)
Form: not applicable
Reference: Peakall 1974
Test Species: Ringed Dove
Body weight: 0.155 kg (Terres 1980)
Food Consumption: 0.01727 kg/d (calculated using allometric equation from Nagy 1987)
Exposure Duration: 4 weeks (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: one dose level:
10 ppm = LOAEL

Calculations:

$$LOAEL: \left(\frac{10\,mg\ DBP}{kg\ food} \times \frac{17.27\,g\ food}{day} \times \frac{1\,kg}{1000\,g}\right) / 0.155\ kg\ BW = 1.11\ mg/kg/d$$

Comments: Eggshell thickness and water permeability of the shell was reduced among doves on diets containing 10 ppm DBP. Because the study considered exposure during a critical lifestage the 10 ppm dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.

Final NOAEL: 0.11 mg/kg/d
Final LOAEL: 1.1 mg/kg/d

Compound: Di-n-hexylphthalate (DHP)
Form: not applicable
Reference: Lamb et al. 1987
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)

Food Consumption: 0.0055 kg/d
(calculated using allometric equation from EPA 1988a)
Exposure Duration: 105 d (during a critical lifestage = chronic)..
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
0.3%, 0.6% and 1.2% of diet;
LOAEL = 0.3% = 3000 mg/kg
Calculations:

$$LOAEL: \left(\frac{3000\,mg\ DHP}{kg\ food} \ x\ \frac{5.5\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.03\ kg\ BW\ =\ 550\ mg/kg/d$$

Comments: Significant reproductive effects were observed among mice on all diets. Because the study considered exposure during a critical lifestage, the 0.3% dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 55 mg/kg/d
Final LOAEL: 550 mg/kg/d

Compound: 1,4-Dioxane
Form: not applicable
Reference: Giavini et al. 1985
Test Species: rat
Body weight: 0.35 kg (EPA 1988a)
Exposure Duration: days 6-15 of gestation (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral intubation
Dosage: three dose levels:
0.25, 0.5, and 1.0 mg/kg/d; NOAEL = 0.5 mg/kg/d
Calculations: not applicable
Comments: Maternal toxicity and reduced fetal weights were observed among rats receiving the 1.0 mg/kg/d dose. No adverse effects were observed among the other treatments. Because the study considered exposure during a critical lifestage, the 0.5 mg/kg/d was considered to be a chronic NOAEL, and the 1.0 mg/kg/d was considered to be a chronic LOAEL.
Final NOAEL: 0.5 mg/kg/d
Final LOAEL: 1.0 mg/kg/d

Compound: Endosulfan
Form: not applicable
Reference: Dikshith et al. 1984
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)

Exposure Duration: 30 days
(<1 yr and not during a critical lifestage = subchronic).
Endpoint: reproduction, blood chemistry
Exposure Route: oral intubation
Dosage: three dose levels per sex:
male: 0.75, 2.5, and 5.0 mg/kg/d
female 0.25, 0.75, and 1.5 mg/kg/d
Calculations: not applicable

Comments: Male and female rats were dosed for 30 days at the three respective dose levels, then one male and two females from the following groups were paired and allowed to mate: 5 mg/kg/d (♂) x 0 mg/kg/d (control ♀) and 0 mg/kg/d (control ♂) x 1.5 mg/kg/d (♀). No adverse effects were observed for any dose level. Because it was assumed that adverse reproductive effects were more likely to be observed in exposed females than males, and because the study was < 1 yr in duration and did not include a critical lifestage (exposure was discontinued prior to gestation), the 1.5 mg/kg/d dose was considered a subchronic NOAEL. A chronic NOAEL was estimated by multiplying the subchronic NOAEL by a subchronic-chronic uncertainty factor of 0.1.

Final NOAEL: 0.15 mg/kg/d

Compound: Endosulfan
Form: not applicable
Reference: Abiola 1992
Test Species: Gray Partridge
Body weight: 0.400 kg (from study)
Food Consumption: 0.032 kg/d (calculated using allometric equation from Nagy 1987)
Exposure Duration: 4 weeks (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
5, 25, 125 ppm; NOAEL = 125 ppm
Calculations:

$$NOAEL: \left(\frac{125\, mg\ Endosulfan}{kg\ food} \times \frac{32\, g\ food}{day} \times \frac{1\, kg}{1000\, g} \right) / \ 0.400\ kg\ BW = 10\ mg/kg/d$$

Comments: No adverse effects were observed at any dose level. Because exposure occurred during reproduction, the maximum dose was considered a chronic NOAEL.

Final NOAEL: 10 mg/kg/d

Compound: Endrin
Form: not applicable
Reference: Good and Ware 1969
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)
Food Consumption: 0.0055 kg/d
(calculated using allometric equation from EPA 1988a)
Exposure Duration: 120 d (during a critical lifestage = chronic)..

Endpoint: reproduction
Exposure Route: oral in diet
Dosage: one dose level:
5 ppm = LOAEL
Calculations:

$$LOAEL: \left(\frac{5\,mg\ Endrin}{kg\ food} \ x\ \frac{5.5\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.03\ kg\ BW\ =\ 0.92\ mg/kg/d$$

Comments: Significant reproductive effects (reduced parental survival, litter size, and number of young/d) were observed among mice fed diets containing 5 ppm Endrin. Because the study considered exposure during a critical lifestage, this dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.

Final NOAEL: 0.092 mg/kg/d
Final LOAEL: 0.92 mg/kg/d

Compound: Endrin
Form: not applicable
Reference: Spann et al. 1986
Test Species: Mallard duck
Body weight: 1.15 kg (from study)
Food Consumption: Mallard ducks, weighing 1 kg consume 100 g food/d (Heinz et al.1989). Therefore, it was assumed that a 1.15 kg Mallard duck would consume 115 g food/d.
Exposure Duration: >200 d. (>10 weeks and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: two dose levels:
1 and 3 ppm Endrin in diet; NOAEL = 3 ppm
Calculations:

$$NOAEL: \left(\frac{3\,mg\ Endrin}{kg\ food} \ x\ \frac{115\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 1.15\ kg\ BW\ =\ 0.3\ mg/kg/d$$

Comments: While the authors state that birds receiving the 3 ppm dose appeared to reproduce more poorly than controls, this difference was not significant. Because no significant differences were observed at the 3 ppm dose level and the study considered exposure throughout a critical lifestage (reproduction), this dose was considered to be a chronic NOAEL.

Final NOAEL: 0.3 mg/kg/d

Compound: Endrin
Form: not applicable
Reference: Fleming et al. 1982
Test Species: Screech Owl

Body weight: 0.181 kg (Dunning 1984)
food consumption: 1300-1700 g/month/pair (Pattee et al. 1988)
Daily food consumption was estimated as follows:
median food consumption/month/pair = 1500 g;
1 month = 30 d;
Males and females consume equal amounts of food = 750 g/month
750 g/month ÷ 30 d = 25 g/ d

Exposure Duration: >83 d. (>10 weeks and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: one dose level: 0.75 ppm Endrin in diet = LOAEL
Calculations:

$$LOAEL: \left(\frac{0.75\,mg\ Endrin}{kg\ food} \times \frac{25\,g\ food}{day} \times \frac{1\,kg}{1000\,g}\right) / \ 0.181\ kg\ BW = 0.1035\ mg/kg/d$$

Comments: Egg production and hatching success were reduced among owls fed 0.75 ppm endrin. Because the study considered exposure throughout a critical lifestage (reproduction), this dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 0.01 mg/kg/d
Final LOAEL: 0.1 mg/kg/d

Compound: Ethanol
Form: not applicable
Reference: Mankes et al. 1982
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Exposure Duration: through gestation (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral intubation
Dosage: two dose levels: 0.4 and 4.0 ml/kg/d; LOAEL=0.4 ml/kg/d
Calculations: density of ethanol=0.798 g/mL (Merck 1976)

$$LOAEL: \left(\frac{0.4\,mL\ Ethanol}{kg\ BW} \times \frac{0.798\,g\ Ethanol}{mL\ Ethanol} \times \frac{1000\,mg}{1\,g}\right) = 319\ mg/kg/d$$

Comments: While 0.4 ml Ethanol/kg/d had no effect on most reproductive parameters, the incidence of malformed fetuses was significantly increased at this dose level. Therefore this dose was considered to be a chronic LOAEL. To estimate the chronic NOAEL, the LOAEL was multiplied by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 31.9 mg/kg/d
Final LOAEL: 319 mg/kg/d

Compound: Ethyl Acetate
Form: not applicable

Reference: EPA 1986d
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Exposure Duration: 90 days (<1 yr and not during a critical lifestage=subchronic).
Endpoint: mortality and weight loss
Exposure Route: oral intubation
Dosage: three dose levels:
300, 900, and 3600 mg/kg/d; NOAEL = 900 mg/kg/d
Calculations: not applicable

Comments: While Ethyl Acetate at 3600 mg/kg/d reduced body and organ weights and food consumption by male rats, no effects were observed at the 900 mg/kg/d dose level. Because the study was 90 days in duration and did not consider exposure during critical lifestages, the 900 and 3600 mg/kg/d doses were considered to be subchronic. Chronic NOAELs and LOAELs were estimated by multiplying the subchronic values by a subchronic-chronic uncertainty factor of 0.1.

Final NOAEL: 90 mg/kg/d
Final LOAEL: 360 mg/kg/d

Compound: Fluoride
Form: NaF
Reference: Aulerich et al. 1987
Test Species: Mink
Body weight: 1.0 kg (EPA 1993e)
food consumption: 0.137 kg/d (Bleavins and Aulerich 1981)
Exposure Duration: 382 d (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: five dose levels:
33, 60, 108, 194, and 350 ppm supplemental F + 35 ppm F in base diet; NOAEL = 194 ppm + 35 ppm = 229 ppm F
Calculations:

$$NOAEL: \left(\frac{229\,mg\ F}{kg\ food} \times \frac{137\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / 1\ kg\ BW = 31.37\ mg/kg/d$$

$$LOAEL: \left(\frac{385\,mg\ F}{kg\ food} \times \frac{137\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / 1\ kg\ BW = 52.75\ mg/kg/d$$

Comments: Fluoride up to 229 ppm in mink diets had no adverse effects on reproduction; Survivorship of kits in the 385 ppm (350+35 ppm) group was significantly reduced. These doses were considered to be NOAELs and LOAELs, respectively. Because and the study considered exposure over 382 days including critical lifestages (reproduction), these doses were considered to be a chronic.

Final NOAEL: 31.37 mg/kg/d
Final LOAEL: 52.75 mg/kg/d

Compound: Fluoride
Form: NaF
Reference: Pattee et al. 1988
Test Species: Screech Owl
Body weight: 0.181 kg (Dunning 1984)
food consumption: 1300-1700 g/month/pair (from study)
Daily food consumption was estimated as follows:
median food consumption/month/pair = 1500 g;
1 month = 30 d;
Males and females consume equal amounts of food = 750 g/month
750 g/month ÷ 30 d = 25 g/ d
Exposure Duration: 5-6 months (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: two dose levels:
56.5 and 232 ppm F; NOAEL = 56.5 ppm F
Calculations:

$$NOAEL: \left(\frac{56.5\, mg\ F}{kg\ food} \times \frac{25\, g\ food}{day} \times \frac{1\, kg}{1000\, g} \right) / \ 0.181\ kg\ BW = 7.8\ mg/kg/d$$

$$LOAEL: \left(\frac{232\, mg\ F}{kg\ food} \times \frac{25\, g\ food}{day} \times \frac{1\, kg}{1000\, g} \right) / \ 0.181\ kg\ BW = 32\ mg/kg/d$$

Comments: While fertility and hatching success was significantly reduced by 232 ppm F in the diet, 56.5 ppm F in the diet had no adverse effect. Because the study considered exposure during reproduction, these doses were considered to be chronic.
Final NOAEL: 7.8 mg/kg/d
Final LOAEL: 32 mg/kg/d

Compound: Formaldehyde
Form: not applicable
Reference: Hurni and Ohder 1973
Test Species: dog (beagle)
Body weight: 12 kg (from study)
Exposure Duration: through gestation and lactation
(during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: two dose levels:
3.1 and 9.4 mg/kg/d; NOAEL = 9.4 mg/kg/d
Calculations: not applicable
Comments: Because significant effects were not observed at any dose level, the 9.4 mg/kg/d was considered to be a chronic NOAEL.
Final NOAEL: 9.4 mg/kg/d

Compound: Heptachlor
Form: not applicable
Reference: Crum et al. 1993
Test Species: Mink
Body weight: 1 kg (EPA 1993ea)
Food Consumption: 0.137 kg/d (Bleavins and Aulerich 1981)
Exposure Duration: 181 d (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
6.25, 12.5, and 25 ppm; LOAEL = 6.25 ppm
Daily heptachlor consumption reported in study to be:
1.0, 1.7, and 3.1 mg/kg/d
Calculations: not applicable
Comments: Mink consuming 25 ppm heptachlor in their diet experienced 100% mortality within 88 days. Fertility (♀s with kits/♀s mated) in the 12.5 ppm group was 40% of controls; kit weight and kit survival to 3 weeks were also reduced. Among mink in the 6.25 ppm group, while fertility, litter size, and kit survival were not affected, kit weights at 3 and 6 weeks were reduced 23% and 19% relative to controls. Because adverse effects were observed at all dose levels and the study considered exposure during reproduction, the 6.25 ppm dose level was considerd to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1
Final NOAEL: 0.1 mg/kg/d
Final LOAEL: 1 mg/kg/d

Compound: 1,2,3,6,7,8 - Hexachloro Dibenzofuran (HxDBF)
Form: not applicable
Reference: Poiger et al. 1989
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 13 weeks
(<1 yr and not during a critical lifestage = subchronic).
Endpoint: Body weight, organ weight, blood chemistry
Exposure Route: oral in diet
Dosage: three dose levels:
2, 20, and 200 ppb; NOAEL = 20 ppb
Calculations:

$$NOAEL: \left(\frac{0.02\,mg\ HxDBF}{kg\ food} \ x\ \frac{28\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) /\ 0.35\ kg\ BW = 0.0016\ mg/kg/d$$

$$LOAEL: \left(\frac{0.2\,mg\ HxDBF}{kg\ food} \ x\ \frac{28\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) /\ 0.35\ kg\ BW = 0.016\ mg/kg/d$$

Comments: Because rats exposed to 200 ppb HxDBF in the diet displayed reduced body, thymus and liver weights, while those in the 20 ppb group did not, the 20 ppb dose was considered to be a subchronic NOAEL and the 200 ppb dose was considered to be a subchronic LOAEL. Chronic values were estimated by multiplying the subchronic NOAEL and LOAEL by a subchronic-chronic uncertainty factor of 0.1.

Final NOAEL: 0.00016 mg/kg/d
Final LOAEL: 0.0016 mg/kg/d

Compound: Lead
Form: Lead Acetate
Reference: Azar et al. 1973
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 3 generations (>1 yr and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: five dose levels:

10, 50, 100, 1000, and 2000 ppm Pb; NOAEL = 100 ppm Pb

Calculations:

$$NOAEL: \left(\frac{100\,mg\ Pb}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.35\ kg\ BW = 8\ mg/kg/d$$

Comments: While none of the Pb exposure levels studied affected the number of pregnancies,

$$LOAEL: \left(\frac{1000\,mg\ Pb}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.35\ kg\ BW = 80\ mg/kg/d$$

the number of live births, or other reproductive indices, Pb exposure of 1000 and 2000 ppm resulted in reduced offspring weights and produced kidney damage in the young. Therefore the 100 ppm Pb dose was considered to be a chronic NOAEL and the 1000 ppm Pb dose was considered to be a chronic LOAEL.

Final NOAEL: 8 mg/kg/d
Final LOAEL: 80 mg/kg/d

Compound: Lead
Form: Metallic
Reference: Pattee 1984
Test Species: American Kestrels
Body weight: 0.130 kg ($mean_{♂+♀}$; from study)

Food Consumption: Kenaga (1973) states that the congeneric European kestrel consumes 7.7% of body weight/d. Therefore, food consumption was assumed to be 0.077 x 0.130 kg or 0.01 kg/d.

Exposure Duration: 7 months (>10 weeks and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: two dose levels:
10 and 50 ppm Pb; NOAEL = 50 ppm Pb
Calculations:

$$NOAEL: \left(\frac{50 mg\ Pb}{kg\ food} \ x\ \frac{10 g\ food}{day} \ x\ \frac{1 kg}{1000 g} \right) \ / \ 0.13\ kg\ BW\ =\ 3.85\ mg/kg/d$$

Comments: Because significant effects were not observed at either dose levels and the study considered exposure over 7 months and throughout a critical lifestage (reproduction), the maximum dose was considered to be a chronic NOAEL.
Final NOAEL: 3.85 mg/kg/d

Compound: Lead
Form: Acetate
Reference: Edens et al. 1976
Test Species: Japanese Quail
Body weight: 0.15 kg (from Vos et al. 1971)
Food Consumption: 0.0169 kg/d (calculated using allometric equation from Nagy 1987)
Exposure Duration: 12 weeks
(>10 weeks and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: four dose levels:
1, 10, 100, and 1000 ppm Pb; NOAEL = 10 ppm Pb
Calculations:

$$NOAEL: \left(\frac{10 mg\ Pb}{kg\ food} \ x\ \frac{16.9 g\ food}{day} \ x\ \frac{1 kg}{1000 g} \right) \ / \ 0.15\ kg\ BW\ =\ 1.13\ mg/kg/d$$

$$LOAEL: \left(\frac{100 mg\ Pb}{kg\ food} \ x\ \frac{16.9 g\ food}{day} \ x\ \frac{1 kg}{1000 g} \right) \ / \ 0.15\ kg\ BW\ =\ 11.3\ mg/kg/d$$

Comments: While egg hatching success was reduced among birds consuming the 100 ppm Pb dose, reproduction was not impaired by the 10 ppm Pb dose. Because the study considered exposure over 12 weeks and throughout a critical lifestage (reproduction), these values were considered to be chronic LOAELs and NOAELs.
Final NOAEL: 1.13 mg/kg/d
Final LOAEL: 11.3 mg/kg/d

Compound: Lindane (γ-BHC)
Form: not applicable
Reference: Palmer et al. 1978
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 3 generations (>1 yr and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
25, 50, and 100 ppm; NOAEL = 100 ppm
Calculations:

$$NOAEL: \left(\frac{100\,mg\ Lindane}{kg\ food} \ x \ \frac{28\,g\ food}{day} \ x \ \frac{1\,kg}{1000\,g} \right) \ / \ 0.35\ kg\ BW = 8\ mg/kg/d$$

Comments: Because significant effects were not observed at any dose level, the 100 ppm was considered to be a chronic NOAEL.
Final NOAEL: 8 mg/kg/d

Compound: Lindane (γ-BHC)
Form: not applicable
Reference: Chakravarty and Lahiri 1986; Chakravarty et al. 1986
Test Species: Mallard Duck
Body weight: 1.0 kg (Heinz et al. 1989)
Exposure Duration: 8 weeks (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral intubation
Dosage: one dose level:
20 mg/kg/d = LOAEL
Calculations: not applicable
Comments: Mallards exposed to 20 mg/kg/d displayed reduced eggshell thickness, laid fewer eggs and had longer time intervals between eggs. Because the study considered exposure during a critical lifestage, the 20 mg/kg/d was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 2 mg/kg/d
Final LOAEL: 20 mg/kg/d

Compound: Lithium
Form: Lithium Carbonate (18.78% Li)
Reference: Marathe and Thomas 1986
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)

Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: days 6-15 of gestation (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: two dose levels:
50 and 100 mg/kg/d Lithium Carbonate: NOAEL = 50 mg/kg/d
Calculations: mg Li /kg/d = 0.1878 x 50 mg/kg/d = 9.39
Comments: Lithium carbonate exposure of 100 mg/kg/d reduced the number of offspring and offspring weights. No adverse effects were observed at the 50 mg/kg level. While the Lithium exposures evaluated in this study were of a short duration, they occurred during a critical lifestage. Therefore, the 50 mg/kg/d dose was considered to be a chronic NOAEL and the 100 mg/kg/d dose was considered to be a chronic LOAEL.
Final NOAEL: 9.4 mg/kg/d
Final LOAEL: 18.8 mg/kg/d

Compound: Manganese
Form: Manganese Oxide (Mn_3O_4)
Reference: Laskey et al. 1982
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: through gestation for 224 d (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
350, 1050, and 3500 ppm supplemented Mn + 50 ppm Mn in base diet; NOAEL = 1100 ppm
Calculations:

$$NOAEL: \left(\frac{1100\,mg\ Mn}{kg\ food} \ x\ \frac{28\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.35\ kg\ BW\ =\ 88\ mg/kg/d$$

$$LOAEL: \left(\frac{3550\,mg\ Mn}{kg\ food} \ x\ \frac{28\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.35\ kg\ BW\ =\ 284\ mg/kg/d$$

Comments: While the pregnancy percentage and fertility among rats consuming 3550 ppm Mn in their diet was significantly reduced, all other reproductive parameters (e.g., litter size, ovulations, resorptions, preimplantation death, fetal weights) were not affected. No effects were observed at lower Mn exposure levels. Therefore the 1100 ppm Mn dose was considered to be a chronic NOAEL and the 3550 ppm Mn dose was considered to be a chronic LOAEL.
Final NOAEL: 88 mg/kg/d
Final LOAEL: 284 mg/kg/d

Compound: Manganese
Form: Manganese Oxide (Mn_3O_4)
Reference: Laskey and Edens 1985
Test Species: Japanese Quail (♂s only, starting at 1 day old)
Body weight: 0.072 kg (for 3 wk-old ♂ quail; Shellenberger 1978)
Exposure Duration: 75 d (>10 weeks = chronic).
Endpoint: growth, aggressive behavior
Exposure Route: oral in diet
Dosage: one dose level: 5000 ppm supplemented Mn + 56 ppm Mn in base diet = NOAEL
Calculations: not applicable
Comments: While no reduction in growth was observed, aggressive behavior was 25% to 50% reduced relative to controls. Reduced aggressive behavior was not considered to be a significant adverse effect. Daily Mn consumption was reported to range from 575 mg/kg/day for adults at the end of the study and 977 mg/kg/d for 20 d-old birds. Because the study was >10 weeks in duration, the 977 mg/kg/d dose was considered to be a chronic NOAEL.
Final NOAEL: 977 mg/kg/d

Compound: Mercury
Form: Mercuric Chloride ($HgCl_2$: 73.9% Hg)
Reference: Aulerich et al. 1974
Test Species: Mink
Body weight: 1 kg (EPA 1993e)
Food Consumption: 0.137 kg/d (Bleavins and Aulerich 1981)
Exposure Duration: 6 months (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: one dose level:
10 ppm mercuric chloride = NOAEL
NOAEL = 7.39 ppm Hg
Calculations:

$$NOAEL: \left(\frac{7.39\, mg\ Hg}{kg\ food} \ x\ \frac{137\, g\ food}{day} \ x\ \frac{1\, kg}{1000\, g} \right) / \ 1\ kg\ BW = 1.01\ mg/kg/d$$

Comments: While kit weight was somewhat reduced (9% relative to controls), fertility, and kit survival were not reduced. Because the study considered exposure through reproduction, the 7.39 ppm Hg dose was considered to be a chronic NOAEL.
Final NOAEL: 1.0 mg/kg/d

Compound: Mercury
Form: Mercuric Chloride
Reference: Hill and Schaffner 1976

Test Species: Japanese Quail
Body weight: 0.15 kg (Vos et al. 1971)
Food consumption: 0.0169 kg/d (calculated using allometric equation of Nagy 19687)
Exposure Duration: 1 yr (during a reproduction = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: five dose levels:
2, 4, 8, 16, and 32 mg Hg/kg in diet;
NOAEL= 4 mg/kg
Calculations:

$$NOAEL: \left(\frac{4\,mg\ Hg}{kg\ food} \times \frac{16.9\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.15\ kg\ BW = 0.45\ mg/kg/d$$

$$LOAEL: \left(\frac{8\,mg\ Hg}{kg\ food} \times \frac{16.9\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.15\ kg\ BW = 0.9\ mg/kg/d$$

Comments: While egg production increased with increasing Hg dose, fertility and hatchability decreased. Adverse effects of Hg were evident at the 8 mg Hg /kg dose. Because the study considered exposure during reproduction, the 4 and 8 mg/kg dose levels were considered to be chronic NOAELs and LOAELs respectively.
Final NOAEL: 0.45 mg/kg/d
Final LOAEL: 0.9 mg/kg/d

Compound: Mercury
Form: Mercuric sulfide
Reference: Revis et al. 1989
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)
Exposure Duration: 20 month (> 1 yr = chronic).
Endpoint: mortality, liver and kidney histology, reproduction (6 month only)
Exposure Route: oral in diet
Dosage: 30 dose levels ranging up to 13.2 mg/kg/d
Calculations: not applicable
Comments: No adverse effects were observed at any dose level. Because the study was over one year in duration, the maximum dose 13.2 mg/kg/d was considered to be a chronic NOAEL.
Final NOAEL: 13.2 mg/kg/d

Compound: Mercury
Form: Methyl Mercury Chloride
Reference: Wobeser et al. 1976

Test Species: Mink
Body weight: 1 kg (EPA 1993e)
Food Consumption: 0.137 kg/d (Bleavins and Aulerich 1981)
Exposure Duration: 93 days
(<1 yr and not during a critical lifestage = subchronic).
Endpoint: mortality, weight loss, ataxia
Exposure Route: oral in diet
Dosage: five dose levels:
1.1, 1.8, 4.8, 8.3, and 15 ppm Hg as methyl mercury;
NOAEL = 1.1 ppm Hg
Calculations:

$$NOAEL: \left(\frac{1.1 mg\ Hg}{kg\ food}\ x\ \frac{137 g\ food}{day}\ x\ \frac{1 kg}{1000 g} \right)\ /\ 1\ kg\ BW\ =\ 0.15\ mg/kg/d$$

$$LOAEL: \left(\frac{1.8 mg\ Hg}{kg\ food}\ x\ \frac{137 g\ food}{day}\ x\ \frac{1 kg}{1000 g} \right)\ /\ 1\ kg\ BW\ =\ 0.247\ mg/kg/d$$

Comments: Mercury doses of 1.8 ppm or greater produced significant adverse effects (mortality, weight loss, behavioral abnormalities). Because significant effects were not observed at the 1.1 ppm Hg dose level, this dose was considered to be a subchronic NOAEL and the 1.8 ppm dose was considered a subchronic LOAEL. Chronic values were estimated by multiplying the subchronic NOAEL and LOAEL by a subchronic-chronic uncertainty factor of 0.1
Final NOAEL: 0.015 mg/kg/d
Final LOAEL: 0.025 mg/kg/d

Compound: Mercury
Form: Methyl Mercury Chloride (CH_3HgCl; 79.89% Hg)
Reference: Verschuuren et al. 1976
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 3 generations (>1 yr and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
0.1, 0.5, and 2.5 ppm Methyl Mercury Chloride;
NOAEL = 0.5 ppm Methyl Mercury Chloride
0.7989 x 0.5 mg/kg = 0.399 mg Hg /kg
Calculations:

$$NOAEL: \left(\frac{0.399 mg\ Hg}{kg\ food}\ x\ \frac{28 g\ food}{day}\ x\ \frac{1 kg}{1000 g} \right)\ /\ 0.35\ kg\ BW\ =\ 0.032\ mg/kg/d$$

$$LOAEL: \left(\frac{1.99725\,mg\ Hg}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.35\ kg\ BW = 0.16\ mg/kg/d$$

Comments: While exposure to 2.5 ppm methyl mercury chloride reduced pup viability, adverse effects were not observed at lower doses. Because significant effects were not observed at the 0.5 ppm Methyl Mercury Chloride dose level, this dose was considered to be a chronic NOAEL. The 2.5 ppm Methyl Mercury Chloride dose level was considered to be a chronic LOAEL.

Final NOAEL: 0.032 mg/kg/d

Final LOAEL: 0.16 mg/kg/d

Compound: Mercury

Form: Methyl Mercury Dicyandiamide

Reference: Heinz 1979

Test Species: Mallard Duck

Body weight: 1 kg (Heinz et al. 1989)

Food Consumption: 0.128 kg/d (from study)

Exposure Duration: 3 generations (>1 yr and during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: one dose level:

0.5 ppm Hg as Methyl Mercury Dicyandiamide

LOAEL = 0.5 ppm

Calculations:

$$LOAEL: \left(\frac{0.5\,mg\ Hg}{kg\ food} \times \frac{128\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 1\ kg\ BW = 0.064\ mg/kg/d$$

Comments: Because significant effects (fewer eggs and ducklings were produced) were observed at the 0.5 ppm Hg dose level and the study consider exposure over three generations, this dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.

Final NOAEL: 0.0064 mg/kg/d

Final LOAEL: 0.064 mg/kg/d

Compound: Methanol

Form: not applicable

Reference: EPA 1986e

Test Species: Rat

Body weight: 0.35 kg (EPA 1988a)

Exposure Duration: 90 days (<1 yr and not during a critical lifestage=subchronic).

Endpoint: mortality, blood chemistry

Exposure Route: oral intubation

Dosage: three dose levels:

100, 500, and 2500 mg/kg/d; NOAEL = 500 mg/kg/d

Calculations: not applicable

Comments: While Methanol at 2500 mg/kg/d reduced brain and liver weights and altered blood chemistry, no effects were observed at the 500 mg/kg/d dose level. Because the study was 90 days in duration and did not consider exposure during critical lifestages, the 500 mg/kg/d dose was considered to be a subchronic NOAEL; the 2500 mg/kg/d dose was considered to be a subchronic LOAEL. Chronic values were estimated by multiplying the subchronic NOAEL and LOAEL by a subchronic-chronic uncertainty factor of 0.1.

Final NOAEL: 50 mg/kg/d

Final LOAEL: 250 mg/kg/d

Compound: Methoxychlor

Form: not applicable

Reference: Gray et al. 1988

Test Species: Rat

Body weight: 0.35 kg (EPA 1988a)

Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)

Exposure Duration: 11 month (during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: four dose levels:

25, 50, 100 and 200 ppm; NOAEL = 50 ppm

Calculations:

$$NOAEL: \left(\frac{50\,mg\ Methoxychlor}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / 0.35\ kg\ BW = 4\ mg/kg/d$$

$$LOAEL: \left(\frac{100\,mg\ Methoxychlor}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / 0.35\ kg\ BW = 8\ mg/kg/d$$

Comments: Fertility and litter size was significantly reduced among rats fed diets containing 100 or 200 ppm methoxychlor. Because significant effects were not observed at the 50 ppm dose level and the study considered exposure during reproduction, the 50 ppm was considered to be a chronic NOAEL. The 100 ppm was considered to be a chronic LOAEL.

Final NOAEL: 4 mg/kg/d

Final LOAEL: 8 mg/kg/d

Compound: Methylene Chloride

Form: not applicable

Reference: NCA 1982

Test Species: Rat

Body weight: 0.35 kg (EPA 1988a)

Exposure Duration: 2 yrs (>1 yr=chronic).

Endpoint: liver histology
Exposure Route: oral in water
Dosage: four dose levels:
5.85, 50, 125, and 250 mg/kg/d; NOAEL = 5.85 mg/kg/d
Calculations: not applicable
Comments: While Methylene Chloride at 50 mg/kg/d or greater produced histological changes in the liver, no effects were observed at the 5.85 mg/kg/d dose level. Because the study was 2 yrs in duration, the 5.85 mg/kg/d dose was considered to be a chronic NOAEL. The 50 mg/kg/d dose was considered to be a chronic LOAEL.
Final NOAEL: 5.85 mg/kg/d
Final LOAEL: 50 mg/kg/d

Compound: Methyl Ethyl Ketone
Form: not applicable
Reference: Cox et al. 1975
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Exposure Duration: 2 generations (>1 yr and during a critical lifestage=chronic).
Endpoint: reproduction
Exposure Route: oral in water
Dosage: three dose levels:
538, 1644, and 5089 mg/kg/d (males),
594, 1771, and 4571 mg/kg/d (females);
NOAEL = 1771 mg/kg/d
Calculations: not applicable
Comments: While Methyl Ethyl Ketone at the highest dose levels (4571 and 5089 mg/kg/d) reduced the number of pups/litter, pup survivorship, and pup body weight, no adverse effects were observed at the next higher levels (1644 mg/kg/d and 1771 mg/kg/d for males and females respectively). Because the study was 2 generations in duration, the 1771and 4571 mg/kg/d doses were considered to be chronic.
Final NOAEL: 1771 mg/kg/d
Final LOAEL: 4571 mg/kg/d

Compound: 4-Methyl 2-Pentanone (Methyl Isobutyl Ketone)
Form: not applicable
Reference: Microbiological Associates 1986 (obtained from Health Effects Assessment Summary Tables (HEAST; EPA 1993f)
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Exposure Duration: 13 weeks
(<1 yr and not during a critical lifestage=subchronic).
Endpoint: Liver and kidney function
Exposure Route: oral gavage
Dosage: one dose level stated in HEAST summary:
250 mg/kg/d = NOAEL

Calculations: not applicable

Comments: Because the study was less than 1 year in duration and not considered exposure during a critical life stage, the 250 mg/kg/d dose was considered to be a subchronic NOAEL. A chronic NOAEL was estimated by multiplying the subchronic NOAEL by a subchronic-chronic uncertainty factor of 0.1

Final NOAEL: 25 mg/kg/d

Compound: Molybdenum

Form: Molybdate (MoO_4)

Reference: Schroeder and Mitchner 1971

Test Species: Mouse

Body weight: 0.03 kg (EPA 1988a)

Food Consumption: 0.0055 kg/d

Water Consumption: 0.0075 L/d

(calculated using allometric equation from EPA 1988a)

Exposure Duration: 3 generations (> 1 yr and during critical lifestage=chronic)

Endpoint: reproduction

Exposure Route: oral in water

Dosage: one dose level:

10 mg Mo/L + 0.45 mg/kg in diet = LOAEL

Calculations:

$$NOAEL: \left(\frac{10\,mg\ Mo}{L\ water} \times \frac{7.5mL\ water}{day} \times \frac{1L}{1000\,mL} \right) / \ 0.03\ kg\ BW = 2.5 mg/kg/d$$

$$LOAEL: \left(\frac{0.45\,mg\ Mo}{kg\ food} \times \frac{5.5g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.03\ kg\ BW = 0.0825 mg/kg/d$$

Total Exposure = 2.5 mg/kg/d + 0.0825 mg/kg/d =2.5825 mg/kg/d

Comments: Because mice exposed to Mo displayed reduced reproductive success with a high incidence of runts, this dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.

Final NOAEL: 0.26 mg/kg/d

Final LOAEL: 2.6 mg/kg/d

Compound: Molybdenum

Form: Sodium Molybdate

Reference: Lepore and Miller 1965

Test Species: Chicken

Body weight: 1.5 kg (EPA 1988a)

Food Consumption: 0.106 kg/d

(calculated using allometric equation from EPA 1988a)

Exposure Duration: 21 d through reproduction (during a critical lifestage=chronic)

Endpoint: reproduction

Exposure Route: oral in diet
Dosage: three dose levels:
500, 1000, and 2000 ppm Mo; 500 ppm = LOAEL
Calculations:

$$LOAEL: \left(\frac{500\,mg\ Mo}{L\ water} \times \frac{106 mg\ food}{day} \times \frac{1\,kg}{1000\,mg} \right) / 1.5\ kg\ BW = 35.33\,mg/kg/d$$

Comments: Embryonic viabiliability was reduced to zero in the 500 ppm Mo treatment, therefore this dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 3.5/kg/d
Final LOAEL: 35.3 mg/kg/d

Compound: Nickel
Form: Nickel Sulfate Hexahydrate
Reference: Ambrose et al. 1976
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 3 generations (>1 yr and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
250, 500, and 1000 ppm Ni
NOAEL = 500 ppm
Calculations:

$$NOAEL: \left(\frac{500\,mg\ Ni}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / 0.35\ kg\ BW = 40\ mg/kg/d$$

$$LOAEL: \left(\frac{1000\,mg\ Ni}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / 0.35\ kg\ BW = 80\ mg/kg/d$$

Comments: While 1000 ppm Ni in the diet reduced offspring body weights, no adverse effects were observed in the other dose levels. Because this study considers exposures over multiple generations, the 500 ppm dose was considered to be a chronic NOAEL and the 1000 ppm dose was considered to be a chronic LOAEL..
Final NOAEL: 40 mg/kg/d
Final LOAEL: 80 mg/kg/d

Compound: Nickel
Form: Nickel Sulfate
Reference: Cain and Pafford 1981
Test Species: Mallard Duckling
Body weight: 0.782 kg ($mean_{control\ ♂+♀}$ at 45 days; from study)
Food Consumption: Adult Mallard ducks, weighing 1 kg consume 100 g food/d (Heinz et al.1989). Therefore, it was assumed that a 0.782 kg mallard duckling would consume 78.2 g food/d.
Exposure Duration: 90 d (>10 week = chronic).
Endpoint: mortality, growth, behavior
Exposure Route: oral in diet
Dosage: three dose levels:
176, 774, and 1069 ppm Ni;
NOAEL = 774 ppm
Calculations:

$$NOAEL: \left(\frac{774\,mg\ Ni}{kg\ food} \ x\ \frac{78.2\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.782\ kg\ BW\ =\ 77.4\ mg/kg/d$$

$$LOAEL: \left(\frac{1069\,mg\ Ni}{kg\ food} \ x\ \frac{78.2\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.782\ kg\ BW\ =\ 107\ mg/kg/d$$

Comments: While consumption of up to 774 ppm Ni in diet did not increase mortality or reduce growth, the 1069 ppm Ni diet reduced growth and resulted in 70% mortality. Because the study considered exposure over 90 days, the 774 ppm dose was considered to be a chronic NOAEL and the 1069 ppm dose was considered to be a chronic LOAEL. To estimate daily Ni intake throughout the 90 day study period, food consumption of 45-day-old ducklings was calculated. While this value will over- and underestimate food consumption by younger and older ducklings, it was assumed to approximate food consumption throughout the entire 90 day study.
Final NOAEL: 77.4 mg/kg/d
Final LOAEL: 107 mg/kg/d

Compound: Niobium
Form: Sodium niobate
Reference: Schroeder et al. 1968
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)
Water Consumption: 0.0075 L/d
Food Consumption: 0.0055 kg/d
(calculated using allometric equation from EPA 1988a)
Exposure Duration: lifetime (>1 yr = chronic).
Endpoint: lifespan, longevity
Exposure Route: oral in water (+incidental in food)
Dosage: one dose level:
5 ppm Nb (in water) + 1.62 ppm Nb (in food) = LOAEL

Calculations:

$$NOAEL: \left(\frac{5\,mg\ Nb}{L\ water} \ x\ \frac{7.5\,mL\ water}{day} \ x\ \frac{1\,L}{1000\,mL} \right) \ /\ 0.03\ kg\ BW\ =\ 1.25\ mg/kg/d$$

$$LOAEL: \left(\frac{1.62\,mg\ Nb}{kg\ food} \ x\ \frac{5.5\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) \ /\ 0.03\ kg\ BW\ =\ 0.297\ mg/kg/d$$

Total Exposure = 1.25 mg/kg/d + 0.297 mg/kg/d = 1.547 mg/kg/d

Comments: Because median lifespan was reduced among female mice exposed to the 5 ppm dose level and the study considered exposure throughout the entire lifespan, this dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.

Final NOAEL: 0.155 mg/kg/d

Final LOAEL: 1.55 mg/kg/d

Compound: Nitrate

Form: Potassium Nitrate

Reference: Sleight and Atallah 1968

Test Species: Guinea pig

Body weight: 0.86 kg (EPA 1988a)

Exposure Duration: 143-204 days (during a critical lifestage=chronic).

Endpoint: reproduction

Exposure Route: oral in water

Dosage: four dose levels:

12, 102, 507, and 1130 mg nitrate-Nitrogen kg/d;

NOAEL = 507 mg/kg/d

Calculations: not applicable

Comments: While Nitrate at the 1130 mg/kg/d dose level reduced the number of live births, no adverse effects were observed at the other dose levels. Because the study considered exposure during reproduction, the 507 mg/kg/d dose was considered to be a chronic NOAEL and the 1130 mg/kg/d dose was considered to be a chronic LOAEL. .

Final NOAEL: 507 mg/kg/d

Final LOAEL: 1130 mg/kg/d

Compound: 1,2,3,4,8 - Pentachloro Dibenzofuran (PeDBF)

Form: not applicable

Reference: Poiger et al. 1989

Test Species: Rat

Body weight: 0.35 kg (EPA 1988a)

Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)

Exposure Duration: 13 weeks

(<1 yr and not during a critical lifestage = subchronic).

Endpoint: Body weight, organ weight, blood chemistry
Exposure Route: oral in diet
Dosage: two dose levels:
600 and 6000 ppb; NOAEL = 6000 ppb
Calculations:

$$NOAEL: \left(\frac{6\,mg\ PeDBF}{kg\ food}\ x\ \frac{28\,g\ food}{day}\ x\ \frac{1\,kg}{1000\,g} \right)\ /\ 0.35\ kg\ BW\ =\ 0.48\ mg/kg/d$$

Comments: Because no significant effects were observed at either dose level, the 6000 ppb dose was considered to be a subchronic NOAEL. A chronic NOAEL was estimated by multiplying the subchronic NOAEL by a subchronic-chronic uncertainty factor of 0.1.

Final NOAEL: 0.048 mg/kg/d

Compound: 1,2,3,7,8 - Pentachloro Dibenzofuran (PeDBF)
Form: not applicable
Reference: Poiger et al. 1989
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 13 weeks
(<1 yr and not during a critical lifestage = subchronic).
Endpoint: Body weight, organ weight, blood chemistry
Exposure Route: oral in diet
Dosage: three dose levels:
2, 20, and 200 ppb; NOAEL = 20 ppb
Calculations:

$$NOAEL: \left(\frac{0.02\,mg\ HxDBF}{kg\ food}\ x\ \frac{28\,g\ food}{day}\ x\ \frac{1\,kg}{1000\,g} \right)\ /\ 0.35\ kg\ BW\ =\ 0.0016\ mg/kg/d$$

$$LOAEL: \left(\frac{0.2\,mg\ HxDBF}{kg\ food}\ x\ \frac{28\,g\ food}{day}\ x\ \frac{1\,kg}{1000\,g} \right)\ /\ 0.35\ kg\ BW\ =\ 0.016\ mg/kg/d$$

Comments: Because rats exposed to 200 ppb PeDBF in the diet displayed reduced body, thymus weights, while those in the 20 ppb group did not, the 20 ppb dose was considered to be a subchronic NOAEL and the 200 ppb dose was considered to be a subchronic LOAEL. Chronic values estimated by multiplying the subchronic NOAEL and LOAEL by a subchronic-chronic uncertainty factor of 0.1.

Final NOAEL: 0.00016 mg/kg/d
Final LOAEL: 0.0016 mg/kg/d

Compound: 2,3,4,7,8 - Pentachloro Dibenzofuran (PeDBF)
Form: not applicable
Reference: Poiger et al. 1989
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 13 weeks
(<1 yr and not during a critical lifestage = subchronic).
Endpoint: Body weight, organ weight, blood chemistry
Exposure Route: oral in diet
Dosage: three dose levels:
2, 20, and 200 ppb; NOAEL = 2 ppb
Calculations:

$$NOAEL: \left(\frac{0.002\,mg\ PeDBF}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.35\ kg\ BW = 0.00016\ mg/kg/d$$

$$LOAEL: \left(\frac{0.02\,mg\ PeDBF}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.35\ kg\ BW = 0.0016\ mg/kg/d$$

Comments: Because rats exposed to 20 and 200 ppb PeDBF in the diet displayed reduced body, thymus and liver weights, while those in the 2 ppb group did not, the 2 ppb dose was considered to be a subchronic NOAEL and the 20 ppb dose level was considered to be a subchronic LOAEL. Chronic values were estimated by multiplying the subchronic NOAEL and LOAEL by a subchronic-chronic uncertainty factor of 0.1.
Final NOAEL: 0.000016 mg/kg/d
Final LOAEL: 0.00016 mg/kg/d

Compound: Pentachloronitrobenzene (PCNB)
Form: not applicable
Reference: Dunn et al. 1979
Test Species: Chicken
Body weight: 1.5 kg (EPA 1988a)
Food Consumption: 0.106 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 35 weeks
(>10 weeks and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: four dose levels:
10, 50, 100, and 1000 ppm; NOAEL = 100 ppm
Calculations:

$$NOAEL: \left(\frac{100\,mg\ PCNB}{kg\ food} \times \frac{106\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 1.5\ kg\ BW = 7.07\ mg/kg/d$$

$$LOAEL: \left(\frac{1000\,mg\ PCNB}{kg\ food} \times \frac{106\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / 1.5\ kg\ BW = 70.7\ mg/kg/d$$

Comments: Onset on egg production and egg hatchability was reduced among birds receiving 1000 ppm PCNB. No adverse effects were observed among the other dose levels. Because the study considered exposure through reproduction, the 100 ppm dose was considered to be a chronic NOAEL and the 1000 ppm dose was considered to be a chronic LOAEL..

Final NOAEL: 7.07 mg/kg/d

Final LOAEL: 70.7 mg/kg/d

Compound: Pentachlorophenol (PCP)

Form: not applicable

Reference: Schwetz et al. 1978

Test Species: Rat

Body weight: 0.35 kg (EPA 1988a)

Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)

Exposure Duration: 62 d prior to mating, 15 d during mating, and through gestation and lactation (during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: two dose levels:

3 and 30 ppm; NOAEL = 3 ppm

Calculations:

$$NOAEL: \left(\frac{3\,mg\ PCP}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / 0.35\ kg\ BW = 0.24\ mg/kg/d$$

Comments: While survival and growth were significantly reduced (<20% of controls) among rats consuming the 30 ppm PCP diet, no adverse effects were observed among rats on the 3 ppm diet. Because the study considered exposure during reproduction, the 3 ppm dose was considered to be a chronic NOAEL and the 30 ppm dose was considered a chronic LOAEL.

Final NOAEL: 0.24 mg/kg/d

Final LOAEL: 2.4 mg/kg/d

Compound: Selenium

Form: Selanate (SeO_4)

Reference: Schroeder and Mitchner 1971

Test Species: Mouse

Body weight: 0.03 kg (EPA 1988a)

Food Consumption: 0.0055 kg/d

Water Consumption: 0.0075 L/d
(calculated using allometric equation from EPA 1988a)

Exposure Duration: 3 generations (> 1 yr and during critical lifestage=chronic)
Endpoint: reproduction
Exposure Route: oral in water
Dosage: one dose level:
3 mg Se/L + 0.056 mg/kg in diet = LOAEL
Calculations:

$$LOAEL: \left(\frac{3\,mg\ Se}{L\ water} \ x\ \frac{7.5mL\ water}{day} \ x\ \frac{1\,L}{1000\,mL} \right) \ /\ 0.03\ kg\ BW\ =\ 0.75 mg/kg/d$$

$$LOAEL: \left(\frac{0.056\,mg\ Se}{kg\ food} \ x\ \frac{5.5kg\ food}{day} \ x\ \frac{1\,kg}{1000\,mg} \right) \ /\ 0.03\ kg\ BW\ =\ 0.01 mg/kg/d$$

Total Exposure = 0.75 mg/kg/d + 0.01 mg/kg/d = 0.76 mg/kg/d

Comments: Because mice exposed to Se displayed reduced reproductive success with a high incidence of runts and failure to breed, this dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 0.076 mg/kg/d
Final LOAEL: 0.76 mg/kg/d

Compound: Selenium
Form: Sodium Selanite
Reference: Heinz et al. 1987
Test Species: Mallard Duck
Body Weight: 1 kg (from study)
Food Consumption: 100 g/d (from study)
Exposure Duration: 78 days (>10 wks and during critical lifestage=chronic)
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: five dose levels:
1, 5, 10, 25, and 100 ppm Se; 5 ppm = NOAEL
Calculations:

$$NOAEL: \left(\frac{5\,mg\ Se}{kg\ food} \ x\ \frac{100\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,mg} \right) \ /\ 1\ kg\ BW\ =\ 0.5\ mg/kg/d$$

$$LOAEL: \left(\frac{10\,mg\ Se}{kg\ food} \ x\ \frac{100\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,mg} \right) \ /\ 1\ kg\ BW\ =\ 1\ mg/kg/d$$

Comments: While consumption of 1, 5, or 10 ppm Se on the diet as Sodium Selanite had no effect on weight or survival of adults, 100 ppm Se reduced adult survival and 25 ppm Se reduced duckling survival. Consumption of 10 or 25 ppm Se in the diet resulted in a significantly larger frequency of lethally deformed embryos as compared to the 1 or 5 ppm Se exposures. Because 5 ppm Se in the diet was the highest dose level that produced no adverse effects and the study considered exposure through reproduction, this dose was considered to be a chronic NOAEL. The lowest dose at which adverse effects were observed, 10 ppm, was considered to be a chronic LOAEL

Final NOAEL: 0.5 mg/kg/d
Final LOAEL: 1 mg/kg/d

Compound: Selenium
Form: Selanomethionine
Reference: Heinz et al. 1989
Test Species: Mallard Duck
Body Weight: 1 kg (from study)
Food Consumption: 100 g/d (from study)
Exposure Duration: 100 days (>10 wks and during critical lifestage=chronic)
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: five dose levels:
1, 2, 4, 8, and 16 ppm Se; 4 ppm = NOAEL
Calculations:

$$NOAEL: \left(\frac{4\,mg\ Se}{kg\ food} \ x\ \frac{100\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,mg} \right) / \ 1\ kg\ BW\ =\ 0.4\ mg/kg/d$$

$$LOAEL: \left(\frac{8\,mg\ Se}{kg\ food} \ x\ \frac{100\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,mg} \right) / \ 1\ kg\ BW\ =\ 0.8\ mg/kg/d$$

Comments: Consumption of 8 or 16 ppm Se in the diet as Selanomethionine resulted in a reduced duckling survival as compared to the 1, 2, or 4 ppm Se exposures. Because 4 ppm Se in the diet was the highest dose level that produced no adverse effects and the study considered exposure through reproduction, this dose was considered to be a chronic NOAEL. The 8 ppm Se dose was considered to be a chronic LOAEL

Final NOAEL: 0.4 mg/kg/d
Final LOAEL: 0.8 mg/kg/d

Compound: Strontium (stable)
Form: Strontium Chloride (55% Sr)
Reference: Skoryna 1981
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Exposure Duration: 3 yrs (>1 yr = chronic).
Endpoint: Body weight and bone changes
Exposure Route: oral in water

Dosage: three dose levels:
70, 147, and 263 mg Sr kg/d;
NOAEL = 263 mg/kg/d
Calculations: not applicable
Comments: No adverse effects were observed for any Sr dosage level. Therefore, because the study considered exposure over three years, the maximum dose was considered to be a chronic NOAEL.
Final NOAEL: 263 mg/kg/d

Compound: 2,3,7,8 - Tetrachloro Dibenzodioxin (TCDD)
Form: not applicable
Reference: Murray et al. 1979
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: 3 generations (>1 yr and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
0.001, 0.01, and 0.01 ug/kg BW/d; NOAEL = 0.001 ug/kg/d
Calculations: 0.001 ug/kg/d = 0.000001 mg/kg/d
Comments: Fertility and neonatal survival was significantly reduced among rats receiving 0.1 and 0.01 ug/kg/d. Because no significant differences were observed at the 0.001 ug/kg/d dose level and the study considered exposure throughout 3 generations including critical lifestages (reproduction), this dose was considered to be a chronic NOAEL. The 0.01 ug/kg/d dose was considered to be a chronic LOAEL.
Final NOAEL: 0.000001 mg/kg/d
Final LOAEL: 0.00001 mg/kg/d

Compound: 2,3,7,8 - Tetrachloro Dibenzodioxin (TCDD)
Form: not applicable
Reference: Nosek et al. 1992
Test Species: Ring-necked Pheasant
Body weight: 1 kg (EPA 1993e)
Exposure Duration: 10 weeks (10 week and during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: weekly intraperitoneal injection
Dosage: three dose levels:
0.01, 0.1, and 1 ug/kg BW/week; NOAEL = 0.1 ug/kg/week
Calculations: 0.1 ug/kg/week = 0.0001 mg/kg/week = 0.000014 mg/kg/d
1 ug/kg/week = 0.001 mg/kg/week = 0.00014 mg/kg/d
Comments: Egg production and hatchability was significantly reduced among birds receiving 1 ug/kg/week dose. No significant effects were observed among the other two dose levels. The weekly intraperitoneal injection exposure route used in this study is believed to be comparable to

oral routes of exposure (EPA 1993e). Because no significant differences were observed at the two lower dose levels and the study considered exposure throughout a critical lifestage (reproduction), the 0.1 ug/kg/week dose was considered to be a chronic NOAEL and the 1 ug/kg/week dose was considered to be a chronic LOAEL.

Final NOAEL: 0.000014 mg/kg/d

Final LOAEL: 0.00014 mg/kg/d

Compound: 2,3,7,8 - Tetrachloro Dibenzofuran (TDBF)

Form: not applicable

Reference: McKinney et al. 1976

Test Species: 1-day old chicks

Body weight: 0.121 kg (mean$_{♂+♀}$ at 14 d; EPA 1988a)

Food Consumption: 0.0126 kg/d (calculated using allometric equation from EPA 1988a)

Exposure Duration: 21 d

(<10 weeks and not during a critical lifestage = subchronic).

Endpoint: mortality, weight gain

Exposure Route: oral in diet

Dosage: two dose levels:

1 and 5 ppb; LOAEL = 1 ppb

Calculations:

$$LOAEL: \left(\frac{0.001\,mg\ TDBF}{kg\ food} \times \frac{12.6\,g\ food}{day} \times \frac{1\,kg}{1000\,g}\right) / \ 0.121\ kg\ BW = 0.0001\ mg/kg/d$$

Comments: Because chicks exposed to 1 and 5 ppb TDBF experienced 16% and 100% mortality, respectively, the 1 ppb dose was considered to be a subchronic LOAEL. A chronic NOAEL was estimated by multiplying the subchronic LOAEL by a subchronic-chronic uncertainty factor of 0.1 and a LOAEL-NOAEL uncertainty factor of 0.1. To estimate daily TDBF intake throughout the 21d study period, food consumption of 2-week-old chicks was calculated. While this value will over- and underestimate food consumption by younger and older chicks, it was assumed to approximate food consumption throughout the entire 21 day study.

Final NOAEL: 0.000001 mg/kg/d

Final LOAEL: 0.00001 mg/kg/d

Compound: 1,1,2,2-Tetrachloroethylene

Form: not applicable

Reference: Buben and O'Flaherty 1985

Test Species: Mouse

Body weight: 0.03 kg (EPA 1988a)

Exposure Duration: 6 weeks

(<1 yr and not during a critical lifestage = subchronic).

Endpoint: Hepatotoxicity

Exposure Route: oral gavage

Dosage: seven dose levels (administered daily 5 days/week for 6 weeks):

20, 100, 200, 500, 1000, 1500, and 2000 mg/kg/d;
NOAEL = 20 mg/kg/d

Calculations: not applicable

Comments: Because mice were exposed for 5 days/week, 7 day/week exposure were estimated by multiplying doses by 0.7 (5 days/7 days). Hepatotoxicity was observed at doses of 100 mg/kg/d or greater. Therefore, the 20 mg/kg/d dose was considered to be a subchronic NOAEL and the 100 mg/kg/d dose was considered to be a subchronic LOAEL. A chronic NOAEL was estimated by multiplying the subchronic NOAEL by a subchronic-chronic uncertainty factor of 0.1

Final NOAEL: 1.4 mg/kg/d

Final LOAEL: 7 mg/kg/d

Compound: Thallium

Form: Thallium Sulfate

Reference: Formigli et al. 1986

Test Species: Rat

Body weight: 0.365 kg (from study)

Exposure Duration: 60 days

(<1 yr and not during a critical lifestage = subchronic).

Endpoint: reproduction (male testicular function)

Exposure Route: oral in water

Dosage: one dose level: 10 ppm Tl = LOAEL

Calculations: mean daily intake (from study) = 270 ug Tl/rat
= 0.74 mg/kg/d

Comments: Because rats exposed to 10 ppm Tl in the diet displayed reduced sperm motility and the study considered exposures only for 60 d , this dose was considered to be a subchronic LOAEL. A chronic NOAEL was estimated by multiplying the subchronic LOAEL by a subchronic-chronic uncertainty factor of 0.1 and a LOAEL-NOAEL uncertainty factor of 0.1.

Final NOAEL: 0.0074 mg/kg/d

Final LOAEL: 0.074 mg/kg/d

Compound: Tin

Form: bis (Tributyltin) oxide (TBTO)

Reference: Davis et al. 1987

Test Species: mouse

Body weight: 0.03 kg (EPA 1988a)

Exposure Duration: days 6-15 of gestation (during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral intubation

Dosage: six dose levels:
1.2, 3.5, 5.8, 11.7, 23.4, and 35 mg/kg/d;
NOAEL= 23.4 mg/kg/d

Calculations: not applicable

Comments: Mice dosed with 35 mg/kg/d TBTO displayed reduced fetal weight and fetal survival and increased frequency of litter resorption. Adverse effects were not observed at lower dose levels. Because the study considered exposure during gestation, the 23.4 and 35 mg/kg/d dose levels were considered to be chronic NOAELs and LOAELs respectively.

Final NOAEL: 23.4 mg/kg/d

Final LOAEL: 35 mg/kg/d

Compound: Tin

Form: bis (Tributyltin) oxide (TBTO)

Reference: Schlatterer et al. (1993)

Test Species: Japanese Quail

Body weight: 0.15 kg (Vos et al. 1971)

Food consumption: 0.0169 kg/d (calculated using allometric equation of Nagy 19687)

Exposure Duration: 6 wks (during a reproduction = chronic).

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: four dose levels:

24, 60, 150, and 375 mg/kg in diet;

NOAEL= 60 mg/kg

Calculations:

$$NOAEL: \left(\frac{60\,mg\ TBTO}{kg\ food} \times \frac{16.9\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.15\ kg\ BW = 6.76\ mg/kg/d$$

$$LOAEL: \left(\frac{150\,mg\ TBTO}{kg\ food} \times \frac{16.9\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.15\ kg\ BW = 16.9\ mg/kg/d$$

Comments: While egg weight and hatchability were reduced among quail consuming diets containing 150 mg TBTO/kg, no consistent adverse effects were observed among the 60 mg/kg groups. Because the study considered exposure during reproduction, the 60 and 150 mg/kg dose levels were considered to be chronic NOAELs and LOAELs respectively.

Final NOAEL: 6.8 mg/kg/d

Final LOAEL: 16.9 mg/kg/d

Compound: Toluene

Form: not applicable

Reference: Nawrot and Staples 1979

Test Species: Mouse

Body weight: 0.03 kg (EPA 1988a)

Exposure Duration: days 6-12 of gestation (during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral gavage

Dosage: three dose levels:

0.3, 0.5, and 1 mL/kg/d; LOAEL = 0.3 mL/kg/d

Calculations: density of toluene =0.866 g/mL (Merck 1976)

$$LOAEL: \left(\frac{0.3\,mL\ Toluene}{kg\ BW} \times \frac{0.866\,g\ Toluene}{mL\ Toluene} \times \frac{1000\,mg}{1\,g} \right) = 259.8\ mg/kg/d$$

Comments: Toluene exposure of 0.5 and 1.0 mL/kg/d significantly reduced fetal weights. Embryomortality was significantly reduced by all three dose levels. While the toluene exposures evaluated in this study were of a short duration, they occurred during a critical lifestage. Therefore, the 0.3 mL/kg/d dose was considered to be a chronic LOAEL. A chronic NOAEL was estimated by multiplying the chronic LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.

Final NOAEL: 26 mg/kg/d

Final LOAEL: 260 mg/kg/d

Compound: Toxaphene

Form: not applicable

Reference: Kennedy et al. 1973

Test Species: Rat

Body weight: 0.35 kg (EPA 1988a)

Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)

Exposure Duration: 3 generations (>1 yr and during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: two dose levels:

25 and 100 ppm; NOAEL = 100 ppm

Calculations:

$$NOAEL: \left(\frac{100\,mg\ Toxaphene}{kg\ food} \times \frac{28\,g\ food}{day} \times \frac{1\,kg}{1000\,g} \right) / \ 0.35\ kg\ BW = 8\ mg/kg/d$$

Comments: No adverse effects were observed at either dose level. Therefore because the study considered exposure over 2 generations and included reproduction, the 100 ppm dose was considered to be a chronic NOAEL.

Final NOAEL: 8 mg/kg/d

Compound: 1,1,1-Trichloroethane

Form: not applicable

Reference: Lane et al. 1982

Test Species: Mouse

Body weight: 0.035 kg (from study)

Water Consumption: 6 mL/d (from study)

Exposure Duration: 2 generations (>1 yr and during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in water

Dosage: three dose levels:

100, 300, and 1000 mg/kg/d
No effects observed at any dose level.

Calculations: not applicable

Comments: Because no significant differences were observed at any dose level and the study considered exposure throughout 2 generations including critical lifestages (reproduction), the maximum dose was considered to be a chronic NOAEL.

Final NOAEL: 1000 mg/kg/d.

Compound: Trichloroethylene
Form: not applicable
Reference: Buben and O'Flaherty 1985
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)
Exposure Duration: 6 weeks
(<1 yr and not during a critical lifestage = subchronic).
Endpoint: Hepatotoxicity
Exposure Route: oral gavage
Dosage: seven dose levels (administered daily 5 days/week for 6 weeks):
100, 200, 400, 800, 1600, 2400, and 3200 mg/kg/d;
LOAEL = 100 mg/kg/d
Calculations: not applicable

Comments: Because mice were exposed for 5 days/week, 7 day/week exposures were estimated by multiplying doses by 0.7 (5 days/7 days). Hepatotoxicity was observed at doses of 100 mg/kg/d or greater. Therefore, the 100 mg/kg/d dose was considered to be a subchronic LOAEL. A chronic NOAEL was estimated by multiplying the subchronic NOAEL by a subchronic-chronic uncertainty factor of 0.1 and a LOAEL-NOAEL uncertainty factor of 0.1.

Final NOAEL: 0.7 mg/kg/d
Final LOAEL: 7 mg/kg/d

Compound: Uranium
Form: Uranyl acetate (61.32% U)
Reference: Paternain et al. 1989
Test Species: Mouse
Body weight (from study): 0.028 kg
Exposure Duration: 60 d prior to gestation, plus through gestation, delivery and lactation (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral intubation
Dosage: three dose levels:
5, 10, and 25 mg uranyl acetate /kg/d;NOAEL=5 mg/kg/d or
Calculations: NOAEL dosage of elemental U is:
0.6132 x 5 mg uranyl acetate /kg/d or 3.07 mg U/kg/d.
LOAEL dosage of elemental U is:
0.6132 x 10 mg uranyl acetate /kg/d or 6.13 mg U/kg/d.

Comments: Significant differences in reproductive parameters (e.g., no.dead young/litter, size and weight of offspring, etc.) were observed at the 10 and 25 mg/kg/d dose levels. Because no significant differences were observed at the 5 mg/kg/d level and the study considered exposure throughout a critical lifestage (reproduction), this dose was considered to be a chronic NOAEL. The 10 mg/kg/d dose was considered to be a chronic LOAEL.

Final NOAEL: 3.07 mg U/kg/d.

Final LOAEL: 6.13 mg U/kg/d.

Compound: Uranium

Form: depleted metallic

Reference: Haseltine and Sileo 1983

Test Species: Black Duck

Body weight: 1.25 kg (mean$_{♂+♀}$; Dunning 1984)

Food Consumption: Congeneric Mallard ducks, weighing 1 kg consume 100 g food/d (Heinz et al.1989). Therefore, it was assumed that a 1.25 kg black duckwould consume 125 g food/d.

Exposure Duration: 6 weeks

(<10 wks and not during a critical lifestage = subchronic).

Endpoint: mortality, body weight, blood chemistry, liver or kidney effects

Exposure Route: oral in diet

Dosage: four dose levels:

25, 100, 400, and 1600 ppm U in food;

NOAEL = 1600 ppm

Calculations:

$$NOAEL: \left(\frac{1600\,mg\ U}{kg\ food} \ x\ \frac{125\,g\ food}{day} \ x\ \frac{1\,kg}{1000\,g} \right) / \ 1.25\ kg\ BW = 160\ mg/kg/d$$

Comments: No effects observed at any dose level. Because this study was less than 10 weeks in duration and did not consider a critical lifestage (i.e., reproduction), it is considered to be subchronic. To estimate the chronic NOAEL, the subchronic NOAEL was multiplied by a subchronic-chronic uncertainty factor of 0.1.

Final NOAEL: 16 mg U/kg/d.

Compound: Vanadium

Form: Sodium Metavanadate ($NaVO_3$; 41.78% V)

Reference: Domingo et al. 1986

Test Species: Rat

Body weight (from study): 0.26 kg

Exposure Duration: 60 d prior to gestation, plus through gestation, delivery and lactation (during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral intubation

Dosage: three dose levels:

5, 10, and 20 mg $NaVO_3$ /kg/d; LOAEL=5 mg/kg/d

Calculations: LOAEL dosage of elemental V is:

0.4178 x 5 mg $NaVO_3$ /kg/d or 2.1 mg V/kg/d.

Comments: Significant differences in reproductive parameters (e.g., no.dead young/litter, size and weight of offspring, etc.) were observed at all dose levels. Therefore, the lowest dose was considered to be a chronic LOAEL. To estimate the chronic NOAEL, the chronic LOAEL was multiplied by a LOAEL-NOAEL uncertainty factor of 0.1.

Final NOAEL: 0.21 mg V/kg/d.

Final LOAEL: 2.1 mg V/kg/d.

Compound: Vanadium

Form: Vanadyl Sulfate

Reference: White and Dieter 1978

Test Species: Mallard Duck

Body weight: 1.17 kg (from study)

Food Consumption: 0.121 kg/d (from study)

Exposure Duration: 12 weeks (>10 wks = chronic).

Endpoint: mortality, body weight, blood chemistry

Exposure Route: oral in diet

Dosage: three dose levels:

2.84, 10.36, and 110 ppm V in food;

NOAEL = 110 ppm

Calculations:

$$NOAEL: \left(\frac{110 mg\ V}{kg\ food} \times \frac{121 g\ food}{day} \times \frac{1 kg}{1000 g} \right) / 1.17\ kg\ BW = 11.38\ mg/kg/d$$

Comments: No effects observed at any dose level. Because this study was greater than 10 weeks in duration and did not consider a critical lifestage (i.e., reproduction), the maximum dose was considered to be a chronic NOAEL.

Final NOAEL: 11.4 mg V/kg/d.

Compound: Vinyl Chloride

Form: not applicable

Reference: Feron et al. 1981

Test Species: Rat

Body weight: 0.35 kg (EPA 1988a)

Exposure Duration: lifetime (~144 wks)

Endpoint: longevity, mortality

Exposure Route: oral in diet

Dosage: three dose levels:

1.7, 5.0, and 14.1 mg /kg/d; LOAEL= 1.7 mg/kg/d or

Calculations: not applicable

Comments: Significantly reduced survivorship was observed at all dose levels, therefore the 1.7 mg/kg/d dose level was considered to be a chronic LOAEL. To estimate the chronic NOAEL, the LOAEL was multiplied by a LOAEL-NOAEL uncertainty factor of 0.1.

Final NOAEL: 0.17 mg/kg/d.

Final LOAEL: 1.7 mg/kg/d.

Compound: Xylene (mixed isomers)
Form: not applicable
Reference: Marks et al. 1982
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)
Exposure Duration: days 6-15 of gestation
(during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral gavage
Dosage: six dose levels:
0.52, 1.03, 2.06, 2.58, 3.10, and 4.13 mg/kg/d;
NOAEL = 2.06 mg/kg/d
Calculations: not applicable
Comments: Xylene exposure of 2.58 mg/kg/d or greater significantly reduced fetal weights and increased the incidence of fetal malformities. While the xylene exposures evaluated in this study were of a short duration, they occurred during a critical lifestage. Therefore, the highest dose that produced no adverse effects, 2.06 mg/kg/d, was considered to be a chronic NOAEL. The 2.58 mg/kg/d dose level was considered to be a chronic LOAEL.
Final NOAEL: 2.1 mg/kg/d
Final LOAEL: 2.6 mg/kg/d

Compound: Zinc
Form: Zinc Oxide
Reference: Schlicker and Cox 1968
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Food Consumption: 0.028 kg/d (calculated using allometric equation from EPA 1988a)
Exposure Duration: days 1 -16 of gestation (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: two dose levels:
2000, and 4000 ppm Zn; NOAEL = 2000 ppm
Calculations:

$$NOAEL: \left(\frac{2000\,mg\ Zn}{kg\ food} \; x \; \frac{28\,g\ food}{day} \; x \; \frac{1\,kg}{1000\,g} \right) \;/\; 0.35\ kg\ BW \; = \; 160\ mg/kg/d$$

$$LOAEL: \left(\frac{4000\,mg\ Zn}{kg\ food} \; x \; \frac{28\,g\ food}{day} \; x \; \frac{1\,kg}{1000\,g} \right) \;/\; 0.35\ kg\ BW \; = \; 320\ mg/kg/d$$

Comments: Rats exposed to 4000 ppm Zn in the diet displayed increased rates of fetal resorption and reduced fetal growth rates. Because no effects were observed at the 2000 ppm Zn dose rate and the exposure occurred during gestation (a critical lifestage), this dose was considered a chronic NOAEL. The 4000 ppm Zn dose was considered to be a chronic LOAEL.
Final NOAEL: 160 mg/kg/d
Final LOAEL: 320 mg/kg/d

Compound: Zinc
Form: Zinc Sulfate
Reference: Stahl et al. 1990
Test Species: White Leghorn Hens
Body Weight: 1.935 kg (228 ppm dose; from study)
1.766 kg (2028 ppm dose; from study)
Food Consumption: 123 g/d (228 ppm dose; from study)
0.114 (2028 ppm dose; from study)
Exposure Duration: 44 weeks (>10 wks and during critical lifestage=chronic)
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: three dose levels:
20, 200, and 2000 ppm supplemental Zn plus 28 ppm Zn in diet; 3000 ppm = LOAEL
Calculations:

$$NOAEL: \left(\frac{228\,mg\ Zn}{kg\ food} \times \frac{123\,g\ food}{day} \times \frac{1\,kg}{1000\,mg} \right) / \ 1.935\ kg\ BW = 14.49\ mg/kg/d$$

$$LOAEL: \left(\frac{2028\,mg\ Zn}{kg\ food} \times \frac{114\,g\ food}{day} \times \frac{1\,kg}{1000\,mg} \right) / \ 1.766\ kg\ BW = 130.9\ mg/kg/d$$

Comments: While no adverse effects were observed among hens consuming 48 and 228 ppm Zn, egg hatchability was <20% of controls among hens consuming 2028 ppm zinc. Because the study was greater than 10 weeks in duration and considered exposure during reproduction, the 228 ppm dose was considered a chronic NOAEL and the 2028 ppm dose was considered a chronic LOAEL..
Final NOAEL: 14.5 mg/kg/d
Final LOAEL: 131 mg/kg/d

Compound: Zirconium
Form: Zirconium Sulfate
Reference: Schroeder et al. 1968b
Test Species: Mouse
Body weight: 0.03 kg (EPA 1988a)
Water Consumption: 0.0075 L/d
Food Consumption: 0.0055 kg/d
(calculated using allometric equation from EPA 1988a)
Exposure Duration: lifetime (>1 yr = chronic).
Endpoint: lifespan, longevity
Exposure Route: oral in water (+incidental in food)
Dosage: one dose level:
5 ppm Zr (in water) + 2.66 ppm Zr (in food) = NOAEL

Calculations:

$$NOAEL: \left(\frac{5\,mg\ Zr}{L\ water}\ x\ \frac{7.5\,mL\ water}{day}\ x\ \frac{1\,L}{1000\,mL} \right) /\ 0.03\ kg\ BW\ =\ 1.25\ mg/kg/d$$

$$LOAEL: \left(\frac{2.66\,mg\ Zr}{kg\ food}\ x\ \frac{5.5\,g\ food}{day}\ x\ \frac{1\,kg}{1000\,g} \right) /\ 0.03\ kg\ BW\ =\ 0.488\ mg/kg/d$$

Total Exposure = 1.25 mg/kg/d + 0.488 mg/kg/d = 1.738 mg/kg/d

Comments: Because no significant treatment effects were observed at the 5 ppm dose level and the study considered exposure throughout the entire lifespan, this dose was considered to be a chronic NOAEL.

Final NOAEL: 1.74 mg/kg/d

Appendix B

BODY WEIGHTS, FOOD AND WATER CONSUMPTION RATES FOR SELECTED AVIAN AND MAMMALIAN WILDLIFE ENDPOINT SPECIES

Table B.1. Body weights and food and water consumption rates for selected avian and mammalian wildlife endpoint species

Species	Body Weight		Food Intake		Water Intake[a]	
	kg	Citation	kg/d	Citation	L/d	Citation
Mammals						
Short-tailed Shrew (*Blarina brevicauda*)	0.015	Schlesinger and Potter 1974	0.009	Barrett and Stueck 1976 Buckner 1964	0.0033	Chew 1951
Little Brown Bat (*Myotis lucifugus*)	0.0075	Gould 1955	0.0025	Anthony and Kunz 1977	0.0012	
Meadow Vole (*Microtus pennsylvanicus*)	0.044	Reich 1981	0.005	Estimated from Figure 2. in Dark et al. 1983.	0.006	
White-footed Mouse (*Peromyscus leucopus*)	0.022	Green and Miller 1987	0.0034	Green and Miller 1987	0.0066	Oswald et al. 1993
Eastern Cottontail (*Sylvilagus floridanus*)	1.2	Chapman et al. 1980	0.237	Dalke and Sime 1941	0.116	
Mink (*Mustela vison*)	1.0	EPA 1993e	0.137	Bleavins and Aulerich 1981.	0.099	
Red Fox (*Vulpes fulva*)	4.5	Storm et al. 1976[b]	0.45	Sargent 1978[c] Vogtsberger and Barrett 1973	0.38	
White-tailed Deer (*Odocoileus virginianus*)	56.5	Smith 1991	1.74	Mautz et al. 1976	3.7	
Birds						
American Robin (*Turdus migratorius*)	0.077	Dunning 1984	0.093	Skorupa and Hothem 1985 Hazelton et al. 1984	0.0106	

Table B.1. (continued)

Species	Body Weight		Food Intake		Water Intake[a]	
	kg	Citation	kg/d	Citation	L/d	Citation
Rough-winged Swallow (*Stelgidopteryx serripennis*)	0.0159	Dunning 1984	0.012	0.0042 kg/d (dry; calc according to Nagy 1987); adjusted to wet weight using 65% water content reported for terrestrial insects in EPA 1993a	0.0037	
American Woodcock (*Scolopax minor*)	0.198	Dunning 1984	0.15	Sheldon 1975	0.02	
Wild Turkey (*Meleagris gallipavo*)	5.8	Dunning 1984	0.174	Korschgen 1967	0.19	
Belted Kingfisher (*Ceryle alcyon*)	0.148	Dunning 1984	0.075	Alexander 1977	0.016	
Great Blue Heron (*Ardea herodias*)	2.39	Dunning 1984	0.42	Kushlan 1978	0.1058	
Barred Owl (*Strix varia*)	0.717	Dunning 1984	0.084	Craighead and Craighead 1969	0.047	
Barn Owl (*Tyto alba*)	0.466	Johnsgard 1988	0.0625	Johnsgard 1988	0.035	
Cooper's Hawk (*Accipiter cooperi*)	0.439	Dunning 1984	0.076	Craighead and Craighead 1969	0.034	
Red-tailed Hawk (*Buteo jamaciencis*)	1.126	Dunning 1984	0.109	Craighead and Craighead 1969	0.064	

Table B.1. (continued)

Species	Body Weight		Food Intake		Water Intake[a]	
	kg	Citation	kg/d	Citation	L/d	Citation
Osprey (*Pandion haliaetus*)	1.5	EPA 1993d	0.3	EPA 1993d	0.077	EPA 1993d

[a] All values calculated according to Calder and Braun (1983) unless stated otherwise.
[b] Mean for males and females from both Iowa and Illinois.
[c] 0.069 g/g/day for nonbreeding adult times 4.5 kg BW.

Appendix C

SELECTED TOXICITY DATA FOR AVIAN AND MAMMALIAN WILDLIFE

Appendix C.1. Selected toxicity data for avian and mammalian wildlife[a]

		LOAEL		NOAEL		
Chemical	Species	Dose or Conc.[b]	Effect	Dose or Conc.[b]	Acute or Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
Aroclor 1016	ferret			20 ppm (9 mo)		
Aroclor 1016	mink	20 ppm (9 mo)	reproduction		20 ppm	
Aroclor 1221	bobwhite quail		30% mortality		6000 ppm (5 d)	
Aroclor 1221	Japanese quail					>6000 ppm (5 d)
Aroclor 1221	ring-necked pheasant				>4000 ppm (5 d)	
Aroclor 1232	bobwhite quail					3002 ppm (5 d)
Aroclor 1232	Japanese quail					>5000 ppm (5 d)
Aroclor 1232	ring-necked pheasant					3146 ppm (5 d)
Aroclor 1242	ferret	20 ppm (9 mo)	reproduction		20 ppm	
Aroclor 1242	mink	5 ppm (9 mo)	reproduction		10 ppm (9 mo)	
Aroclor 1242	Japanese quail	321.5 ppm (21 d)	reproduction			
Aroclor 1242	Japanese quail	10 ppm (45 d)	reproduction			
Aroclor 1248	screech owl		reproduction	3 ppm (18 mo)		
Aroclor 1248	chicken	10 ppm (8 wk)	reproduction	1 ppm (8 wk)		

Table C.1. (continued)

Chemical	Species	LOAEL Dose or Conc.[b]	LOAEL Effect	NOAEL Dose or Conc.[b]	Acute or Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
Aroclor 1254	raccoon	50 mg/kg (8 d)	physiology			
Aroclor 1254	cottontail rabbit	10 ppm (12 wk)	weight loss			
Aroclor 1254	white-footed mouse	10 ppm (18 mo)	reproduction; decreased pup survival			
Aroclor 1254	quail	50 ppm (14 wk)	reproduction			
Aroclor 1254	Japanese quail	78.1 ppm (21 d)	reproduction			
Aroclor 1254	Japanese quail			20 ppm (8 wk)		
Aroclor 1254	Japanese quail	5 ppm (12 wk)	physiology			
Aroclor 1254	mourning dove	40 ppm (42 d)	metabolism			
Aroclor 1254	ring dove	10 ppm	reproduction			
Aroclor 1254	pheasant	12.5 mg (1x/wk, 17 wk)				
Aroclor 1260	bobwhite quail	5 ppm (4 mo)	thyroid weight			
Aroclor 1260	Japanese quail	62.5 ppm (21 d)	reproduction			
Arsanilic acid	rat					216 mg/kg
Cadmium	deer mouse	1 mg/L	infertility			

Table C.1. (continued)

Chemical	Species	LOAEL Dose or Conc.[b]	LOAEL Effect	NOAEL Dose or Conc.[b]	Acute or Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
Cadmium	wood duck	100 ppm (3 mo)	pathology	10 ppm (3 mo)		
Cadmium	black duck	4 ppm (4 mo)	offspring behavior			
Cadmium chloride	mallard duck	20 ppm (30-90 d)	pathology			
Cadmium succinate	bobwhite quail					1728 ppm (5 d)
Cadmium succinate	Japanese quail					2693 ppm (5 d)
Cadmium succinate	ring-necked pheasant					1411 ppm (5 d)
Cadmium succinate	mallard duck					>5000 ppm (5 d)
Chlordane	bobwhite quail					331 ppm (5 day)
Chlordane	Japanese quail					350 ppm (5 d)
Chlordane	Japanese quail	25 ppm (8 d)	reproduction			
Chlordane	ring-necked pheasant					430 ppm (5 d)
Chlordane	mallard duck					858 ppm (5 d)
Chlordane	golden eagle				100 mg/kg	10 mg/kg
Chromium (trivalent)	black duck (young)	10 ppm	survival			

Table C.1. (continued)

		LOAEL		NOAEL	Acute or Lethal	
Chemical	Species	Dose or Conc.[b]	Effect	Dose or Conc.[b]	Dose/Conc.[b]	LD_{50} or LC_{50}
Chromium - potassium dichromate	Japanese quail		5-d LC_{50}			4400 ppm
2,4,D	deer mouse			3 lb/acre		
DDD	cowbird	1500 ppm (17 d)	lethal			
DDE	cowbird	1500 ppm (27 d)	lethal			
DDE	Japanese quail	25 ppm (14 wk)	reproduction; liver	5 ppm (12 wk)		
DDE	rat-tailed bat			107 ppm (40 d)		
p,p'-DDE	mallard duck	5 ppm (several mo)	thin egg shells	1 ppm		
p,p'-DDE	black duck	10 ppm (6 mo/yr)	thin egg shells			
p,p'-DDE	pigeon	18 mg/kg (8 wk)			36 mg/kg (8 wk)	
DDT	Japanese quail	25 ppm (14 wk)	reproduction			
DDT	Japanese quail	50 ppm (10 wk)	reproduction	5 ppm (10 wk)		
DDT	bobwhite quail	500 ppm (4 mo)	thyroid	50 ppm (4 mo)		
DDT	mallard duck	330 ppm (5 d)	growth			

Table C.1. (continued)

Chemical	Species	LOAEL Dose or Conc.[b]	LOAEL Effect	NOAEL Dose or Conc.[b]	Acute or Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
DDT	mallard duck	50 ppm (6 mo)				
DDT	mallard duck					1869 ppm (5 d)
DDT	house sparrow				1500 ppm (3 d)	
DDT	white-throated sparrow	5 ppm (11 wk)	behavior; physiology			
DDT	earthworm	5 lb/acre	decreased population			
Di-butyl phthalate	mallard duck		5-d lethal concentration		>5000 ppm	
Di-butyl phthalate	ring dove	10 ppm	thin egg shells			
2,4-Dichlorophenyl-p-nitrophenyl ether	rat	100 ppm (97 wk)	reproduction	10 ppm (3 gen.)		2600 ppm
2,4-Dichlorophenyl-p-nitrophenyl ether	dog			2000 ppm (2 yr)		
Di(2-ethylhexyl)phthalate	ferret	10000 ppm (14 mo)	physiology			
Di(2-ethylhexyl)phthalate	ring dove			10 ppm		

Table C.1. (continued)

		LOAEL		NOAEL	Acute or	
Chemical	Species	Dose or Conc.[b]	Effect	Dose or Conc.[b]	Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
Ferrous sulfate	rat					1187 mg/kg
Hexachlorobenzene	Japanese quail	20 ppm (90 d)	reproduction			
Hexachlorobenzene	Japanese quail				1 ppm (90 d)	
Hexachlorobenzene	mallard duck		30% mortality		5000 ppm	>5000 ppm
Hexachlorobutadiene	Japanese quail	0.3 ppm (90 d)				
Hexachlorophene	rat	100 ppm (3 gen.)	reproduction	20 ppm (3 gen.)		
Hexamethylphosphoric triamide	rat	2 mg/kg/d (169 d)	reproduction			
Kepone	Japanese quail				200 ppm (240 d)	
Lead	bobwhite quail			2000 ppm (6 wk)		
Lead acetate	Japanese quail	1 ppm (12 wk)	reproductiion			
Lead acetate	bobwhite quail	1000 ppm (6 wk)	growth			
Lead arsenate	rat					1545 mg/kg
Lead arsonate	Japanese quail					4185 ppm (5 d)

Table C.1. (continued)

Chemical	Species	LOAEL Dose or Conc.[b]	LOAEL Effect	NOAEL Dose or Conc.[b]	Acute or Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
Lead arsonate	ring-necked pheasant					4989 ppm (5 d)
Lead, tetraethyl	mallard duck				6 mg/kg	
Lithium chloride	red-winged blackbird				15000 ppm (4 d)	
Magnesium	Japanese quail	1500 ppm (2 wk)	physiology	1000 ppm (2 wk)		
Mercuric chloride	Japanese quail			2 ppm (1 yr)		
Mercuric chloride	Japanese quail	4 ppm (12 wk)	physiology	2 ppm		
Mercuric chloride	chicken	100 ppm (8 wk)	reproduction			
Mercuric sulfate	chicken	100 ppm (8 wk)	reproduction			
Methyl mercury chloride	mallard duck			5 ppm (3 mo)		
Methyl mercury chloride	chicken	5 ppm (8 wk)	reproduction			
Methyl mercury dicyandiamide	mallard duck	0.5 ppm (1 yr)	reproduction			
Methyl mercury dicyandiamide	black duck	3 ppm (28 wk/yr, 2 yr)	reproduction			

Table C.1. (continued)

Chemical	Species	LOAEL Dose or Conc.[b]	LOAEL Effect	NOAEL Dose or Conc.[b]	Acute or Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
Monosodium methanearsonate	white-footed mouse	1000 ppm (30 d)	physiology			300 mg/kg
Octochlorodibenzo-p-dioxin	rat	0.5 mg/kg (2 wk)	pathology	0.1 mg/kg (2 wk)		
PBB (hexabromo biphenyl)	Japanese quail	100 ppm (9 wk)	reproduction	20 ppm (9 wk)		
PBB (polybrominated biphenyl)	mink	1 ppm (10 mo)	reproduction			179 mg/kg 3.95 ppm
PBB	Japanese quail	25 ppm (7 d)	blood chemistry			
Sodium arsenite	mallard duck	100 mg/kg (1 d)	thin eggshells			
Sodium cyanide	coyote	4 mg/kg	physiology			
Sodium monofluoroacetate	mallard duck					3.71 mg/kg
Sodium monofluoroacetate	mallard duck				9.11 mg/kg	
Sodium monofluoroacetate	ring-necked pheasant				6.46 mg/kg	
Sodium monofluoroacetate	chukar partridge				3.51 mg/kg	

Table C.1. (continued)

		LOAEL		NOAEL	Acute or	
Chemical	Species	Dose or Conc.[b]	Effect	Dose or Conc.[b]	Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
Sodium monofluoroacetate	quail				17.7 mg/kg	
Sodium monofluoroacetate	pigeon				4.24 mg/kg	
Sodium monofluoroacetate	house sparrow				3.00 mg/kg	
Sodium monofluoroacetate	kit fox					0.22 mg/kg
Sodium nitrate	Japanese quail				3300 ppm (7 d)	
Sodium nitrate	Japanese quail				660 ppm (15 wk)	
Thallium sulfate	golden eagle					120 mg/kg
Tribromoethanol	mallard duck				150 mg/kg	
Vanadyl sulfate	mallard duck	100 ppm (12 wk)	blood chemistry	10 ppm (12 wk)		
Zinc phosphide	kit fox					93 mg/kg
Zinc phosphide	red fox				10.64 mg/kg/d (3 d)	

Table C.1. (continued)

		LOAEL		NOAEL	Acute or	
Chemical	Species	Dose or Conc.[b]	Effect	Dose or Conc.[b]	Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
Zinc phosphide	grey fox				8.6 mg/kg/d (3 d)	
Zinc phosphide	great horned owl				22.31 mg/kg/d (3 d)	

[a] Data extracted from TERRE-TOX database (Meyers and Schiller 1986). Complete citations for these data are not currently available.
[b] Dose in mg/kg/day; dietary concentration in ppm; water concentration in mg/L.

Appendix D

TABLES 12 AND 13

TABLE 12

Table 12. NOAEL-based toxicological benchmarks for selected avian and mammalian wildlife species

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Acetone	Rat	10	Short-tailed Shrew	28.3	47.1	128.5	
not applicable			Little Brown Bat	35.5	106.6	222.2	
			White-footed Mouse	24.9	161.2	83.1	
			Meadow Vole	19.8	174.5	145.4	
			Cottontail Rabbit	6.7	33.7	68.9	
			Mink	7.1	51.6	71.4	4.64e+01
			Red Fox	4.3	43.1	51.0	
			Whitetail Deer	1.9	60.7	28.5	
Aldrin	Rat	0.2	Short-tailed Shrew	0.57	0.94	2.57	
not applicable			Little Brown Bat	0.71	2.13	4.44	
			White-footed Mouse	0.50	3.22	1.66	
			Meadow Vole	0.40	3.49	2.91	
			Cottontail Rabbit	0.13	0.67	1.38	
			Mink	0.14	1.03	1.43	
			Red Fox	0.09	0.86	1.02	
			Whitetail Deer	0.04	1.21	0.57	
Aluminum	Mouse	1.93	Short-tailed Shrew	2.43	4.04	11.03	
$AlCl_3$			Little Brown Bat	3.05	9.15	19.06	
			White-footed Mouse	2.14	13.83	7.13	
			Meadow Vole	1.70	14.97	12.47	
			Cottontail Rabbit	0.57	2.89	5.91	
			Mink	0.61	4.43	6.13	1.91e-02
			Red Fox	0.37	3.69	4.37	
			Whitetail Deer	0.16	5.20	2.45	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Aluminum	Ringed Dove	109.7	American Robin	138.2	114.4	1003.8	
$Al_2(SO_4)_2$			American Woodcock	101.2	133.6	1001.7	
			Wild Turkey	33.2	1106.5	1013.4	
			Belted Kingfisher	111.4	219.8	1030.3	9.51e-01
			Great Blue Heron	44.5	253.1	1004.7	1.09e+00
			Barred Owl	66.2	564.9	1009.5	
			Barn Owl	76.3	284.4	1015.7	
			Cooper's Hawk	77.8	449.4	1004.6	
			Red-tailed Hawk	57.0	589.0	1003.2	
			Osprey	51.9	259.3	1010.4	1.12e+00
			Rough-winged Swallow	232.6	308.2	999.4	
Anitmony	Mouse	0.125	Short-tailed Shrew	0.157	0.262	0.714	
Antimony Potassium Tartrate			Little Brown Bat	0.198	0.593	1.234	
			White-footed Mouse	0.138	0.896	0.462	
			Meadow Vole	0.110	0.969	0.808	
			Cottontail Rabbit	0.037	0.187	0.383	
			Mink	0.039	0.287	0.397	1.67e-01
			Red Fox	0.024	0.239	0.283	
			Whitetail Deer	0.010	0.337	0.159	
Aroclor 1016	Mink	1.37	Short-tailed Shrew	5.48	9.13	24.90	
not applicable			Little Brown Bat	6.89	20.66	43.04	
			White-footed Mouse	4.83	31.24	16.09	
			Meadow Vole	3.84	33.80	28.16	
			Cottontail Rabbit	1.29	6.53	13.34	
			Mink	1.37	10.00	13.84	1.26e-04
			Red Fox	0.83	8.34	9.88	
			Whitetail Deer	0.36	11.75	5.53	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Aroclor 1242	Mink	0.069	Short-tailed Shrew	0.276	0.460	1.254	
not applicable			Little Brown Bat	0.347	1.040	2.168	
			White-footed Mouse	0.243	1.573	0.810	
			Meadow Vole	0.193	1.702	1.418	
			Cottontail Rabbit	0.065	0.329	0.672	
			Mink	0.069	0.504	0.697	6.33e-06
			Red Fox	0.042	0.420	0.497	
			Whitetail Deer	0.018	0.592	0.278	
Aroclor 1242	Screech Owl	0.41	American Robin	0.54	0.45	3.95	
not applicable			American Woodcock	0.40	0.53	3.94	
			Wild Turkey	0.13	4.35	3.99	
			Belted Kingfisher	0.44	0.86	4.05	1.09e-05
			Great Blue Heron	0.17	1.00	3.95	1.25e-05
			Barred Owl	0.26	2.22	3.97	
			Barn Owl	0.30	1.12	4.00	
			Cooper's Hawk	0.31	1.77	3.95	
			Red-tailed Hawk	0.22	2.32	3.95	
			Osprey	0.20	1.02	3.97	1.28e-05
			Rough-winged Swallow	0.91	1.21	3.93	
Aroclor 1248	Rhesus Monkey	0.01	Short-tailed Shrew	0.07	0.11	0.31	
not applicable			Little Brown Bat	0.09	0.26	0.53	
			White-footed Mouse	0.06	0.39	0.20	
			Meadow Vole	0.05	0.42	0.35	
			Cottontail Rabbit	0.02	0.08	0.17	
			Mink	0.02	0.12	0.17	1.41e-07
			Red Fox	0.01	0.10	0.12	
			Whitetail Deer	0.00	0.15	0.07	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Aroclor 1254	Oldfield Mouse	0.068	Short-tailed Shrew	0.066	0.111	0.302	
not applicable			Little Brown Bat	0.084	0.251	0.522	
			White-footed Mouse	0.059	0.379	0.195	
			Meadow Vole	0.047	0.410	0.342	
			Cottontail Rabbit	0.016	0.079	0.162	
			Whitetail Deer	0.004	0.143	0.067	
Aroclor 1254	Mink	0.14	Mink	0.14	1.02	1.41	4.43e-07
not applicable			Red Fox	0.09	0.85	1.01	
Aroclor 1254	Ring-necked Pheasant	0.18	American Robin	0.42	0.35	3.05	
not applicable			American Woodcock	0.31	0.41	3.04	
			Wild Turkey	0.10	3.36	3.08	
			Belted Kingfisher	0.34	0.67	3.13	2.89e-07
			Great Blue Heron	0.14	0.77	3.05	3.33e-07
			Barred Owl	0.20	1.71	3.06	
			Barn Owl	0.23	0.86	3.08	
			Cooper's Hawk	0.24	1.36	3.05	
			Red-tailed Hawk	0.17	1.79	3.05	
			Osprey	0.16	0.79	3.07	3.41e-07
			Rough-winged Swallow	0.71	0.94	3.03	
Arsenic	Mouse	0.126	Short-tailed Shrew	0.158	0.264	0.720	
Arsenite			Little Brown Bat	0.199	0.597	1.244	
			White-footed Mouse	0.140	0.903	0.465	
			Meadow Vole	0.111	0.977	0.814	
			Cottontail Rabbit	0.037	0.189	0.386	
			Mink	0.040	0.289	0.400	1.63e-02
			Red Fox	0.024	0.241	0.286	
			Whitetail Deer	0.010	0.340	0.160	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Arsenic	Mallard Duck	5.135	American Robin	11.97	9.91	86.93	
Sodium Arsenite			American Woodcock	8.76	11.57	86.75	
			Wild Turkey	2.87	95.83	87.76	
			Belted Kingfisher	9.65	19.04	89.23	1.11e+00
			Great Blue Heron	3.85	21.92	87.01	1.27e+00
			Barred Owl	5.73	48.92	87.43	
			Barn Owl	6.61	24.63	87.96	
			Cooper's Hawk	6.74	38.92	87.00	
			Red-tailed Hawk	4.94	51.01	86.87	
			Osprey	4.49	22.46	87.50	1.30e+00
			Rough-winged Swallow	20.14	26.69	86.55	
Arsenic	Brown-headed Cowbird	2.46	American Robin	2.12	1.75	15.39	
Paris Green: Copper Acetoarsenite			American Woodcock	1.55	2.05	15.36	
			Wild Turkey	0.51	16.97	15.54	
			Belted Kingfisher	1.71	3.37	15.80	1.96e-01
			Great Blue Heron	0.68	3.88	15.41	2.25e-01
			Barred Owl	1.01	8.66	15.48	
			Barn Owl	1.17	4.36	15.58	
			Cooper's Hawk	1.19	6.89	15.41	
			Red-tailed Hawk	0.87	9.03	15.38	
			Osprey	0.80	3.98	15.50	2.30e-01
			Rough-winged Swallow	3.57	4.73	15.33	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Barium	Rat	5.1	Short-tailed Shrew	15.5	25.8	70.4	
Braium Chloride			Little Brown Bat	19.5	58.4	121.7	
			White-footed Mouse	13.7	88.4	45.5	
			Meadow Vole	10.9	95.6	79.7	
			Cottontail Rabbit	3.6	18.5	37.7	
			Mink	3.9	28.3	39.1	
			Red Fox	2.4	23.6	27.9	
			Whitetail Deer	1.0	33.2	15.6	
Barium	Chicks	20.8	American Robin	24.1	20.0	175.4	
Barium Hydroxide			American Woodcock	17.7	23.3	175.0	
			Wild Turkey	5.8	193.3	177.1	
			Belted Kingfisher	19.5	38.4	180.0	
			Great Blue Heron	7.8	44.2	175.6	
			Barred Owl	11.6	98.7	176.4	
			Barn Owl	13.3	49.7	177.5	
			Cooper's Hawk	13.6	78.5	175.5	
			Red-tailed Hawk	10.0	102.9	175.3	
			Osprey	9.1	45.3	176.6	
			Rough-winged Swallow	40.6	53.8	174.6	
Benzene	Mouse	26.36	Short-tailed Shrew	33.13	55.22	150.61	
not applicable			Little Brown Bat	41.65	124.95	260.32	
			White-footed Mouse	29.20	188.95	97.34	
			Meadow Vole	23.23	204.43	170.36	
			Cottontail Rabbit	7.80	39.51	80.72	
			Mink	8.29	60.49	83.71	2.40e+00
			Red Fox	5.04	50.45	59.74	
			Whitetail Deer	2.19	71.08	33.43	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
beta-BHC	Rat	0.4	Short-tailed Shrew	1.1	1.9	5.1	
not applicable			Little Brown Bat	1.4	4.3	8.9	
			White-footed Mouse	1.0	6.4	3.3	
			Meadow Vole	0.8	7.0	5.8	
			Cottontail Rabbit	0.3	1.3	2.8	
			Mink	0.3	2.1	2.9	
			Red Fox	0.2	1.7	2.0	
			Whitetail Deer	0.1	2.4	1.1	
BHC-mixed isomers	Rat	1.6	Short-tailed Shrew	4.5	7.5	20.6	
not applicable			Little Brown Bat	5.7	17.1	35.5	
			White-footed Mouse	4.0	25.8	13.3	
			Meadow Vole	3.2	27.9	23.3	
			Cottontail Rabbit	1.1	5.4	11.0	
			Whitetail Deer	0.3	9.7	4.6	
BHC-mixed isomers	Mink	0.014	Mink	0.014	0.102	0.141	4.32e-06
not applicable			Red Fox	0.009	0.085	0.101	
BHC-mixed isomers	Japanese Quail	0.56	American Robin	0.70	0.58	5.07	
not applicable			American Woodcock	0.51	0.67	5.06	
			Wild Turkey	0.17	5.59	5.12	
			Belted Kingfisher	0.56	1.11	5.20	4.69e-05
			Great Blue Heron	0.22	1.28	5.07	5.40e-05
			Barred Owl	0.33	2.85	5.10	
			Barn Owl	0.39	1.44	5.13	
			Cooper's Hawk	0.39	2.27	5.07	
			Red-tailed Hawk	0.29	2.97	5.07	
			Osprey	0.26	1.31	5.10	5.54e-05
			Rough-winged Swallow	1.17	1.56	5.05	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Benzo(a)pyrene	Mouse	1	Short-tailed Shrew	1.26	2.10	5.71	
not applicable			Little Brown Bat	1.58	4.74	9.88	
			White-footed Mouse	1.11	7.17	3.69	
			Meadow Vole	0.88	7.76	6.46	
			Cottontail Rabbit	0.30	1.50	3.06	
			Mink	0.31	2.29	3.18	3.60e-06
			Red Fox	0.19	1.91	2.27	
			Whitetail Deer	0.08	2.70	1.27	
Beryllium	Rat	0.66	Short-tailed Shrew	1.87	3.11	8.48	
Beryllium Sulfate			Little Brown Bat	2.35	7.04	14.66	
			White-footed Mouse	1.64	10.64	5.48	
			Meadow Vole	1.31	11.51	9.60	
			Cottontail Rabbit	0.44	2.23	4.55	
			Mink	0.47	3.41	4.71	1.73e-01
			Red Fox	0.28	2.84	3.36	
			Whitetail Deer	0.12	4.00	1.88	
Bis(2-ethylhexyl) phthalate	Mouse	18.3	Short-tailed Shrew	23.0	38.3	104.6	
not applicable			Little Brown Bat	28.9	86.7	180.7	
			White-footed Mouse	20.3	131.2	67.6	
			Meadow Vole	16.1	141.9	118.3	
			Cottontail Rabbit	5.4	27.4	56.0	
			Mink	5.8	42.0	58.1	3.73e-03
			Red Fox	3.5	35.0	41.5	
			Whitetail Deer	1.5	49.3	23.2	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Bis(2-ethylhexyl) phthalate	Ringed Dove	1.1	American Robin	1.39	1.15	10.07	
not applicable			American Woodcock	1.01	1.34	10.04	
			Wild Turkey	0.33	11.10	10.16	
			Belted Kingfisher	1.12	2.20	10.33	1.96e-04
			Great Blue Heron	0.45	2.54	10.08	2.25e-04
			Barred Owl	0.66	5.66	10.12	
			Barn Owl	0.76	2.85	10.18	
			Cooper's Hawk	0.78	4.51	10.07	
			Red-tailed Hawk	0.57	5.91	10.06	
			Osprey	0.52	2.60	10.13	2.31e-04
			Rough-winged Swallow	2.33	3.09	10.02	
Boron	Rat	28	Short-tailed Shrew	79.2	132.0	359.9	
boric acid or borax			Little Brown Bat	99.5	298.6	622.0	
			White-footed Mouse	69.8	451.5	232.6	
			Meadow Vole	55.5	488.5	407.1	
			Cottontail Rabbit	18.6	94.4	192.9	
			Mink	19.8	144.5	200.0	
			Red Fox	12.1	120.5	142.7	
			Whitetail Deer	5.2	169.8	79.9	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Boron	Mallard Duck	28.8	American Robin	67.1	55.6	487.6	
boric acid			American Woodcock	49.1	64.9	486.6	
			Wild Turkey	16.1	537.5	492.2	
			Belted Kingfisher	54.1	106.8	500.4	
			Great Blue Heron	21.6	122.9	488.0	
			Barred Owl	32.1	274.4	490.3	
			Barn Owl	37.1	138.1	493.3	
			Cooper's Hawk	37.8	218.3	487.9	
			Red-tailed Hawk	27.7	286.1	487.2	
			Osprey	25.2	126.0	490.8	
			Rough-winged Swallow	113.0	149.7	485.4	
Cadmium	Rat	0.008	Short-tailed Shrew	0.023	0.038	0.103	
Cadmium Chloride			Little Brown Bat	0.028	0.085	0.178	
			White-footed Mouse	0.020	0.129	0.066	
			Meadow Vole	0.016	0.140	0.116	
			Cottontail Rabbit	0.005	0.027	0.055	
			Mink	0.006	0.041	0.057	3.33e-06
			Red Fox	0.003	0.034	0.041	
			Whitetail Deer	0.001	0.048	0.023	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Cadmium	Mallard Duck	1.45	American Robin	3.5	2.9	25.7	
Cadmium Chloride			American Woodcock	2.6	3.4	25.7	
			Wild Turkey	0.9	28.4	26.0	
			Belted Kingfisher	2.9	5.6	26.4	4.54e-04
			Great Blue Heron	1.1	6.5	25.8	5.23e-04
			Barred Owl	1.7	14.5	25.9	
			Barn Owl	2.0	7.3	26.0	
			Cooper's Hawk	2.0	11.5	25.7	
			Red-tailed Hawk	1.5	15.1	25.7	
			Osprey	1.3	6.6	25.9	5.36e-04
			Rough-winged Swallow	6.0	7.9	25.6	
			Endpoint Species				
Carbon Tetrachloride	Rat	16	Short-tailed Shrew	45.2	75.4	205.7	
not applicable			Little Brown Bat	56.9	170.6	355.4	
			White-footed Mouse	39.9	258.0	132.9	
			Meadow Vole	31.7	279.1	232.6	
			Cottontail Rabbit	10.7	53.9	110.2	
			Mink	11.3	82.6	114.3	9.83e-01
			Red Fox	6.9	68.9	81.6	
			Whitetail Deer	3.0	97.1	45.6	
Chlordane	Mouse	4.6	Short-tailed Shrew	5.8	9.6	26.3	
not applicable			Little Brown Bat	7.3	21.8	45.4	
			White-footed Mouse	5.1	33.0	17.0	
			Meadow Vole	4.1	35.7	29.7	
			Cottontail Rabbit	1.4	6.9	14.1	
			Mink	1.4	10.6	14.6	1.87e-04
			Red Fox	0.9	8.8	10.4	
			Whitetail Deer	0.4	12.4	5.8	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Chlordane	Red-winged Blackbird	2.14	American Robin	2.01	1.67	14.62	
not applicable			American Woodcock	1.47	1.95	14.59	
			Wild Turkey	0.48	16.12	14.76	
			Belted Kingfisher	1.62	3.20	15.01	5.68e-05
			Great Blue Heron	0.65	3.69	14.64	6.54e-05
			Barred Owl	0.96	8.23	14.71	
			Barn Owl	1.11	4.14	14.80	
			Cooper's Hawk	1.13	6.55	14.64	
			Red-tailed Hawk	0.83	8.58	14.62	
			Osprey	0.76	3.78	14.72	6.70e-05
			Rough-winged Swallow	3.39	4.49	14.56	
Chlordecone (Kepone)	Rat	0.08	Short-tailed Shrew	0.23	0.38	1.03	
not applicable			Little Brown Bat	0.28	0.85	1.78	
			White-footed Mouse	0.20	1.29	0.66	
			Meadow Vole	0.16	1.40	1.16	
			Cottontail Rabbit	0.05	0.27	0.55	
			Mink	0.06	0.41	0.57	
			Red Fox	0.03	0.34	0.41	
			Whitetail Deer	0.01	0.49	0.23	
Chloroform	Rat	15	Short-tailed Shrew	42.4	70.7	192.8	
not applicable			Little Brown Bat	53.3	160.0	333.2	
			White-footed Mouse	37.4	241.9	124.6	
			Meadow Vole	29.7	261.7	218.1	
			Cottontail Rabbit	10.0	50.6	103.3	
			Mink	10.6	77.4	107.2	4.03e+00
			Red Fox	6.5	64.6	76.5	
			Whitetail Deer	2.8	91.0	42.8	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Chromium	Rat	2737	Short-tailed Shrew	7739	12899	35179	
Cr^{+3} as Cr_2O_3			Little Brown Bat	9729	29186	60803	
			White-footed Mouse	6821	44133	22735	
			Meadow Vole	5426	47748	39790	
			Cottontail Rabbit	1823	9228	18854	
			Mink	1936	14129	19552	
			Red Fox	1178	11783	13954	
			Whitetail Deer	511	16602	7807	
Chromium	Black Duck	1	American Robin	2.5	2.1	18.2	
Cr^{+3} as $CrK(SO_4)_2$			American Woodcock	1.8	2.4	18.2	
			Wild Turkey	0.6	20.1	18.4	
			Belted Kingfisher	2.0	4.0	18.7	
			Great Blue Heron	0.8	4.6	18.2	
			Barred Owl	1.2	10.3	18.3	
			Barn Owl	1.4	5.2	18.4	
			Cooper's Hawk	1.4	8.2	18.2	
			Red-tailed Hawk	1.0	10.7	18.2	
			Osprey	0.9	4.7	18.3	
			Rough-winged Swallow	4.2	5.6	18.1	
Chromium	Rat	3.28	Short-tailed Shrew	9.27	15.46	42.16	
Cr^{+6} as $K_2Cr_2O_4$			Little Brown Bat	11.66	34.98	72.87	
			White-footed Mouse	8.17	52.89	27.25	
			Meadow Vole	6.50	57.22	47.68	
			Cottontail Rabbit	2.18	11.06	22.59	
			Mink	2.32	16.93	23.43	4.55e+00
			Red Fox	1.41	14.12	16.72	
			Whitetail Deer	0.61	19.90	9.36	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Copper	Mink	11.7	Short-tailed Shrew	46.8	78.0	212.6	
Copper Sulfate			Little Brown Bat	58.8	176.4	367.5	
			White-footed Mouse	41.2	266.8	137.4	
			Meadow Vole	32.8	288.6	240.5	
			Cottontail Rabbit	11.0	55.8	114.0	
			Mink	11.7	85.4	118.2	2.94e-01
			Red Fox	7.1	71.2	84.3	
			Whitetail Deer	3.1	100.3	47.2	
Copper	Chick	47	American Robin	89	74	647	
Copper Oxide			American Woodcock	65	86	646	
			Wild Turkey	21	713	653	
			Belted Kingfisher	72	142	664	4.88e-01
			Great Blue Heron	29	163	647	5.62e-01
			Barred Owl	43	364	651	
			Barn Owl	49	183	655	
			Cooper's Hawk	50	290	647	
			Red-tailed Hawk	37	380	646	
			Osprey	33	167	651	5.76e-01
			Rough-winged Swallow	150	199	644	
o-Cresol	Mink	219.2	Short-tailed Shrew	876.5	1460.8	3983.9	
not applicable			Little Brown Bat	1101.7	3305.2	6885.7	
			White-footed Mouse	772.4	4997.7	2574.7	
			Meadow Vole	614.5	5407.3	4506.1	
			Cottontail Rabbit	206.4	1045.1	2135.2	
			Mink	219.2	1600	2214.1	8.6e+01
			Red Fox	133.4	1334.4	1580.2	
			Whitetail Deer	57.9	1880	884.1	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Cyanide	Rat	68.7	Short-tailed Shrew	179.0	298.3	813.5	
Potassium Cyanide			Little Brown Bat	225.0	674.9	1406.0	
			White-footed Mouse	157.7	1020.6	525.7	
			Meadow Vole	125.5	1104.2	920.1	
			Cottontail Rabbit	42.1	213.4	436.0	
			Mink	44.8	326.7	452.1	4.52e+02
			Red Fox	27.2	272.5	322.7	
			Whitetail Deer	11.8	383.9	180.5	
DDT (and metabolites)	Rat	0.8	Short-tailed Shrew	2.26	3.77	10.28	
not applicable			Little Brown Bat	2.84	8.53	17.77	
			White-footed Mouse	1.99	12.90	6.65	
			Meadow Vole	1.59	13.96	11.63	
			Cottontail Rabbit	0.53	2.70	5.51	
			Mink	0.57	4.13	5.71	2.64e-06
			Red Fox	0.34	3.44	4.08	
			Whitetail Deer	0.15	4.85	2.28	
DDT (and metabolites)	Brown Pelican	0.0028	American Robin	0.0099	0.0082	0.0717	
not applicable			American Woodcock	0.0072	0.0095	0.0715	
			Wild Turkey	0.0024	0.0790	0.0724	
			Belted Kingfisher	0.0080	0.0157	0.0735	1.00e-08
			Great Blue Heron	0.0032	0.0181	0.0718	1.16e-08
			Barred Owl	0.0047	0.0403	0.0720	
			Barn Owl	0.0055	0.0203	0.0726	
			Cooper's Hawk	0.0056	0.0321	0.0718	
			Red-tailed Hawk	0.0041	0.0420	0.0716	
			Osprey	0.0037	0.0185	0.0721	1.18e-08
			Rough-winged Swallow	0.0166	0.0220	0.0714	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
1,2-Dichloroethane	Mouse	50	Short-tailed Shrew	66	110	301	
not applicable			Little Brown Bat	83	249	520	
			White-footed Mouse	58	377	194	
			Meadow Vole	46	408	340	
			Cottontail Rabbit	16	79	161	
			Mink	17	121	167	1.41e+01
			Red Fox	10	101	119	
			Whitetail Deer	4	142	67	
1,2-Dichloroethane	Chicken	17.2	American Robin	46.8	38.8	340.0	
not applicable			American Woodcock	34.3	45.2	339.3	
			Wild Turkey	11.2	374.8	343.3	
			Belted Kingfisher	37.7	74.5	349.0	9.24e+00
			Great Blue Heron	15.1	85.7	340.4	1.06e+01
			Barred Owl	22.4	191.3	342.0	
			Barn Owl	25.8	96.3	344.1	
			Cooper's Hawk	26.4	152.2	340.3	
			Red-tailed Hawk	19.3	199.5	339.8	
			Osprey	17.6	87.9	342.3	1.08e+01
			Rough-winged Swallow	78.8	104.4	338.5	
1,1-Dichloroethylene	Rat	30	Short-tailed Shrew	84.8	141.4	385.6	
not applicable			Little Brown Bat	106.6	319.9	666.5	
			White-footed Mouse	74.8	483.7	249.2	
			Meadow Vole	59.5	523.4	436.1	
			Cottontail Rabbit	20.0	101.2	206.7	
			Whitetail Deer	5.6	182.0	85.6	
1,1-Dichloroethylene	Beagle Dog	2.5	Mink	5.3	39.0	54.0	1.55e+00
not applicable			Red Fox	3.3	32.5	38.5	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
1,2-Dichloroethylene	Mouse	45.2	Short-tailed Shrew	56.8	94.7	258.3	
not applicable			Little Brown Bat	71.4	214.3	446.4	
			White-footed Mouse	50.1	324.0	166.9	
			Meadow Vole	39.8	350.5	292.1	
			Cottontail Rabbit	13.4	67.7	138.4	
			Mink	14.2	103.7	143.5	6.49e+00
			Red Fox	8.7	86.5	102.4	
			Whitetail Deer	3.8	121.9	57.3	
Dieldrin	Rat	0.02	Short-tailed Shrew	0.057	0.094	0.257	
not applicable			Little Brown Bat	0.071	0.213	0.444	
			White-footed Mouse	0.050	0.322	0.166	
			Meadow Vole	0.040	0.349	0.291	
			Cottontail Rabbit	0.013	0.067	0.138	
			Mink	0.014	0.103	0.143	4.61e-05
			Red Fox	0.009	0.086	0.102	
			Whitetail Deer	0.004	0.121	0.057	
Dieldrin	Barn Owl	0.077	American Robin	0.139	0.115	1.013	
not applicable			American Woodcock	0.102	0.135	1.011	
			Wild Turkey	0.034	1.117	1.023	
			Belted Kingfisher	0.112	0.222	1.040	9.92e-05
			Great Blue Heron	0.045	0.255	1.014	1.14e-04
			Barred Owl	0.067	0.570	1.019	
			Barn Owl	0.077	0.287	1.025	
			Cooper's Hawk	0.079	0.454	1.014	
			Red-tailed Hawk	0.058	0.595	1.013	
			Osprey	0.052	0.262	1.020	1.17e-04
			Rough-winged Swallow	0.235	0.311	1.009	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Diethylphthalate	Mouse	4583	Short-tailed Shrew	5761	9601	26186	
not applicable			Little Brown Bat	7242	21725	45259	
			White-footed Mouse	5077	32851	16923	
			Meadow Vole	4039	35542	29618	
			Cottontail Rabbit	1357	6869	14034	
			Mink	1441	10517	14554	2.33e+02
			Red Fox	877	8771	10387	
			Whitetail Deer	381	12358	5811	
Di-n-butyl phthalate	Mouse	550	Short-tailed Shrew	691	1152	3143	
not applicable			Little Brown Bat	869	2607	5432	
			White-footed Mouse	609	3942	2031	
			Meadow Vole	485	4265	3554	
			Cottontail Rabbit	163	824	1684	
			Mink	173	1262	1747	1.41e+00
			Red Fox	105	1053	1246	
			Whitetail Deer	46	1483	697	
Di-n-butyl phthalate	Ring Dove	0.11	American Robin	0.14	0.11	1.01	
not applicable			American Woodcock	0.10	0.13	1.00	
			Wild Turkey	0.03	1.11	1.02	
			Belted Kingfisher	0.11	0.22	1.03	2.47e-04
			Great Blue Heron	0.04	0.25	1.01	2.85e-04
			Barred Owl	0.07	0.57	1.01	
			Barn Owl	0.08	0.29	1.02	
			Cooper's Hawk	0.08	0.45	1.01	
			Red-tailed Hawk	0.06	0.59	1.01	
			Osprey	0.05	0.26	1.01	2.92e-04
			Rough-winged Swallow	0.23	0.31	1.00	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Di-n-hexyl phthalate	Mouse	55	Short-tailed Shrew	69.1	115.2	314.3	
not applicable			Little Brown Bat	86.9	260.7	543.2	
			White-footed Mouse	60.9	394.2	203.1	
			Meadow Vole	48.5	426.5	355.4	
			Cottontail Rabbit	16.3	82.4	168.4	
			Mink	17.3	126.2	174.7	
			Red Fox	10.5	105.3	124.6	
			Whitetail Deer	4.6	148.3	69.7	
1,4-Dioxane	Rat	0.5	Short-tailed Shrew	1.4	2.4	6.4	
not applicable			Little Brown Bat	1.8	5.3	11.1	
			White-footed Mouse	1.2	8.1	4.2	
			Meadow Vole	1.0	8.7	7.3	
			Cottontail Rabbit	0.3	1.7	3.4	
			Mink	0.4	2.6	3.6	2.37e+00
			Red Fox	0.2	2.2	2.5	
			Whitetail Deer	0.1	3.0	1.4	
Endosulfan	Rat	0.15	Short-tailed Shrew	0.42	0.71	1.93	
not applicable			Little Brown Bat	0.53	1.60	3.33	
			White-footed Mouse	0.37	2.42	1.25	
			Meadow Vole	0.30	2.62	2.18	
			Cottontail Rabbit	0.10	0.51	1.03	
			Mink	0.11	0.77	1.07	
			Red Fox	0.06	0.65	0.76	
			Whitetail Deer	0.03	0.91	0.43	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Endosulfan	Gray Partridge	10	American Robin	17	14	125	
not applicable			American Woodcock	13	17	125	
			Wild Turkey	4	138	126	
			Belted Kingfisher	14	27	128	
			Great Blue Heron	6	32	125	
			Barred Owl	8	70	126	
			Barn Owl	10	35	127	
			Cooper's Hawk	10	56	125	
			Red-tailed Hawk	7	73	125	
			Osprey	6	32	126	
			Rough-winged Swallow	29	38	125	
Endrin	Mouse	0.092	Short-tailed Shrew	0.116	0.193	0.526	
not applicable			Little Brown Bat	0.145	0.436	0.909	
			White-footed Mouse	0.102	0.659	0.340	
			Meadow Vole	0.081	0.714	0.595	
			Cottontail Rabbit	0.027	0.138	0.282	
			Mink	0.029	0.211	0.292	9.44e-05
			Red Fox	0.018	0.176	0.209	
			Whitetail Deer	0.008	0.248	0.117	
Endrin	Mallard Duck	0.3	American Robin	0.73	0.61	5.32	
not applicable			American Woodcock	0.54	0.71	5.31	
			Wild Turkey	0.18	5.86	5.37	
			Rough-winged Swallow	1.23	1.63	5.30	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Endrin	Screech Owl	0.01	Belted Kingfisher	0.011	0.021	0.099	9.43e-06
not applicable			Great Blue Heron	0.004	0.024	0.096	1.09e-05
			Barred Owl	0.006	0.054	0.097	
			Barn Owl	0.007	0.027	0.097	
			Cooper's Hawk	0.007	0.043	0.096	
			Red-tailed Hawk	0.005	0.057	0.096	
			Osprey	0.005	0.025	0.097	1.11e-05
Ethanol	Rat	31.9	Short-tailed Shrew	90.2	150.3	410.0	
not applicable			Little Brown Bat	113.4	340.2	708.7	
			White-footed Mouse	79.5	514.4	265.0	
			Meadow Vole	63.2	556.5	463.8	
			Cottontail Rabbit	21.2	107.6	219.8	
			Mink	22.6	164.7	227.9	1.55e+02
			Red Fox	13.7	137.3	162.6	
			Whitetail Deer	6.0	193.5	91.0	
Ethyl Acetate	Rat	90	Short-tailed Shrew	254	424	1157	
not applicable			Little Brown Bat	320	960	1999	
			White-footed Mouse	224	1451	748	
			Meadow Vole	178	1570	1308	
			Cottontail Rabbit	60	303	620	
			Mink	64	465	643	
			Red Fox	39	387	459	
			Whitetail Deer	17	546	257	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Fluoride	mink	31.37	Short-tailed Shrew	125.43	209.05	570.14	
NaF			Little Brown Bat	157.67	473.00	985.43	
			White-footed Mouse	110.54	715.25	368.46	
			Meadow Vole	87.94	773.85	644.88	
			Cottontail Rabbit	29.54	149.56	305.57	
			Mink	31.37	228.98	316.87	
			Red Fox	19.10	190.96	226.14	
			Whitetail Deer	8.29	269.05	126.53	
Fluoride	Screech Owl	7.8	American Robin	10.3	8.6	75.1	
NaF			American Woodcock	7.6	10.0	75.0	
			Wild Turkey	2.5	82.8	75.8	
			Belted Kingfisher	8.3	16.4	77.1	
			Great Blue Heron	3.3	18.9	75.2	
			Barred Owl	5.0	42.3	75.5	
			Barn Owl	5.7	21.3	76.0	
			Cooper's Hawk	5.8	33.6	75.2	
			Red-tailed Hawk	4.3	44.1	75.1	
			Osprey	3.9	19.4	75.6	
			Rough-winged Swallow	17.4	23.1	74.8	
Formaldehyde	Beagle Dog	9.4	Short-tailed Shrew	85.3	142.2	387.9	
not applicable			Little Brown Bat	107.3	321.8	670.5	
			White-footed Mouse	75.2	486.6	250.7	
			Meadow Vole	59.8	526.5	438.8	
			Cottontail Rabbit	20.1	101.8	207.9	
			Mink	21.3	155.8	215.6	8.61e+01
			Red Fox	13.0	129.9	153.9	
			Whitetail Deer	5.6	183.1	86.1	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Heptachlor	Mink	0.1	Short-tailed Shrew	0.40	0.67	1.82	
not applicable			Little Brown Bat	0.50	1.51	3.14	
			White-footed Mouse	0.35	2.28	1.17	
			Meadow Vole	0.28	2.47	2.06	
			Cottontail Rabbit	0.09	0.48	0.97	
			Mink	0.10	0.73	1.01	6.40e-04
			Red Fox	0.06	0.61	0.72	
			Whitetail Deer	0.03	0.86	0.40	
1,2,3,6,7,8-Hexachloro Dibenzofuran	Rat	0.00016	Short-tailed Shrew	0.00045	0.00075	0.00205	
not applicable			Little Brown Bat	0.001	0.002	0.004	
			White-footed Mouse	0.0004	0.00259	0.00133	
			Meadow Vole	0.00032	0.00282	0.00235	
			Cottontail Rabbit	0.00011	0.00056	0.00114	
			Mink	0.00011	0.0008	0.00111	
			Red Fox	0.00007	0.0007	0.00083	
			Whitetail Deer	0.00003	0.00097	0.00046	
Lead	Rat	8	Short-tailed Shrew	22.6	37.7	102.8	
Lead Acetate			Little Brown Bat	28.4	85.3	177.7	
			White-footed Mouse	19.9	129.0	66.5	
			Meadow Vole	15.9	139.6	116.3	
			Cottontail Rabbit	5.3	27.0	55.1	
			Mink	5.7	41.3	57.1	9.03e-01
			Red Fox	3.4	34.4	40.8	
			Whitetail Deer	1.5	48.5	22.8	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Lead	American Kestrel	3.85	American Robin	4.58	3.79	33.24	
Metal			American Woodcock	3.35	4.42	33.17	
			Wild Turkey	1.10	36.64	33.56	
			Belted Kingfisher	3.69	7.28	34.12	1.61e-01
			Great Blue Heron	1.47	8.38	33.27	1.85e-01
			Barred Owl	2.19	18.71	33.43	
			Barn Owl	2.53	9.42	33.64	
			Cooper's Hawk	2.58	14.88	33.27	
			Red-tailed Hawk	1.89	19.51	33.22	
			Osprey	1.72	8.59	33.46	1.90e-01
			Rough-winged Swallow	7.70	10.21	33.10	
Lead	Japanese Quail	1.13	American Robin	1.41	1.17	10.23	
acetate			American Woodcock	1.03	1.36	10.21	
			Wild Turkey	0.34	11.28	10.33	
			Belted Kingfisher	1.14	2.24	10.50	4.95e-02
			Great Blue Heron	0.45	2.58	10.24	5.70e-02
			Barred Owl	0.67	5.76	10.29	
			Barn Owl	0.78	2.90	10.35	
			Cooper's Hawk	0.79	4.58	10.24	
			Red-tailed Hawk	0.58	6.00	10.22	
			Osprey	0.53	2.64	10.30	5.84e-02
			Rough-winged Swallow	2.37	3.14	10.18	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Lindane (Gamma-BHC)	Rat	8	Short-tailed Shrew	22.6	37.7	102.8	
not applicable			Little Brown Bat	28.4	85.3	177.7	
			White-footed Mouse	19.9	129.0	66.5	
			Meadow Vole	15.9	139.6	116.3	
			Cottontail Rabbit	5.3	27.0	55.1	
			Mink	5.7	41.3	57.1	1.04e-01
			Red Fox	3.4	34.4	40.8	
			Whitetail Deer	1.5	48.5	22.8	
Lindane (Gamma-BHC)	Mallard Duck	2	American Robin	4.7	3.9	33.9	
not applicable			American Woodcock	3.4	4.5	33.8	
			Wild Turkey	1.1	37.3	34.2	
			Belted Kingfisher	3.8	7.4	34.8	1.87e-02
			Great Blue Heron	1.5	8.5	33.9	2.16e-02
			Barred Owl	2.2	19.1	34.1	
			Barn Owl	2.6	9.6	34.3	
			Cooper's Hawk	2.6	15.2	33.9	
			Red-tailed Hawk	1.9	19.9	33.8	
			Osprey	1.7	8.7	34.1	2.21e-02
			Rough-winged Swallow	7.8	10.4	33.7	
Lithium	Rat	9.4	Short-tailed Shrew	26.6	44.3	120.8	
Lithium Carbonate			Little Brown Bat	33.4	100.2	208.8	
			White-footed Mouse	23.4	151.6	78.1	
			Meadow Vole	18.6	164.0	136.7	
			Cottontail Rabbit	6.3	31.7	64.8	
			Mink	6.6	48.5	67.1	
			Red Fox	4.0	40.5	47.9	
			Whitetail Deer	1.8	57.0	26.8	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Manganese	Rat	88	Short-tailed Shrew	249	415	1131	
Manganese Oxide			Little Brown Bat	313	938	1955	
			White-footed Mouse	219	1419	731	
			Meadow Vole	174	1535	1279	
			Cottontail Rabbit	59	297	606	
			Mink	62	454	629	
			Red Fox	38	379	449	
			Whitetail Deer	16	534	251	
Manganese	Japanese Quail	977	American Robin	956	791	6942	
Manganese Oxide			American Woodcock	700	924	6927	
			Wild Turkey	230	7652	7007	
			Belted Kingfisher	770	1520	7125	
			Great Blue Heron	308	1750	6948	
			Barred Owl	458	3906	6981	
			Barn Owl	528	1967	7024	
			Cooper's Hawk	538	3108	6947	
			Red-tailed Hawk	394	4073	6937	
			Osprey	359	1793	6987	
			Rough-winged Swallow	1608	2131	6911	
Mercury	Mink	1	Short-tailed Shrew	4.0	6.7	18.2	
Mercuric Chloride			Little Brown Bat	5.0	15.1	31.4	
			White-footed Mouse	3.5	22.8	11.7	
			Meadow Vole	2.8	24.7	20.6	
			Cottontail Rabbit	0.9	4.8	9.7	
			Mink	1.0	7.3	10.1	
			Red Fox	0.6	6.1	7.2	
			Whitetail Deer	0.3	8.6	4.0	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Mercury	Japanese Quail	0.45	American Robin	0.56	0.46	4.07	
Mercuric Chloride			American Woodcock	0.41	0.54	4.06	
			Wild Turkey	0.13	4.49	4.11	
			Belted Kingfisher	0.45	0.89	4.18	
			Great Blue Heron	0.18	1.03	4.08	
			Barred Owl	0.27	2.29	4.10	
			Barn Owl	0.31	1.15	4.12	
			Cooper's Hawk	0.32	1.82	4.08	
			Red-tailed Hawk	0.23	2.39	4.07	
			Osprey	0.21	1.05	4.10	
			Rough-winged Swallow	0.94	1.25	4.06	
Mercury	Mouse	13.2	Short-tailed Shrew	16.6	27.7	75.4	
Mercuric Sulfide			Little Brown Bat	20.9	62.6	130.4	
			White-footed Mouse	14.6	94.6	48.7	
			Meadow Vole	11.6	102.4	85.3	
			Cottontail Rabbit	3.9	19.8	40.4	
			Mink	4.1	30.3	41.9	
			Red Fox	2.5	25.3	29.9	
			Whitetail Deer	1.1	35.6	16.7	
Mercury	Rat	0.032	Short-tailed Shrew	0.090	0.151	0.411	
Methyl Mercury Chloride			Little Brown Bat	0.114	0.341	0.711	
			White-footed Mouse	0.080	0.516	0.266	
			Meadow Vole	0.063	0.558	0.465	
			Cottontail Rabbit	0.021	0.108	0.220	
			Whitetail Deer	0.006	0.194	0.091	
Mercury	Mink	0.015	Mink	0.015	0.109	0.152	1.82e-06
Methyl Mercury Chloride			Red Fox	0.009	0.091	0.108	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Mercury	Mallard Duck	0.0064	American Robin	0.015	0.012	0.108	
Methyl Mercury Dicyandiamide			American Woodcock	0.011	0.014	0.108	
			Wild Turkey	0.004	0.119	0.109	
			Belted Kingfisher	0.012	0.024	0.111	3.95e-07
			Great Blue Heron	0.005	0.027	0.108	4.55e-07
			Barred Owl	0.007	0.061	0.109	
			Barn Owl	0.008	0.031	0.110	
			Cooper's Hawk	0.008	0.049	0.108	
			Red-tailed Hawk	0.006	0.064	0.108	
			Osprey	0.006	0.028	0.109	4.67e-07
			Rough-winged Swallow	0.025	0.033	0.108	
Methanol	Rat	50	Short-tailed Shrew	141	236	643	
not applicable			Little Brown Bat	178	533	1111	
			White-footed Mouse	125	806	415	
			Meadow Vole	99	872	727	
			Cottontail Rabbit	33	169	344	
			Mink	35	258	357	2.95e+02
			Red Fox	22	215	255	
			Whitetail Deer	9	303	143	
Methoxychlor	Rat	4	Short-tailed Shrew	11.3	18.9	51.4	
not applicable			Little Brown Bat	14.2	42.7	88.9	
			White-footed Mouse	10.0	64.5	33.2	
			Meadow Vole	7.9	69.8	58.2	
			Cottontail Rabbit	2.7	13.5	27.6	
			Mink	2.8	20.6	28.6	
			Red Fox	1.7	17.2	20.4	
			Whitetail Deer	0.7	24.3	11.4	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Methylene Chloride	Rat	5.85	Short-tailed Shrew	16.54	27.57	75.19	
not applicable			Little Brown Bat	20.79	62.38	129.96	
			White-footed Mouse	14.58	94.33	48.59	
			Meadow Vole	11.60	102.06	85.05	
			Cottontail Rabbit	3.90	19.72	40.30	
			Mink	4.14	30.20	41.79	5.06e+00
			Red Fox	2.52	25.18	29.82	
			Whitetail Deer	1.09	35.48	16.69	
Methyl Ethyl Ketone	Rat	1771	Short-tailed Shrew	5008	8346	22763	
not applicable			White-footed Mouse	4413	28557	14711	
			Little Brown Bat	6295	18885	39343	
			Meadow Vole	3511	30896	25747	
			Cottontail Rabbit	1179	5971	12200	
			Mink	1252	9142	12651	5.38e+03
			Red Fox	762	7624	9029	
			Whitetail Deer	331	10742	5052	
4-Methyl 2-Pentanone	Rat	25	Short-tailed Shrew	71	118	321	
not applicable			Little Brown Bat	89	267	555	
			White-footed Mouse	62	403	208	
			Meadow Vole	50	436	363	
			Cottontail Rabbit	17	84	172	
			Mink	18	129	179	2.37e+01
			Red Fox	11	108	127	
			Whitetail Deer	5	152	71	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Molybdenum	Mouse	0.26	Short-tailed Shrew	0.33	0.54	1.49	
Molybdate (MoO_4)			Little Brown Bat	0.41	1.23	2.57	
			White-footed Mouse	0.29	1.86	0.96	
			Meadow Vole	0.23	2.02	1.68	
			Cottontail Rabbit	0.08	0.39	0.80	
			Mink	0.08	0.60	0.83	
			Red Fox	0.05	0.50	0.59	
			Whitetail Deer	0.02	0.70	0.33	
Molybdenum	Chicken	3.5	American Robin	9.3	7.7	67.7	
sodium molybdate			American Woodcock	6.8	9.0	67.6	
			Wild Turkey	2.2	74.7	68.4	
			Belted Kingfisher	7.5	14.8	69.5	
			Great Blue Heron	3.0	17.1	67.8	
			Barred Owl	4.5	38.1	68.1	
			Barn Owl	5.1	19.2	68.5	
			Cooper's Hawk	5.3	30.3	67.8	
			Red-tailed Hawk	3.8	39.7	67.7	
			Osprey	3.5	17.5	68.2	
			Rough-winged Swallow	15.7	20.8	67.4	
Nickel	Rat	40	Short-tailed Shrew	113.1	188.5	514.1	
Nickel Sulfate Hexahydrate			Little Brown Bat	142.2	426.5	888.6	
			White-footed Mouse	99.7	645.0	332.3	
			Meadow Vole	79.3	697.8	581.5	
			Cottontail Rabbit	26.6	134.9	275.5	
			Mink	28.3	206.5	285.7	1.93e+00
			Red Fox	17.2	172.2	203.9	
			Whitetail Deer	7.5	242.6	114.1	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Nickel	Mallard Duckling	77.4	American Robin	166.3	137.7	1208.2	
Nickel Sulfate			American Woodcock	121.8	160.8	1205.7	
			Wild Turkey	40.0	1331.8	1219.7	
			Belted Kingfisher	134.1	264.6	1240.1	2.49e+00
			Great Blue Heron	53.5	304.6	1209.3	2.87e+00
			Barred Owl	79.6	679.9	1215.1	
			Barn Owl	91.8	342.3	1222.5	
			Cooper's Hawk	93.6	540.9	1209.1	
			Red-tailed Hawk	68.6	708.9	1207.4	
			Osprey	62.4	312.1	1216.2	2.94e+00
			Rough-winged Swallow	279.9	370.9	1202.9	
Niobium	Mouse	0.155	Short-tailed Shrew	0.195	0.325	0.886	
Sodium Niobate			Little Brown Bat	0.245	0.735	1.531	
			White-footed Mouse	0.172	1.111	0.572	
			Meadow Vole	0.137	1.202	1.002	
			Cottontail Rabbit	0.046	0.232	0.475	
			Mink	0.049	0.356	0.492	
			Red Fox	0.030	0.297	0.351	
			Whitetail Deer	0.013	0.418	0.197	
Nitrate	Guinea Pig	507	Short-tailed Shrew	1929	3215	8767	
Potassium Nitrate			Little Brown Bat	2424	7273	15153	
			White-footed Mouse	1700	10999	5666	
			Meadow Vole	1352	11900	9916	
			Cottontail Rabbit	454	2300	4699	
			Mink	482	3521	4873	
			Red Fox	294	2936	3477	
			Whitetail Deer	127	4137	1946	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
1,2,3,4,8-Pentachloro Dibenzofuran	Rat	0.048	Short-tailed Shrew	0.136	0.226	0.617	
not applicable			Little Brown Bat	0.171	0.512	1.066	
			White-footed Mouse	0.120	0.774	0.399	
			Meadow Vole	0.095	0.837	0.698	
			Cottontail Rabbit	0.032	0.162	0.331	
			Mink	0.034	0.248	0.343	
			Red Fox	0.021	0.207	0.245	
			Whitetail Deer	0.009	0.291	0.137	
1,2,3,7,8-Pentachloro Dibenzofuran	Rat	0.00016	Short-tailed Shrew	0.00045	0.00075	0.00205	
not applicable			Little Brown Bat	0.00057	0.00171	0.00355	
			White-footed Mouse	0.00040	0.00259	0.00133	
			Meadow Vole	0.00032	0.00282	0.00235	
			Cottontail Rabbit	0.00011	0.00056	0.00114	
			Mink	0.00011	0.00080	0.00111	
			Red Fox	0.00007	0.00070	0.00083	
			Whitetail Deer	0.00003	0.00097	0.00046	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
2,3,4,7,8-Pentachloro Dibenzofuran	Rat	0.000016	Short-tailed Shrew	0.0000452	0.0000753	0.000206	
not applicable			Little Brown Bat	0.0000567	0.00017	0.00035	
			White-footed Mouse	0.0000399	0.0002582	0.000133	
			Meadow Vole	0.0000317	0.000279	0.000233	
			Cottontail Rabbit	0.0000107	0.0000542	0.000111	
			Mink	0.0000113	0.0000825	0.000114	
			Red Fox	0.0000069	0.000069	0.000082	
			Whitetail Deer	0.000003	0.0000974	0.000046	
Pentachloronitrobenzene	Chicken	7.07	American Robin	18.84	15.60	136.83	
not applicable			American Woodcock	13.79	18.21	136.54	
			Wild Turkey	4.52	150.83	138.13	
			Belted Kingfisher	15.18	29.96	140.44	1.16e-02
			Great Blue Heron	6.06	34.50	136.95	1.34e-02
			Barred Owl	9.02	76.99	137.60	
			Barn Owl	10.40	38.76	138.45	
			Cooper's Hawk	10.61	61.26	136.93	
			Red-tailed Hawk	7.77	80.29	136.74	
			Osprey	7.07	35.35	137.73	1.37e-02
			Rough-winged Swallow	31.70	42.00	136.23	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Pentachlorophenol	Rat	0.24	Short-tailed Shrew	0.68	1.13	3.08	
not applicable			Little Brown Bat	0.85	2.56	5.33	
			White-footed Mouse	0.60	3.87	1.99	
			Meadow Vole	0.48	4.19	3.49	
			Cottontail Rabbit	0.16	0.81	1.65	
			Mink	0.17	1.24	1.71	2.82e-03
			Red Fox	0.10	1.03	1.22	
			Whitetail Deer	0.04	1.46	0.68	
Selenium	Mouse	0.076	Short-tailed Shrew	0.096	0.159	0.434	
Selanate			Little Brown Bat	0.120	0.360	0.751	
			White-footed Mouse	0.084	0.545	0.281	
			Meadow Vole	0.067	0.589	0.491	
			Cottontail Rabbit	0.023	0.114	0.233	
			Mink	0.024	0.174	0.241	6.71e-05
			Red Fox	0.015	0.145	0.172	
			Whitetail Deer	0.006	0.205	0.096	
Selenium	Mallard Duck	0.5	American Robin	1.2	1.0	8.5	
Sodium Selanite			American Woodcock	0.9	1.1	8.4	
			Wild Turkey	0.3	9.3	8.5	
			Belted Kingfisher	0.9	1.9	8.7	7.13e-04
			Great Blue Heron	0.4	2.1	8.5	8.21e-04
			Barred Owl	0.6	4.8	8.5	
			Barn Owl	0.6	2.4	8.6	
			Cooper's Hawk	0.7	3.8	8.5	
			Red-tailed Hawk	0.5	5.0	8.5	
			Osprey	0.4	2.2	8.5	8.41e-04
			Rough-winged Swallow	2.0	2.6	8.4	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Selenium	Mallard Duck	0.4	American Robin	0.9	0.8	6.8	
Selanomethionine			American Woodcock	0.7	0.9	6.8	
			Wild Turkey	0.2	7.5	6.8	
			Belted Kingfisher	0.8	1.5	7.0	
			Great Blue Heron	0.3	1.7	6.8	
			Barred Owl	0.4	3.8	6.8	
			Barn Owl	0.5	1.9	6.9	
			Cooper's Hawk	0.5	3.0	6.8	
			Red-tailed Hawk	0.4	4.0	6.8	
			Osprey	0.3	1.7	6.8	
			Rough-winged Swallow	1.6	2.1	6.7	
Strontium (stable)	Rat	263	Short-tailed Shrew	744	1239	3380	
Strontium Chloride			Little Brown Bat	935	2804	5843	
			White-footed Mouse	655	4241	2185	
			Meadow Vole	521	4588	3823	
			Cottontail Rabbit	175	887	1812	
			Mink	186	1358	1879	
			Red Fox	113	1132	1341	
			Whitetail Deer	49	1595	750	
2,3,7,8-Tetrachloro Dibenzodioxin	Rat	0.000001	Short-tailed Shrew	0.0000028	0.0000047	0.000013	
not applicable			Little Brown Bat	0.0000036	0.000011	0.000022	
			White-footed Mouse	0.0000025	0.000016	0.000008	
			Meadow Vole	0.000002	0.000018	0.000015	
			Cottontail Rabbit	0.0000007	0.0000035	0.000007	
			Mink	0.0000007	0.0000051	0.000007	5.89e-11
			Red Fox	0.00000043	0.0000043	0.000005	
			Whitetail Deer	0.00000019	0.0000061	0.000003	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
2,3,7,8-Tetrachloro Dibenzodioxin	Ring-necked Pheasant	0.000014	American Robin	0.000033	0.000027	0.00024	
not applicable			American Woodcock	0.000024	0.000032	0.00024	
			Wild Turkey	0.0000078	0.00026	0.00024	
			Belted Kingfisher	0.000026	0.000052	0.00024	5.99e-10
			Great Blue Heron	0.000011	0.00006	0.00024	6.89e-10
			Barred Owl	0.000016	0.00013	0.00024	
			Barn Owl	0.000018	0.000067	0.00024	
			Cooper's Hawk	0.000018	0.00011	0.00024	
			Red-tailed Hawk	0.000014	0.00014	0.00024	
			Osprey	0.0000122	0.000061	0.00024	7.04e-10
			Rough-winged Swallow	0.000055	0.000073	0.00024	
2,3,7,8-Tetrachloro Dibenzofuran	Chick	1.0e-06	American Robin	0.0000012	0.000001	0.000009	
not applicable			American Woodcock	0.0000009	0.0000012	0.000009	
			Wild Turkey	0.0000003	0.00001	0.000009	
			Belted Kingfisher	0.0000009	0.0000018	0.000008	
			Great Blue Heron	0.0000004	0.0000023	0.000009	
			Barred Owl	0.0000006	0.000005	0.000009	
			Barn Owl	0.0000006	0.0000022	0.000008	
			Cooper's Hawk	0.0000007	0.000004	0.000009	
			Red-tailed Hawk	0.0000005	0.000005	0.000009	
			Osprey	0.0000004	0.000002	0.000008	
			Rough-winged Swallow	0.000002	0.0000027	0.000009	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
1,1,2,2-Tetrachloroethylene	Mouse	1.4	Short-tailed Shrew	1.8	2.9	8.0	
not applicable			Little Brown Bat	2.2	6.6	13.8	
			White-footed Mouse	1.6	10.0	5.2	
			Meadow Vole	1.2	10.9	9.0	
			Cottontail Rabbit	0.4	2.1	4.3	
			Mink	0.4	3.2	4.4	1.42e-02
			Red Fox	0.3	2.7	3.2	
			Whitetail Deer	0.1	3.8	1.8	
Thallium	Rat	0.0074	Short-tailed Shrew	0.021	0.035	0.096	
Thallium Sulfate			Little Brown Bat	0.027	0.080	0.167	
			White-footed Mouse	0.019	0.121	0.062	
			Meadow Vole	0.015	0.131	0.109	
			Cottontail Rabbit	0.005	0.025	0.052	
			Mink	0.005	0.039	0.054	1.12e-03
			Red Fox	0.003	0.032	0.038	
			Whitetail Deer	0.001	0.045	0.021	
Tin	Mouse	23.4	Short-tailed Shrew	29.4	49.0	133.7	
bis(Tributyltin) oxide (TBTO)			Little Brown Bat	37.0	110.9	231.1	
			White-footed Mouse	25.9	167.7	86.4	
			Meadow Vole	20.6	181.5	151.2	
			Cottontail Rabbit	6.9	35.1	71.7	
			Mink	7.4	53.7	74.3	
			Red Fox	4.5	44.8	53.0	
			Whitetail Deer	1.9	63.1	29.7	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Tin	Japanese Quail	6.8	American Robin	8.5	7.0	61.6	
bis(Tributyltin) oxide (TBTO)			American Woodcock	6.2	8.2	61.4	
			Wild Turkey	2.0	67.9	62.1	
			Belted Kingfisher	6.8	13.5	63.2	
			Great Blue Heron	2.7	15.5	61.6	
			Barred Owl	4.1	34.6	61.9	
			Barn Owl	4.7	17.4	62.3	
			Cooper's Hawk	4.8	27.6	61.6	
			Red-tailed Hawk	3.5	36.1	61.5	
			Osprey	3.2	15.9	62.0	
			Rough-winged Swallow	14.3	18.9	61.3	
Toluene	Mouse	26	Short-tailed Shrew	32.7	54.5	148.6	
not applicable			Little Brown Bat	41.1	123.2	256.8	
			White-footed Mouse	28.8	186.4	96.0	
			Meadow Vole	22.9	201.6	168.0	
			Cottontail Rabbit	7.7	39.0	79.6	
			Mink	8.2	59.7	82.6	8.44e-01
			Red Fox	5.0	49.8	58.9	
			Whitetail Deer	2.2	70.1	33.0	
Toxaphene	Rat	8	Short-tailed Shrew	22.6	37.7	102.8	
not applicable			Little Brown Bat	28.4	85.3	177.7	
			White-footed Mouse	19.9	129.0	66.5	
			Meadow Vole	15.9	139.6	116.3	
			Cottontail Rabbit	5.3	27.0	55.1	
			Mink	5.7	41.3	57.1	1.02e-02
			Red Fox	3.4	34.4	40.8	
			Whitetail Deer	1.5	48.5	22.8	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
1,1,1-Trichloroethane	Mouse	1000	Short-tailed Shrew	1323	2204	6012	
not applicable			Little Brown Bat	1663	4988	10391	
			White-footed Mouse	1166	7542	3885	
			Meadow Vole	927	8160	6800	
			Cottontail Rabbit	311	1577	3222	
			Mink	331	2414	3341	5.17e+01
			Red Fox	201	2014	2385	
			Whitetail Deer	87	2837	1334	
Trichloroethylene	Mouse	0.7	Short-tailed Shrew	0.88	1.47	4.00	
not applicable			Little Brown Bat	1.11	3.32	6.91	
			White-footed Mouse	0.78	5.02	2.58	
			Meadow Vole	0.62	5.43	4.52	
			Cottontail Rabbit	0.21	1.05	2.14	
			Mink	0.22	1.61	2.22	3.88e-02
			Red Fox	0.13	1.34	1.59	
			Whitetail Deer	0.06	1.89	0.89	
Uranium	Mouse	3.07	Short-tailed Shrew	3.77	6.29	17.15	
Uranyl Acetate			Little Brown Bat	4.74	14.22	29.64	
			White-footed Mouse	3.32	21.51	11.08	
			Meadow Vole	2.64	23.27	19.39	
			Cottontail Rabbit	0.89	4.50	9.19	
			Mink	0.94	6.89	9.53	
			Red Fox	0.57	5.74	6.80	
			Whitetail Deer	0.25	8.09	3.81	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks: Diet[d] (mg/kg)	Toxicological Benchmarks: Water[e] (mg/L)	Toxicological Benchmarks: Piscivore Water Value[f] (mg/L)
Uranium	Black Duck	16	American Robin	40	33	292	
depleted metal			American Woodcock	29	39	291	
			Wild Turkey	10	321	294	
			Belted Kingfisher	32	64	299	
			Great Blue Heron	13	74	292	
			Barred Owl	19	164	293	
			Barn Owl	22	83	295	
			Cooper's Hawk	23	131	292	
			Red-tailed Hawk	17	171	291	
			Osprey	15	75	293	
			Rough-winged Swallow	68	90	290	
Vanadium	Rat	0.21	Short-tailed Shrew	0.54	0.90	2.45	
Sodium Metavanadate			Little Brown Bat	0.68	2.03	4.23	
			White-footed Mouse	0.47	3.07	1.58	
			Meadow Vole	0.38	3.32	2.77	
			Cottontail Rabbit	0.13	0.64	1.31	
			Mink	0.13	0.98	1.36	
			Red Fox	0.08	0.82	0.97	
			Whitetail Deer	0.04	1.15	0.54	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Vanadium	Mallard Duck	11.4	American Robin	28.0	23.2	203.3	
Vanadyl Sulfate			American Woodcock	20.5	27.0	202.8	
			Wild Turkey	6.7	224.1	205.2	
			Belted Kingfisher	22.6	44.5	208.6	
			Great Blue Heron	9.0	51.2	203.4	
			Barred Owl	13.4	114.4	204.4	
			Barn Owl	15.4	57.6	205.7	
			Cooper's Hawk	15.8	91.0	203.4	
			Red-tailed Hawk	11.5	119.3	203.1	
			Osprey	10.5	52.5	204.6	
			Rough-winged Swallow	47.1	62.4	202.4	
Vinyl Chloride	Rat	0.17	Short-tailed Shrew	0.48	0.80	2.19	
not applicable			Little Brown Bat	0.60	1.81	3.78	
			White-footed Mouse	0.42	2.74	1.41	
			Meadow Vole	0.34	2.97	2.47	
			Cottontail Rabbit	0.11	0.57	1.17	
			Mink	0.12	0.88	1.21	1.24e-01
			Red Fox	0.07	0.73	0.87	
			Whitetail Deer	0.03	1.03	0.48	
Xylene (mixed isomers)	Mouse	2.1	Short-tailed Shrew	2.64	4.40	12.00	
not applicable			Little Brown Bat	3.32	9.95	20.74	
			White-footed Mouse	2.33	15.05	7.75	
			Meadow Vole	1.85	16.29	13.57	
			Cottontail Rabbit	0.62	3.15	6.43	
			Mink	0.66	4.82	6.67	3.01e-02
			Red Fox	0.40	4.02	4.76	
			Whitetail Deer	0.17	5.66	2.66	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Zinc	Rat	160	Short-tailed Shrew	452	754	2057	
Zinc Oxide			Little Brown Bat	569	1706	3554	
			White-footed Mouse	399	2580	1329	
			Meadow Vole	317	2791	2326	
			Cottontail Rabbit	107	539	1102	
			Mink	113	826	1143	8.54e-01
			Red Fox	69	689	816	
			Whitetail Deer	30	971	456	
Zinc	Chicken (White Leghorn Hen)	14.5	American Robin	42.0	34.8	305.2	
Zinc sulfate			American Woodcock	30.8	40.6	304.6	
			Wild Turkey	10.1	336.4	308.1	
			Belted Kingfisher	33.9	66.8	313.3	6.92e-02
			Great Blue Heron	13.5	77.0	305.5	7.96e-02
			Barred Owl	20.1	171.7	307.0	
			Barn Owl	23.2	86.5	308.8	
			Cooper's Hawk	23.7	136.7	305.5	
			Red-tailed Hawk	17.3	179.1	305.0	
			Osprey	15.8	78.9	307.2	8.16e-02
			Rough-winged Swallow	70.7	93.7	303.9	

Table 12. (continued)

Contaminant and Form	Test Species	Test Species NOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Zirconium	Mouse	1.74	Short-tailed Shrew	2.19	3.65	9.94	
Zirconium Sulfate			Little Brown Bat	2.75	8.25	17.18	
			White-footed Mouse	1.93	12.47	6.43	
			Meadow Vole	1.53	13.49	11.25	
			Cottontail Rabbit	0.52	2.61	5.33	
			Mink	0.55	3.99	5.53	
			Red Fox	0.33	3.33	3.94	
			Whitetail Deer	0.14	4.69	2.21	

[a] See Appendix A for NOAEL derivation, study duration, and study endpoint.
[b] See Appendix B for body weights, food and water consumption rates.
[c] Calculated using Eq. 4.
[d] Calculated using Eq. 8.
[e] Calculated using Eq. 19.
[f] Combined food and water benchmark for aquatic-feeding species. Calculated using Eq. 26.

TABLE 13

Table 13. LOAEL-based toxicological benchmarks for selected avian and mammalian wildlife species

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Acetone	Rat	50	Short-tailed Shrew	141	236	643	
not applicable			Little Brown Bat	178	533	1111	
			White-footed Mouse	125	806	415	
			Meadow Vole	99	872	727	
			Cottontail Rabbit	33	169	344	
			Mink	35	258	357	232
			Red Fox	22	215	255	
			Whitetail Deer	9	303	143	
Aldrin	Rat	1	Short-tailed Shrew	2.8	4.7	12.9	
not applicable			Little Brown Bat	3.6	10.7	22.2	
			White-footed Mouse	2.5	16.1	8.3	
			Meadow Vole	2.0	17.4	14.5	
			Cottontail Rabbit	0.7	3.4	6.9	
			Mink	0.7	5.2	7.1	
			Red Fox	0.4	4.3	5.1	
			Whitetail Deer	0.2	6.1	2.9	
Aluminum	Mouse	19.3	Short-tailed Shrew	24.3	40.4	110.3	
$AlCl_3$			Little Brown Bat	30.5	91.5	190.6	
			White-footed Mouse	21.4	138.3	71.3	
			Meadow Vole	17.0	149.7	124.7	
			Cottontail Rabbit	5.7	28.9	59.1	
			Mink	6.1	44.3	61.3	1.91e-01
			Red Fox	3.7	36.9	43.7	
			Whitetail Deer	1.6	52.0	24.5	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Aluminum	White Leghorn Chicks	44.5	American Robin	45.1	37.3	327.4	
$AlCl_3$			American Woodcock	33.0	43.6	326.7	
			Wild Turkey	10.8	360.9	330.5	
			Belted Kingfisher	36.3	71.7	336.0	3.10e-01
			Great Blue Heron	14.5	82.5	327.7	3.57e-01
			Barred Owl	21.6	184.2	329.2	
			Barn Owl	24.9	92.7	331.2	
			Cooper's Hawk	25.4	146.6	327.6	
			Red-tailed Hawk	18.6	192.1	327.1	
			Osprey	16.9	84.6	329.5	3.66e-01
			Rough-winged Swallow	75.8	100.5	325.9	
Anitmony	Mouse	1.25	Short-tailed Shrew	1.57	2.62	7.14	
Antimony Potassium Tartrate			Little Brown Bat	1.98	5.93	12.34	
			White-footed Mouse	1.38	8.96	4.62	
			Meadow Vole	1.10	9.69	8.08	
			Cottontail Rabbit	0.37	1.87	3.83	
			Mink	0.39	2.87	3.97	1.67e+00
			Red Fox	0.24	2.39	2.83	
			Whitetail Deer	0.10	3.37	1.59	
Aroclor 1016	Mink	3.43	Short-tailed Shrew	13.71	22.86	62.34	
not applicable			Little Brown Bat	17.24	51.72	107.75	
			White-footed Mouse	12.09	78.21	40.29	
			Meadow Vole	9.62	84.61	70.51	
			Cottontail Rabbit	3.23	16.35	33.41	
			Mink	3.43	25.04	34.65	3.14e-04
			Red Fox	2.09	20.88	24.73	
			Whitetail Deer	0.91	29.42	13.83	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Aroclor 1242	Mink	0.69	Short-tailed Shrew	2.76	4.60	12.54	
not applicable			Little Brown Bat	3.47	10.40	21.68	
			White-footed Mouse	2.43	15.73	8.10	
			Meadow Vole	1.93	17.02	14.18	
			Cottontail Rabbit	0.65	3.29	6.72	
			Mink	0.69	5.04	6.97	6.33e-05
			Red Fox	0.42	4.20	4.97	
			Whitetail Deer	0.18	5.92	2.78	
Aroclor 1248	Rhesus Monkey	0.1	Short-tailed Shrew	0.68	1.13	3.09	
not applicable			Little Brown Bat	0.85	2.56	5.34	
			White-footed Mouse	0.60	3.88	2.00	
			Meadow Vole	0.48	4.20	3.50	
			Cottontail Rabbit	0.16	0.81	1.66	
			Mink	0.17	1.24	1.72	1.41e-06
			Red Fox	0.10	1.04	1.23	
			Whitetail Deer	0.04	1.46	0.69	
Aroclor 1254	Oldfield Mouse	0.68	Short-tailed Shrew	0.66	1.11	3.02	
not applicable			Little Brown Bat	0.84	2.51	5.22	
			White-footed Mouse	0.59	3.79	1.95	
			Meadow Vole	0.47	4.10	3.42	
			Cottontail Rabbit	0.16	0.79	1.62	
			Whitetail Deer	0.04	1.43	0.67	
Aroclor 1254	Mink	0.69	Mink	0.69	5.04	6.97	2.18e-06
not applicable			Red Fox	0.42	4.20	4.97	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Aroclor 1254	Ring-necked Pheasant	1.8	American Robin	4.19	3.47	30.47	
not applicable			American Woodcock	3.07	4.05	30.41	
			Wild Turkey	1.01	33.59	30.76	
			Belted Kingfisher	3.38	6.67	31.28	2.89e-06
			Great Blue Heron	1.35	7.68	30.50	3.33e-06
			Barred Owl	2.01	17.15	30.65	
			Barn Owl	2.32	8.63	30.83	
			Cooper's Hawk	2.36	13.64	30.50	
			Red-tailed Hawk	1.73	17.88	30.45	
			Osprey	1.57	7.87	30.67	3.41e-06
			Rough-winged Swallow	7.06	9.35	30.34	
Arsenic	Mouse	1.26	Short-tailed Shrew	1.58	2.64	7.20	
Arsenite			Little Brown Bat	1.99	5.97	12.44	
			White-footed Mouse	1.40	9.03	4.65	
			Meadow Vole	1.11	9.77	8.14	
			Cottontail Rabbit	0.37	1.89	3.86	
			Mink	0.40	2.89	4.00	1.63e-01
			Red Fox	0.24	2.41	2.86	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Arsenic	Mallard Duck	12.84	American Robin	29.9	24.8	217.4	
Sodium Arsenite			American Woodcock	21.9	28.9	216.9	
			Wild Turkey	7.2	239.6	219.4	
			Belted Kingfisher	24.1	47.6	223.1	2.77e+00
			Great Blue Heron	9.6	54.8	217.6	3.18e+00
			Barred Owl	14.3	122.3	218.6	
			Barn Owl	16.5	61.6	219.9	
			Cooper's Hawk	16.8	97.3	217.5	
			Red-tailed Hawk	12.3	127.5	217.2	
			Osprey	11.2	56.2	218.8	3.25e+00
			Rough-winged Swallow	50.4	66.7	216.4	
Arsenic	Brown-headed Cowbird	7.38	American Robin	6.4	5.3	46.2	
Paris Green: Copper Acetoarsenite			American Woodcock	4.7	6.1	46.1	
			Wild Turkey	1.5	50.9	46.6	
			Belted Kingfisher	5.1	10.1	47.4	5.87e-01
			Great Blue Heron	2.0	11.6	46.2	6.75e-01
			Barred Owl	3.0	26.0	46.4	
			Barn Owl	3.5	13.1	46.7	
			Cooper's Hawk	3.6	20.7	46.2	
			Red-tailed Hawk	2.6	27.1	46.1	
			Osprey	2.4	11.9	46.5	6.91e-01
			Rough-winged Swallow	10.7	14.2	46.0	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks: Diet[d] (mg/kg)	Toxicological Benchmarks: Water[e] (mg/L)	Toxicological Benchmarks: Piscivore Water Value[f] (mg/L)
Barium	Rat	19.8	Short-tailed Shrew	56.0	93.3	254.5	
Braium Chloride			Little Brown Bat	70.4	211.1	439.9	
			White-footed Mouse	49.3	319.3	164.5	
			Meadow Vole	39.3	345.4	287.9	
			Cottontail Rabbit	13.2	66.8	136.4	
			Mink	14.0	102.2	141.4	
			Red Fox	8.5	85.2	100.9	
			Whitetail Deer	3.7	120.1	56.5	
Barium	Chicks	41.7	American Robin	48.4	40.1	351.6	
Barium Hydroxide			American Woodcock	35.4	46.8	350.9	
			Wild Turkey	11.6	387.6	355.0	
			Belted Kingfisher	39.0	77.0	360.9	
			Great Blue Heron	15.6	88.7	352.0	
			Barred Owl	23.2	197.9	353.6	
			Barn Owl	26.7	99.6	355.8	
			Cooper's Hawk	27.3	157.4	351.9	
			Red-tailed Hawk	20.0	206.3	351.4	
			Osprey	18.2	90.8	354.0	
			Rough-winged Swallow	81.5	107.9	350.1	
Benzene	Mouse	263.6	Short-tailed Shrew	331	552	1506	
not applicable			Little Brown Bat	417	1250	2603	
			White-footed Mouse	292	1889	973	
			Meadow Vole	232	2044	1704	
			Cottontail Rabbit	78	395	807	
			Mink	83	605	837	2.40e+01
			Red Fox	50	504	597	
			Whitetail Deer	22	711	334	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
beta-BHC	Rat	2	Short-tailed Shrew	5.7	9.4	25.7	
not applicable			Little Brown Bat	7.1	21.3	44.4	
			White-footed Mouse	5.0	32.2	16.6	
			Meadow Vole	4.0	34.9	29.1	
			Cottontail Rabbit	1.3	6.7	13.8	
			Mink	1.4	10.3	14.3	
			Red Fox	0.9	8.6	10.2	
			Whitetail Deer	0.4	12.1	5.7	
BHC-mixed isomers	Rat	3.2	Short-tailed Shrew	9.0	15.1	41.1	
not applicable			Little Brown Bat	11.4	34.1	71.1	
			White-footed Mouse	8.0	51.6	26.6	
			Meadow Vole	6.3	55.8	46.5	
			Cottontail Rabbit	2.1	10.8	22.0	
			Whitetail Deer	0.6	19.4	9.1	
BHC-mixed isomers	Mink	0.14	Mink	0.14	1.02	1.41	4.32e-05
not applicable			Red Fox	0.09	0.85	1.01	
BHC-mixed isomers	Japanese Quail	2.25	American Robin	2.80	2.32	20.37	
not applicable			American Woodcock	2.05	2.71	20.32	
			Wild Turkey	0.67	22.45	20.56	
			Belted Kingfisher	2.26	4.46	20.90	1.89e-04
			Great Blue Heron	0.90	5.14	20.39	2.17e-04
			Barred Owl	1.34	11.46	20.48	
			Barn Owl	1.55	5.77	20.61	
			Cooper's Hawk	1.58	9.12	20.38	
			Red-tailed Hawk	1.16	11.95	20.35	
			Osprey	1.05	5.26	20.50	2.23e-04
			Rough-winged Swallow	4.72	6.25	20.28	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Benzo(a)pyrene	Mouse	10	Short-tailed Shrew	12.6	21.0	57.1	
not applicable			Little Brown Bat	15.8	47.4	98.8	
			White-footed Mouse	11.1	71.7	36.9	
			Meadow Vole	8.8	77.6	64.6	
			Cottontail Rabbit	3.0	15.0	30.6	
			Mink	3.1	22.9	31.8	3.60e-05
			Red Fox	1.9	19.1	22.7	
			Whitetail Deer	0.8	27.0	12.7	
Bis(2-ethylhexyl) phthalate	Mouse	183	Short-tailed Shrew	230	383	1046	
not applicable			Little Brown Bat	289	867	1807	
			White-footed Mouse	203	1312	676	
			Meadow Vole	161	1419	1183	
			Cottontail Rabbit	54	274	560	
			Mink	58	420	581	3.73e-02
			Red Fox	35	350	415	
			Whitetail Deer	15	493	232	
Boron	Rat	93.6	Short-tailed Shrew	265	441	1203	
boric acid or borax			Little Brown Bat	333	998	2079	
			White-footed Mouse	233	1509	777	
			Meadow Vole	186	1633	1361	
			Cottontail Rabbit	62	316	645	
			Mink	66	483	669	
			Red Fox	40	403	477	
			Whitetail Deer	17	568	267	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Boron	Mallard Duck	100	American Robin	233	193	1693	
boric acid			American Woodcock	171	225	1689	
			Wild Turkey	56	1866	1709	
			Belted Kingfisher	188	371	1738	
			Great Blue Heron	75	427	1695	
			Barred Owl	112	953	1703	
			Barn Owl	129	480	1713	
			Cooper's Hawk	131	758	1694	
			Red-tailed Hawk	96	993	1692	
			Osprey	87	437	1704	
			Rough-winged Swallow	392	520	1686	
Cadmium	Rat	0.01	Short-tailed Shrew	0.028	0.047	0.129	
Cadmium Chloride			Little Brown Bat	0.036	0.107	0.222	
			White-footed Mouse	0.025	0.161	0.083	
			Meadow Vole	0.020	0.174	0.145	
			Cottontail Rabbit	0.007	0.034	0.069	
			Mink	0.007	0.052	0.071	4.16e-06
			Red Fox	0.004	0.043	0.051	
			Whitetail Deer	0.002	0.061	0.029	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Cadmium	Mallard Duck	20	American Robin	49	40	355	
Cadmium Chloride			American Woodcock	36	47	354	
			Wild Turkey	12	391	358	
			Belted Kingfisher	39	78	364	6.27e-03
			Great Blue Heron	16	89	355	7.22e-03
			Barred Owl	23	200	357	
			Barn Owl	27	101	359	
			Cooper's Hawk	28	159	355	
			Red-tailed Hawk	20	208	355	
			Osprey	18	92	357	7.39e-03
			Rough-winged Swallow	82	109	353	
Chlordane	Mouse	9.2	Short-tailed Shrew	11.6	19.3	52.6	
not applicable			Little Brown Bat	14.5	43.6	90.9	
			White-footed Mouse	10.2	65.9	34.0	
			Meadow Vole	8.1	71.3	59.5	
			Cottontail Rabbit	2.7	13.8	28.2	
			Mink	2.9	21.1	29.2	3.74e-04
			Red Fox	1.8	17.6	20.9	
			Whitetail Deer	0.8	24.8	11.7	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Chlordane	Red-winged Blackbird	10.7	American Robin	10.1	8.3	73.1	
not applicable			American Woodcock	7.4	9.7	73.0	
			Wild Turkey	2.4	80.6	73.8	
			Belted Kingfisher	8.1	16.0	75.1	2.84e-04
			Great Blue Heron	3.2	18.4	73.2	3.27e-04
			Barred Owl	4.8	41.1	73.5	
			Barn Owl	5.6	20.7	74.0	
			Cooper's Hawk	5.7	32.7	73.2	
			Red-tailed Hawk	4.2	42.9	73.1	
			Osprey	3.8	18.9	73.6	3.35e-04
			Rough-winged Swallow	16.9	22.4	72.8	
Chlordecone (Kepone)	Rat	0.4	Short-tailed Shrew	1.13	1.89	5.14	
not applicable			Little Brown Bat	1.42	4.27	8.89	
			White-footed Mouse	1.00	6.45	3.32	
			Meadow Vole	0.79	6.98	5.82	
			Cottontail Rabbit	0.27	1.35	2.76	
			Mink	0.28	2.06	2.86	
			Red Fox	0.17	1.72	2.04	
			Whitetail Deer	0.07	2.43	1.14	
Chloroform	Rat	41	Short-tailed Shrew	115.9	193.2	527.0	
not applicable			Little Brown Bat	145.7	437.2	910.8	
			White-footed Mouse	102.2	661.1	340.6	
			Meadow Vole	81.3	715.3	596.1	
			Cottontail Rabbit	27.3	138.2	282.4	
			Mink	29.0	211.6	292.9	1.10e+01
			Red Fox	17.7	176.5	209.0	
			Whitetail Deer	7.7	248.7	117.0	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Chromium	Black Duck	5	American Robin	12.5	10.4	91.1	
Cr^{+3} as $CrK(SO_4)_2$			American Woodcock	9.2	12.1	90.9	
			Wild Turkey	3.0	100.4	92.0	
			Belted Kingfisher	10.1	20.0	93.5	
			Great Blue Heron	4.0	23.0	91.2	
			Barred Owl	6.0	51.3	91.6	
			Barn Owl	6.9	25.8	92.2	
			Cooper's Hawk	7.1	40.8	91.2	
			Red-tailed Hawk	5.2	53.5	91.1	
			Osprey	4.7	23.5	91.7	
			Rough-winged Swallow	21.1	28.0	90.7	
Chromium	Rat	13.14	Short-tailed Shrew	37.2	61.9	168.9	
Cr^{+6}			Little Brown Bat	46.7	140.1	291.9	
			White-footed Mouse	32.7	211.9	109.1	
			Meadow Vole	26.0	229.2	191.0	
			Cottontail Rabbit	8.8	44.3	90.5	
			Mink	9.3	67.8	93.9	1.82e+01
			Red Fox	5.7	56.6	67.0	
			Whitetail Deer	2.5	79.7	37.5	
Copper	Mink	15.14	Short-tailed Shrew	60.5	100.9	275.2	
Copper Sulfate			Little Brown Bat	76.1	228.3	475.6	
			White-footed Mouse	53.3	345.2	177.8	
			Meadow Vole	42.4	373.5	311.2	
			Cottontail Rabbit	14.3	72.2	147.5	
			Mink	15.1	110.5	152.9	3.80e-01
			Red Fox	9.2	92.2	109.1	
			Whitetail Deer	4.0	129.9	61.1	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Copper	Chick	61.7	American Robin	116.9	96.8	849.2	
Copper Oxide			American Woodcock	85.6	113.0	847.4	
			Wild Turkey	28.1	936.1	857.3	
			Belted Kingfisher	94.2	185.9	871.6	6.41e-01
			Great Blue Heron	37.6	214.1	850.0	7.38e-01
			Barred Owl	56.0	477.8	854.0	
			Barn Owl	64.5	240.6	859.3	
			Cooper's Hawk	65.8	380.2	849.9	
			Red-tailed Hawk	48.2	498.3	848.6	
			Osprey	43.9	219.4	854.8	7.56e-01
			Rough-winged Swallow	196.7	260.7	845.5	
DDT (and metabolites)	Rat	4	Short-tailed Shrew	11.31	18.85	51.41	
not applicable			Little Brown Bat	14.22	42.65	88.86	
			White-footed Mouse	9.97	64.50	33.23	
			Meadow Vole	7.93	69.78	58.15	
			Cottontail Rabbit	2.66	13.49	27.55	
			Mink	2.83	20.65	28.57	1.32e-05
			Red Fox	1.72	17.22	20.39	
			Whitetail Deer	0.75	24.26	11.41	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
DDT (and metabolites)	Brown Pelican	0.028	American Robin	0.099	0.082	0.717	
not applicable			American Woodcock	0.072	0.095	0.715	
			Wild Turkey	0.024	0.790	0.723	
			Belted Kingfisher	0.080	0.157	0.736	1.00e-07
			Great Blue Heron	0.032	0.181	0.717	1.15e-07
			Barred Owl	0.047	0.403	0.721	
			Barn Owl	0.054	0.203	0.725	
			Cooper's Hawk	0.056	0.321	0.717	
			Red-tailed Hawk	0.041	0.421	0.716	
			Osprey	0.037	0.185	0.721	1.18e-07
			Rough-winged Swallow	0.166	0.220	0.714	
1,2-Dichloroethane	Chicken	34.4	American Robin	94	78	680	
not applicable			American Woodcock	69	90	679	
			Wild Turkey	22	750	687	
			Belted Kingfisher	75	149	698	1.85e+01
			Great Blue Heron	30	171	681	2.12e+01
			Barred Owl	45	383	684	
			Barn Owl	52	193	688	
			Cooper's Hawk	53	304	681	
			Red-tailed Hawk	39	399	680	
			Osprey	35	176	685	2.17e+01
			Rough-winged Swallow	158	209	677	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Dieldrin	Rat	0.2	Short-tailed Shrew	0.57	0.94	2.57	
not applicable			Little Brown Bat	0.71	2.13	4.44	
			White-footed Mouse	0.50	3.22	1.66	
			Meadow Vole	0.40	3.49	2.91	
			Cottontail Rabbit	0.13	0.67	1.38	
			Mink	0.14	1.03	1.43	4.61e-04
			Red Fox	0.09	0.86	1.02	
			Whitetail Deer	0.04	1.21	0.57	
Di-n-butyl phthalate	Mouse	1833	Short-tailed Shrew	2304	3840	10473	
not applicable			Little Brown Bat	2896	8689	18102	
			White-footed Mouse	2031	13139	6768	
			Meadow Vole	1615	14215	11846	
			Cottontail Rabbit	543	2747	5613	
			Mink	576	4206	5821	4.71e+00
			Red Fox	351	3508	4154	
			Whitetail Deer	152	4943	2324	
Di-n-butyl phthalate	Ring Dove	1.1	American Robin	1.4	1.1	10.1	
not applicable			American Woodcock	1.0	1.3	10.0	
			Wild Turkey	0.3	11.1	10.2	
			Belted Kingfisher	1.1	2.2	10.3	2.47e-03
			Great Blue Heron	0.4	2.5	10.1	2.85e-03
			Barred Owl	0.7	5.7	10.1	
			Barn Owl	0.8	2.9	10.2	
			Cooper's Hawk	0.8	4.5	10.1	
			Red-tailed Hawk	0.6	5.9	10.1	
			Osprey	0.5	2.6	10.1	2.92e-03
			Rough-winged Swallow	2.3	3.1	10.0	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Di-n-hexyl phthalate	Mouse	550	Short-tailed Shrew	691	1152	3143	
not applicable			Little Brown Bat	869	2607	5432	
			White-footed Mouse	609	3942	2031	
			Meadow Vole	485	4265	3554	
			Cottontail Rabbit	163	824	1684	
			Mink	173	1262	1747	
			Red Fox	105	1053	1246	
			Whitetail Deer	46	1483	697	
1,4-Dioxane	Rat	1	Short-tailed Shrew	2.83	4.71	12.85	
not applicable			Little Brown Bat	3.55	10.66	22.22	
			White-footed Mouse	2.49	16.12	8.31	
			Meadow Vole	1.98	17.45	14.54	
			Cottontail Rabbit	0.67	3.37	6.89	
			Mink	0.71	5.16	7.14	4.74e+00
			Red Fox	0.43	4.31	5.10	
			Whitetail Deer	0.19	6.07	2.85	
Endrin	Mouse	0.92	Short-tailed Shrew	1.16	1.93	5.26	
not applicable			Little Brown Bat	1.45	4.36	9.09	
			White-footed Mouse	1.02	6.59	3.40	
			Meadow Vole	0.81	7.13	5.95	
			Cottontail Rabbit	0.27	1.38	2.82	
			Mink	0.29	2.11	2.92	9.44e-04
			Red Fox	0.18	1.76	2.09	
			Whitetail Deer	0.08	2.48	1.17	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Endrin	Screech Owl	0.1	American Robin	0.14	0.11	1.00	
not applicable			American Woodcock	0.10	0.13	1.00	
			Wild Turkey	0.03	1.10	1.01	
			Rough-winged Swallow	0.23	0.31	1.00	
			Belted Kingfisher	0.11	0.21	0.99	9.43e-05
			Great Blue Heron	0.04	0.24	0.96	1.09e-04
			Barred Owl	0.06	0.54	0.97	
			Barn Owl	0.07	0.27	0.97	
			Cooper's Hawk	0.07	0.43	0.96	
			Red-tailed Hawk	0.05	0.57	0.96	
			Osprey	0.05	0.25	0.97	1.11e-04
Ethanol	Rat	319	Short-tailed Shrew	902	1503	4100	
not applicable			Little Brown Bat	1134	3402	7087	
			White-footed Mouse	795	5144	2650	
			Meadow Vole	632	5565	4638	
			Cottontail Rabbit	212	1076	2198	
			Mink	226	1647	2279	1.55e+03
			Red Fox	137	1373	1626	
			Whitetail Deer	60	1935	910	
Ethyl Acetate	Rat	360	Short-tailed Shrew	1018	1697	4627	
not applicable			Little Brown Bat	1280	3839	7998	
			White-footed Mouse	897	5805	2990	
			Meadow Vole	714	6280	5234	
			Cottontail Rabbit	240	1214	2480	
			Mink	255	1858	2572	
			Red Fox	155	1550	1835	
			Whitetail Deer	67	2184	1027	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Fluoride	mink	52.75	Short-tailed Shrew	211	352	959	
NaF			Little Brown Bat	265	795	1657	
			White-footed Mouse	186	1203	620	
			Meadow Vole	148	1301	1084	
			Cottontail Rabbit	50	251	514	
			Mink	53	385	533	
			Red Fox	32	321	380	
			Whitetail Deer	14	452	213	
Fluoride	Screech Owl	32	American Robin	42	35	308	
NaF			American Woodcock	31	41	308	
			Wild Turkey	10	340	311	
			Belted Kingfisher	34	67	316	
			Great Blue Heron	14	78	308	
			Barred Owl	20	173	310	
			Barn Owl	23	87	312	
			Cooper's Hawk	24	138	308	
			Red-tailed Hawk	18	181	308	
			Osprey	16	80	310	
			Rough-winged Swallow	71	95	307	
Heptachlor	Mink	1	Short-tailed Shrew	4.0	6.7	18.2	
not applicable			Little Brown Bat	5.0	15.1	31.4	
			White-footed Mouse	3.5	22.8	11.7	
			Meadow Vole	2.8	24.7	20.6	
			Cottontail Rabbit	0.9	4.8	9.7	
			Mink	1.0	7.3	10.1	6.40e-03
			Red Fox	0.6	6.1	7.2	
			Whitetail Deer	0.3	8.6	4.0	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
1,2,3,6,7,8-Hexachloro Dibenzofuran	Rat	0.0016	Short-tailed Shrew	0.0045	0.0075	0.0206	
not applicable			Little Brown Bat	0.0057	0.0171	0.0355	
			White-footed Mouse	0.0040	0.0258	0.0133	
			Meadow Vole	0.0032	0.0279	0.0233	
			Cottontail Rabbit	0.0011	0.0054	0.0111	
			Mink	0.0011	0.0083	0.0114	
			Red Fox	0.0007	0.0069	0.0082	
			Whitetail Deer	0.0003	0.0097	0.0046	
Lead	Rat	80	Short-tailed Shrew	226	377	1028	
Lead Acetate			Little Brown Bat	284	853	1777	
			White-footed Mouse	199	1290	665	
			Meadow Vole	159	1396	1163	
			Cottontail Rabbit	53	270	551	
			Mink	57	413	571	9.03e+00
			Red Fox	34	344	408	
			Whitetail Deer	15	485	228	
Lead	Japanese Quail	11.3	American Robin	14	12	102	
acetate			American Woodcock	10	14	102	
			Wild Turkey	3	113	103	
			Belted Kingfisher	11	22	105	4.95e-01
			Great Blue Heron	5	26	102	5.70e-01
			Barred Owl	7	58	103	
			Barn Owl	8	29	104	
			Cooper's Hawk	8	46	102	
			Red-tailed Hawk	6	60	102	
			Osprey	5	26	103	5.84e-01
			Rough-winged Swallow	24	31	102	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Lindane (Gamma-BHC)	Mallard Duck	20	American Robin	47	39	339	
not applicable			American Woodcock	34	45	338	
			Wild Turkey	11	373	342	
			Belted Kingfisher	38	74	348	1.87e-01
			Great Blue Heron	15	85	339	2.16e-01
			Barred Owl	22	191	341	
			Barn Owl	26	96	343	
			Cooper's Hawk	26	152	339	
			Red-tailed Hawk	19	199	338	
			Osprey	17	87	341	2.21e-01
			Rough-winged Swallow	78	104	337	
Lithium	Rat	18.8	Short-tailed Shrew	53	89	242	
Lithium Carbonate			Little Brown Bat	67	200	418	
			White-footed Mouse	47	303	156	
			Meadow Vole	37	328	273	
			Cottontail Rabbit	13	63	130	
			Mink	13	97	134	
			Red Fox	8	81	96	
			Whitetail Deer	4	114	54	
Manganese	Rat	284	Short-tailed Shrew	803	1338	3650	
Manganese Oxide			Little Brown Bat	1009	3028	6309	
			White-footed Mouse	708	4579	2359	
			Meadow Vole	563	4955	4129	
			Cottontail Rabbit	189	958	1956	
			Mink	201	1466	2029	
			Red Fox	122	1223	1448	
			Whitetail Deer	53	1723	810	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Mercury	Japanese Quail	0.9	American Robin	1.12	0.93	8.15	
Mercuric Chloride			American Woodcock	0.82	1.08	8.13	
			Wild Turkey	0.27	8.98	8.22	
			Belted Kingfisher	0.90	1.78	8.36	
			Great Blue Heron	0.36	2.05	8.15	
			Barred Owl	0.54	4.58	8.19	
			Barn Owl	0.62	2.31	8.24	
			Cooper's Hawk	0.63	3.65	8.15	
			Red-tailed Hawk	0.46	4.78	8.14	
			Osprey	0.42	2.10	8.20	
			Rough-winged Swallow	1.89	2.50	8.11	
Mercury	Rat	0.16	Short-tailed Shrew	0.45	0.75	2.06	
Methyl Mercury Chloride			Little Brown Bat	0.57	1.71	3.55	
			White-footed Mouse	0.40	2.58	1.33	
			Meadow Vole	0.32	2.79	2.33	
			Cottontail Rabbit	0.11	0.54	1.10	
			Mink	0.11	0.83	1.14	
			Red Fox	0.07	0.69	0.82	
			Whitetail Deer	0.03	0.97	0.46	
Mercury	Mink	0.025	Mink	0.025	0.182	0.253	3.04e-06
Methyl Mercury Chloride			Red Fox	0.015	0.152	0.180	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Mercury	Mallard Duck	0.064	American Robin	0.149	0.124	1.084	
Methyl Mercury Dicyandiamide			American Woodcock	0.109	0.144	1.081	
			Wild Turkey	0.036	1.194	1.094	
			Belted Kingfisher	0.120	0.237	1.112	3.95e-06
			Great Blue Heron	0.048	0.273	1.085	4.55e-06
			Barred Owl	0.071	0.610	1.090	
			Barn Owl	0.082	0.307	1.096	
			Cooper's Hawk	0.084	0.485	1.084	
			Red-tailed Hawk	0.062	0.636	1.083	
			Osprey	0.056	0.280	1.091	4.66e-06
			Rough-winged Swallow	0.251	0.333	1.079	
Methanol	Rat	250	Short-tailed Shrew	707	1178	3213	
not applicable			Little Brown Bat	889	2666	5554	
			White-footed Mouse	623	4031	2077	
			Meadow Vole	496	4361	3634	
			Cottontail Rabbit	166	843	1722	
			Mink	177	1291	1786	1.47e+03
			Red Fox	108	1076	1275	
			Whitetail Deer	47	1516	713	
Methoxychlor	Rat	8	Short-tailed Shrew	22.6	37.7	102.8	
not applicable			Little Brown Bat	28.4	85.3	177.7	
			White-footed Mouse	19.9	129.0	66.5	
			Meadow Vole	15.9	139.6	116.3	
			Cottontail Rabbit	5.3	27.0	55.1	
			Mink	5.7	41.3	57.1	
			Red Fox	3.4	34.4	40.8	
			Whitetail Deer	1.5	48.5	22.8	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Methylene Chloride	Rat	50	Short-tailed Shrew	141	236	643	
not applicable			Little Brown Bat	178	533	1111	
			White-footed Mouse	125	806	415	
			Meadow Vole	99	872	727	
			Cottontail Rabbit	33	169	344	
			Mink	35	258	357	4.32e+01
			Red Fox	22	215	255	
			Whitetail Deer	9	303	143	
Methyl Ethyl Ketone	Rat	4571	Short-tailed Shrew	12925	21542	58752	
not applicable			White-footed Mouse	11391	73705	37969	
			Little Brown Bat	16247	48742	101546	
			Meadow Vole	9062	79744	66453	
			Cottontail Rabbit	3044	15412	31488	
			Mink	3233	23596	32653	1.39e+04
			Red Fox	1968	19679	23304	
			Whitetail Deer	854	27726	13039	
Molybdenum	Mouse	2.6	Short-tailed Shrew	3.3	5.4	14.9	
Molybdate (MoO_4)			Little Brown Bat	4.1	12.3	25.7	
			White-footed Mouse	2.9	18.6	9.6	
			Meadow Vole	2.3	20.2	16.8	
			Cottontail Rabbit	0.8	3.9	8.0	
			Mink	0.8	6.0	8.3	
			Red Fox	0.5	5.0	5.9	
			Whitetail Deer	0.2	7.0	3.3	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Molybdenum	Chicken	35.3	American Robin	94	78	683	
sodium molybdate			American Woodcock	69	91	682	
			Wild Turkey	23	753	690	
			Belted Kingfisher	76	150	701	
			Great Blue Heron	30	172	684	
			Barred Owl	45	384	687	
			Barn Owl	52	194	691	
			Cooper's Hawk	53	306	684	
			Red-tailed Hawk	39	401	683	
			Osprey	35	177	688	
			Rough-winged Swallow	158	210	680	
Nickel	Rat	80	Short-tailed Shrew	226	377	1028	
Nickel Sulfate Hexahydrate			Little Brown Bat	284	853	1777	
			White-footed Mouse	199	1290	665	
			Meadow Vole	159	1396	1163	
			Cottontail Rabbit	53	270	551	
			Mink	57	413	571	3.87e+00
			Red Fox	34	344	408	
			Whitetail Deer	15	485	228	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Nickel	Mallard Duckling	107	American Robin	230	190	1670	
Nickel Sulfate			American Woodcock	168	222	1667	
			Wild Turkey	55	1841	1686	
			Belted Kingfisher	185	366	1714	3.44e+00
			Great Blue Heron	74	421	1672	3.96e+00
			Barred Owl	110	940	1680	
			Barn Owl	127	473	1690	
			Cooper's Hawk	129	748	1672	
			Red-tailed Hawk	95	980	1669	
			Osprey	86	432	1681	4.06e+00
			Rough-winged Swallow	387	513	1663	
Niobium	Mouse	1.55	Short-tailed Shrew	1.95	3.25	8.86	
Sodium Niobate			Little Brown Bat	2.45	7.35	15.31	
			White-footed Mouse	1.72	11.11	5.72	
			Meadow Vole	1.37	12.02	10.02	
			Cottontail Rabbit	0.46	2.32	4.75	
			Mink	0.49	3.56	4.92	
			Red Fox	0.30	2.97	3.51	
			Whitetail Deer	0.13	4.18	1.97	
Nitrate	Guinea Pig	1130	Short-tailed Shrew	4299	7165	19540	
Potassium Nitrate			Little Brown Bat	5404	16211	33773	
			White-footed Mouse	3788	24514	12628	
			Meadow Vole	3014	26522	22102	
			Cottontail Rabbit	1012	5126	10473	
			Mink	1075	7848	10860	
			Red Fox	654	6545	7750	
			Whitetail Deer	284	9221	4336	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
1,2,3,7,8-Pentachloro Dibenzofuran	Rat	0.0016	Short-tailed Shrew	0.0045	0.0075	0.0206	
not applicable			Little Brown Bat	0.0057	0.0171	0.0355	
			White-footed Mouse	0.0040	0.0258	0.0133	
			Meadow Vole	0.0032	0.0279	0.0233	
			Cottontail Rabbit	0.0011	0.0054	0.0111	
			Mink	0.0011	0.0083	0.0114	
			Red Fox	0.0007	0.0069	0.0082	
			Whitetail Deer	0.0003	0.0097	0.0046	
2,3,4,7,8-Pentachloro Dibenzofuran	Rat	1.6e-04	Short-tailed Shrew	0.00045	0.00075	0.00206	
not applicable			Little Brown Bat	0.00006	0.00017	0.00035	
			White-footed Mouse	0.00040	0.00258	0.00133	
			Meadow Vole	0.00032	0.00279	0.00233	
			Cottontail Rabbit	0.00011	0.00054	0.00110	
			Mink	0.00011	0.00083	0.00114	
			Red Fox	0.00007	0.00069	0.00082	
			Whitetail Deer	0.00003	0.00097	0.00046	
Pentachloronitrobenzene	Chicken	70.7	American Robin	188	156	1368	
not applicable			American Woodcock	138	182	1365	
			Wild Turkey	45	1508	1381	
			Belted Kingfisher	152	300	1404	1.16e-01
			Great Blue Heron	61	345	1370	1.34e-01
			Barred Owl	90	770	1376	
			Barn Owl	104	388	1384	
			Cooper's Hawk	106	613	1369	
			Red-tailed Hawk	78	803	1367	
			Osprey	71	354	1377	1.37e-01
			Rough-winged Swallow	317	420	1362	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Pentachlorophenol	Rat	2.4	Short-tailed Shrew	6.8	11.3	30.8	
not applicable			Little Brown Bat	8.5	25.6	53.3	
			White-footed Mouse	6.0	38.7	19.9	
			Meadow Vole	4.8	41.9	34.9	
			Cottontail Rabbit	1.6	8.1	16.5	
			Mink	1.7	12.4	17.1	4.81e-03
			Red Fox	1.0	10.3	12.2	
			Whitetail Deer	0.4	14.6	6.8	
Selenium	Mouse	0.76	Short-tailed Shrew	0.96	1.59	4.34	
Selanate			Little Brown Bat	1.20	3.60	7.51	
			White-footed Mouse	0.84	5.45	2.81	
			Meadow Vole	0.67	5.89	4.91	
			Cottontail Rabbit	0.22	1.14	2.33	
			Mink	0.24	1.74	2.41	6.71e-04
			Red Fox	0.15	1.45	1.72	
			Whitetail Deer	0.06	2.05	0.96	
Selenium	Mallard Duck	1	American Robin	2.3	1.9	16.9	
Sodium Selanite			American Woodcock	1.7	2.3	16.9	
			Wild Turkey	0.6	18.7	17.1	
			Belted Kingfisher	1.9	3.7	17.4	1.43e-03
			Great Blue Heron	0.8	4.3	16.9	1.64e-03
			Barred Owl	1.1	9.5	17.0	
			Barn Owl	1.3	4.8	17.1	
			Cooper's Hawk	1.3	7.6	16.9	
			Red-tailed Hawk	1.0	9.9	16.9	
			Osprey	0.9	4.4	17.0	1.68e-03
			Rough-winged Swallow	3.9	5.2	16.9	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Selenium	Mallard Duck	0.8	American Robin	1.9	1.5	13.5	
Selanomethionine			American Woodcock	1.4	1.8	13.5	
			Wild Turkey	0.4	14.9	13.7	
			Belted Kingfisher	1.5	3.0	13.9	
			Great Blue Heron	0.6	3.4	13.6	
			Barred Owl	0.9	7.6	13.6	
			Barn Owl	1.0	3.8	13.7	
			Cooper's Hawk	1.0	6.1	13.6	
			Red-tailed Hawk	0.8	7.9	13.5	
			Osprey	0.7	3.5	13.6	
			Rough-winged Swallow	3.1	4.2	13.5	
2,3,7,8-Tetrachloro Dibenzodioxin	Rat	1e-05	Short-tailed Shrew	0.000028	0.000047	0.00013	
not applicable			Little Brown Bat	0.000036	0.00011	0.00022	
			White-footed Mouse	0.000025	0.00016	0.00008	
			Meadow Vole	0.000020	0.00017	0.00015	
			Cottontail Rabbit	0.000007	0.00003	0.00007	
			Mink	0.000007	0.00005	0.00007	5.98e-10
			Red Fox	0.000004	0.00004	0.00005	
			Whitetail Deer	0.000002	0.00006	0.00003	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
2,3,7,8-Tetrachloro Dibenzodioxin	Ring-necked Pheasant	1.4e-04	American Robin	0.00033	0.00027	0.00237	
not applicable			American Woodcock	0.00024	0.00032	0.00237	
			Wild Turkey	0.00008	0.00261	0.00239	
			Belted Kingfisher	0.00026	0.00052	0.00243	5.99e-09
			Great Blue Heron	0.00011	0.00060	0.00237	6.89e-09
			Barred Owl	0.00016	0.00133	0.00238	
			Barn Owl	0.00018	0.00067	0.00240	
			Cooper's Hawk	0.00018	0.00106	0.00237	
			Red-tailed Hawk	0.00013	0.00139	0.00237	
			Osprey	0.00012	0.00061	0.00239	7.06e-09
			Rough-winged Swallow	0.00055	0.00073	0.00236	
2,3,7,8-Tetrachloro Dibenzofuran	Chick	1.0e-05	American Robin	0.000012	0.00001	0.00008	
not applicable			American Woodcock	0.000009	0.00001	0.00008	
			Wild Turkey	0.000003	0.00009	0.00009	
			Belted Kingfisher	0.000009	0.00002	0.00009	
			Great Blue Heron	0.000004	0.00002	0.00008	
			Barred Owl	0.000006	0.00005	0.00009	
			Barn Owl	0.000006	0.00002	0.00009	
			Cooper's Hawk	0.000007	0.00004	0.00008	
			Red-tailed Hawk	0.000005	0.00005	0.00009	
			Osprey	0.000004	0.00002	0.00009	
			Rough-winged Swallow	0.000020	0.00003	0.00008	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
1,1,2,2-Tetrachloroethylene	Mouse	7	Short-tailed Shrew	8.8	14.7	40.0	
not applicable			Little Brown Bat	11.1	33.2	69.1	
			White-footed Mouse	7.8	50.2	25.8	
			Meadow Vole	6.2	54.3	45.2	
			Cottontail Rabbit	2.1	10.5	21.4	
			Mink	2.2	16.1	22.2	7.09e-02
			Red Fox	1.3	13.4	15.9	
			Whitetail Deer	0.6	18.9	8.9	
Thallium	Rat	0.074	Short-tailed Shrew	0.212	0.354	0.964	
Thallium Sulfate			Little Brown Bat	0.267	0.800	1.667	
			White-footed Mouse	0.187	1.210	0.623	
			Meadow Vole	0.149	1.309	1.091	
			Cottontail Rabbit	0.050	0.253	0.517	
			Mink	0.053	0.387	0.536	1.12e-02
			Red Fox	0.032	0.323	0.383	
			Whitetail Deer	0.014	0.455	0.214	
Tin	Mouse	35	Short-tailed Shrew	44.0	73.3	200.0	
bis(Tributyltin) oxide (TBTO)			Little Brown Bat	55.3	165.9	345.6	
			White-footed Mouse	38.8	250.9	129.2	
			Meadow Vole	30.8	271.4	226.2	
			Cottontail Rabbit	10.4	52.5	107.2	
			Mink	11.0	80.3	111.1	
			Red Fox	6.7	67.0	79.3	
			Whitetail Deer	2.9	94.4	44.4	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Tin	Japanese Quail	16.9	American Robin	21.1	17.4	153.0	
bis(Tributyltin) oxide (TBTO)			American Woodcock	15.4	20.4	152.7	
			Wild Turkey	5.1	168.6	154.4	
			Belted Kingfisher	17.0	33.5	157.0	
			Great Blue Heron	6.8	38.6	153.1	
			Barred Owl	10.1	86.1	153.9	
			Barn Owl	11.6	43.3	154.8	
			Cooper's Hawk	11.9	68.5	153.1	
			Red-tailed Hawk	8.7	89.8	152.9	
			Osprey	7.9	39.5	154.0	
			Rough-winged Swallow	35.4	47.0	152.3	
Toluene	Mouse	260	Short-tailed Shrew	327	545	1486	
not applicable			Little Brown Bat	411	1232	2568	
			White-footed Mouse	288	1864	960	
			Meadow Vole	229	2016	1680	
			Cottontail Rabbit	77	390	796	
			Mink	82	597	826	8.44e+00
			Red Fox	50	498	589	
			Whitetail Deer	22	701	330	
Trichloroethylene	Mouse	7	Short-tailed Shrew	8.8	14.7	40.0	
not applicable			Little Brown Bat	11.1	33.2	69.1	
			White-footed Mouse	7.8	50.2	25.8	
			Meadow Vole	6.2	54.3	45.2	
			Cottontail Rabbit	2.1	10.5	21.4	
			Mink	2.2	16.1	22.2	3.88e-01
			Red Fox	1.3	13.4	15.9	
			Whitetail Deer	0.6	18.9	8.9	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Uranium	Mouse	6.13	Short-tailed Shrew	7.5	12.6	34.2	
Uranyl Acetate			Little Brown Bat	9.5	28.4	59.2	
			White-footed Mouse	6.6	43.0	22.1	
			Meadow Vole	5.3	46.5	38.7	
			Cottontail Rabbit	1.8	9.0	18.3	
			Mink	1.9	13.8	19.0	
			Red Fox	1.1	11.5	13.6	
			Whitetail Deer	0.5	16.2	7.6	
Vanadium	Rat	2.1	Short-tailed Shrew	5.4	9.0	24.5	
Sodium Metavanadate			Little Brown Bat	6.8	20.3	42.3	
			White-footed Mouse	4.7	30.7	15.8	
			Meadow Vole	3.8	33.2	27.7	
			Cottontail Rabbit	1.3	6.4	13.1	
			Mink	1.3	9.8	13.6	
			Red Fox	0.8	8.2	9.7	
			Whitetail Deer	0.4	11.5	5.4	
Vinyl Chloride	Rat	1.7	Short-tailed Shrew	4.8	8.0	21.9	
not applicable			Little Brown Bat	6.0	18.1	37.8	
			White-footed Mouse	4.2	27.4	14.1	
			Meadow Vole	3.4	29.7	24.7	
			Cottontail Rabbit	1.1	5.7	11.7	
			Mink	1.2	8.8	12.1	1.24e+00
			Red Fox	0.7	7.3	8.7	
			Whitetail Deer	0.3	10.3	4.8	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Xylene (mixed isomers)	Mouse	2.6	Short-tailed Shrew	3.3	5.4	14.9	
not applicable			Little Brown Bat	4.1	12.3	25.7	
			White-footed Mouse	2.9	18.6	9.6	
			Meadow Vole	2.3	20.2	16.8	
			Cottontail Rabbit	0.8	3.9	8.0	
			Mink	0.8	6.0	8.3	3.73e-02
			Red Fox	0.5	5.0	5.9	
			Whitetail Deer	0.2	7.0	3.3	
Zinc	Rat	320	Short-tailed Shrew	905	1508	4113	
Zinc Oxide			Little Brown Bat	1137	3412	7109	
			White-footed Mouse	797	5160	2658	
			Meadow Vole	634	5583	4652	
			Cottontail Rabbit	213	1079	2204	
			Mink	226	1652	2286	1.71e+00
			Red Fox	138	1378	1631	
			Whitetail Deer	60	1941	913	

Table 13. (continued)

Contaminant and Form	Test Species	Test Species LOAEL[a] (mg/kg-d)	Endpoint Species[b]	Estimated Wildlife LOAEL[c] (mg/kg-d)	Toxicological Benchmarks		
					Diet[d] (mg/kg)	Water[e] (mg/L)	Piscivore Water Value[f] (mg/L)
Zinc	Chicken (White Leghorn Hen)	131	American Robin	380	314	2758	
Zinc sulfate			American Woodcock	278	367	2752	
			Wild Turkey	91	3040	2784	
			Belted Kingfisher	306	604	2830	6.25e-01
			Great Blue Heron	122	695	2760	7.20e-01
			Barred Owl	182	1552	2773	
			Barn Owl	210	781	2790	
			Cooper's Hawk	214	1235	2760	
			Red-tailed Hawk	157	1618	2756	
			Osprey	142	712	2776	7.37e-01
			Rough-winged Swallow	639	847	2745	

[a] See Appendix A for LOAEL derivation, study duration, and study endpoint.
[b] See Appendix B for body weights, food and water consumption rates.
[c] Calculated using Eq. 4.
[d] Calculated using Eq. 8.
[e] Calculated using Eq. 19.
[f] Combined food and water benchmark for aquatic-feeding species. Calculated using Eq. 26.

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