ES/ER/TM-86/R3

Toxicological Benchmarks for Wildlife: 1996 Revision

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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 9 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 9 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 20 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 from animal data (EPA 1992, 1995). 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 were 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 AND LOAELS 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). For mammals, it has been shown that this relationship is best expressed in terms of body weight (bw) raised to the 3/4 power ($bw^{3/4}$) (Travis and White 1988, Travis et al. 1990, EPA 1992a). If the dose (d) has been calculated in terms of unit body weight (i.e., mg/kg), then the metabolic rate-based dose (D) equates to:

$$D = \frac{d \text{ x } bw}{bw^{3/4}} = d \text{ x } bw^{1/4}. \tag{1}$$

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

$$d_a \text{ x } bw_a^{1/4} = d_b \text{ x } bw_b^{1/4}. \tag{2}$$

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:

$$d_a = d_b \text{ x } \frac{bw_b^{1/4}}{bw_a^{1/4}} = d_b \text{ x } \left(\frac{bw_b}{bw_a}\right)^{1/4}. \tag{3}$$

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

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

Recent research suggests that physiological scaling factors developed for mammals may not be appropriate for interspecies extrapolation among birds. Mineau et al. (1996) developed body weight-based scaling factors for birds using LC_{50} data for 37 pesticides. Scaling factors ranged from 0.63 to 1.55 with a mean of 1.15. However, scaling factors for the majority of the chemicals evaluated (29 of 37) were not significantly different from 1. A scaling factor of 1 was therefore considered most appropriate for interspecies extrapolation among birds. If the dose (d) itself has been calculated in terms of unit body weight (i.e., mg/kg), then the extrapolated dose (D) equates to:

$$D = \frac{d \text{ x } bw}{bw^{1}} = d \text{ x } bw^{0}. \tag{5}$$

For birds, if a NOAEL was available for an avian test species ($NOAEL_t$), the equivalent NOAEL for an avian wildlife species ($NOAEL_w$) would be calculated by using the adjustment factor for differences in body size:

$$NOAEL_w = NOAEL_t \left(\frac{bw_t}{bw_w}\right)^{0} = NOAEL_t \ (1) = NOAEL_t \tag{6}$$

EPA uses this scaling methodology in carcinogenicity assessments and reportable quantity documents for adjusting from animal data to an equivalent human dose (EPA 1992). The same approach has also been proposed for use in extrapolating from one animal species to another as part of the Great Lakes Water Quality Initiative (EPA 1995).

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.

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 (EPA 1995), the LOAEL can be reduced by a factor of up to 10 to derive the NOAEL.

$$\text{NOAEL} = \frac{\text{LOAEL}}{\leq 10}. \tag{7}$$

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 (EPA 1995):

$$\text{chronic NOAEL} = \frac{\text{subchronic NOAEL}}{\leq 10}. \tag{8}$$

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 technical support for the Great Lakes Water Initiative Wildlife Criteria, EPA (1995) 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 $(\text{LD}_{50})_w$ for the compound of interest.

$$\text{NOAEL}_w = (\text{LD}_{50})_w \frac{\text{NOAEL}_a}{(\text{LD}_{50})_a}. \tag{9}$$

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:

$$C_f = \frac{\text{NOAEL}_w}{f}. \tag{10}$$

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):

$$f = \frac{F}{bw}. \tag{11}$$

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):

$$F = 0.056(bw)^{0.6611} \quad \text{(laboratory mammals)}. \tag{12}$$

$$F = 0.054(bw)^{0.9451} \quad \text{(moist diet)}. \tag{13}$$

$$F = 0.049(bw)^{0.6087} \quad \text{(dry diet)}. \tag{14}$$

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):

$$F = 0.235(bw)^{0.822} \quad \text{(placental mammals).} \tag{15}$$

$$F = 0.621(bw)^{0.564} \quad \text{(rodents).} \tag{16}$$

$$F = 0.577(bw)^{0.727} \quad \text{(herbivores).} \tag{17}$$

$$F = 0.492(bw)^{0.673} \quad \text{(marsupials).} \tag{18}$$

$$F = 0.648(bw)^{0.651} \quad \text{(birds).} \tag{19}$$

$$F = 0.398(bw)^{0.850} \quad \text{(passerine birds).} \tag{20}$$

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:

$$C_w = \frac{NOAEL_w \text{ x } bw_w}{W}. \tag{21}$$

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:

$$C_w = \frac{NOAEL_w}{\omega}. \tag{22}$$

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):

$$W = 0.10(bw)^{0.7377} \quad \text{(laboratory mammals).} \tag{23}$$

$$W = 0.009(bw)^{1.2044} \quad \text{(mammals, moist diet).} \tag{24}$$

$$W = 0.093(bw)^{0.7584} \quad \text{(mammals, dry diet).} \tag{25}$$

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):

$$W = 0.099(bw)^{0.90} \tag{26}$$

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

$$W = 0.059(bw)^{0.67} \tag{27}$$

3.5 COMBINED FOOD AND WATER BENCHMARKS FOR PISCIVOROUS WILDLIFE

If a wildlife species (such as mink, river otter, belted kingfisher, great blue heron, or osprey) 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 1995a, 1995b, 1995c):

$$C_w = \frac{NOAEL_w \times bw_w}{W + (F \times BAF)} \tag{28}$$

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 1995c).

Table 2. Aquatic food chain multiplying factors[a]

	Prey Trophic Level[b]		
Log P_{oct}	**2**	**3**	**4**
2	1	1.005	1
2.5	1	1.01	1.002
3	1	1.028	1.007
3.1	1	1.034	1.007
3.2	1	1.042	1.009
3.3	1	1.053	1.012
3.4	1	1.067	1.014
3.5	1	1.083	1.019
3.6	1	1.103	1.023
3.7	1	1.128	1.033
3.8	1	1.161	1.042
3.9	1	1.202	1.054
4	1	1.253	1.072
4.1	1	1.315	1.096
4.2	1	1.38	1.13
4.3	1	1.491	1.178
4.4	1	1.614	1.242
4.5	1	1.766	1.334
4.6	1	1.95	1.459
4.7	1	2.175	1.633
4.8	1	2.452	1.871
4.9	1	2.78	2.193
5	1	3.181	2.612
5.1	1	3.643	3.162
5.2	1	4.188	3.873
5.3	1	4.803	4.742
5.4	1	5.502	5.821
5.5	1	6.266	7.079
5.6	1	7.096	8.551
5.7	1	7.962	10.209
5.8	1	8.841	12.05
5.9	1	9.716	13.964
6	1	10.556	15.996
6.1	1	11.337	17.783
6.2	1	12.064	19.907
6.3	1	12.691	21.677
6.4	1	13.228	23.281
6.5	1	13.662	24.604
6.6	1	13.98	25.645

Table 2. (continued)

	Prey Trophic Level[b]		
Log P_{oct}	**2**	**3**	**4**
6.7	1	14.223	26.363
6.8	1	14.355	26.669
6.9	1	14.388	26.669
7	1	14.305	26.242
7.1	1	14.142	25.468
7.2	1	13.852	24.322
7.3	1	13.474	22.856
7.4	1	12.987	21.038
7.5	1	21.517	18.967
7.6	1	11.708	16.749
7.7	1	10.914	14.388
7.8	1	10.069	12.05
7.9	1	9.162	9.84
8	1	8.222	7.798
8.1	1	7.278	6.012
8.2	1	6.361	4.519
8.3	1	5.489	3.311
8.4	1	4.683	2.371
8.5	1	3.949	1.663
8.6	1	3.296	1.146
8.7	1	2.732	0.778
8.8	1	2.246	0.521
8.9	1	1.837	0.345
9	1	1.493	0.226

[a] From EPA 1993c.

[b] Trophic level: 2 = zooplankton; 3 = small fish; 4 = piscivorous fish, including top predators.

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):

$$\log\ BCF = 0.76\ \log\ P_{oct} - 0.23. \qquad (29)$$

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

$$\log\ BCF = 2.791 - 0.564\ \log\ WS \qquad (30)$$

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). Mink, belted kingfisher, great blue heron, and osprey consume 100% trophic level 3 fish (EPA 1995d); the trophic level 3 FCM appropriate for the log P_{oct} of the chemical was applied as appropriate. River otter were assumed to consume 80% trophic level 3 and 20% trophic level for fish (EPA 1995d). To calculate the final piscivore benchmark for river otter, the level 3 BAF was applied to 80% of the diet, and the level 4 BAF was applied to the remaining 20%.

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	Trophic Level 4 FCM	Trophic Level 4 BAF	Source[b]
Acetone	-0.24	0.39[a]	1	0.39	1	0.39	EPA 1995e
Aldrin	6.5	51286.14[a]	13.662	700671.22	24.604	1261844.15	EPA 1995e
Aluminum		231	1	231.00	1	231.00	EPA 1988c
Antimony		1	1	1.00	1	1.00	EPA 1980b
Aroclor 1016	5.6	10616.96[a]	7.096	75337.92	8.551	90785.59	ATSDR 1989
Aroclor 1242	5.6	10616.96[a]	7.096	75337.92	8.551	90785.59	ATSDR 1989
Aroclor 1248	6.2	30338.91[a]	12.064	366008.63	19.907	603956.72	ATSDR 1989
Aroclor 1254	6.5	51286.14[a]	13.662	1850000.00	24.604	6224000.00	ATSDR 1989, EPA 1995b[c]
Arsenic (arsenite)		17.00	1	17.00	1	17.00	EPA 1984g
Benzene	2.13	24.48[a]	1.005	24.60	1	24.48	EPA 1995e
beta-BHC	3.81	463.02[a]	1.161	537.56	1.042	482.47	EPA 1995e
BHC-mixed isomers	5.89	17636.00[a]	9.716	171351.34	13.964	246269.05	EPA 1995e
Benzo(a)pyrene	6.11	25917.91[a]	11.337	293831.36	17.783	460898.22	EPA 1995e
Beryllium		19.00	1	19.00	1	19.00	EPA 1980c
Bis(2-ethylhexyl) phthalate	7.3	207969.67[a]	13.747	2858959.04	22.856	4753354.75	EPA 1995e
Cadmium		12400.00	1	12400.00	1	12400.00	EPA 1984f
Carbon Tetrachloride	2.73	69.95[a]	1.01	70.65	1.002	70.09	EPA 1995e
Chlordane	6.32	37428.29[a]	12.691	475002.44	21.677	811333.07	EPA 1995e
Chlordecone (kepone)	5.3	6280.58[a]	4.803	30165.64	4.742	29782.53	EPA 1995e
Chloroform	1.92	16.95[a]	1.005	17.04	1	16.95	EPA 1995e
Chromium (Cr+6)		3.00	1	3.00	1	3.00	EPA 1985d
Copper		290.00	1	290.00	1	290.00	EPA 1985e
o-Cresol	1.99	19.16[a]	1.005	19.26	1	19.16	EPA 1995e
Cyanide		0.00	1	0.00	1	0.00	EPA 1985c
DDT (and metabolites)	6.53	54050.54[a]	13.662	1336000.00	24.604	3706000.00	EPA 1995e, EPA 1995b[c]
1,2-Dichloroethane	1.47	7.71[a]	1	7.71	1	7.71	EPA 1995e
1,1-Dichloroethylene	2.13	24.48[a]	1.005	24.60	1	24.48	EPA 1995e
1,2-Dichloroethylene	1.86	15.26[a]	1.006	15.35	1	15.26	EPA 1995e
Dieldrin	5.37	7099.05[a]	7.962	56522.61	10.209	72474.16	EPA 1995e
Diethylphthalate	2.5	46.77[a]	1.01	47.24	1.002	46.87	EPA 1995e
Di-n-butyl phthalate	4.61	1877.59[a]	1.95	3661.29	1.459	2739.40	EPA 1995e
1,4-Dioxane	-0.39	0.30[a]	1	0.30	1	0.30	EPA 1995e
Endosulfan	4.1	769.13[a]	1.315	1011.41	1.096	842.97	EPA 1995e
Endrin	5.06	4126.67[a]	3.643	15033.47	3.162	13048.54	EPA 1995e
Ethanol	-0.31	0.34[a]	1	0.34	1	0.34	EPA 1992b

Chemical and Form	Log P_{oct}	BCF	Trophic Level 3 FCM	Trophic Level 3 BAF	Trophic Level 4 FCM	Trophic Level 4 BAF	Source[b]
Ethyl Acetate	0.69	1.97[a]	1	1.97	1	1.97	EPA 1995e
Formaldehyde	-0.05	0.54[a]	1	0.54	1	0.54	EPA 1995e
Heptachlor	6.26	33697.68[a]	12.691	427657.26	21.677	730464.61	EPA 1995e
Lead		45.00	1	45.00	1	45.00	EPA 1985b
Lindane (Gamma-BHC)	3.73	402.53[a]	1.128	454.06	1.033	415.82	EPA 1995e
Mercury (Methyl Mercury Chloride)				27900.00		140000.00	EPA 1995b[c]
Methanol	-0.71	0.17[a]	1	0.17	1	0.17	EPA 1995e
Methoxychlor	5.08	4273.66[a]	3.643	15568.94	3.162	13513.31	EPA 1995e
Methylene Chloride	1.25	5.25[a]	1	5.25	1	5.25	EPA 1995e
Methyl Ethyl Ketone	0.28	0.96[a]	1	0.96	1	0.96	EPA 1995e
4-Methyl 2-Pentanone	1.19	4.73[a]	1	4.73	1	4.73	EPA 1992b
Nickel		106.00	1	106.00	1	106.00	EPA 1986f
Pentachloro-nitrobenzene	4.64	1978.79[a]	1.95	3858.64	1.459	2887.06	EPA 1995e
Pentachlorophenol	5.09	1000.00[a]	3.643	3643.00	3.162	3162.00	EPA 1995e
Selenium				2600.00		6800.00	Peterson and Nebeker 1992[c]
2,3,7,8-Tetrachloro-Dibenzodioxin	6.53	54050.54[a]	13.662	172100.00	24.604	264100.00	EPA 1995e, EPA 1995b[c]
1,1,2,2-Tetrachloro-ethylene	2.67	62.98[a]	1.01	63.61	1.002	63.11	EPA 1995e
Thallium		34.00	1	34.00	1	34.00	EPA 1980d
Toluene	2.75	72.44[a]	1.028	74.47	1.007	72.95	EPA 1995e
Toxaphene	5.5	8912.51[a]	6.266	55845.78	7.079	63091.65	EPA 1995e
1,1,1-Trichloroethane	2.48	45.16[a]	1.01	45.62	1.002	45.26	EPA 1995e
Trichloroethylene	2.71	67.55[a]	1.01	68.22	1.002	67.68	EPA 1995e
Vinyl Chloride	1.5	8.13[a]	1	8.13	1	8.13	EPA 1995e
Xylene (mixed isomers)	3.2	159.22[a]	1.042	165.91	1.009	160.65	EPA 1995e
Zinc		966.00	1	966.00	1	966.00	EPA 1987

[a] Values estimated using Eq. 29

[b] Citation for P_{oct} values unless otherwise noted.

[a] Source for BAF values.

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. 12 and 23). 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. 12, 13, and 14.

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. 12, 13, and 14.
[d] Estimated using reference body weight (see Table 1) and Eqs. 23, 24 and 25.

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. 10. Similarly, concentrations in water (C_w) equivalent to the NOAELs were estimated from the water factors given in Table 1 and Eq. 22.

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]

					NOAEL (as arsenic)				
Species	BW (kg)	Food factor f[c]	Water factor ω[c]	LOAEL	Dose (mg/kg)	$C_f^{(8)}$ (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	$0.126^{(10)}$	0.7	$0.5^{(5)}$	39.4	0.002
White-footed mouse	0.022	0.155	0.3						
	Extrapolated from data for laboratory mice →				$0.13^{(4)}$	0.88	0.45		
Rat	0.35	0.05	0.13		$5^{(10)}$	62.5	38.5	15.1	0.21
Cotton rat	0.15	0.070	0.12						
	Extrapolated from data for laboratory rat →				$6.2^{(4)}$	88	51.5		
	Extrapolated from data for laboratory mouse →				$0.08^{(4)}$	1.2	0.7		
Dog	12.7	0.024	0.051		$1.2^{(10)}$	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 →				$0.036^{(4)}$	0.36	0.43		
Whitetail deer	56.5	0.031	0.065					>19.5	
	Extrapolated from data for laboratory rat →				$1.4^{(4)}$	45.5	21.4		
	Extrapolated from data for dog →				$0.83^{(4)}$	26.8	12.6		
	Extrapolated from data for laboratory mice →				$0.02^{(4)}$	0.62	0.29		

[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 $\geq$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 $\geq$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. 10 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. 10.

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

						Benchmarks			
Species	**bw (kg)**	Food factor *f*	Water factor **ω**	LOAEL (ppm diet)	NOAEL (mg/kg/d)	C_f (mg/kg food)	C_w (mg/L)	LD_{50} (mg/kg)	NOAEL/LD_{50}
Rat (lab)	0.35	0.08	0.13		0.4(10)	5.0	3.1	1,010	0.0004
Oldfield Mouse	0.014			5	≥0.068(10)				
White-footed mouse	0.022	0.155	0.3	10	≥0.155(10)	1.0	0.52		
	Extrapolated from oldfield mouse data →				0.061(4)	0.39(10)	0.20(22)		
	Extrapolated from rat data →				0.8(4)	5.2(10)	2.66(22)		
	Extrapolated from mink data →				0.34(4)	2.2(10)	1.12(22)		
Mink	0.80[c]	0.137	0.099		0.137(10)	1	0.71	1.25	0.06
	Extrapolated from white-footed mouse data →				0.06(4)	0.46(10)	0.63(22)		
	Extrapolated from oldfield mouse data →				≥0.025(4)	0.18(10)	0.25(22)		
	Extrapolated from rat data →				0.33(4)	2.37(10)	3.29(22)		
Cotton rat	0.15	0.07	0.12						
	Extrapolated from white-footed mouse data →				≥0.096(4)	1.37(10)	0.8(22)		
	Extrapolated from oldfield mouse data →				0.038(4)	0.54(10)	0.31(22)		
	Extrapolated from rat data →				0.49(4)	7.06(10)	4.12(22)		
	Extrapolated from mink data →				0.21(4)	3.0(10)	1.73(22)		
Whitetail deer	56.5	0.031	0.065						
	Extrapolated from white-footed mouse data →				≥0.022(4)	0.71(10)	0.33(22)		
	Extrapolated from oldfield mouse data →				0.009(4)	0.28(10)	0.13(22)		
	Extrapolated from rat data →				0.11(4)	3.64(10)	1.71(22)		
	Extrapolated from mink data →				0.05(4)	1.53(10)	0.72(22)		

[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 (0.009 mg/kg bw/day) extrapolated from the data for the oldfield mouse. The NOAEL derived from the mink data (0.05 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.

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).

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 $(bw_t/bw_w)^{1/4}$**
rat	0.35	short-tailed shrew	0.015	2.2
rat	0.35	white-footed mouse	0.022	2.0
rat	0.35	meadow vole	0.044	1.68
rat	0.35	cottontail rabbit	1.2	0.73
rat	0.35	mink	1.0	0.77

Table 11. (continued)

Experimental Animals		Wildlife		
Species	Body Weight[a] (bw$_t$, in kg)	Species	Body weight[b] (bw$_w$ in kg)	Scaling factor (bw$_t$/bw$_w$)$^{1/4}$
rat	0.35	red fox	4.5	0.53
rat	0.35	whitetail deer	56.5	0.28
mouse	0.03	short-tailed shrew	0.015	1.19
mouse	0.03	white-footed mouse	0.022	1.08
mouse	0.03	meadow vole	0.044	0.91
mouse	0.03	cottontail rabbit	1.2	0.40
mouse	0.03	mink	1.0	0.42
mouse	0.03	red fox	4.5	0.29
mouse	0.03	whitetail deer	56.5	0.15

[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 Table 12 (NOAELs and LOAELs) (**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 to 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.

6.1 CHANGES IN BENCHMARKS

In this revision of the toxicological benchmarks for wildlife, new studies were selected as the basis for the mammalian benchmarks for cadmium and selenium. The logic for the selection of the new studies is outlined in the following sections.

6.2 CADMIUM

A total of six studies were evaluated for the revision of the cadmium benchmark (Schroeder and Mitchner 1971, Baranski et al. 1983, Webster 1978, Wills et al. 1981, Machemer and Lorke 1981, and Sutou et al. 1980a). Detailed summaries of the results of each study are listed in Appendix E. All studies considered reproductive effects to rats or mice following oral exposure to cadmium salts. Study durations extended from mating through gestation to up to 4 generations. Two studies report only experimental NOAELs (Baranski et al. 1983, Webster 1978). Because these studies did not identify a LOAEL, they were considered inadequate for benchmark derivation.

The 1994 benchmark was based by Schroeder and Mitchner (1971). In this study, only one dose level was administered and only an experimental LOAEL is reported. Using Eq. 7, a NOAEL was estimated. Because this study considered only one dose level, requiring the estimation of the NOAEL, it was considered inappropriate for benchmark derivation if high quality studies with both a NOAEL and LOAEL are available. Experimental NOAELs and LOAELs were observed in three studies (Wills et al. 1981, Machemer and Lorke 1981, and Sutou et al. 1980a).

The 1995 cadmium benchmark was based on the results of Wills et al. (1981). The NOAELs and LOAELs from this study were much lower than those from other studies, and when they were used in risk assessments performed at Oak Ridge National Laboratory, the results indicated that cadmium toxicity should be expected at uncontaminated background locations. Because exposures at uncontaminated background locations are assumed to be nonhazardous, the results of Wills et al. (1981) were believe to be too conservative and therefore inappropriate for benchmark derivation.

Both the remaining studies (Machemer and Lorke 1981, Sutou et al. 1980a) were considered suitable for benchmark derivation (considered multiple dose levels, identified experimental NOAELs and LOAELs, and were greater than background exposure). Of the two studies, the lowest NOAELs and LOAELs were reported by Sutou et al. (1980a). To be conservative, the results of this study were selected for derivation of the 1996 cadmium benchmark.

6.3 SELENIUM

A total of six studies were evaluated for the revision of the selenium benchmark (Schroeder and Mitchner 1971, Rosenfeld and Beath 1954, Nobunga et al. 1979, Chiachun et al. 1991, Tarantal et al. 1991, and Chernoff and Kavlock 1982). Detailed summaries of the results of each study are listed in Appendix E. All studies considered reproductive effects following oral exposure to organic or inorganic selenium compounds. Study durations extended from mating through gestation to up to 3 generations. Two studies report only experimental NOAELs (Nobunga et al. 1979, Chiachun et al. 1991). Because these studies did not identify a LOAEL, they were considered inadequate for benchmark derivation.

Two studies report only experimental LOAELs (Schroeder and Mitchner 1971, Chernoff and Kavlock 1982). In both studies, only one dose level was administered and only an experimental LOAEL is reported. Because these studies considered only one dose level, requiring the estimation of the NOAEL, they were considered inappropriate for benchmark derivation if high quality studies with both a NOAEL and LOAEL are available. Experimental NOAELs and LOAELs were observed in two studies (Rosenfeld and Beath 1954, Tarantal et al. 1991).

Tarantal et al. (1991) exposed pregnant female long-tailed macaques to three dose levels of selenomethionine for 30 days during gestation. While no adverse effects were observed at the lowest dose level (0.025 mg/kg/d), fetal mortality was 30% and 20%, and adult toxicity was observed in the 0.15 and 0.3 mg/kg/d groups. Because the fetal mortality observed at the higher doses are within the range observed among the macaque colony at large, they may not be the result of selenium toxicity. Because a definitive LOAEL could not be established, this study was determined to be inappropriate for benchmarks derivation.

In the last study, Rosenfeld and Beath (1954) exposed rats to 1.5, 2.5, or 7.5 mg selenium/L in drinking water for two generations. While no adverse effects on reproduction were observed among rats exposed to 1.5 mg /L in drinking water, the number of second-generation young was reduced by 50% among females in the 2.5 mg/L group. In the 7.5 mg/L group, fertility, juvenile growth, and survival were reduced. In addition, the LOAEL observed in this study is lower than the LOAELs observed by Schroeder and Mitchner (1971) and Chernoff and Kavlock (1982). Because the study by Rosenfeld and Beath (1954) considered multiple dose levels over two generations and identified experimental NOAELs and LOAELs that were consistent with results of other studies, it was selected as the most appropriate for derivation of the 1996 selenium benchmark.

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 13 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 13. 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 (mg/L)	**Soil (mg/kg)**	**Estimated in Plants[a] (mg/kg)**	**Water (mg/L)**	**Diet (mg/kg)**	**Water**		**Diet**	
						HQ[b]	**Retain as COPC**	**HQ[b]**	**Retain as COPC**
Arsenic	0.038	131	5.24	0.84	1.01	0.045	NO	5.2	YES
Lead	0.069	18.8	0.85	98.5	118.2	0.0007	NO	0.007	NO
Mercury[c]	0.005	0.71	0.64	0.39	0.47	0.013	NO	1.35	YES
Selenium	0.02	14.8	0.37	2.46	2.96	0.008	NO	0.125	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:

$$E_{total} = E_{food} + E_{water} + E_{soil} \, , \tag{31}$$

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 14 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:

$$E_{medium} = \frac{\text{Medium Consumption Rate (kg or L/d) x Analyte Concentration in Medium (mg/kg or mg/L}}{\text{Body Weight (kg)}} \tag{32}$$

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 14. 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	1.145	0.44
Lead	0.069	18.8	1.07	0.0094	0.043	0.122	0.174	134.35	0.0013
Mercury[b]	0.005	0.71	0.06	0.0007	0.0016	0.007	0.0093	0.27	0.035
Selenium	0.02	14.8	23.61	0.003	0.034	2.68	2.717	0.55	4.9

[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.

8. REFERENCES

Abiola, F. A. 1992. Ecotoxicity of organochloride insecticides: effects of endosulfan on birds reproduction and evaluation of its induction effects in partridge, *Perdix perdix* L. *Rev. Vet. Med*. 143: 443-450.

Alexander, G. R. 1977. Food of vertebrate predators on trout waters in north central lower Michigan. *Mich. Acad*. 10: 181-195.

Alumot, E. (Olomucki), E. Nachtomi, E. Mandel, and P. Holstein. 1976a. Tolerance and acceptable daily intake of chlorinated fumigants in the rat diet. *Fd. Cosmet. Toxicol*. 14: 105-110.

Alumot, E., M. Meidler, and P. Holstein. 1976b. Tolerance and acceptable daily intake of ethylene dichloride in the chicken diet. *Fd. Cosmet. Toxicol*. 14: 111-114.

Ambrose, A. M., P. S. Larson, J. F. Borzelleca, and G. R. Hennigar, Jr. 1976. Long-term toxicologic assessment of nickel in rats and dogs. *J. Food Sci. Tech*. 13: 181-187.

Anderson, D. W., R. W. Risebrough, L. A. Woods, Jr., L. R. DeWeese, and W. G. Edgecomb. 1975. Brown pelicans: improved reproduction off the southern California coast. *Science* 190: 806-808.

Anthony, E. L. P. and T. H. Kunz. 1977. Feeding strategies of the little brown bat, Myotis lucifugus, in Southern New Hampshire. *Ecology*. 58: 775-786.

Aulerich, R. J., A. C. Napolitano, S. J. Bursian, B. A. O lson, and J. R. Hochstein. 1987. Chronic toxicity of dietary fluorine in mink. J. Anim. Sci. 65: 1759-1767.

Aulerich, R. J. and R. K. Ringer. 1977. Current status of PCB toxicity, including reproduction in mink. *Arch. Environ. Contam. Toxicol*. 6: 279.

Aulerich, R. J. and R. K. Ringer. 1980. *Toxicity of the polychlorinated biphenyl Aroclor 1016 to mink*. Environmental Research Laboratory, Office of Research and Development.

Aulerich, R. J., R. K. Ringer, M. R. Bleavins, et al. 1982. Effects of supplemental dietary copper on growth, reproductive performance and kit survival of standard dark mink and the acute toxicity of copper to mink. *J. Animal Sci*. 55: 337-343.

Aulerich, R. J., R. K. Ringer, and S. Iwamoto. 1974. Effects of dietary mercury on mink. *Arch. Environ. Contam. Toxicol.* 2: 43-51.

ATSDR (Agency for Toxic Substances and Disease Registry). 1989. *Toxicological profile for selected PCBs (Aroclor-1260, -1254, -1248, -1242, -1232, -1221, and -1016)*. ATSDR/TP-88/21.

Azar, A., H. J. Trochimowicz, and M. E. Maxwell. 1973. Review of lead studies in animals carried out at Haskell Laboratory: two-year feeding study and response to hemorrhage study. **In:** *Environmental Health Aspects of Lead: Proceedings, International Symposium*, D. Barth et al., eds. Commission of European Communities. pp. 199-210.

Baes, C. F.,III, R. D. Sharp, A. L. Sjoren, and R. W. Shor. 1994. *A review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture*. Oak Ridge National Laboratory, Oak Ridge, TN. ORNL-5786

Baranski, B., I. Stetkiewisc, K. Sitarek, and W. Szymczak. 1983. Effects of oral, subchronic cadmium administration on fertility, prenatal and postnatal progeny development in rats. Arch. Toxicol. 54: 297–302.

Baroni, C., G. J. VanEsch, and U. Saffiotti. 1963. Carcinogenesis tests of two inorganic arsenicals. *Arch. Environ. Health*. 7: 668-674.

Barrett, G. W., and K. L . Stueck. 1976. Caloric ingestion rate and assimilation efficiency of the short-tailed shrew, Blarina brevicauda. *Ohio J. Sci*. 76: 25-26.

Barsotti, D. A., R. J. Marlar and J. R. Allen. 1976. Reproductive dysfunction in Rhesus monkeys exposed to low levels of polychlorinated biphenyls (Aroclor 1248). *Fd. Cosmet. Toxicol*. 14: 99-103.

Baxley, M. N., R. D. Hood, G. C. Vedel, W. P. Harrison, and G. M. Szczech. 1981. Prenatal toxicity of orally administered sodium arsenite in mice. *Bull. Environ. Contam. Toxicol*. 26: 749-756.

Beyer, W. N., E. Conner, and S. Gerould. 1994. Survey of soil ingestion by wildlife. *J. Wildl. Mgmt*. 58: 375-382.

Blakely, B. R., C. S. Sisodia, and T. K. Mukkur. 1980. The effect of methyl mercury, tetrethyl lead, and sodium arsenite on the humoral immune response in mice. *Toxicol. Appl. Pharmacol*. 52: 245-254.

Bleavins, M. R., R. J. Aulerich, and R. K. Ringer. 1980. Polychlorinated biphenyls (Aroclors 1016 and 1242): Effect on survival and reproduction in mink and ferrets. *Arch. Environ. Contam. Toxicol*. 9: 627-635.

Bleavins, M. R. and R. J. Aulerich. 1981. Feed consumption and food passage time in mink (Mustela vison) and European ferrets (Mustela putorius furo). *Lab. Anim. Sci*. 31: 268-269.

Bleavins, M. R., R. J. Aulerich, and R. K. Ringer. 1984. Effects of chronic dietary hexachlorobenzene exposure on the reproductive performance and survivability of mink and European ferrets. *Arch. Environ. Contam. Toxicol*. 13: 357-365.

Borzelleca, J. F., L. W. Condie, Jr., and J. L. Egle, Jr. 1988. Short-term toxicity (one-and ten-day gavage) of barium chloride in male and female rats. *J. American College of Toxicology*. 7: 675-685.

Buben, J. A. and E. J. O'Flaherty. 1985. Delineation of the role of metabolism in the hepatotoxicity of trichloroethylene and perchloroethylene: a dose-effect study. *Toxicol. Appl. Pharmacol*. 78: 105-122.

Buckner, C. H. 1964. Metabolism, food capacity, and feeding behavior in four species of shrews. *Can. J. Zool*. 42: 259-279.

Burt, W. H. and R. P. Grossenheider. 1976. *A field guide to the mammals of America north of Mexico*. Third Edition. Houghton Mifflin Co., Boston.

Byron, W. R., G. W. Bierbower, J. B. Brower, and W. H. Hansen. 1967. Pathological changes in rats and dogs from two-year feeding of sodium arsenite or sodium arsenate. *Toxicol. Appl. Pharmacol*. 10: 132-147.

Cain, B. W. and E. A. Pafford. 1981. Effects of dietary nickel on survival and growth of Mallard ducklings. *Arch. Environm. Contam. Toxicol*. 10: 737-745.

Calder, W. A. and E. J. Braun. 1983. Scaling of osmotic regulation in mammals and birds. *Am. J. Physiol*. 224: Rr601-R606.

Carriere, D., K. Fischer, D. Peakall, and P. Angehrn. 1986. Effects of dietary aluminum in combination with reduced calcium and phosphorus on the ring dove (*Streptopelia risoria*). *Water, Air, and Soil Poll*. 30: 757-764.

Chakravarty, S. and P. Lahiri. 1986. Effect of lindane on eggshell characteristics and calcium level in the domestic duck. *Toxicology*. 42: 245-258.

Chapman, J. A., J. G. Hockman, and M. M. Ojeda C. 1980. Sylvilagus floridanus. *Mamm. Species*. No. 136, pp. 1-8.

Chernoff, N., and R. J. Kavlock. 1982. An in vivo teratology screen utilizing pregnant mice. J. Toxicol. Environ. Health 10: 541–550.

Chew, R. M. 1951. The water exchanges of some small mammals. *Ecol. Monogr*. 21(3): 215-224.

Chiachun, T., C. Hong, and R. Haifun. 1991. The effects of selenium on gestation, fertility, and offspring in mice. Biol. Trace Elements Res. 30: 227–231.

Collins, W. T. and C. C. Capen. 1980. Fine structural lesions and hormonal alterations in thyroid glands of perinatal rats exposed in utero and by milk to polychlorinated biphenyls. *Am. J. Pathol*. 99: 125-142.

Cox, G. E., D. E. Bailey, and K. Morgareidge. 1975. *Toxicity studies in rats with 2-butanol including growth, reproduction and teratologic observations*. Food and Drug Research Laboratories, Inc., Waverly, NY, Report No. 91MR R 1673.

Craighead, J. J., and F. C. Craighead. 1969, Hawks, owls, and wildlife. Dover Publ. Co. New York. 443 pp.

Crum, J. A., S. J. Bursian, R. J. Aulerich, P. Polin, and W. E. Braselton. 1993. The reproductive effects of dietary heptachlor in mink (Mustela vison). Arch. Environ. Contam. Toxicol. 24: 156-164.

Dahlgren, R. B., R. L. Linder, and C. W. Carlson. 1972. Polychlorinated biphenyls: their effects on penned pheasants. *Environ. Health Perspect*. 1: 89-101.

Dalke, P. D. and P. R. Sime. 1941. Food habits of the eastern and New England cottontails. *J. Wildl. Manage*. 5(2): 216-228.

Dark, J., I. Zucker, and G. N. Wade. 1983. Photoperiodic regulation of body mass, food intake, and reproduction in meadow voles. *Am. J. Physiol*. 245: R334-R338.

Davis, A., R. Barale, G. Brun, et al. 1987. Evaluation of the genetic and embryotoxic effects of bis(tri-n-butyltin)oxide (TBTO), a broad-spectrum pesticide, in multiple in vivo and in vitro short-term tests. Muta. Res. 188: 65-95.

Dikshith, T. S. S., R. B. Raizada, M. K. Srivastava, and B. S. Kaphalia. 1984. Response of rats to repeated oral administration of endosulfan. *Ind. Health*. 22: 295-304.

Domingo, J. L., J. L. Paternain, J. M. Llobet, and J. Corbella. 1986. Effects of vanadium on reproduction, gestation, parturition and lactation in rats upon oral administration. *Life Sci*. 39: 819-824.

Dunn, J. S., P. B. Bush, N. H. Booth, R. L. Farrell, D. M. Thomason, and D. D. Goetsch. 1979. Effect of pentachloronitrobenzene upon egg production, hatchability, and residue accumulation in the tissues of White Leghorn hens. *Toxocol. Appl. Pharmacol*. 48: 425-433.

Dunning, J. B. 1984. *Body weights of 686 species of North American birds*. West. Bird Banding Assoc. Monogr. No. 1. Eldon Publ. Co. Cave Crk, AZ. 38 pp.

Dunning, J. B. 1993. CRC handbook of avian body masses CRC Press, Boca Raton, FL. 371 pp.

Edens, F., W. E. Benton, S. J. Bursian, and G. W. Morgan. 1976. Effect of Dietary Lead on Reproductive Performance in Japanese Quail, Coturnix coturnix japonica. Toxicol. Appl. Pharmacol. 38: 307-314.

Eisler, R. 1988. *Arsenic hazards to fish, wildlife, and invertebrates: a synoptic review*. Fish and Wildlife Service, U.S. Department of the Interior. Report No. 85(1.12).

EPA (U.S. Environmental Protection Agency). 1980a. *Guidelines and methodology used in the preparation of health effects assessment chapters of the consent decree water quality criteria documents*. Fed. Regist. 45(231): 79347-79356.

EPA. 1980b. *Ambient water quality criteria for antimony*. Office of Water Regulations and Standards, Washington, D.C.

EPA. 1980c. *Ambient water quality criteria for beryllium*. EPA 440/5-80-024. Office of Water Regulations and Standards, Washington, D.C.

EPA. 1980d. *Ambient water quality criteria for thallium*. EPA 440/5-80-074. Office of Water Regulations and Standards, Washington, D.C.

EPA. 1985a. *Reference values for risk assessment*. Prepared by Syracuse Research Corporation, Syracuse, NY for Environmental Criteria and Assessment Office, Cincinnati, OH.

EPA. 1985b. *Ambient water quality criteria for Lead - 1984*. EPA 440/5-84-027. Office of Water Regulations And Standards, Washington, D.C.

EPA. 1985c. *Ambient water quality criteria for cyanide - 1984*. EPA 440/5-84-028. Office of Water Regulations And Standards, Washington, D.C.

EPA. 1985d. *Ambient water quality criteria for chromium - 1984*. EPA 440/5-84-029. Office of Water Regulations and Standards, Washington, D.C.

EPA. 1985e. *Ambient water quality criteria for copper - 1984*. EPA 440/5-84-031. Office of Water Regulations and Standards, Washington, D.C.

EPA. 1985f. *Ambient water quality criteria for cadmium - 1984*. EPA 440/5-84-032. Office of Water Regulations and Standards, Washington, D.C.

EPA. 1985g. *Ambient water quality criteria for arsenic - 1984,* EPA 440/5-84-033. Office of Water Regulations and Standards, Washington, D.C.

EPA. 1986a. *Toxicology Handbook*. Government Institutes, Inc., Rockville, MD

EPA. 1986b. Guidelines for carcinogenic risk assessment. *Fed. Regist*. 51:33992.

EPA. 1986c. *90-day gavage study in albino rats using acetone*. Office of Solid Waste, Washington, D.C.

EPA. 1986d. *Rat oral subchronic study with ethyl acetate*. Office of Solid Waste, Washington, D.C.

EPA. 1986e. *Rat oral subchronic study with methanol*. Office of Solid Waste, Washington, D.C.

EPA. 1986f. *Ambient water quality criteria for nickel -1986*. EPA 440/5-86-004. Office of Water Regulations and Standards, Washington, D.C.

EPA. 1986g. Ambient water quality criteria for pentachlorophenol-986, EPA 440/5-86-009. Office of Water Regulations and Standards, Washington, D.C.

EPA. 1987. *Ambient aquatic life water quality criteria document for zinc*. EPA/440/5-87-003. Office of Research and Development, Washington, D.C.

EPA. 1988a. *Recommendations for and documentation of biological values for use in risk assessment*. Environmental Criteria and Assessment Office, Cincinnati, OH. EPA/600/6-87/008.

EPA. 1988b. *Methodology for evaluating potential carcinogenicity in support of reportable quantity adjustments pursuant to CERCLA Section 102*. OHEA-C-073, External Review Draft. Office of Health and Environmental Assessment, Washington, D.C.

EPA. 1988c. *Ambient water quality criteria for aluminum*. EPA/440/5-86-008. Office of Research and Development, Washington, D.C.

EPA. 1989. *Water quality criteria to protect wildlife resources*. EPA/600/3-89/067. Environmental Research Laboratory, Corvallis, OR.

EPA. 1992a. Draft Report: A cross-species scaling factor for carcinogen risk assessment based o n equivalence of mg/kg$^{3/4}$/day; Notice. Federal Register. 57(109)24152–24173.

EPA. 1992b. Dermal exposure assessment: principles and applications. EPA/600/8-91/011B, Office of Health and Environmental Assessment, Washington, D.C.

EPA. 1993a. *Wildlife exposure factors handbook*. Volume I. EPA/600/R-93/187a, Office of Research and Development, Washington, D.C.

EPA. 1993b. *Wildlife exposure factors handbook.* Volume II. EPA/600/R93/187b, Office of Research and Development, Washington, D.C.

EPA. 1993c. Water quality guidance for the Great Lakes System and correction; proposed rules. *Fed. Regist*. 58:20802–21047.

EPA. 1993d. *Wildlife criteria portions of the proposed water quality guidance for the Great Lakes system*. EPA/822/R-93/006. Office of Science and Technology, Washington, D.C.

EPA. 1993e. *Great Lakes water quality initiative criteria documents for the protection of wildlife (proposed): DDT, Mercury, 2,3,7,8-TCDD, PCBs*. EPA/822/R-93-007. Office Science and Technology, Washington, D.C.

EPA. 1993f. *Health effects assessment summary tables: Annual update*. U. S. Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. OHEA-ECAO-CIN-909.

EPA. 1994. Integrated Risk Information System (IRIS). Office of Health and Environmental Assessment. Environmental Criteria and Assessment Office. Cincinnati, Ohio.

EPA. 1995a. Great Lakes water quality initiative technical support document for wildlife criteria. EPA-820-B-95-009, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

EPA. 1995b. Great Lakes water quality initiative criteria documents for the protection of wildlife. EPA-820-B-95-008, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

EPA. 1995c. Final water quality guidance for the Great Lakes system; Final rule. Federal Register 60(56): 15366–15425.

EPA. 1995d. Trophic level and exposure analyses for selected piscivorous birds and mammals. Volume I: Analyses of species in the Great Lakes basin. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. 90 pp.

EPA. 1995e. Internal report on summary of measured, calculated, and recommended Log K_{ow} values. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. 38 pp.

Feron, V. J., C. F. M. Hendriksen, A. J. Speek, et al. 1981. Lifespan oral toxicity study of vinyl chloride in rats. *Food Cosmet. Toxicol.* 13:633–638.

Fitzhugh, O. G. 1948. Use of DDT insecticides on food products. *Ind. Eng. Chem.* 40: 704-705.

Fleming, W. J., M. A. Ross McLane, E. Cromartie. 1982. Endrin decreases screech owl productivity. J. Wildl. Manage. 46:462-468

Formigli, L., R. Scelsi, P. Poggi, C. Gregotti, A. DiNucci, E. Sabbioni, L. Gottardi, and L. Manzo. 1986. Thallium-induced testicular toxicity in the rat. *Environ. Res.* 40: 531-539.

Garthoff, L. H., F. E. Cerra, and E. M. Marks. 1981. Blood chemistry alteration in rats after single and multiple gavage administration of polychlorinated biphenyls. *Toxicol. Appl. Pharmacol.* 60: 33-44.

Gasaway, W. C. and I. O. Buss. 1972. Zinc toxicity in the mallard. *J. Wildl. Manage.* 36: 1107-1117.

Giavini, E., C. Vismara, and L. Broccia. 1985. Teratogenesis study of dioxane in rats. *Toxicol. Lett.* 26: 85-88.

Good, E. E., and G. W. Ware. 1969. Effects of insecticides on reproduction in the laboratory mouse, IV. Endrin and Dieldrin. *Toxicol. Appl. Pharmacol.* 14: 201-203.

Gould, Ed. 1955. The feeding efficiency of insectivorous bats. *J. Mammal*. 36: 399-407.

Grant, D. L., W. E. J. Phillips, and G. V. Hatina. 1977. Effects of hexachlorobenzene on reproduction in the rat. *Arch. Environ. Contam. Toxicol*. 5: 207-216.

Gray, L. E., Jr., J. Ostby, R. Sigmon, J. Ferrell, G. Rehnberg, R. Linder, R. Cooper, J. Goldman, and J. Laskey. 1988. The development of a protocol to assess reproductive effects of toxicants in the rat. *Reprod. Toxicol*. 2: 281-287.

Green, D. A. and J. S. Millar. 1987. Changes in gut dimensions and capacity of Peromyscus maniculatus relative to diet quality and energy needs. *Can. J. Zool*. 65: 2159-2162.

Harrison, J. W., E. W. Packman, and D.D. Abbott. 1958. Acute oral toxicity and chemical and physical properties of arsenic trioxides. *Arch. Ind. Health*. 17: 118-123.

Haseltine, S. D. and L. Sileo. 1983. Response of American Black ducks to dietary uranium: a proposed substitute for lead shot. *J. Wildl. Manage*. 47: 1124-1129.

Haseltine, S.D., L. Sileo, D.J. Hoffman, and B.D. Mulhern. 1985. Effects of chromium on reproduction and growth in black ducks.

Hazelton, P. K., R. J. Robel, and A. D. Dayton. 1984. Preferences and influence of paired food items on energy intake of American robins and gray catbirds. *J. Wildl. Manage*. 48(1): 198-202.

Heinz, G. H. 1979. Methyl mercury: reproductive and behavioral effects on three generations of mallard ducks. *J. Wildl. Mgmt*. 43: 394-401..

Heinz, G. H., D. J. Hoffman, A. J. Krynitsky, and D. M. G. Weller. 1987. Reproduction in mallards fed selenium. *Environ. Toxicol. Chem*. 6: 423-433.

Heinz, G. H., D. J. Hoffman, and L. G. Gold. 1989. Impaired reproduction of mallards fed an organic form of selenium. *J. Wildl. Mgmt*. 53: 418-428.

Hill, E. F. and C. S. Schaffner. 1976. Sexual maturation and productivity of Japanese Quail fed graded concentrations of mercuric chloride. Poult. Sci. 55: 1449-1459.

Hornshaw, T. C., R. J. Aulerich, and R. K. Ringer. 1986. Toxicity of o-Cresol to mink and European ferrets. *Environ. Toxicol*. 5: 713-720.

Hudson, R. H., R. K. Tucker, and M. A. Haegele. 1984. Handbook of toxicity of pesticides to wildlife. U.S. Fish and Wildl. Serv. Resour. Publ. 153. 90 pp.

Hurni, H. and H. Ohder. 1973. Reproduction study with formaldehyde and hexamethylenetetramine in Beagle dogs. *Fd. Cosmet. Toxicol*. 11: 459-462.

Ivankovic, S. and R. Preussmann. 1975. Absence of toxic and carcinogenic effects after administration of high doses of chromic oxide pigment in subacute and long-term feeding experiments in rats. *Fd. cosmet. Toxicol*. 13: 347-351.

Johnsgard, P. A. 1988. North American Owls: Biology and Natural History. Smithsonian Institution Press, Washington.

Johnson, D., Jr., A. L. Mehring, Jr., and H. W. Titus. 1960. Tolerance of chickens for barium. *Proc. Soc. Exp. Biol. Med*. 104: 436-438.

Kennedy, G. L.,Jr., J. P. Frawley., and J. C. Calandra. 1973. Multigeneration reproductive effects of three pesticides. Toxicol. Appl. Pharmacol. 25: 589-596.

Knoflach, P., B. Albini, and M. M. Weiser. 1986. Autoimmune disease induced by oral administration of mercuric chloride in brown-Norway rats. *Toxicol. Pathol*. 14: 188-193.

Korschgen, L. J. 1967. Feeding habits and foods. **In:** *The Wild Turkey and Its Management*. pp. 137-198.

Kushlan, J. A. 1978. Feeding ecology of wading birds. *Wading Birds*. National Audobon Society. p. 249-297.

Lamb, J. C., IV, R. E. Chapin, J. Teague, A. D. Lawton, and J. R. Reel. 1987. Reproductive effects of four phthalic acid esters in the mouse. *Toxicol. Appl. Pharmacol*. 88: 255-269.

Lane, R. W., B. L. Riddle, and J. F. Borzelleca. 1982. Effects of 1,2-dichloroethane and 1,1,1-trichloroethane in drinking water on reproduction and development in mice. *Toxicol. Appl. Pharmacol*. 63: 409-421.

Larson, P. S., J. L. Egle, Jr., G. R. Hennigar, R. W. Lane, and J. F. Borzelleca. 1979. Acute, subchronic, and chronic toxicity of chlordecone. *Toxicol. Appl. Pharmacol*. 48: 29-41.

Laskey, J. W., G. L. Rehnberg, J. F. Hein, and S. D. Carter. 1982. Effects of chronic manganese (Mn_3O_4) exposure on selected reproductive parameters in rats. *J. Toxicol. Environ. Health*. 9: 677-687.

Laskey, J. W., and F. W. Edens. 1985. Effects of chronic high-level manganese exposure on male behavior in the Japanese Quail (Cotirnix coturnix japonica). Poult. Sci. 64: 579-584.

Lepore, P. D., and R. F. Miller, 1965. Embryonic viability as influenced by excess molybdenum in chicken breeder diets. Proc. Soc. Exp. Biol. Med. 118: 155-157

Linder, R. E., T. B. Gaines, and R. D. Kimbrough. 1974. The effect of PCB on rat reproduction. *Food Cosmet. Toxicol*. 12: 63.

Linzey, A. V. 1987. Effects of chronic polychlorinated biphenyls exposure on reproductive success of white-footed mice (*Peromyscus leucopus*). *Arch. Environ. Contamin. Toxicol*. 16: 455-460.

Lyman, W. J., W. F. Reehl, and D. H. Rosenblatt. 1982. Handbook of chemical property estimation methods: environmental behavior of organic compounds. McGraw-Hill Book Company, New York.

McCoy, G, M. F. Finlay, A. Rhone, K. James, and G. P. Cobb. 1995. Chronic polychlorinated biphenyls exposure on three generations of oldfield mice (Permyscus polionotus): effects on reproduction, growth, and body residues. Arch. Environ. Contam. Toxicol. 28: 431-435

Machemer, L., and D. Lorke. 1981. Embryotoxic effect of cadmium on rats upon oral administration. Toxicol. Appl. Pharmacol. 58: 438–443.

Mackenzie, R. D., R. U. Byerrum, C. F. Decker, C. A. Hoppert, and R. F. Langham. 1958. Chronic toxicity studies, II. Hexavalent and trivalent chromium administered in drinking water to rats. *Am. Med. Assoc. Arch. Ind. Health*. 18: 232-234.

Mackenzie, K. M. and D. M. Angevine. 1981. Infertility in mice exposed in utero to benzo[a]pyrene. *Biol. Reprod*. 24: 183-191.

McKinney, J. D., K. Chae, B. N. Gupta, J. A. Moore, and J. A. Goldstein. 1976. Toxicological assessment of hexachlorobiphenyl and 2,3,7,8-tetrachlorodibenzofuran in chicks. I. Relationship of chemical parameters. Toxicol. Appl. Pharmacol. 36: 65-80.

McLane, M. A. R., and D. L. Hughes. 1980 Reproductive success of Screech owls fed Aroclor 1248. Arch. Environm. Contam. Toxicol. 9: 661-665.

Mankes, R. F., I. Rosenblum, K. F. Benitz, R. Lefevre, and R. Abraham. 1982. Teratogenic and reproductive effects of ethanol in Long-Evans rats. *J. of Toxicol. Environ. Health*. 10: 267-276.

Marathe, M. R.,and G. P. Thomas. 1986. Embryotoxicity and teratogenicity of lithium carbonate in Wistar rat. *Toxicol. Lett*. 34: 115-120.

Marks, T. A., T. A. Ledoux, and J. A. Moore. 1982. Teratogenicity of a commercial xylene mixture in the mouse. *J. Toxico. Environ. Health*. 9: 97-105.

Mautz, W. W., H. Silver, J. B. Holter, H. H. Hayes, and W. E. Urban. 1976. Digestibility and related nutritional data for seven northern deer browse species. *J. Wildl. Manage*. 40(4): 630-638.

Mehring, A. L. Jr., J. H. Brumbaugh, A. J. Sutherland, and H. W. Titus. 1960. The tolerance of growing chickens for dietary copper. *Poult. Sci*. 39: 713-719.

Mendenhall, V. M., E. E. Klaas, and M. A. R. McLane. 1983. Breeding success of barn owls (*Tyto alba*)fed low levels of DDE and dieldrin. *Arch. Environ. Contam. Toxicol*. 12: 235-240.

Menzies, C. A., D. E. Burmaster, J. S. Freshman, and C. A. Callahan. 1992. Assessment of methods for estimating ecological risk in the terrestrial component: a case study at the Baird and McGuire Superfund site in Holbrook, Massachusetts. *Environ. Toxicol. Chem*. 11: 245-260.

Merck. 1976. *The Merck Index: an encyclopedia of chemicals and drugs*. Merck and Co. Inc. Rahway, NJ. 1313pp.

Merson, M. H. and R. L. Kirkpatrick. 1976. Reproductive performance of captive white-footed mice fed a polychlorinated biphenyl. *Bull. Environ. Contam. Toxicol*. 16: 392-398.

Meyers, S. M. and S. M. Schiller. 1986. TERRE-TOX: a data base for the effects of anthropogenic substances on terrestrial animals. *J. Chem. Info. Comp. Sci*. 26: 33-36.

Microbiological Associates. 1986. Subchronic toxicity of methyl isobutyl ketone in Sprague-Dawley rats. Study No. 5221.0. Preliminary report to Research Triangle Institute, Research Triangle Park, NC.

Mineau, P., B. T. Collins, and A. Baril. 1996. On the use of scaling factors to improve interspecie s extrapolation of acute toxicity in birds. Reg. Toxicol. and Pharmacol. In Press.

Murray, F. J., F. A. Smith, K. D. Nitschke, C. G. Humiston, R. J. Kociba, and B. A. Schwetz. 1979. Three-generation reproduction study of rats given 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in the diet. *Toxicol. Appl. Pharmacol*. 50: 241-252.

Nagy, K. A. 1987. Field metabolic rate and food requirement scaling in mammals and birds. *Ecol. Monogr*. 57: 111-128.

NAS. 1977. Arsenic. Nat'l. Acad. Aci., Washington, D.C. 332 pp.

Nawrot, P. S. and R. E. Staples. 1979. Embryofetal toxicity and teratogenicity of benzene and toluene in the mouse. *Teratology*. 19: 41A

NCA (National Coffe Association). 1982. 24-month chronic toxicity and oncogenicity study of methylene chloride in rats. Final Report. Hazelton Laboratories, Inc., Vienna VA.

NCI. 1978. Bioassay of Aroclor 1254 for possible carcinogenicity. NCI Carcinogenesis Technical Rep. Series No. 38, NCI-CG-TR-38, DHEW Pub. No. (NIH) 78-838.

Neiger, R. D. and G. D. Osweiler. 1989. Effect of subacute low level dietary sodium arsenite on dogs. *Fund. Appl. Toxicol*. 13: 439-451.

Nobunga, T., H. Satoh, and T. Suzuki. 1979. Effects of sodium selenite on methyl mercur y embryotoxicity and teratogenicity in mice. Toxicol. Appl. Pharmacol. 47:79–88.

Nosek, J. A., S. R. Craven, J. R. Sullivan, S. S. Hurley, and R. E. Peterson. 1992. Toxicity and reproductive effects of 2,3,7,8-tetrachlorodibenzo-p-dioxin in ring-necked pheasants. *J. Toxicol. Environ. Health*. 35: 187-198.

NRCC. 1978. Effects of arsenic in the Canadian environment. Natl. Res. Coun. Canada. Publ. No. NRCC 15391. 349 pp.

Ondreicka, R., E. Ginter, and J. Kortus. 1966. Chronic toxicity of aluminum in rats and mice and its effects on phosphorus metabolism. *Brit. J. Indust. Med*. 23: 305-313.

Oswald, C., P. Fonken, D. Atkinson, and M. Palladino. 1993. Lactational water balance and recycling in White-footed mice, Red-backed voles, and gerbils. *J. Mammal*. 74: 963-970.

Palmer, A. K., D. D. Cozens, E. J. F. Spicer, and A. N. Worden. 1978. Effects of lindane upon reproductive functions in a 3-generation study in rats. *Toxicology*. 10: 45-54.

Palmer, A. K., A. E. Street, F. J. C. Roe, A. N. Worden, and N. J. Van Abbe. 1979. Safety evaluation of toothpaste containing chloroform, II. Long term studies in rats. *J. Environ. Pathol. Toxicol*. 2: 821-833.

Paternain, J. L., J. L. Domingo, A. Ortega, and J. M. Llobet. 1989. The effects of uranium on reproduction, gestation, and postnatal survival in mice. *Ecotoxicol. Environ. Saf*. 17: 291-296.

Pattee, O. H. 1984. Eggshell thickness and reproduction in American kestrels exposed to chronic dietary lead. *Arch Environ. Contam. Toxicol*. 13: 29-34.

Pattee, O. H., S. N. Wiemeyer, and D. M. Swineford. 1988. Effects of dietary fluoride on reproduction in eastern Screech-Owls. *Arch. Environ. Contam. Toxicol*. 17: 213-218.

Peakall, D. B. 1974. Effects of di-N-buylphthalate and di-2-ethylhexylphthalate on the eggs of ring doves. *Bull. Environ. Contam. Toxicol*. 12: 698-702.

Perry, H. M., E. F. Perry, M. N. Erlanger, and S. J. Kopp. 1983. Cardiovascular effects of chronic barium ingestion. In: Proc. 17th Ann. Conf. Trace Substances in Environ. Health, vol. 17. U. of Missouri Press, Columbia, MO.

Pershagen, G. and M. Vahter. 1979. Arsenic—a toxicological and epidemiological appraisal. Naturvardsverket Rapp. SNV PM 1128, Liber Tryck, Stockholm. 265 pp.

Peterson, J. A. and A. V. Nebeker. 1992. Estimation of waterborne selenium concentrations that are toxicity thresholds for wildlife. *Arch. Environ. Contam. Toxicol*. 23: 154-162.

Poiger, H., N. Pluess, and C. Schlatter. 1989. Subchronic toxicity of some chlorinated dibenzofurans to rats. *Chemosphere*. 18: 265-275.

Quast, J. F., C. G. Humiston, C. E. Wade, et al. 1983. A chronic toxicity and oncogenicity study in rats and subchronic toxicity in dogs on ingested vinylidene chloride. *Fund. Appl. Toxicol*. 3: 55-62.

Reich, L. M. 1981. Microtus pennsylvanicus. *Mammalian Spec*. 159: 1-8.

Revis, N., G. Holdsworth, G. Bingham, A. King, and J. Elmore. 1989. An assessment of health risk associated with mercury in soil and sediment from East Fork Poplar Creek, Oak Ridge, Tennessee. Oak Ridge Research Institute, Final Report, 58 pp.

Ringer, R. K., R. J. Aulerich and M. R. Bleavins. 1981. Biological effects of PCBs and PBBs on mink and ferrets; a review. **In:** *Halogenated Hydrocarbons: Health and Ecological Effects*. M.A.Q. Khan, ed. Permagon Press, Elmsford, NY, pp. 329-343.

Robertson, I.D., W. E. Harms, and P. J. Ketterer. 1984. Accidental arsenical toxicity to cattle. *Aust. Vet. J*. 61: 366-367.

Rosenfeld, I. and O. A. Beath. 1954. Effect of selenium on reproduction in rats. Proc. Soc. Exp. Biol. Med. 87: 295–297.

Sanders, O. T. and R. L. Kirkpatrick. 1975. Effects of a polychlorinated biphenyl on sleeping times, plasma corticosteroids, and testicular activity of white-footed mice. *Environ. Physiol. Biochem*. 5: 308-313.

Sargeant, A. B. 1978. Red fox prey demands and implications to prairie duck production. *J. Wildl. Manage*. 42(3): 520-527.

Schlatterer, B., T. M. M. Coenen, E. Ebert, R. Grau, V. Hilbig, and R. Munk. 1993. Effects of Bis(tri-n-butyltin)oxide in Japanese Quail exposed during egg laying period: an interlaboratory comparison study. Arch. Environ. Contam. Toxicol. 24: 440-448.

Schlesinger, W. H. and G. L. Potter. 1974. Lead, copper, and cadmium concentrations in small mammals in the Hubbard Brook experimental forest. *OIKOS*. 25: 148-152.

Schlicker, S. A. and D. H. Cox. 1968. Maternal dietary zinc, and development and zinc, iron, and copper content of the rat fetus. *J. Nutr*. 95: 287-294.

Schroeder, H. A. and J. J. Balassa. 1967. Arsenic, germanium, tin, and vanadium in mice: effects on growth, survival and tissue levels. *J. Nutr*. 92: 245-252.

Schroeder, H. A., M. Kanisawa, D. V. Frost, and M. Mitchener. 1968a. Germanium, tin, and arsenic in rats: effects on growth, survival and tissue levels. *J. Nutr*. 96: 37-45.

Schroeder, H. A., M. Mitchener, J. J. Balassa, M. Kanisawa, and A. P. Nason. 1968b. Zirconium, niobium, antimony, and fluorine in mice: effects on growth, survival and tissue levels. *J. Nutr*. 95: 95-101.

Schroeder, H. A and M. Mitchener. 1971. Toxic effects of trace elements on the reproduction of mice and rats. *Arch. Environ. Health*. 23: 102-106.

Schroeder, H. A and M. Mitchener. 1975. Life-term studies in rats: effects of aluminum, barium, beryllium, and tungsten. *J. Nutr*. 105: 421-427.

Schwetz, B. A., J. F. Quast, P. A. Keeler, C. G. Humiston, and R. J. Kociba. 1978. Results of two-year toxicity and reproduction studies on pentachlorophenol in rats. pp 301-309 in K. R. Rao, ed., Pentachlorophenol: Chemistry, Pharmacology, and Environmental Toxicology. Plenum Press, New York. 401 pp.

Sheldon, W. G. 1971. The book of the American woodcock. The University of Massachusetts Press, Amherst, MA. 227 pp.

Shellenberger, T. E. 1978. A multi-generation toxicity evaluation of P-P'-DDT and dieldrin with Japanese Quail. I. Effects on growth and reproduction. Drug Chem. Toxicol.1:137-146

Silva, M., and J. A. Downing. 1995. CRC handbook of mammalian body masses CRC Press, Boca Raton, FL. 359 pp.

Skorupa, J. P. and R. L. Hothem. 1985. Consumption of commercially-grown grapes by American robins: a field evaluation of laboratory estimates. *J. Field Ornithol*. 56(4): 369-378.

Skoryna, S. C. 1981. Effects of oral supplementation with stable strontium. *Can. Med. Assoc. J*. 125: 703-712.

Sleight, S. D. and O. A. Atallah. 1968. Reproduction in the guinea pig as affected by chronic administration of potassium nitrate and potassium nitrite. *Toxicol. Appl. Pharmacol*. 12: 179-185.

Smith, G. J. and V. P. Anders. 1989. Toxic effects of boron on mallard reproduction. Environ. Toxicol. Chem. 8: 943-950.

Smith W. P. 1991. Odocoileus virginianus. *Mammalian Species*. 388: 1-13.

Spann, J. W., G. H. Heinz, and C. S. Hulse. 1986. Reproduction and health in mallards fed endrin. *Environ. Toxicol. Chem*. 5: 755-759.

Stahl, J. L., J. L. Greger, and M. E. Cook. 1990. Breeding-hen and progeny performance when hens are fed excessive dietary zinc. Poult. Sci. 69: 259-263.

Steven, J. D., L. J. Davies, E. K. Stanley, R.A. Abbott, M. Ihnat, L. Bidstrup, and J. F. Jaworski. 1976. Effects of chromium in the Canadian environment. NRCC No. 151017. 168 pp.

Stickel, L. F., W. H. Stickel, R. A. Dyrland, and D. L. Hughes. 1983. Oxychlordane, HCS-3260, and nonachlor in birds: lethal residues and loss rates. *J. Toxicol. Environ. Health*. 12: 611-622.

Storm, G. L., R. D. Andrews, R. L. Phillips, R. A. Bishop, D. B. Siniff, and J. R. Tester. 1976. Morphology, reproduction, dispersal, and mortality of midwestern red fox populations. *Wildl. Monogr*.

Suter, G. W., II. 1993. *Ecological risk assessment*. Lewis Publ. Co., Boca Raton, Fl. 538 pp.

Sutou, S., K. Yamamoto, H. Sendota, K. Tomomatsu, Y. Shimizu, and M. Sugiyama. 1980a. Toxicity, fertility, teratogenicity, and dominant lethal tests in rats administered cadmium subchronically. I. Toxicity studies. Ecotoxicol. Environ. Safety 4:39–50.

Sutou, S., K. Yamamoto, H. Sendota, and M. Sugiyama. 1980b. Toxicity, fertility, teratogenicity, and dominant lethal tests in rats administered cadmium subchronically. I. Fertility, teratogenicity, and dominant lethal tests. Ecotoxicol. Environ. Safety. 4:51–56.

Tarantal, A.F., C. C. Willhite, B. L. Lasley, C. J. Murphy, C. J. Miller, M. J. Cukierski, S. A. Brooks, and A. G. Hendrickx. 1991. Developmental toxicity of l-selenomethionine in Macaca fascicularis. Fund. Appl. Toxicol.16:147–160.

Tewe, O. O. and J. H. Maner. 1981. Long-term and carry-over effect of dietary inorganic cyanide (KCN) in the life cycle performance and metabolism of rats. *Toxicol. Appl. Pharmacol*. 58: 1-7.

Travis, C. C., and A. D. Arms. 1988. Bioconcentration of organics in beef, milk, and vegetation. *Environ. Sci. Technol*. 22: 271-274.

Travis, C. C., and R. K. White. 1988. Interspecific scaling of toxicity data. Risk Analysis 8:119–125.

Travis, C. C., R. K. White, and R. C. Wards. 1990. Interspecies extrapolation of pharmacokinetics. J. Theor. Biol. 142:285–304.

Treon, J. F. and F. P. Cleveland. 1955. Toxicity of certain chlorinated hydrocarbon insecticides for laboratory animals, with special reference to aldrin and dieldrin. *Ag. Food Chem*. 3: 402-408.

USAF (U.S. Air Force Systems Command). 1989. The installation restoration program toxicology guide. Harry G. Armstrong Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, OH.

U.S. Fish and Wildlife Service. 1964. Pesticide-wildlife studies, 1963: a review of Fish and Wildlife Service investigations during the calendar year. FWS Circular 199.

U.S. Fish and Wildlife Service. 1969. Bureau of sport fisheries and wildlife. Publication 74, pp. 56–57.

Van Velsen, F. L., L. H. J. C. Danse, F. X. R. Van Leeuwen, J. A. M. A. Dormans, and M. J. Van Logten. 1986. The subchronic oral toxicity of the beta-isomer of hexachlorocyclohexane in rats. *Fund. Appl. Toxicol*. 6: 697-712.

Verschuuren, H. G., R. Kroes, E. M. Den Tonkelaar, J. M. Berkvens, P. W. Helleman, A. G. Rauws, P. L. Schuller, and G. J. Van Esch. 1976. Toxicity of methyl mercury chloride in rats. II. Reproduction study. *Toxicol*. 6: 97-106.

Villeneuve, D. C., D. L. Grant, K. Khera, D. J. Klegg, H. Baer, and W. E. J. Phillips. 1971. The fetotoxicity of a polychlorinated biphenyl mixture (Aroclor 1254) in the rabbit and in the rat. *Environ. Physiol*. 1: 67-71.

Vogtsberger, L. M. and G. W. Barrett. 1973. Bioenergetics of captive red foxes. *J. Wildl. Manage*. 37(4): 495-500.

Vos, J. G., H. L. Van Der Maas, A. Musch, and E. Ram. 1971. Toxicity of hexachlorobenzene in Japanese quail with special reference to porphyria, liver damage, reproduction, and tissue residues. *Toxicol. Appl. Pharmacol*. 18: 944-957.

Webster, W. S. 1978. Cadmium-induced fetal growth retardation in the mouse. Arch. Environ. Health. 33:36–43.

Weir, R. J., and R. S. Fisher. 1972. Toxicologica studies on borax and boric acid. Toxicol. Appl. Pharmacol. 23: 351-364.

Whitaker, J. O. 1980. The Audubon Society field guide to north American mammals. Alfred A. Knopf, New York, 745 pp.

White, D. H. and M. P. Dieter. 1978a. Effects of dietary vanadium in mallard ducks. *J. Toxicol. Environ. Health*. 4: 43-50.

White, D. H. and M. T. Finley. 1978b. Uptake and retention of dietary cadmium in mallard ducks. *Environ. Res*. 17: 53-59.

WHO (World Health Organization). 1984. Chlordane. *Environ. Health Criter*. 34. 82 pp.

Wills, J. H., G. E. Groblewski, and F. Coulston. 1981. Chronic and multigeneration toxicities of small concentrations of cadmium in the diet rats. Ecotoxicol. Environ. Safety 5: 452-464.

Wobeser, G., N. O. Nielson, and B. Schiefer. 1976. Mercury and mink II. Experimental methyl mercury intoxication. *Can. J. Comp. Med*. 34-45.

Woolson, E. A. (Ed.). 1975. Arsenical pesticides. *Am. Chem. Soc. Symp. Ser*. 7. 176 pp.

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)
Study 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:

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

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

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)
Study 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)
Study 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:

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

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: 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)
Study Duration: lifetime (>1 yr = chronic)
Endpoint: lifespan, longevity
Exposure Route: oral in water
Dosage: one dose level:
5 ppm Sb = LOAEL
Calculations:

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

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)
Study 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:

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

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

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)
Study **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:

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

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

Study **Duration:** 2 generations(during a critical lifestage = chronic)
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: one dose level:
3 ppm = NOAEL
Calculations:

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

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)
Study 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:

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

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)
Study **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
Study **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:

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

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)

Study Duration: 4.5 months (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:

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

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

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)
Study **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:

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

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

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)
Study 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:

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

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

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)
Study **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:

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

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

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)
Study **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:

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

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)
Study **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)
Study **Duration:** 4 wk (< 10 wk = subchronic)
Endpoint: mortality
Exposure Route: oral in diet
Dosage: eight dose level:
250, 500, 1000, 2000, 4000, 8000, 16,000, and 32,000 ppm
Ba (as Barium Hydroxide)
NOAEL = 2000 ppm

Calculations:

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

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

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)
Study **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)

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

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)
Study **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:

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

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

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)
Study **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:

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

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)
Study 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:

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

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

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)
Study 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:

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

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

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)
Study **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)
Study **Duration:** lifetime (> 1yr = chronic)
Endpoint: longevity, weight loss
Exposure Route: oral in water
Dosage: one dose level:
5 ppm Be = NOAEL
Calculations:

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

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)
Study **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:

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

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

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)
Study **Duration:** 4 weeks (during critical lifestage = chronic)
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: one dose level:
10 ppm = NOAEL
Calculations:

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

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)

Study **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:

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

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

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)

Study **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:

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

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

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: Sutou et al. (1980b)
Test Species: Rat
Body weight: 0.303 kg (mean from all dose levels; from Sutou et al. 1980a)
Study **Duration:** 6 weeks through mating and gestation (during a critical lifestage = chronic).
Endpoint: reproduction
Exposure Route: oral gavage
Dosage: four dose levels: 0, 0.1, 1.0, and 10.0 Cd/kg/d
1 mg/kg/d = NOAEL
10 mg/kg/d = LOAEL
Calculations: NA

Comments: While no adverse effects were observed at the 1 mg/kg/d dose level, fetal implantations were reduced by 28%, fetal survivorship was reduced by 50% and fetal resorptions increased by 400% amongst the 10 mg/kg/d group. Because the study considered oral exposure during reproduction, the 1 and 10 mg/kg/d doses were considered to be chronic NOAELs and LOAELs, respectively.

Final NOAEL: 1 mg/kg/d
Final LOAEL: 10 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)
Study **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:

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

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

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)
Study **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:

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

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)
Study **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:

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

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

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)
Study **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:

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

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

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)
Study **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:

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

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

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)
Study **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)
Study **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:

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

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)
Study **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:

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

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)
Study **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:

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

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.
Study **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:

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

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

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)
Study **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:

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

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

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)
Study **Duration:** 10 weeks (10 weeks = chronic)
Endpoint: growth, mortality
Exposure Route: oral in diet
Dosage: 11 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:

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

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

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)
Study **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:

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

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)
Study **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:

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

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)
Study **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:

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

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

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)
Study **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:

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

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)

Study **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)

Study **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:

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

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

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)
Study **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)
Study **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)
Study **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)
Study 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:

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

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
Study 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:

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

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)
Study 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:

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

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)
Study 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:

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

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

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)
Study Duration: 4 weeks (during a critical lifestage = chronic)
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: one dose level:
10 ppm = LOAEL

Calculations:

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

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)
Study 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:

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

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)
Study 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)
Study 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)
Study 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:

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

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)
Study Duration: 120 d (during a critical lifestage = chronic)..
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: one dose level:
5 ppm = LOAEL
Calculations:

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

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.

Study 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:

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

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

Study 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:

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

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)
Study 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)

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

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)
Study 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)
Study 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:

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

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

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
Study 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:

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

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

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)
Study 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)
Study 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 considered 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)
Study 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:

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

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

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)
Study 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:

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

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

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

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.
Study 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:

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

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)
Study 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:

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

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

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)
Study 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:

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

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)
Study 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)
Study 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)
Study 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:

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

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

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)
Study 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)

Study 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:

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

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)

Study 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:

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

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

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)
Study 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)
Study 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:

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

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

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)
Study 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 × 0.5 mg/kg = 0.399 mg Hg /kg

Calculations:

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

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

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)
Study 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:

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

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)
Study 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)
Study 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:

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

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

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)
Study 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)
Study 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)
Study 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)
Study 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:

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

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

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)
Study 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:

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

Comments: Embryonic viability 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)
Study 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:

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

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

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$_{\text{control ♂+♀}}$ 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.

Study 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:

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

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

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)
Food Consumption: 0.0055 kg/d
(calculated using allometric equation from EPA 1988a)
Water Consumption: 0.0075 L/d
Study 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:

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

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

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)
Study 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)

Study 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:

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

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)
Study 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:

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

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

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)
Study 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:

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

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

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)
Study 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:

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

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

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)
Study 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:

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

$$\text{LOAEL: } \left(\frac{30\,\text{mg PCP}}{\text{kg food}} \text{ x } \frac{28\,\text{g food}}{\text{day}} \text{ x } \frac{1\,\text{kg}}{1000\,\text{g}} \right) \ / \ 0.35 \ \text{kg BW} = 2.4 \ \text{mg/kg/d}$$

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: Potassium Selenate (SeO_4)
Reference: Rosenfeld and Beath 1954

Test Species: rat
Body weight: 0.35 kg (EPA 1988a)
Water Consumption: 0.046 L/d
(calculated using allometric equation from EPA 1988a)
Study Duration: 1 year, through 2 generations (1 yr and during critical lifestage=chronic)
Endpoint: reproduction
Exposure Route: oral in water
Dosage: three dose levels:
1.5, 2.5, and 7.5 mg Se/L
2.5 mg/L = LOAEL
Calculations:

$$\text{NOAEL:}\ \left(\frac{1.5\,\text{mg Se}}{\text{L water}}\ \text{x}\ \frac{46\,\text{mL water}}{\text{day}}\ \text{x}\ \frac{1\,\text{L}}{1000\,\text{mL}}\right)\ /\ 0.35\ \text{kg BW} = 0.20\,\text{mg/kg/d}$$

$$\text{LOAEL:}\ \left(\frac{2.5\ \text{Se}}{\text{L water}}\ \text{x}\ \frac{46\,\text{water}}{\text{day}}\ \text{x}\ \frac{1\,\text{L}}{1000\,\text{mL}}\right)\ /\ 0.35\ \text{kg BW} = 0.33\,\text{mg/kg/d}$$

Comments: While no adverse effects on reproduction were observed among rats exposed to 1.5 mg Se /L in drinking water, the number of second-generation young was reduced by 50% among females in the 2.5 mg/L group. In the 7.5 mg/L group, fertility, juvenile growth and survival were all reduced. Because study considered exposure over multiple generations, the 1.5 and 2.5 mg/L doses were considered to be chronic NOAEL and LOAEL, respectively.
Final NOAEL: 0.20 mg/kg/d
Final LOAEL: 0.33 mg/kg/d

Compound: Selenium
Form: Sodium Selenite
Reference: Heinz et al. 1987
Test Species: Mallard Duck
Body Weight: 1 kg (from study)
Food Consumption: 100 g/d (from study)
Study 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:

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

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

Comments: While consumption of 1, 5, or 10 ppm Se on the diet as Sodium Selenite 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)
Study 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:

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

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

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: Selenium
Form: selenomethionine
Reference: Wiemeyer and Hoffman 1996
Test Species: Screech Owl
Body weight: 0.2 kg (mean ♂+♀ from study)
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 = 25g/d
Study Duration: 13.7 wks through reproduction (during a critical lifestage = chronic)
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: two dose levels:
3.53 and 12 ppm
12 ppm = LOAEL
Calculations:

$$\text{NOAEL: } \left(\frac{3.53\text{ mg Se}}{\text{kg food}} \text{ x } \frac{25\text{ g food}}{\text{day}} \text{ x } \frac{1\text{ kg}}{1000\text{ g}} \right) \text{ / 0.2 kg BW} = 0.44\text{ mg/kg/d}$$

$$\text{LOAEL: } \left(\frac{12\text{ mg Se}}{\text{kg food}} \text{ x } \frac{25\text{ g food}}{\text{day}} \text{ x } \frac{1\text{ kg}}{1000\text{ g}} \right) \text{ / 0.2 kg BW} = 1.5\text{ mg/kg/d}$$

Comments: While exposure of owls to 0.44 mg Se/kg/d had no adverse effects on reproduction, egg production and hatchability were reduced 38% and 88%, and nestling survival was reduced by 100% among owls in the 1.5 mg/kg/d group. Because exposure was greater than 10 weeks and occurred during reproduction, the study was considered to be chronic in duration.

Final NOAEL: 0.44 mg/kg/d
Final LOAEL: 1.5 mg/kg/d

Compound: Selenium
Form: selenomethionine
Reference: Smith et al. (1988)
Test Species: Black-Crowned Night-Heron
Body weight: 0.883 kg (Dunning 1993)
Food Consumption: 160.6 g/d
Daily food consumption was estimated based on equation for herons by Kushlan (1978):
log (food consumption) = 0.966 log(body weight) - 0.640
with food consumption and body weight in g.
Study Duration: 94 d through reproduction (during a critical lifestage = chronic)
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: two dose levels:
10 and 30 ppm

10 ppm = NOAEL
insufficient data to evaluate effects of 30 ppm dose

Calculations:

$$\text{NOAEL: } \left(\frac{10\,\text{mg Se}}{\text{kg food}} \text{ x } \frac{160.6\,\text{g food}}{\text{day}} \text{ x } \frac{1\,\text{kg}}{1000\,\text{g}} \right) / \ 0.883 \text{ kg BW} = 1.8 \text{ mg/kg/d}$$

Comments: Exposure of night-herons to 1.8 mg Se/kg/d had no adverse effects on reproduction. Only 2 pairs of birds received the higher dose level; data on reproduction incomplete for this dose level. Because exposure was greater than 10 weeks and occurred during reproduction, the study was considered to be chronic in duration.

Final NOAEL: 1.8 mg/kg/d

Compound: Strontium (stable)
Form: Strontium Chloride (55% Sr)
Reference: Skoryna 1981
Test Species: Rat
Body weight: 0.35 kg (EPA 1988a)
Study 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)
Study 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 µp/kg BW/d; NOAEL = 0.001 µp/kg/d
Calculations: 0.001 µp/kg/d = 0.000001 mg/kg/d

Comments: Fertility and neonatal survival was significantly reduced among rats receiving 0.1 and 0.01 µp/kg/d. Because no significant differences were observed at the 0.001 µp/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 µp/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)
Study 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 µp/kg BW/week; NOAEL = 0.1 µp/kg/week
Calculations: 0.1 µp/kg/week = 0.0001 mg/kg/week = 0.000014 mg/kg/d
1 µp/kg/week = 0.001 mg/kg/week = 0.00014 mg/kg/d

Comments: Egg production and hatchability was significantly reduced among birds receiving 1 µp/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 µp/kg/week dose was considered to be a chronic NOAEL and the 1 µp/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)
Study 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:

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

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)
Study 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)
Study 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 μp 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)
Study 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)
Study 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:

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

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

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)
Study 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)

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

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)

Study 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:

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

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)

Study 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)

Study 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
Study 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 gfood/d (Heinz et al.1989). Therefore, it was assumed that a 1.25 kg black duck would consume 125 g food/d.

Study 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:

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

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
Study 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)

Study 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:

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

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)
Study 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)
Study 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)
Study 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:

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

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

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)
Study 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:

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

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

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)
Study 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:

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

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

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	Acute or Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
Chemical	Species	Dose or Conc.[b]	Effect	Dose or Conc.[b]		
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			
Cadmium	wood duck	100 ppm (3 mo)	pathology	10 ppm (3 mo)		

Table C.1. (continued)

		LOAEL		NOAEL	Acute or Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
Chemical	Species	Dose or Conc.[b]	Effect	Dose or Conc.[b]		
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		
Chemical	Species	Dose or Conc.[b]	Effect	Dose or Conc.[b]	Acute or Lethal 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)

		LOAEL		NOAEL	Acute or Lethal Dose/Conc.^{b}	LD_{50} or LC_{50}
Chemical	Species	Dose or Conc.^{b}	Effect	Dose or Conc.^{b}		
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		
Ferrous sulfate	rat					1187 mg/kg

Table C.1. (continued)

		LOAEL		NOAEL	Acute or Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
Chemical	Species	Dose or Conc.[b]	Effect	Dose or Conc.[b]		
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)	reproduction			
Lead acetate	bobwhite quail	1000 ppm (6 wk)	growth			
Lead arsenate	rat					1545 mg/kg
Lead arsonate	Japanese quail					4185 ppm (5 d)
Lead arsonate	ring-necked pheasant					4989 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, 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			
Monosodium methanearsonate	white-footed mouse	1000 ppm (30 d)	physiology			300 mg/kg

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}
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	
Sodium monofluoroacetate	quail				17.7 mg/kg	

Table C.1. (continued)

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

Table C.1. (continued)

Chemical	Species	LOAEL Dose or Conc.[b]	Effect	NOAEL Dose or Conc.[b]	Acute or Lethal Dose/Conc.[b]	LD_{50} or LC_{50}
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

TABLE 12

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

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Acetone	n/a	rat	10	50	Little Brown Bat	26.1	78.4	163.4		130.7	392.1	816.8	
Acetone	n/a	rat	10	50	Short-tailed Shrew	22.0	36.6	99.9		109.9	183.2	499.5	
Acetone	n/a	rat	10	50	White-footed Mouse	20.0	129.2	66.6		99.9	646.1	332.9	
Acetone	n/a	rat	10	50	Meadow Vole	16.8	147.8	123.2		84.0	738.9	615.8	
Acetone	n/a	rat	10	50	Mink	7.7	56.1	77.7	50.460	38.5	280.7	388.5	252.300
Acetone	n/a	rat	10	50	Cottontail Rabbit	7.3	37.2	76.0		36.7	186.0	380.1	
Acetone	n/a	rat	10	50	Red Fox	5.3	52.8	62.5		26.4	264.0	312.7	
Acetone	n/a	rat	10	50	River Otter	4.6	40.7	57.2	33.237	22.9	203.3	285.8	166.187
Acetone	n/a	rat	10	50	Whitetail Deer	2.8	91.1	42.8		14.0	455.5	214.2	
Aldrin	n/a	rat	0.2	1	Little Brown Bat	0.523	1.568	3.267		2.614	7.841	16.335	
Aldrin	n/a	rat	0.2	1	Short-tailed Shrew	0.440	0.733	1.998		2.198	3.663	9.990	
Aldrin	n/a	rat	0.2	1	White-footed Mouse	0.399	2.585	1.331		1.997	12.923	6.657	
Aldrin	n/a	rat	0.2	1	Meadow Vole	0.336	2.956	2.463		1.679	14.779	12.316	
Aldrin	n/a	rat	0.2	1	Mink	0.154	1.123	1.554	1.603e-06	0.769	5.614	7.769	8.013e-06
Aldrin	n/a	rat	0.2	1	Cottontail Rabbit	0.147	0.744	1.520		0.735	3.721	7.602	
Aldrin	n/a	rat	0.2	1	Red Fox	0.106	1.056	1.251		0.528	5.281	6.254	
Aldrin	n/a	rat	0.2	1	River Otter	0.091	0.813	1.143	1.000e-06	0.457	4.065	5.717	5.802e-06
Aldrin	n/a	rat	0.2	1	Whitetail Deer	0.056	1.822	0.857		0.281	9.110	4.284	
Aluminum	$AlCl_3$	mouse	1.93	19.3	Little Brown Bat	2.729	8.188	17.059		27.294	81.883	170.590	
Aluminum	$AlCl_3$	mouse	1.93	19.3	Short-tailed Shrew	2.295	3.825	10.433		22.952	38.253	104.326	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Aluminum	$AlCl_3$	mouse	1.93	19.3	White-footed Mouse	2.086	13.495	6.952		20.856	134.951	69.520	
Aluminum	$AlCl_3$	mouse	1.93	19.3	Meadow Vole	1.754	15.433	12.861		17.538	154.332	128.610	
Aluminum	$AlCl_3$	mouse	1.93	19.3	Mink	0.803	5.863	8.113	0.025	8.032	58.630	81.134	0.253
Aluminum	$AlCl_3$	mouse	1.93	19.3	Cottontail Rabbit	0.767	3.886	7.939		7.674	38.858	79.390	
Aluminum	$AlCl_3$	mouse	1.93	19.3	Red Fox	0.551	5.515	6.531		5.515	55.149	65.308	
Aluminum	$AlCl_3$	mouse	1.93	19.3	River Otter	0.478	4.245	5.970	0.018	4.776	42.453	59.700	0.183
Aluminum	$AlCl_3$	mouse	1.93	19.3	Whitetail Deer	0.293	9.513	4.474		2.930	95.132	44.738	
Aluminum	$Al_2(SO_4)_2$	ringed dove	109.7		Rough-winged Swallow	109.7	145.4	471.4					
Aluminum	$Al_2(SO_4)_2$	ringed dove	109.7		American Robin	109.7	90.8	796.9					
Aluminum	$Al_2(SO_4)_2$	ringed dove	109.7		Belted Kingfisher	109.7	216.5	1014.7	0.936				
Aluminum	$Al_2(SO_4)_2$	ringed dove	109.7		American Woodcock	109.7	144.8	1086.0					
Aluminum	$Al_2(SO_4)_2$	ringed dove	109.7		Cooper's Hawk	109.7	633.7	1416.4					
Aluminum	$Al_2(SO_4)_2$	ringed dove	109.7		Barn Owl	109.7	409.0	1460.6					
Aluminum	$Al_2(SO_4)_2$	ringed dove	109.7		Barred Owl	109.7	936.4	1673.5					
Aluminum	$Al_2(SO_4)_2$	ringed dove	109.7		Red-tailed Hawk	109.7	1133.2	1930.0					
Aluminum	$Al_2(SO_4)_2$	ringed dove	109.7		Osprey	109.7	548.5	2137.0	2.372				
Aluminum	$Al_2(SO_4)_2$	ringed dove	109.7		Great Blue Heron	109.7	624.2	2478.1	2.699				
Aluminum	$Al_2(SO_4)_2$	ringed dove	109.7		Wild Turkey	109.7	3656.7	3348.7					
Aluminum	$AlCl_3$	day-old white leghorn chicks		44.5	Rough-winged Swallow					44.5	59.0	191.2	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Aluminum	$AlCl_3$	day-old white leghorn chicks		44.5	American Robin					44.5	36.8	323.3	
Aluminum	$AlCl_3$	day-old white leghorn chicks		44.5	Belted Kingfisher					44.5	87.8	411.6	0.380
Aluminum	$AlCl_3$	day-old white leghorn chicks		44.5	American Woodcock					44.5	58.7	440.6	
Aluminum	$AlCl_3$	day-old white leghorn chicks		44.5	Cooper's Hawk					44.5	257.0	574.6	
Aluminum	$AlCl_3$	day-old white leghorn chicks		44.5	Barn Owl					44.5	165.9	592.5	
Aluminum	$AlCl_3$	day-old white leghorn chicks		44.5	Barred Owl					44.5	379.8	678.9	
Aluminum	$AlCl_3$	day-old white leghorn chicks		44.5	Red-tailed Hawk					44.5	459.7	782.9	
Aluminum	$AlCl_3$	day-old white leghorn chicks		44.5	Osprey					44.5	222.5	866.9	0.962
Aluminum	$AlCl_3$	day-old white leghorn chicks		44.5	Great Blue Heron					44.5	253.2	1005.2	1.095
Aluminum	$AlCl_3$	day-old white leghorn chicks		44.5	Wild Turkey					44.5	1483.3	1358.4	
Antimony	antimony potassium tartrate	mouse	0.125	1.25	Little Brown Bat	0.177	0.530	1.105		1.768	5.303	11.049	
Antimony	antimony potassium tartrate	mouse	0.125	1.25	Short-tailed Shrew	0.149	0.248	0.676		1.487	2.478	6.757	
Antimony	antimony potassium tartrate	mouse	0.125	1.25	White-footed Mouse	0.135	0.874	0.450		1.351	8.740	4.503	
Antimony	antimony potassium tartrate	mouse	0.125	1.25	Meadow Vole	0.114	1.000	0.833		1.136	9.996	8.330	
Antimony	antimony potassium tartrate	mouse	0.125	1.25	Mink	0.052	0.380	0.525	0.220	0.520	3.797	5.255	2.204
Antimony	antimony potassium tartrate	mouse	0.125	1.25	Cottontail Rabbit	0.050	0.252	0.514		0.497	2.517	5.142	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Antimony	antimony potassium tartrate	mouse	0.125	1.25	Red Fox	0.036	0.357	0.423		0.357	3.572	4.230	
Antimony	antimony potassium tartrate	mouse	0.125	1.25	River Otter	0.031	0.275	0.387	0.161	0.309	2.750	3.867	1.607
Antimony	antimony potassium tartrate	mouse	0.125	1.25	Whitetail Deer	0.019	0.616	0.290		0.190	6.161	2.898	
Aroclor 1016	n/a	mink	1.37	3.43	Little Brown Bat	4.66	13.97	29.10		11.66	34.97	72.85	
Aroclor 1016	n/a	mink	1.37	3.43	Short-tailed Shrew	3.91	6.52	17.79		9.80	16.34	44.55	
Aroclor 1016	n/a	mink	1.37	3.43	White-footed Mouse	3.56	23.02	11.86		8.91	57.63	29.69	
Aroclor 1016	n/a	mink	1.37	3.43	Meadow Vole	2.99	26.32	21.94		7.49	65.90	54.92	
Aroclor 1016	n/a	mink	1.37	3.43	Mink	1.37	10.00	13.84	1.327e-04	3.43	25.04	34.65	3.323e-04
Aroclor 1016	n/a	mink	1.37	3.43	Cottontail Rabbit	1.31	6.63	13.54		3.28	16.59	33.90	
Aroclor 1016	n/a	mink	1.37	3.43	Red Fox	0.94	9.41	11.14		2.36	23.55	27.89	
Aroclor 1016	n/a	mink	1.37	3.43	River Otter	0.81	7.24	10.18	9.233e-05	2.04	18.13	25.49	2.312e-04
Aroclor 1016	n/a	mink	1.37	3.43	Whitetail Deer	0.50	16.23	7.63		1.25	40.62	19.10	
Aroclor 1242	n/a	mink	0.069	0.69	Little Brown Bat	0.234	0.703	1.465		2.345	7.034	14.654	
Aroclor 1242	n/a	mink	0.069	0.69	Short-tailed Shrew	0.197	0.329	0.896		1.972	3.286	8.962	
Aroclor 1242	n/a	mink	0.069	0.69	White-footed Mouse	0.179	1.159	0.597		1.792	11.593	5.972	
Aroclor 1242	n/a	mink	0.069	0.69	Meadow Vole	0.151	1.326	1.105		1.507	13.258	11.048	
Aroclor 1242	n/a	mink	0.069	0.69	Mink	0.069	0.504	0.697	6.685e-06	0.690	5.036	6.970	6.685e-05
Aroclor 1242	n/a	mink	0.069	0.69	Cottontail Rabbit	0.066	0.334	0.682		0.659	3.338	6.820	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Aroclor 1242	n/a	mink	0.069	0.69	Red Fox	0.047	0.474	0.561		0.474	4.737	5.610	
Aroclor 1242	n/a	mink	0.069	0.69	River Otter	0.041	0.365	0.513	4.650e-06	0.410	3.647	5.128	4.650e-05
Aroclor 1242	n/a	mink	0.069	0.69	Whitetail Deer	0.025	0.817	0.384		0.252	8.172	3.843	
Aroclor 1242	n/a	screech owl	0.41		Rough-winged Swallow	0.410	0.543	1.762					
Aroclor 1242	n/a	screech owl	0.41		American Robin	0.410	0.339	2.978					
Aroclor 1242	n/a	screech owl	0.41		Belted Kingfisher	0.410	0.809	3.793	1.074e-05				
Aroclor 1242	n/a	screech owl	0.41		American Woodcock	0.410	0.541	4.059					
Aroclor 1242	n/a	screech owl	0.41		Cooper's Hawk	0.410	2.368	5.294					
Aroclor 1242	n/a	screech owl	0.41		Barn Owl	0.410	1.528	5.459					
Aroclor 1242	n/a	screech owl	0.41		Barred Owl	0.410	3.500	6.255					
Aroclor 1242	n/a	screech owl	0.41		Red-tailed Hawk	0.410	4.235	7.213					
Aroclor 1242	n/a	screech owl	0.41		Osprey	0.410	2.050	7.987	2.721e-05				
Aroclor 1242	n/a	screech owl	0.41		Great Blue Heron	0.410	2.333	9.262	3.097e-05				
Aroclor 1242	n/a	screech owl	0.41		Wild Turkey	0.410	13.667	12.516					
Aroclor 1248	n/a	Rhesus monkey	0.01	0.1	Little Brown Bat	0.051	0.152	0.318		0.508	1.524	3.176	
Aroclor 1248	n/a	Rhesus monkey	0.01	0.1	Short-tailed Shrew	0.043	0.071	0.194		0.427	0.712	1.942	
Aroclor 1248	n/a	Rhesus monkey	0.01	0.1	White-footed Mouse	0.039	0.251	0.129		0.388	2.512	1.294	
Aroclor 1248	n/a	Rhesus monkey	0.01	0.1	Meadow Vole	0.033	0.287	0.239		0.326	2.873	2.394	
Aroclor 1248	n/a	Rhesus monkey	0.01	0.1	Mink	0.015	0.109	0.151	2.982e-07	0.150	1.091	1.510	2.982e-06

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Aroclor 1248	n/a	Rhesus monkey	0.01	0.1	Cottontail Rabbit	0.014	0.072	0.148		0.143	0.723	1.478	
Aroclor 1248	n/a	Rhesus monkey	0.01	0.1	Red Fox	0.010	0.103	0.122		0.103	1.027	1.216	
Aroclor 1248	n/a	Rhesus monkey	0.01	0.1	River Otter	0.009	0.079	0.111	1.911e-07	0.089	0.790	1.111	1.911e-06
Aroclor 1248	n/a	Rhesus monkey	0.01	0.1	Whitetail Deer	0.005	0.177	0.083		0.055	1.771	0.833	
Aroclor 1254	n/a	oldfield mouse	0.068	0.68	Little Brown Bat	0.079	0.238	0.497		0.795	2.38	4.97	
Aroclor 1254	n/a	oldfield mouse	0.068	0.68	Short-tailed Shrew	0.067	0.111	0.304		0.668	1.11	3.04	
Aroclor 1254	n/a	oldfield mouse	0.068	0.68	White-footed Mouse	0.061	0.393	0.202		0.607	3.93	2.02	
Aroclor 1254	n/a	oldfield mouse	0.068	0.68	Meadow Vole	0.051	0.449	0.375		0.511	4.49	3.75	
Aroclor 1254	n/a	mink	0.14	0.69	Mink	0.140	1.022	1.414	5.524e-07	0.690	5.04	6.97	2.722e-06
Aroclor 1254	n/a	oldfield mouse	0.068	0.68	Cottontail Rabbit	0.022	0.113	0.231		0.223	1.13	2.31	
Aroclor 1254	n/a	mink	0.14	0.69	Red Fox	0.096	0.961	1.138		0.474	4.74	5.61	
Aroclor 1254	n/a	mink	0.14	0.69	River Otter	0.083	0.740	1.041	2.716e-07	0.410	3.65	5.13	1.338e-06
Aroclor 1254	n/a	oldfield mouse	0.068	0.68	Whitetail Deer	0.009	0.277	0.130		0.085	2.77	1.30	
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Rough-winged Swallow	0.180	0.239	0.774		1.800	2.39	7.74	
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	American Robin	0.180	0.149	1.308		1.800	1.49	13.08	
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Belted Kingfisher	0.180	0.355	1.665	1.920e-07	1.800	3.55	16.65	1.920e-06
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	American Woodcock	0.180	0.238	1.782		1.800	2.38	17.82	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Cooper's Hawk	0.180	1.040	2.324		1.800	10.40	23.24	
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Barn Owl	0.180	0.671	2.397		1.800	6.71	23.97	
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Barred Owl	0.180	1.536	2.746		1.800	15.36	27.46	
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Red-tailed Hawk	0.180	1.859	3.167		1.800	18.59	31.67	
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Osprey	0.180	0.900	3.506	4.865e-07	1.800	9.00	35.06	4.865e-06
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Great Blue Heron	0.180	1.024	4.066	5.537e-07	1.800	10.24	40.66	5.537e-06
Aroclor 1254	n/a	ring-necked pheasant	0.18	1.8	Wild Turkey	0.180	6.000	5.495		1.800	60.00	54.95	
Arsenic	Arsenite	mouse	0.126	1.26	Little Brown Bat	0.178	0.535	1.114		1.782	5.346	11.137	
Arsenic	Arsenite	mouse	0.126	1.26	Short-tailed Shrew	0.150	0.250	0.681		1.498	2.497	6.811	
Arsenic	Arsenite	mouse	0.126	1.26	White-footed Mouse	0.136	0.881	0.454		1.362	8.810	4.539	
Arsenic	Arsenite	mouse	0.126	1.26	Meadow Vole	0.114	1.008	0.840		1.145	10.076	8.396	
Arsenic	Arsenite	mouse	0.126	1.26	Mink	0.052	0.383	0.530	0.022	0.524	3.828	5.297	0.216
Arsenic	Arsenite	mouse	0.126	1.26	Cottontail Rabbit	0.050	0.254	0.518		0.501	2.537	5.183	
Arsenic	Arsenite	mouse	0.126	1.26	Red Fox	0.036	0.360	0.426		0.360	3.600	4.264	
Arsenic	Arsenite	mouse	0.126	1.26	River Otter	0.031	0.277	0.390	0.016	0.312	2.772	3.898	0.156
Arsenic	Arsenite	mouse	0.126	1.26	Whitetail Deer	0.019	0.621	0.292		0.191	6.211	2.921	
Arsenic	sodium arsenite	mallard duck	5.14	12.84	Rough-winged Swallow	5.1	6.8	22.1		12.8	17.0	55.2	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Arsenic	sodium arsenite	mallard duck	5.14	12.84	American Robin	5.1	4.3	37.3		12.8	10.6	93.3	
Arsenic	sodium arsenite	mallard duck	5.14	12.84	Belted Kingfisher	5.1	10.1	47.5	0.589	12.8	25.3	118.8	1.472
Arsenic	sodium arsenite	mallard duck	5.14	12.84	American Woodcock	5.1	6.8	50.9		12.8	16.9	127.1	
Arsenic	sodium arsenite	mallard duck	5.14	12.84	Cooper's Hawk	5.1	29.7	66.4		12.8	74.2	165.8	
Arsenic	sodium arsenite	mallard duck	5.14	12.84	Barn Owl	5.1	19.2	68.4		12.8	47.9	171.0	
Arsenic	sodium arsenite	mallard duck	5.14	12.84	Barred Owl	5.1	43.9	78.4		12.8	109.6	195.9	
Arsenic	sodium arsenite	mallard duck	5.14	12.84	Red-tailed Hawk	5.1	53.1	90.4		12.8	132.6	225.9	
Arsenic	sodium arsenite	mallard duck	5.14	12.84	Osprey	5.1	25.7	100.1	1.489	12.8	64.2	250.1	3.720
Arsenic	sodium arsenite	mallard duck	5.14	12.84	Great Blue Heron	5.1	29.2	116.1	1.695	12.8	73.1	290.1	4.235
Arsenic	sodium arsenite	mallard duck	5.14	12.84	Wild Turkey	5.1	171.3	156.9		12.8	428.0	392.0	
Arsenic	paris green (copper acetoarsenite)	brown-headed cowbird	2.46	7.38	Rough-winged Swallow	2.5	3.3	10.6		7.4	9.8	31.7	
Arsenic	paris green (copper acetoarsenite)	brown-headed cowbird	2.46	7.38	American Robin	2.5	2.0	17.9		7.4	6.1	53.6	
Arsenic	paris green (copper acetoarsenite)	brown-headed cowbird	2.46	7.38	Belted Kingfisher	2.5	4.9	22.8	0.282	7.4	14.6	68.3	0.846
Arsenic	paris green (copper acetoarsenite)	brown-headed cowbird	2.46	7.38	American Woodcock	2.5	3.2	24.4		7.4	9.7	73.1	
Arsenic	paris green (copper acetoarsenite)	brown-headed cowbird	2.46	7.38	Cooper's Hawk	2.5	14.2	31.8		7.4	42.6	95.3	
Arsenic	paris green (copper acetoarsenite)	brown-headed cowbird	2.46	7.38	Barn Owl	2.5	9.2	32.8		7.4	27.5	98.3	
Arsenic	paris green (copper acetoarsenite)	brown-headed cowbird	2.46	7.38	Barred Owl	2.5	21.0	37.5		7.4	63.0	112.6	
Arsenic	paris green (copper acetoarsenite)	brown-headed cowbird	2.46	7.38	Red-tailed Hawk	2.5	25.4	43.3		7.4	76.2	129.8	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Arsenic	paris green (copper acetoarsenite)	brown-headed cowbird	2.46	7.38	Osprey	2.5	12.3	47.9	0.713	7.4	36.9	143.8	2.138
Arsenic	paris green (copper acetoarsenite)	brown-headed cowbird	2.46	7.38	Great Blue Heron	2.5	14.0	55.6	0.811	7.4	42.0	166.7	2.434
Arsenic	paris green (copper acetoarsenite)	brown-headed cowbird	2.46	7.38	Wild Turkey	2.5	82.0	75.1		7.4	246.0	225.3	
Barium	barium chloride	rat	5.1		Little Brown Bat	14.1	42.2	88.0					
Barium	barium chloride	rat	5.1		Short-tailed Shrew	11.8	19.7	53.8					
Barium	barium chloride	rat	5.1		White-footed Mouse	10.8	69.6	35.8					
Barium	barium chloride	rat	5.1		Meadow Vole	9.0	79.6	66.3					
Barium	barium chloride	rat	5.1		Mink	4.1	30.2	41.8					
Barium	barium chloride	rat	5.1		Cottontail Rabbit	4.0	20.0	40.9					
Barium	barium chloride	rat	5.1		Red Fox	2.8	28.4	33.7					
Barium	barium chloride	rat	5.1		River Otter	2.5	21.9	30.8					
Barium	barium chloride	rat	5.1		Whitetail Deer	1.5	49.1	23.1					
Barium	barium hydroxide	rat		19.8	Little Brown Bat					51.8	155.3	323.4	
Barium	barium hydroxide	rat		19.8	Short-tailed Shrew					43.5	72.5	197.8	
Barium	barium hydroxide	rat		19.8	White-footed Mouse					39.5	255.9	131.8	
Barium	barium hydroxide	rat		19.8	Meadow Vole					33.3	292.6	243.8	
Barium	barium hydroxide	rat		19.8	Mink					15.2	111.2	153.8	
Barium	barium hydroxide	rat		19.8	Cottontail Rabbit					14.6	73.7	150.5	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Barium	barium hydroxide	rat		19.8	Red Fox					10.5	104.6	123.8	
Barium	barium hydroxide	rat		19.8	River Otter					9.1	80.5	113.2	
Barium	barium hydroxide	rat		19.8	Whitetail Deer					5.6	180.4	84.8	
Barium	barium hydroxide	1-day old chicks	20.8	41.7	Rough-winged Swallow	20.8	27.6	89.4		41.7	55.3	179.2	
Barium	barium hydroxide	1-day old chicks	20.8	41.7	American Robin	20.8	17.2	151.1		41.7	34.5	302.9	
Barium	barium hydroxide	1-day old chicks	20.8	41.7	Belted Kingfisher	20.8	41.0	192.4		41.7	82.3	385.7	
Barium	barium hydroxide	1-day old chicks	20.8	41.7	American Woodcock	20.8	27.5	205.9		41.7	55.0	412.8	
Barium	barium hydroxide	1-day old chicks	20.8	41.7	Cooper's Hawk	20.8	120.1	268.6		41.7	240.9	538.4	
Barium	barium hydroxide	1-day old chicks	20.8	41.7	Barn Owl	20.8	77.5	276.9		41.7	155.5	555.2	
Barium	barium hydroxide	1-day old chicks	20.8	41.7	Barred Owl	20.8	177.5	317.3		41.7	355.9	636.1	
Barium	barium hydroxide	1-day old chicks	20.8	41.7	Red-tailed Hawk	20.8	214.9	366.0		41.7	430.8	733.7	
Barium	barium hydroxide	1-day old chicks	20.8	41.7	Osprey	20.8	104.0	405.2		41.7	208.5	812.3	
Barium	barium hydroxide	1-day old chicks	20.8	41.7	Great Blue Heron	20.8	118.4	469.9		41.7	237.3	942.0	
Barium	barium hydroxide	1-day old chicks	20.8	41.7	Wild Turkey	20.8	693.3	634.9		41.7	1390.0	1272.9	
Benzene	n/a	mouse	26.36	263.6	Little Brown Bat	37.3	111.8	233.0		372.8	1118.4	2329.9	
Benzene	n/a	mouse	26.36	263.6	Short-tailed Shrew	31.3	52.2	142.5		313.5	522.5	1424.9	
Benzene	n/a	mouse	26.36	263.6	White-footed Mouse	28.5	184.3	95.0		284.9	1843.2	949.5	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Benzene	n/a	mouse	26.36	263.6	Meadow Vole	24.0	210.8	175.7		239.5	2107.9	1756.6	
Benzene	n/a	mouse	26.36	263.6	Mink	11.0	80.1	110.8	3.162	109.7	800.8	1108.1	31.623
Benzene	n/a	mouse	26.36	263.6	Cottontail Rabbit	10.5	53.1	108.4		104.8	530.7	1084.3	
Benzene	n/a	mouse	26.36	263.6	Red Fox	7.5	75.3	89.2		75.3	753.2	892.0	
Benzene	n/a	mouse	26.36	263.6	River Otter	6.5	58.0	81.5	2.293	65.2	579.8	815.4	22.930
Benzene	n/a	mouse	26.36	263.6	Whitetail Deer	4.0	129.9	61.1		40.0	1299.3	611.0	
Beta-BHC	n/a	rat	0.4	2	Little Brown Bat	1.05	3.14	6.53		5.23	15.68	32.67	
Beta-BHC	n/a	rat	0.4	2	Short-tailed Shrew	0.88	1.47	4.00		4.40	7.33	19.98	
Beta-BHC	n/a	rat	0.4	2	White-footed Mouse	0.80	5.17	2.66		3.99	25.85	13.31	
Beta-BHC	n/a	rat	0.4	2	Meadow Vole	0.67	5.91	4.93		3.36	29.56	24.63	
Beta-BHC	n/a	rat	0.4	2	Mink	0.31	2.25	3.11	0.004	1.54	11.23	15.54	0.021
Beta-BHC	n/a	rat	0.4	2	Cottontail Rabbit	0.29	1.49	3.04		1.47	7.44	15.20	
Beta-BHC	n/a	rat	0.4	2	Red Fox	0.21	2.11	2.50		1.06	10.56	12.51	
Beta-BHC	n/a	rat	0.4	2	River Otter	0.18	1.63	2.29	0.003	0.91	8.13	11.43	0.015
Beta-BHC	n/a	rat	0.4	2	Whitetail Deer	0.11	3.64	1.71		0.56	18.22	8.57	
BHC-mixed isomers	n/a	rat	1.6	3.2	Little Brown Bat	4.18	12.55	26.14		8.36	25.09	52.27	
BHC-mixed isomers	n/a	rat	1.6	3.2	Short-tailed Shrew	3.52	5.86	15.98		7.03	11.72	31.97	
BHC-mixed isomers	n/a	rat	1.6	3.2	White-footed Mouse	3.20	20.68	10.65		6.39	41.35	21.30	
BHC-mixed isomers	n/a	rat	1.6	3.2	Meadow Vole	2.69	23.65	19.70		5.37	47.29	39.41	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
BHC-mixed isomers	n/a	mink	0.014	0.14	Mink	0.01	0.10	0.14	5.964e-07	0.14	1.02	1.41	5.964e-06
BHC-mixed isomers	n/a	rat	1.6	3.2	Cottontail Rabbit	1.18	5.95	12.16		2.35	11.91	24.33	
BHC-mixed isomers	n/a	mink	0.014	0.14	Red Fox	0.01	0.10	0.11		0.10	0.96	1.14	
BHC-mixed isomers	n/a	mink	0.014	0.14	River Otter	0.01	0.07	0.10	3.971e-07	0.08	0.74	1.04	3.971e-06
BHC-mixed isomers	n/a	rat	1.6	3.2	Whitetail Deer	0.45	14.58	6.85		0.90	29.15	13.71	
BHC-mixed isomers	n/a	Japanese quail	0.56	2.25	Rough-winged Swallow	0.56	0.74	2.41		2.25	2.98	9.67	
BHC-mixed isomers	n/a	Japanese quail	0.56	2.25	American Robin	0.56	0.46	4.07		2.25	1.86	16.34	
BHC-mixed isomers	n/a	Japanese quail	0.56	2.25	Belted Kingfisher	0.56	1.11	5.18	6.449e-06	2.25	4.44	20.81	2.591e-05
BHC-mixed isomers	n/a	Japanese quail	0.56	2.25	American Woodcock	0.56	0.74	5.54		2.25	2.97	22.28	
BHC-mixed isomers	n/a	Japanese quail	0.56	2.25	Cooper's Hawk	0.56	3.23	7.23		2.25	13.00	29.05	
BHC-mixed isomers	n/a	Japanese quail	0.56	2.25	Barn Owl	0.56	2.09	7.46		2.25	8.39	29.96	
BHC-mixed isomers	n/a	Japanese quail	0.56	2.25	Barred Owl	0.56	4.78	8.54		2.25	19.21	34.32	
BHC-mixed isomers	n/a	Japanese quail	0.56	2.25	Red-tailed Hawk	0.56	5.78	9.85		2.25	23.24	39.59	
BHC-mixed isomers	n/a	Japanese quail	0.56	2.25	Osprey	0.56	2.80	10.91	1.634e-05	2.25	11.25	43.83	6.565e-05
BHC-mixed isomers	n/a	Japanese quail	0.56	2.25	Great Blue Heron	0.56	3.19	12.65	1.860e-05	2.25	12.80	50.83	7.472e-05
BHC-mixed isomers	n/a	Japanese quail	0.56	2.25	Wild Turkey	0.56	18.67	17.09		2.25	75.00	68.68	
Benzo(a)pyrene	n/a	mouse	1	10	Little Brown Bat	1.41	4.24	8.84		14.14	42.43	88.39	
Benzo(a)pyrene	n/a	mouse	1	10	Short-tailed Shrew	1.19	1.98	5.41		11.89	19.82	54.05	
Benzo(a)pyrene	n/a	mouse	1	10	White-footed Mouse	1.08	6.99	3.60		10.81	69.92	36.02	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Benzo(a)pyrene	n/a	mouse	1	10	Meadow Vole	0.91	8.00	6.66		9.09	79.96	66.64	
Benzo(a)pyrene	n/a	mouse	1	10	Mink	0.42	3.04	4.20	1.034e-05	4.16	30.38	42.04	1.034e-04
Benzo(a)pyrene	n/a	mouse	1	10	Cottontail Rabbit	0.40	2.01	4.11		3.98	20.13	41.13	
Benzo(a)pyrene	n/a	mouse	1	10	Red Fox	0.29	2.86	3.38		2.86	28.57	33.84	
Benzo(a)pyrene	n/a	mouse	1	10	River Otter	0.25	2.20	3.09	6.722e-06	2.47	22.00	30.93	6.722e-05
Benzo(a)pyrene	n/a	mouse	1	10	Whitetail Deer	0.15	4.93	2.32		1.52	49.29	23.18	
Beryllium	beryllium sulfate	rat	0.66		Little Brown Bat	1.73	5.18	10.78					
Beryllium	beryllium sulfate	rat	0.66		Short-tailed Shrew	1.45	2.42	6.59					
Beryllium	beryllium sulfate	rat	0.66		White-footed Mouse	1.32	8.53	4.39					
Beryllium	beryllium sulfate	rat	0.66		Meadow Vole	1.11	9.75	8.13					
Beryllium	beryllium sulfate	rat	0.66		Mink	0.51	3.71	5.13	0.188				
Beryllium	beryllium sulfate	rat	0.66		Cottontail Rabbit	0.49	2.46	5.02					
Beryllium	beryllium sulfate	rat	0.66		Red Fox	0.35	3.49	4.13					
Beryllium	beryllium sulfate	rat	0.66		River Otter	0.30	2.68	3.77	0.136				
Beryllium	beryllium sulfate	rat	0.66		Whitetail Deer	0.19	6.01	2.83					
Bis(2-ethylhexyl)-phthalate	n/a	mouse	18.3	183	Little Brown Bat	25.9	78	162		259	776	1618	
Bis(2-ethylhexyl)-phthalate	n/a	mouse	18.3	183	Short-tailed Shrew	21.8	36	99		218	363	989	
Bis(2-ethylhexyl)-phthalate	n/a	mouse	18.3	183	White-footed Mouse	19.8	128	66		198	1280	659	
Bis(2-ethylhexyl)-phthalate	n/a	mouse	18.3	183	Meadow Vole	16.6	146	122		166	1463	1219	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Bis(2-ethylhexyl)-phthalate	n/a	mouse	18.3	183	Mink	7.6	56	77	1.944e-05	76	556	769	1.944e-04
Bis(2-ethylhexyl)-phthalate	n/a	mouse	18.3	183	Cottontail Rabbit	7.3	37	75		73	368	753	
Bis(2-ethylhexyl)-phthalate	n/a	mouse	18.3	183	Red Fox	5.2	52	62		52	523	619	
Bis(2-ethylhexyl)-phthalate	n/a	mouse	18.3	183	River Otter	4.5	40	57	1.243e-05	45	403	566	1.243e-04
Bis(2-ethylhexyl)-phthalate	n/a	mouse	18.3	183	Whitetail Deer	2.8	90	42		28	902	424	
Bis(2-ethylhexyl)-phthalate	n/a	ringed dove	1.1		Rough-winged Swallow	1.10	1.46	4.73					
Bis(2-ethylhexyl)-phthalate	n/a	ringed dove	1.1		American Robin	1.10	0.91	7.99					
Bis(2-ethylhexyl)-phthalate	n/a	ringed dove	1.1		Belted Kingfisher	1.10	2.17	10.18	7.593e-07				
Bis(2-ethylhexyl)-phthalate	n/a	ringed dove	1.1		American Woodcock	1.10	1.45	10.89					
Bis(2-ethylhexyl)-phthalate	n/a	ringed dove	1.1		Cooper's Hawk	1.10	6.35	14.20					
Bis(2-ethylhexyl)-phthalate	n/a	ringed dove	1.1		Barn Owl	1.10	4.10	14.65					
Bis(2-ethylhexyl)-phthalate	n/a	ringed dove	1.1		Barred Owl	1.10	9.39	16.78					
Bis(2-ethylhexyl)-phthalate	n/a	ringed dove	1.1		Red-tailed Hawk	1.10	11.36	19.35					
Bis(2-ethylhexyl)-phthalate	n/a	ringed dove	1.1		Osprey	1.10	5.50	21.43	1.924e-06				
Bis(2-ethylhexyl)-phthalate	n/a	ringed dove	1.1		Great Blue Heron	1.10	6.26	24.85	2.189e-06				
Bis(2-ethylhexyl)-phthalate	n/a	ringed dove	1.1		Wild Turkey	1.10	36.67	33.58					

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Boron	boric acid or borax	rat	28	93.6	Little Brown Bat	73.2	220	457		245	734	1529	
Boron	boric acid or borax	rat	28	93.6	Short-tailed Shrew	61.5	103	280		206	343	935	
Boron	boric acid or borax	rat	28	93.6	White-footed Mouse	55.9	362	186		187	1210	623	
Boron	boric acid or borax	rat	28	93.6	Meadow Vole	47.0	414	345		157	1383	1153	
Boron	boric acid or borax	rat	28	93.6	Mink	21.5	157	218		72	525	727	
Boron	boric acid or borax	rat	28	93.6	Cottontail Rabbit	20.6	104	213		69	348	712	
Boron	boric acid or borax	rat	28	93.6	Red Fox	14.8	148	175		49	494	585	
Boron	boric acid or borax	rat	28	93.6	River Otter	12.8	114	160		43	381	535	
Boron	boric acid or borax	rat	28	93.6	Whitetail Deer	7.9	255	120		26	853	401	
Boron	boric acid	mallard duck	28.8	100	Rough-winged Swallow	28.8	38	124		100	133	430	
Boron	boric acid	mallard duck	28.8	100	American Robin	28.8	24	209		100	83	726	
Boron	boric acid	mallard duck	28.8	100	Belted Kingfisher	28.8	57	266		100	197	925	
Boron	boric acid	mallard duck	28.8	100	American Woodcock	28.8	38	285		100	132	990	
Boron	boric acid	mallard duck	28.8	100	Cooper's Hawk	28.8	166	372		100	578	1291	
Boron	boric acid	mallard duck	28.8	100	Barn Owl	28.8	107	383		100	373	1331	
Boron	boric acid	mallard duck	28.8	100	Barred Owl	28.8	246	439		100	854	1526	
Boron	boric acid	mallard duck	28.8	100	Red-tailed Hawk	28.8	298	507		100	1033	1759	
Boron	boric acid	mallard duck	28.8	100	Osprey	28.8	144	561		100	500	1948	
Boron	boric acid	mallard duck	28.8	100	Great Blue Heron	28.8	164	651		100	569	2259	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Boron	boric acid	mallard duck	28.8	100	Wild Turkey	28.8	960	879		100	3333	3053	
Cadmium	cadmium chloride	rat	1	10	Little Brown Bat	2.521	7.563	15.757		25.211	75.634	157.571	
Cadmium	cadmium chloride	rat	1	10	Short-tailed Shrew	2.120	3.533	9.636		21.200	35.333	96.364	
Cadmium	cadmium chloride	rat	1	10	White-footed Mouse	1.926	12.465	6.421		19.264	124.652	64.215	
Cadmium	cadmium chloride	rat	1	10	Meadow Vole	1.620	14.255	11.880		16.199	142.554	118.795	
Cadmium	cadmium chloride	rat	1	10	Mink	0.742	5.416	7.494	4.367e-04	7.419	54.155	74.942	4.367e-03
Cadmium	cadmium chloride	rat	1	10	Cottontail Rabbit	0.709	3.589	7.333		7.089	35.892	73.331	
Cadmium	cadmium chloride	rat	1	10	Red Fox	0.509	5.094	6.032		5.094	50.940	60.323	
Cadmium	cadmium chloride	rat	1	10	River Otter	0.441	3.921	5.514	3.162e-04	4.412	39.214	55.144	3.162e-03
Cadmium	cadmium chloride	rat	1	10	Whitetail Deer	0.271	8.787	4.132		2.706	87.871	41.323	
Cadmium	cadmium chloride	mallard duck	1.45	20	Rough-winged Swallow	1.45	1.92	6.23		20.00	26.50	85.95	
Cadmium	cadmium chloride	mallard duck	1.45	20	American Robin	1.45	1.20	10.53		20.00	16.56	145.28	
Cadmium	cadmium chloride	mallard duck	1.45	20	Belted Kingfisher	1.45	2.86	13.41	2.307e-04	20.00	39.47	185.00	3.183e-03
Cadmium	cadmium chloride	mallard duck	1.45	20	American Woodcock	1.45	1.91	14.36		20.00	26.40	198.00	
Cadmium	cadmium chloride	mallard duck	1.45	20	Cooper's Hawk	1.45	8.38	18.72		20.00	115.53	258.24	
Cadmium	cadmium chloride	mallard duck	1.45	20	Barn Owl	1.45	5.41	19.31		20.00	74.56	266.29	
Cadmium	cadmium chloride	mallard duck	1.45	20	Barred Owl	1.45	12.38	22.12		20.00	170.71	305.11	
Cadmium	cadmium chloride	mallard duck	1.45	20	Red-tailed Hawk	1.45	14.98	25.51		20.00	206.61	351.88	
Cadmium	cadmium chloride	mallard duck	1.45	20	Osprey	1.45	7.25	28.25	0.001	20.00	100.00	389.61	0.008

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Cadmium	cadmium chloride	mallard duck	1.45	20	Great Blue Heron	1.45	8.25	32.76	0.001	20.00	113.81	451.80	0.009
Cadmium	cadmium chloride	mallard duck	1.45	20	Wild Turkey	1.45	48.33	44.26		20.00	666.67	610.53	
Carbon Tetrachloride	n/a	rat	16		Little Brown Bat	41.8	125.5	261.4					
Carbon Tetrachloride	n/a	rat	16		Short-tailed Shrew	35.2	58.6	159.8					
Carbon Tetrachloride	n/a	rat	16		White-footed Mouse	32.0	206.8	106.5					
Carbon Tetrachloride	n/a	rat	16		Meadow Vole	26.9	236.5	197.0					
Carbon Tetrachloride	n/a	rat	16		Mink	12.3	89.8	124.3	1.259				
Carbon Tetrachloride	n/a	rat	16		Cottontail Rabbit	11.8	59.5	121.6					
Carbon Tetrachloride	n/a	rat	16		Red Fox	8.4	84.5	100.1					
Carbon Tetrachloride	n/a	rat	16		River Otter	7.3	65.0	91.5	0.913				
Carbon Tetrachloride	n/a	rat	16		Whitetail Deer	4.5	145.8	68.5					
Chlordane	n/a	mouse	4.6	9.2	Little Brown Bat	6.5	19.5	40.7		13.0	39.0	81.3	
Chlordane	n/a	mouse	4.6	9.2	Short-tailed Shrew	5.5	9.1	24.9		10.9	18.2	49.7	
Chlordane	n/a	mouse	4.6	9.2	White-footed Mouse	5.0	32.2	16.6		9.9	64.3	33.1	
Chlordane	n/a	mouse	4.6	9.2	Meadow Vole	4.2	36.8	30.7		8.4	73.6	61.3	
Chlordane	n/a	mouse	4.6	9.2	Mink	1.9	14.0	19.3	2.942e-05	3.8	27.9	38.7	5.884e-05
Chlordane	n/a	mouse	4.6	9.2	Cottontail Rabbit	1.8	9.3	18.9		3.7	18.5	37.8	
Chlordane	n/a	mouse	4.6	9.2	Red Fox	1.3	13.1	15.6		2.6	26.3	31.1	
Chlordane	n/a	mouse	4.6	9.2	River Otter	1.1	10.1	14.2	1.866e-05	2.3	20.2	28.5	3.732e-05

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Chlordane	n/a	mouse	4.6	9.2	Whitetail Deer	0.7	22.7	10.7		1.4	45.3	21.3	
Chlordane	n/a	redwinged blackbird	2.14	10.7	Rough-winged Swallow	2.1	2.8	9.2		10.7	14.2	46.0	
Chlordane	n/a	redwinged blackbird	2.14	10.7	American Robin	2.1	1.8	15.5		10.7	8.9	77.7	
Chlordane	n/a	redwinged blackbird	2.14	10.7	Belted Kingfisher	2.1	4.2	19.8	8.890e-06	10.7	21.1	99.0	4.445e-05
Chlordane	n/a	redwinged blackbird	2.14	10.7	American Woodcock	2.1	2.8	21.2		10.7	14.1	105.9	
Chlordane	n/a	redwinged blackbird	2.14	10.7	Cooper's Hawk	2.1	12.4	27.6		10.7	61.8	138.2	
Chlordane	n/a	redwinged blackbird	2.14	10.7	Barn Owl	2.1	8.0	28.5		10.7	39.9	142.5	
Chlordane	n/a	redwinged blackbird	2.14	10.7	Barred Owl	2.1	18.3	32.6		10.7	91.3	163.2	
Chlordane	n/a	redwinged blackbird	2.14	10.7	Red-tailed Hawk	2.1	22.1	37.7		10.7	110.5	188.3	
Chlordane	n/a	redwinged blackbird	2.14	10.7	Osprey	2.1	10.7	41.7	2.253e-05	10.7	53.5	208.4	1.126e-04
Chlordane	n/a	redwinged blackbird	2.14	10.7	Great Blue Heron	2.1	12.2	48.3	2.564e-05	10.7	60.9	241.7	1.282e-04
Chlordane	n/a	redwinged blackbird	2.14	10.7	Wild Turkey	2.1	71.3	65.3		10.7	356.7	326.6	
Chlordecone (kepone)	n/a	rat	0.08	0.4	Little Brown Bat	0.209	0.627	1.307		1.045	3.136	6.534	
Chlordecone (kepone)	n/a	rat	0.08	0.4	Short-tailed Shrew	0.176	0.293	0.799		0.879	1.465	3.996	
Chlordecone (kepone)	n/a	rat	0.08	0.4	White-footed Mouse	0.160	1.034	0.533		0.799	5.169	2.663	
Chlordecone (kepone)	n/a	rat	0.08	0.4	Meadow Vole	0.134	1.182	0.985		0.672	5.911	4.926	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Chlordecone (kepone)	n/a	rat	0.08	0.4	Mink	0.062	0.449	0.622	1.489e-05	0.308	2.246	3.108	7.445e-05
Chlordecone (kepone)	n/a	rat	0.08	0.4	Cottontail Rabbit	0.059	0.298	0.608		0.294	1.488	3.041	
Chlordecone (kepone)	n/a	rat	0.08	0.4	Red Fox	0.042	0.422	0.500		0.211	2.112	2.502	
Chlordecone (kepone)	n/a	rat	0.08	0.4	River Otter	0.037	0.325	0.457	1.081e-05	0.183	1.626	2.287	5.404e-05
Chlordecone (kepone)	n/a	rat	0.08	0.4	Whitetail Deer	0.022	0.729	0.343		0.112	3.644	1.714	
Chloroform	n/a	rat	15	41	Little Brown Bat	39.2	118	245		107	321	670	
Chloroform	n/a	rat	15	41	Short-tailed Shrew	33.0	55	150		90	150	410	
Chloroform	n/a	rat	15	41	White-footed Mouse	30.0	194	100		82	530	273	
Chloroform	n/a	rat	15	41	Meadow Vole	25.2	222	185		69	606	505	
Chloroform	n/a	rat	15	41	Mink	11.5	84	117	4.741	32	230	319	12.959
Chloroform	n/a	rat	15	41	Cottontail Rabbit	11.0	56	114		30	153	312	
Chloroform	n/a	rat	15	41	Red Fox	7.9	79	94		22	217	256	
Chloroform	n/a	rat	15	41	River Otter	6.9	61	86	3.439	19	167	234	9.399
Chloroform	n/a	rat	15	41	Whitetail Deer	4.2	137	64		12	373	176	
Chromium	Cr^{+3} as Cr_2O_3	rat	2737		Little Brown Bat	7154	21461	44710					
Chromium	Cr^{+3} as Cr_2O_3	rat	2737		Short-tailed Shrew	6015	10026	27343					
Chromium	Cr^{+3} as Cr_2O_3	rat	2737		White-footed Mouse	5466	35370	18221					
Chromium	Cr^{+3} as Cr_2O_3	rat	2737		Meadow Vole	4597	40449	33708					
Chromium	Cr^{+3} as Cr_2O_3	rat	2737		Mink	2105	15366	21265					

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Chromium	Cr^{+3} as Cr_2O_3	rat	2737		Cottontail Rabbit	2011	10184	20807					
Chromium	Cr^{+3} as Cr_2O_3	rat	2737		Red Fox	1445	14454	17117					
Chromium	Cr^{+3} as Cr_2O_3	rat	2737		River Otter	1252	11127	15647					
Chromium	Cr^{+3} as Cr_2O_3	rat	2737		Whitetail Deer	768	24933	11725					
Chromium	Cr^{+3} as $CrK(SO_4)_2$	black duck	1	5	Rough-winged Swallow	1.00	1.33	4.30		5.00	6.63	21.49	
Chromium	Cr^{+3} as $CrK(SO_4)_2$	black duck	1	5	American Robin	1.00	0.83	7.26		5.00	4.14	36.32	
Chromium	Cr^{+3} as $CrK(SO_4)_2$	black duck	1	5	Belted Kingfisher	1.00	1.97	9.25		5.00	9.87	46.25	
Chromium	Cr^{+3} as $CrK(SO_4)_2$	black duck	1	5	American Woodcock	1.00	1.32	9.90		5.00	6.60	49.50	
Chromium	Cr^{+3} as $CrK(SO_4)_2$	black duck	1	5	Cooper's Hawk	1.00	5.78	12.91		5.00	28.88	64.56	
Chromium	Cr^{+3} as $CrK(SO_4)_2$	black duck	1	5	Barn Owl	1.00	3.73	13.31		5.00	18.64	66.57	
Chromium	Cr^{+3} as $CrK(SO_4)_2$	black duck	1	5	Barred Owl	1.00	8.54	15.26		5.00	42.68	76.28	
Chromium	Cr^{+3} as $CrK(SO_4)_2$	black duck	1	5	Red-tailed Hawk	1.00	10.33	17.59		5.00	51.65	87.97	
Chromium	Cr^{+3} as $CrK(SO_4)_2$	black duck	1	5	Osprey	1.00	5.00	19.48		5.00	25.00	97.40	
Chromium	Cr^{+3} as $CrK(SO_4)_2$	black duck	1	5	Great Blue Heron	1.00	5.69	22.59		5.00	28.45	112.95	
Chromium	Cr^{+3} as $CrK(SO_4)_2$	black duck	1	5	Wild Turkey	1.00	33.33	30.53		5.00	166.67	152.63	
Chromium	Cr^{+6}	rat	3.28	13.14	Little Brown Bat	8.57	25.72	53.58		34.34	103.03	214.65	
Chromium	Cr^{+6}	rat	3.28	13.14	Short-tailed Shrew	7.21	12.01	32.77		28.88	48.13	131.27	
Chromium	Cr^{+6}	rat	3.28	13.14	White-footed Mouse	6.55	42.39	21.84		26.24	169.80	87.48	
Chromium	Cr^{+6}	rat	3.28	13.14	Meadow Vole	5.51	48.47	40.40		22.07	194.19	161.83	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Chromium	Cr^{+6}	rat	3.28	13.14	Mink	2.52	18.41	25.48	4.947	10.11	73.77	102.09	19.817
Chromium	Cr^{+6}	rat	3.28	13.14	Cottontail Rabbit	2.41	12.20	24.94		9.66	48.89	99.89	
Chromium	Cr^{+6}	rat	3.28	13.14	Red Fox	1.73	17.32	20.51		6.94	69.39	82.17	
Chromium	Cr^{+6}	rat	3.28	13.14	River Otter	1.50	13.33	18.75	3.593	6.01	53.42	75.12	14.394
Chromium	Cr^{+6}	rat	3.28	13.14	Whitetail Deer	0.92	29.88	14.05		3.69	119.70	56.29	
Copper	copper sulfate	mink	11.7	15.4	Little Brown Bat	39.8	119.3	248.5		52.3	157.0	327.1	
Copper	copper sulfate	mink	11.7	15.4	Short-tailed Shrew	33.4	55.7	152.0		44.0	73.3	200.0	
Copper	copper sulfate	mink	11.7	15.4	White-footed Mouse	30.4	196.6	101.3		40.0	258.7	133.3	
Copper	copper sulfate	mink	11.7	15.4	Meadow Vole	25.5	224.8	187.3		33.6	295.9	246.6	
Copper	copper sulfate	mink	11.7	15.4	Mink	11.7	85.4	118.2	0.294	15.4	112.4	155.6	0.387
Copper	copper sulfate	mink	11.7	15.4	Cottontail Rabbit	11.2	56.6	115.6		14.7	74.5	152.2	
Copper	copper sulfate	mink	11.7	15.4	Red Fox	8.0	80.3	95.1		10.6	105.7	125.2	
Copper	copper sulfate	mink	11.7	15.4	River Otter	7.0	61.8	87.0	0.213	9.2	81.4	114.5	0.280
Copper	copper sulfate	mink	11.7	15.4	Whitetail Deer	4.3	138.6	65.2		5.6	182.4	85.8	
Copper	copper oxide	1 day old chicks	47	61.7	Rough-winged Swallow	47.0	62.3	202.0		61.7	81.8	265.1	
Copper	copper oxide	1 day old chicks	47	61.7	American Robin	47.0	38.9	341.4		61.7	51.1	448.2	
Copper	copper oxide	1 day old chicks	47	61.7	Belted Kingfisher	47.0	92.7	434.8	0.320	61.7	121.8	570.7	0.420
Copper	copper oxide	1 day old chicks	47	61.7	American Woodcock	47.0	62.0	465.3		61.7	81.4	610.8	
Copper	copper oxide	1 day old chicks	47	61.7	Cooper's Hawk	47.0	271.5	606.9		61.7	356.4	796.7	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Copper	copper oxide	1 day old chicks	47	61.7	Barn Owl	47.0	175.2	625.8		61.7	230.0	821.5	
Copper	copper oxide	1 day old chicks	47	61.7	Barred Owl	47.0	401.2	717.0		61.7	526.7	941.3	
Copper	copper oxide	1 day old chicks	47	61.7	Red-tailed Hawk	47.0	485.5	826.9		61.7	637.4	1085.5	
Copper	copper oxide	1 day old chicks	47	61.7	Osprey	47.0	235.0	915.6	0.810	61.7	308.5	1201.9	1.063
Copper	copper oxide	1 day old chicks	47	61.7	Great Blue Heron	47.0	267.5	1061.7	0.921	61.7	351.1	1393.8	1.210
Copper	copper oxide	1 day old chicks	47	61.7	Wild Turkey	47.0	1566.7	1434.7		61.7	2056.7	1883.5	
o-Cresol	n/a	mink	219.2		Little Brown Bat	744.9	2234.6	4655.4					
o-Cresol	n/a	mink	219.2		Short-tailed Shrew	626.4	1043.9	2847.0					
o-Cresol	n/a	mink	219.2		White-footed Mouse	569.2	3682.8	1897.2					
o-Cresol	n/a	mink	219.2		Meadow Vole	478.6	4211.7	3509.8					
o-Cresol	n/a	mink	219.2		Mink	219.2	1600.0	2214.1	80.070				
o-Cresol	n/a	mink	219.2		Cottontail Rabbit	209.4	1060.4	2166.5					
o-Cresol	n/a	mink	219.2		Red Fox	150.5	1505.0	1782.2					
o-Cresol	n/a	mink	219.2		River Otter	130.3	1158.6	1629.2	58.070				
o-Cresol	n/a	mink	219.2		Whitetail Deer	80.0	2596.1	1220.9					
Cyanide	potassium cyanide	rat	68.7		Little Brown Bat	168.7	506.2	1054.7					
Cyanide	potassium cyanide	rat	68.7		Short-tailed Shrew	141.9	236.5	645.0					

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Cyanide	potassium cyanide	rat	68.7		White-footed Mouse	128.9	834.3	429.8					
Cyanide	potassium cyanide	rat	68.7		Meadow Vole	108.4	954.2	795.1					
Cyanide	potassium cyanide	rat	68.7		Mink	49.7	362.5	501.6	501.605				
Cyanide	potassium cyanide	rat	68.7		Cottontail Rabbit	47.4	240.2	490.8					
Cyanide	potassium cyanide	rat	68.7		Red Fox	34.1	341.0	403.8					
Cyanide	potassium cyanide	rat	68.7		River Otter	29.5	262.5	369.1	369.092				
Cyanide	potassium cyanide	rat	68.7		Whitetail Deer	18.1	588.1	276.6					
DDT and metabolites	n/a	rat	0.8	4	Little Brown Bat	2.09	6.27	13.07		10.45	31.36	65.34	
DDT and metabolites	n/a	rat	0.8	4	Short-tailed Shrew	1.76	2.93	7.99		8.79	14.65	39.96	
DDT and metabolites	n/a	rat	0.8	4	White-footed Mouse	1.60	10.34	5.33		7.99	51.69	26.63	
DDT and metabolites	n/a	rat	0.8	4	Meadow Vole	1.34	11.82	9.85		6.72	59.11	49.26	
DDT and metabolites	n/a	rat	0.8	4	Mink	0.62	4.49	6.22	3.362e-06	3.08	22.46	31.08	1.681e-05
DDT and metabolites	n/a	rat	0.8	4	Cottontail Rabbit	0.59	2.98	6.08		2.94	14.88	30.41	
DDT and metabolites	n/a	rat	0.8	4	Red Fox	0.42	4.22	5.00		2.11	21.12	25.02	
DDT and metabolites	n/a	rat	0.8	4	River Otter	0.37	3.25	4.57	1.797e-06	1.83	16.26	22.87	8.984e-06
DDT and metabolites	n/a	rat	0.8	4	Whitetail Deer	0.22	7.29	3.43		1.12	36.44	17.14	
DDT and metabolites	n/a	brown pelican	0.0028	0.028	Rough-winged Swallow	0.003	0.004	0.012		0.028	0.037	0.120	
DDT and metabolites	n/a	brown pelican	0.0028	0.028	American Robin	0.003	0.002	0.020		0.028	0.023	0.203	
DDT and metabolites	n/a	brown pelican	0.0028	0.028	Belted Kingfisher	0.003	0.006	0.026	4.136e-09	0.028	0.055	0.259	4.136e-08

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
DDT and metabolites	n/a	brown pelican	0.0028	0.028	American Woodcock	0.003	0.004	0.028		0.028	0.037	0.277	
DDT and metabolites	n/a	brown pelican	0.0028	0.028	Cooper's Hawk	0.003	0.016	0.036		0.028	0.162	0.362	
DDT and metabolites	n/a	brown pelican	0.0028	0.028	Barn Owl	0.003	0.010	0.037		0.028	0.104	0.373	
DDT and metabolites	n/a	brown pelican	0.0028	0.028	Barred Owl	0.003	0.024	0.043		0.028	0.239	0.427	
DDT and metabolites	n/a	brown pelican	0.0028	0.028	Red-tailed Hawk	0.003	0.029	0.049		0.028	0.289	0.493	
DDT and metabolites	n/a	brown pelican	0.0028	0.028	Osprey	0.003	0.014	0.055	1.048e-08	0.028	0.140	0.545	1.048e-07
DDT and metabolites	n/a	brown pelican	0.0028	0.028	Great Blue Heron	0.003	0.016	0.063	1.193e-08	0.028	0.159	0.633	1.193e-07
DDT and metabolites	n/a	brown pelican	0.0028	0.028	Wild Turkey	0.003	0.093	0.085		0.028	0.933	0.855	
1,2-Dichloroethane	n/a	mouse	50		Little Brown Bat	73.5	220.5	459.3					
1,2-Dichloroethane	n/a	mouse	50		Short-tailed Shrew	61.8	103.0	280.9					
1,2-Dichloroethane	n/a	mouse	50		White-footed Mouse	56.2	363.3	187.2					
1,2-Dichloroethane	n/a	mouse	50		Meadow Vole	47.2	415.5	346.3					
1,2-Dichloroethane	n/a	mouse	50		Mink	21.6	157.9	218.4	18.720				
1,2-Dichloroethane	n/a	mouse	50		Cottontail Rabbit	20.7	104.6	213.8					
1,2-Dichloroethane	n/a	mouse	50		Red Fox	14.8	148.5	175.8					
1,2-Dichloroethane	n/a	mouse	50		River Otter	12.9	114.3	160.7	13.574				
1,2-Dichloroethane	n/a	mouse	50		Whitetail Deer	7.9	256.1	120.5					
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Rough-winged Swallow	17.2	22.8	73.9		34.4	45.6	147.8	
1,2-Dichloroethane	n/a	chicken	17.2	34.4	American Robin	17.2	14.2	124.9		34.4	28.5	249.9	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Belted Kingfisher	17.2	33.9	159.1	4.284	34.4	67.9	318.2	8.567
1,2-Dichloroethane	n/a	chicken	17.2	34.4	American Woodcock	17.2	22.7	170.3		34.4	45.4	340.6	
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Cooper's Hawk	17.2	99.4	222.1		34.4	198.7	444.2	
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Barn Owl	17.2	64.1	229.0		34.4	128.2	458.0	
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Barred Owl	17.2	146.8	262.4		34.4	293.6	524.8	
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Red-tailed Hawk	17.2	177.7	302.6		34.4	355.4	605.2	
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Osprey	17.2	86.0	335.1	10.795	34.4	172.0	670.1	21.590
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Great Blue Heron	17.2	97.9	388.5	12.293	34.4	195.8	777.1	24.586
1,2-Dichloroethane	n/a	chicken	17.2	34.4	Wild Turkey	17.2	573.3	525.1		34.4	1146.7	1050.1	
1,1-Dichloroethylene	n/a	rat	30		Little Brown Bat	78.4	235.2	490.1					
1,1-Dichloroethylene	n/a	rat	30		Short-tailed Shrew	65.9	109.9	299.7					
1,1-Dichloroethylene	n/a	rat	30		White-footed Mouse	59.9	387.7	199.7					
1,1-Dichloroethylene	n/a	rat	30		Meadow Vole	50.4	443.4	369.5					
1,1-Dichloroethylene	n/a	beagle dog	2.5		Mink	4.4	32.5	44.9	1.281				
1,1-Dichloroethylene	n/a	rat	30		Cottontail Rabbit	22.0	111.6	228.1					
1,1-Dichloroethylene	n/a	beagle dog	2.5		Red Fox	3.1	30.5	36.1					
1,1-Dichloroethylene	n/a	beagle dog	2.5		River Otter	2.6	23.5	33.0	0.929				
1,1-Dichloroethylene	n/a	rat	30		Whitetail Deer	8.4	273.3	128.5					
1,2-Dichloroethylene	n/a	mouse	45.2		Little Brown Bat	63.9	191.8	399.5					

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
1,2-Dichloroethylene	n/a	mouse	45.2		Short-tailed Shrew	53.8	89.6	244.3					
1,2-Dichloroethylene	n/a	mouse	45.2		White-footed Mouse	48.8	316.1	162.8					
1,2-Dichloroethylene	n/a	mouse	45.2		Meadow Vole	41.1	361.4	301.2					
1,2-Dichloroethylene	n/a	mouse	45.2		Mink	18.8	137.3	190.0	8.543				
1,2-Dichloroethylene	n/a	mouse	45.2		Cottontail Rabbit	18.0	91.0	185.9					
1,2-Dichloroethylene	n/a	mouse	45.2		Red Fox	12.9	129.2	152.9					
1,2-Dichloroethylene	n/a	mouse	45.2		River Otter	11.2	99.4	139.8	6.197				
1,2-Dichloroethylene	n/a	mouse	45.2		Whitetail Deer	6.9	222.8	104.8					
Dieldrin	n/a	rat	0.02	0.2	Little Brown Bat	0.052	0.157	0.327		0.523	1.568	3.267	
Dieldrin	n/a	rat	0.02	0.2	Short-tailed Shrew	0.044	0.073	0.200		0.440	0.733	1.998	
Dieldrin	n/a	rat	0.02	0.2	White-footed Mouse	0.040	0.258	0.133		0.399	2.585	1.331	
Dieldrin	n/a	rat	0.02	0.2	Meadow Vole	0.034	0.296	0.246		0.336	2.956	2.463	
Dieldrin	n/a	rat	0.02	0.2	Mink	0.015	0.112	0.155	1.987e-06	0.154	1.123	1.554	1.987e-05
Dieldrin	n/a	rat	0.02	0.2	Cottontail Rabbit	0.015	0.074	0.152		0.147	0.744	1.520	
Dieldrin	n/a	rat	0.02	0.2	Red Fox	0.011	0.106	0.125		0.106	1.056	1.251	
Dieldrin	n/a	rat	0.02	0.2	River Otter	0.009	0.081	0.114	1.362e-06	0.091	0.813	1.143	1.362e-05
Dieldrin	n/a	rat	0.02	0.2	Whitetail Deer	0.006	0.182	0.086		0.056	1.822	0.857	
Dieldrin	n/a	barn owl	0.077		Rough-winged Swallow	0.077	0.102	0.331					
Dieldrin	n/a	barn owl	0.077		American Robin	0.077	0.064	0.559					

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Dieldrin	n/a	barn owl	0.077		Belted Kingfisher	0.077	0.152	0.712	2.688e-06				
Dieldrin	n/a	barn owl	0.077		American Woodcock	0.077	0.102	0.762					
Dieldrin	n/a	barn owl	0.077		Cooper's Hawk	0.077	0.445	0.994					
Dieldrin	n/a	barn owl	0.077		Barn Owl	0.077	0.287	1.025					
Dieldrin	n/a	barn owl	0.077		Barred Owl	0.077	0.657	1.175					
Dieldrin	n/a	barn owl	0.077		Red-tailed Hawk	0.077	0.795	1.355					
Dieldrin	n/a	barn owl	0.077		Osprey	0.077	0.385	1.500	6.811e-06				
Dieldrin	n/a	barn owl	0.077		Great Blue Heron	0.077	0.438	1.739	7.752e-06				
Dieldrin	n/a	barn owl	0.077		Wild Turkey	0.077	2.567	2.351					
Diethylphthalate	n/a	mouse	4583		Little Brown Bat	6481	19444	40508					
Diethylphthalate	n/a	mouse	4583		Short-tailed Shrew	5450	9084	24773					
Diethylphthalate	n/a	mouse	4583		White-footed Mouse	4953	32046	16508					
Diethylphthalate	n/a	mouse	4583		Meadow Vole	4165	36648	30540					
Diethylphthalate	n/a	mouse	4583		Mink	1907	13922	19266	290.273				
Diethylphthalate	n/a	mouse	4583		Cottontail Rabbit	1822	9227	18852					
Diethylphthalate	n/a	mouse	4583		Red Fox	1310	13096	15508					
Diethylphthalate	n/a	mouse	4583		River Otter	1134	10081	14176	210.561				
Diethylphthalate	n/a	mouse	4583		Whitetail Deer	696	22590	10623					
Di-N-butylphthalate	n/a	mouse	550	1833	Little Brown Bat	778	2333	4861		2592	7777	16202	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Di-N-butylphthalate	n/a	mouse	550	1833	Short-tailed Shrew	654	1090	2973		2180	3633	9908	
Di-N-butylphthalate	n/a	mouse	550	1833	White-footed Mouse	594	3846	1981		1981	12817	6603	
Di-N-butylphthalate	n/a	mouse	550	1833	Meadow Vole	500	4398	3665		1666	14658	12215	
Di-N-butylphthalate	n/a	mouse	550	1833	Mink	229	1671	2312	0.456	763	5568	7706	1.521
Di-N-butylphthalate	n/a	mouse	550	1833	Cottontail Rabbit	219	1107	2262		729	3690	7540	
Di-N-butylphthalate	n/a	mouse	550	1833	Red Fox	157	1572	1861		524	5238	6203	
Di-N-butylphthalate	n/a	mouse	550	1833	River Otter	136	1210	1701	0.348	454	4032	5670	1.160
Di-N-butylphthalate	n/a	mouse	550	1833	Whitetail Deer	83	2711	1275		278	9035	4249	
Di-N-butylphthalate	n/a	ringed dove	0.11	1.1	Rough-winged Swallow	0.11	0.15	0.47		1.10	1.46	4.73	
Di-N-butylphthalate	n/a	ringed dove	0.11	1.1	American Robin	0.11	0.09	0.80		1.10	0.91	7.99	
Di-N-butylphthalate	n/a	ringed dove	0.11	1.1	Belted Kingfisher	0.11	0.22	1.02	0.000	1.10	2.17	10.18	0.001
Di-N-butylphthalate	n/a	ringed dove	0.11	1.1	American Woodcock	0.11	0.15	1.09		1.10	1.45	10.89	
Di-N-butylphthalate	n/a	ringed dove	0.11	1.1	Cooper's Hawk	0.11	0.64	1.42		1.10	6.35	14.20	
Di-N-butylphthalate	n/a	ringed dove	0.11	1.1	Barn Owl	0.11	0.41	1.46		1.10	4.10	14.65	
Di-N-butylphthalate	n/a	ringed dove	0.11	1.1	Barred Owl	0.11	0.94	1.68		1.10	9.39	16.78	
Di-N-butylphthalate	n/a	ringed dove	0.11	1.1	Red-tailed Hawk	0.11	1.14	1.94		1.10	11.36	19.35	
Di-N-butylphthalate	n/a	ringed dove	0.11	1.1	Osprey	0.11	0.55	2.14	1.502e-04	1.10	5.50	21.43	1.502e-03
Di-N-butylphthalate	n/a	ringed dove	0.11	1.1	Great Blue Heron	0.11	0.63	2.48	1.710e-04	1.10	6.26	24.85	1.710e-03
Di-N-butylphthalate	n/a	ringed dove	0.11	1.1	Wild Turkey	0.11	3.67	3.36		1.10	36.67	33.58	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Di-N-hexylphthalate	n/a	mouse	55	550	Little Brown Bat	77.8	233.3	486.1		777.8	2333.5	4861.4	
Di-N-hexylphthalate	n/a	mouse	55	550	Short-tailed Shrew	65.4	109.0	297.3		654.1	1090.1	2973.0	
Di-N-hexylphthalate	n/a	mouse	55	550	White-footed Mouse	59.4	384.6	198.1		594.3	3845.8	1981.1	
Di-N-hexylphthalate	n/a	mouse	55	550	Meadow Vole	50.0	439.8	366.5		499.8	4398.1	3665.1	
Di-N-hexylphthalate	n/a	mouse	55	550	Mink	22.9	167.1	231.2		228.9	1670.8	2312.1	
Di-N-hexylphthalate	n/a	mouse	55	550	Cottontail Rabbit	21.9	110.7	226.2		218.7	1107.3	2262.4	
Di-N-hexylphthalate	n/a	mouse	55	550	Red Fox	15.7	157.2	186.1		157.2	1571.6	1861.1	
Di-N-hexylphthalate	n/a	mouse	55	550	River Otter	13.6	121.0	170.1		136.1	1209.8	1701.3	
Di-N-hexylphthalate	n/a	mouse	55	550	Whitetail Deer	8.3	271.1	127.5		83.5	2711.0	1274.9	
1,4-Dioxane	n/a	rat	0.5	1	Little Brown Bat	1.31	3.92	8.17		2.61	7.84	16.34	
1,4-Dioxane	n/a	rat	0.5	1	Short-tailed Shrew	1.10	1.83	5.00		2.20	3.66	9.99	
1,4-Dioxane	n/a	rat	0.5	1	White-footed Mouse	1.00	6.46	3.33		2.00	12.92	6.66	
1,4-Dioxane	n/a	rat	0.5	1	Meadow Vole	0.84	7.39	6.16		1.68	14.78	12.32	
1,4-Dioxane	n/a	rat	0.5	1	Mink	0.38	2.81	3.88	2.745	0.77	5.61	7.77	5.490
1,4-Dioxane	n/a	rat	0.5	1	Cottontail Rabbit	0.37	1.86	3.80		0.73	3.72	7.60	
1,4-Dioxane	n/a	rat	0.5	1	Red Fox	0.26	2.64	3.13		0.53	5.28	6.25	
1,4-Dioxane	n/a	rat	0.5	1	River Otter	0.23	2.03	2.86	2.010	0.46	4.07	5.72	4.021
1,4-Dioxane	n/a	rat	0.5	1	Whitetail Deer	0.14	4.55	2.14		0.28	9.11	4.28	
Endosulfan	n/a	rat	0.15		Little Brown Bat	0.39	1.18	2.45					

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Endosulfan	n/a	rat	0.15		Short-tailed Shrew	0.33	0.55	1.50					
Endosulfan	n/a	rat	0.15		White-footed Mouse	0.30	1.94	1.00					
Endosulfan	n/a	rat	0.15		Meadow Vole	0.25	2.22	1.85					
Endosulfan	n/a	rat	0.15		Mink	0.12	0.84	1.17	0.001				
Endosulfan	n/a	rat	0.15		Cottontail Rabbit	0.11	0.56	1.14					
Endosulfan	n/a	rat	0.15		Red Fox	0.08	0.79	0.94					
Endosulfan	n/a	rat	0.15		River Otter	0.07	0.61	0.86	0.001				
Endosulfan	n/a	rat	0.15		Whitetail Deer	0.04	1.37	0.64					
Endosulfan	n/a	gray partridge	10		Rough-winged Swallow	10.0	13.3	43.0					
Endosulfan	n/a	gray partridge	10		American Robin	10.0	8.3	72.6					
Endosulfan	n/a	gray partridge	10		Belted Kingfisher	10.0	19.7	92.5	0.020				
Endosulfan	n/a	gray partridge	10		American Woodcock	10.0	13.2	99.0					
Endosulfan	n/a	gray partridge	10		Cooper's Hawk	10.0	57.8	129.1					
Endosulfan	n/a	gray partridge	10		Barn Owl	10.0	37.3	133.1					
Endosulfan	n/a	gray partridge	10		Barred Owl	10.0	85.4	152.6					
Endosulfan	n/a	gray partridge	10		Red-tailed Hawk	10.0	103.3	175.9					
Endosulfan	n/a	gray partridge	10		Osprey	10.0	50.0	194.8	0.049				
Endosulfan	n/a	gray partridge	10		Great Blue Heron	10.0	56.9	225.9	0.056				
Endosulfan	n/a	gray partridge	10		Wild Turkey	10.0	333.3	305.3					

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Endrin	n/a	mouse	0.092	0.92	Little Brown Bat	0.130	0.390	0.813		1.301	3.903	8.132	
Endrin	n/a	mouse	0.092	0.92	Short-tailed Shrew	0.109	0.182	0.497		1.094	1.823	4.973	
Endrin	n/a	mouse	0.092	0.92	White-footed Mouse	0.099	0.643	0.331		0.994	6.433	3.314	
Endrin	n/a	mouse	0.092	0.92	Meadow Vole	0.084	0.736	0.613		0.836	7.357	6.131	
Endrin	n/a	mouse	0.092	0.92	Mink	0.038	0.279	0.387	1.859e-05	0.383	2.795	3.868	1.859e-04
Endrin	n/a	mouse	0.092	0.92	Cottontail Rabbit	0.037	0.185	0.378		0.366	1.852	3.784	
Endrin	n/a	mouse	0.092	0.92	Red Fox	0.026	0.263	0.311		0.263	2.629	3.113	
Endrin	n/a	mouse	0.092	0.92	River Otter	0.023	0.202	0.285	1.383e-05	0.228	2.024	2.846	1.383e-04
Endrin	n/a	mouse	0.092	0.92	Whitetail Deer	0.014	0.453	0.213		0.140	4.535	2.133	
Endrin	n/a	screech owl	0.01	0.1	Rough-winged Swallow	0.010	0.013	0.043		0.100	0.133	0.430	
Endrin	n/a	screech owl	0.01	0.1	American Robin	0.010	0.008	0.073		0.100	0.083	0.726	
Endrin	n/a	screech owl	0.01	0.1	Belted Kingfisher	0.010	0.020	0.093	1.313e-06	0.100	0.197	0.925	1.313e-05
Endrin	n/a	screech owl	0.01	0.1	American Woodcock	0.010	0.013	0.099		0.100	0.132	0.990	
Endrin	n/a	screech owl	0.01	0.1	Cooper's Hawk	0.010	0.058	0.129		0.100	0.578	1.291	
Endrin	n/a	screech owl	0.01	0.1	Barn Owl	0.010	0.037	0.133		0.100	0.373	1.331	
Endrin	n/a	screech owl	0.01	0.1	Barred Owl	0.010	0.085	0.153		0.100	0.854	1.526	
Endrin	n/a	screech owl	0.01	0.1	Red-tailed Hawk	0.010	0.103	0.176		0.100	1.033	1.759	
Endrin	n/a	screech owl	0.01	0.1	Osprey	0.010	0.050	0.195	3.326e-06	0.100	0.500	1.948	3.326e-05
Endrin	n/a	screech owl	0.01	0.1	Great Blue Heron	0.010	0.057	0.226	3.785e-06	0.100	0.569	2.259	3.785e-05

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Endrin	n/a	screech owl	0.01	0.1	Wild Turkey	0.010	0.333	0.305		0.100	3.333	3.053	
Ethanol	n/a	rat	31.9	319	Little Brown Bat	83	250	521		834	2501	5211	
Ethanol	n/a	rat	31.9	319	Short-tailed Shrew	70	117	319		701	1169	3187	
Ethanol	n/a	rat	31.9	319	White-footed Mouse	64	412	212		637	4122	2124	
Ethanol	n/a	rat	31.9	319	Meadow Vole	54	471	393		536	4714	3929	
Ethanol	n/a	rat	31.9	319	Mink	25	179	248	168.541	245	1791	2478	1685.412
Ethanol	n/a	rat	31.9	319	Cottontail Rabbit	23	119	243		234	1187	2425	
Ethanol	n/a	rat	31.9	319	Red Fox	17	168	199		168	1685	1995	
Ethanol	n/a	rat	31.9	319	River Otter	15	130	182	123.377	146	1297	1824	1233.770
Ethanol	n/a	rat	31.9	319	Whitetail Deer	9	291	137		89	2906	1367	
Ethyl Acetate	n/a	rat	90	360	Little Brown Bat	235	706	1470		941	2823	5881	
Ethyl Acetate	n/a	rat	90	360	Short-tailed Shrew	198	330	899		791	1319	3596	
Ethyl Acetate	n/a	rat	90	360	White-footed Mouse	180	1163	599		719	4652	2397	
Ethyl Acetate	n/a	rat	90	360	Meadow Vole	151	1330	1108		605	5320	4434	
Ethyl Acetate	n/a	rat	90	360	Mink	69	505	699	187.656	277	2021	2797	750.624
Ethyl Acetate	n/a	rat	90	360	Cottontail Rabbit	66	335	684		265	1340	2737	
Ethyl Acetate	n/a	rat	90	360	Red Fox	48	475	563		190	1901	2251	
Ethyl Acetate	n/a	rat	90	360	River Otter	41	366	515	136.465	165	1464	2058	545.858
Ethyl Acetate	n/a	rat	90	360	Whitetail Deer	25	820	386		101	3279	1542	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Fluoride	NaF	mink	31.37	52.75	Little Brown Bat	106.6	319.8	666.2		179.2	537.7	1120.3	
Fluoride	NaF	mink	31.37	52.75	Short-tailed Shrew	89.6	149.4	407.4		150.7	251.2	685.1	
Fluoride	NaF	mink	31.37	52.75	White-footed Mouse	81.5	527.1	271.5		137.0	886.3	456.6	
Fluoride	NaF	mink	31.37	52.75	Meadow Vole	68.5	602.7	502.3		115.2	1013.5	844.6	
Fluoride	NaF	mink	31.37	52.75	Mink	31.4	229.0	316.9		52.8	385.0	532.8	
Fluoride	NaF	mink	31.37	52.75	Cottontail Rabbit	30.0	151.8	310.1		50.4	255.2	521.4	
Fluoride	NaF	mink	31.37	52.75	Red Fox	21.5	215.4	255.1		36.2	362.2	428.9	
Fluoride	NaF	mink	31.37	52.75	River Otter	18.7	165.8	233.2		31.4	278.8	392.1	
Fluoride	NaF	mink	31.37	52.75	Whitetail Deer	11.4	371.5	174.7		19.2	624.8	293.8	
Fluoride	NaF	screech owl	7.8	32	Rough-winged Swallow	7.8	10.3	33.5		32.0	42.4	137.5	
Fluoride	NaF	screech owl	7.8	32	American Robin	7.8	6.5	56.7		32.0	26.5	232.5	
Fluoride	NaF	screech owl	7.8	32	Belted Kingfisher	7.8	15.4	72.2		32.0	63.1	296.0	
Fluoride	NaF	screech owl	7.8	32	American Woodcock	7.8	10.3	77.2		32.0	42.2	316.8	
Fluoride	NaF	screech owl	7.8	32	Cooper's Hawk	7.8	45.1	100.7		32.0	184.8	413.2	
Fluoride	NaF	screech owl	7.8	32	Barn Owl	7.8	29.1	103.9		32.0	119.3	426.1	
Fluoride	NaF	screech owl	7.8	32	Barred Owl	7.8	66.6	119.0		32.0	273.1	488.2	
Fluoride	NaF	screech owl	7.8	32	Red-tailed Hawk	7.8	80.6	137.2		32.0	330.6	563.0	
Fluoride	NaF	screech owl	7.8	32	Osprey	7.8	39.0	151.9		32.0	160.0	623.4	
Fluoride	NaF	screech owl	7.8	32	Great Blue Heron	7.8	44.4	176.2		32.0	182.1	722.9	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Fluoride	NaF	screech owl	7.8	32	Wild Turkey	7.8	260.0	238.1		32.0	1066.7	976.8	
Formaldehyde	n/a	beagle dog	9.4		Little Brown Bat	59.5	178.4	371.6					
Formaldehyde	n/a	beagle dog	9.4		Short-tailed Shrew	50.0	83.3	227.2					
Formaldehyde	n/a	beagle dog	9.4		White-footed Mouse	45.4	293.9	151.4					
Formaldehyde	n/a	beagle dog	9.4		Meadow Vole	38.2	336.2	280.1					
Formaldehyde	n/a	beagle dog	9.4		Mink	17.5	127.7	176.7	101.141				
Formaldehyde	n/a	beagle dog	9.4		Cottontail Rabbit	16.7	84.6	172.9					
Formaldehyde	n/a	beagle dog	9.4		Red Fox	12.0	120.1	142.2					
Formaldehyde	n/a	beagle dog	9.4		River Otter	10.4	92.5	130.0	73.910				
Formaldehyde	n/a	beagle dog	9.4		Whitetail Deer	6.4	207.2	97.4					
Heptachlor	n/a	mink	0.1	1	Little Brown Bat	0.340	1.019	2.124		3.398	10.194	21.238	
Heptachlor	n/a	mink	0.1	1	Short-tailed Shrew	0.286	0.476	1.299		2.857	4.762	12.988	
Heptachlor	n/a	mink	0.1	1	White-footed Mouse	0.260	1.680	0.866		2.597	16.801	8.655	
Heptachlor	n/a	mink	0.1	1	Meadow Vole	0.218	1.921	1.601		2.183	19.214	16.012	
Heptachlor	n/a	mink	0.1	1	Mink	0.100	0.730	1.010	1.707e-06	1.000	7.299	10.101	1.707e-05
Heptachlor	n/a	mink	0.1	1	Cottontail Rabbit	0.096	0.484	0.988		0.955	4.838	9.884	
Heptachlor	n/a	mink	0.1	1	Red Fox	0.069	0.687	0.813		0.687	6.866	8.131	
Heptachlor	n/a	mink	0.1	1	River Otter	0.059	0.529	0.743	1.083e-06	0.595	5.285	7.433	1.083e-05
Heptachlor	n/a	mink	0.1	1	Whitetail Deer	0.036	1.184	0.557		0.365	11.844	5.570	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
1,2,3,6,7,8-Hexa-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Little Brown Bat	0.00042	0.00125	0.00261		0.00418	0.01255	0.02614	
1,2,3,6,7,8-Hexa-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Short-tailed Shrew	0.00035	0.00059	0.00160		0.00352	0.00586	0.01598	
1,2,3,6,7,8-Hexa-chlorodibenzofuran	n/a	rat	0.00016	0.0016	White-footed Mouse	0.00032	0.00207	0.00107		0.00320	0.02068	0.01065	
1,2,3,6,7,8-Hexa-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Meadow Vole	0.00027	0.00236	0.00197		0.00269	0.02365	0.01970	
1,2,3,6,7,8-Hexa-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Mink	0.00012	0.00090	0.00124		0.00123	0.00898	0.01243	
1,2,3,6,7,8-Hexa-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Cottontail Rabbit	0.00012	0.00060	0.00122		0.00118	0.00595	0.01216	
1,2,3,6,7,8-Hexa-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Red Fox	0.00008	0.00084	0.00100		0.00084	0.00845	0.01001	
1,2,3,6,7,8-Hexa-chlorodibenzofuran	n/a	rat	0.00016	0.0016	River Otter	0.00007	0.00065	0.00091		0.00073	0.00650	0.00915	
1,2,3,6,7,8-Hexa-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Whitetail Deer	0.00004	0.00146	0.00069		0.00045	0.01458	0.00685	
Lead	lead acetate	rat	8	80	Little Brown Bat	20.91	62.73	130.68		209.09	627.28	1306.84	
Lead	lead acetate	rat	8	80	Short-tailed Shrew	17.58	29.30	79.92		175.83	293.04	799.21	
Lead	lead acetate	rat	8	80	White-footed Mouse	15.98	103.38	53.26		159.77	1033.82	532.57	
Lead	lead acetate	rat	8	80	Meadow Vole	13.44	118.23	98.52		134.35	1182.30	985.25	
Lead	lead acetate	rat	8	80	Mink	6.15	44.91	62.15	0.982	61.53	449.14	621.54	9.823
Lead	lead acetate	rat	8	80	Cottontail Rabbit	5.88	29.77	60.82		58.79	297.68	608.18	
Lead	lead acetate	rat	8	80	Red Fox	4.22	42.25	50.03		42.25	422.48	500.30	
Lead	lead acetate	rat	8	80	River Otter	3.66	32.52	45.73	0.711	36.59	325.22	457.35	7.115

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Lead	lead acetate	rat	8	80	Whitetail Deer	2.24	72.88	34.27		22.44	728.78	342.72	
Lead	lead acetate	Japanese quail	1.13	11.3	Rough-winged Swallow	1.13	1.50	4.86		11.30	14.97	48.56	
Lead	lead acetate	Japanese quail	1.13	11.3	American Robin	1.13	0.94	8.21		11.30	9.36	82.08	
Lead	lead acetate	Japanese quail	1.13	11.3	Belted Kingfisher	1.13	2.23	10.45	0.049	11.30	22.30	104.53	0.493
Lead	lead acetate	Japanese quail	1.13	11.3	American Woodcock	1.13	1.49	11.19		11.30	14.92	111.87	
Lead	lead acetate	Japanese quail	1.13	11.3	Cooper's Hawk	1.13	6.53	14.59		11.30	65.27	145.90	
Lead	lead acetate	Japanese quail	1.13	11.3	Barn Owl	1.13	4.21	15.05		11.30	42.13	150.45	
Lead	lead acetate	Japanese quail	1.13	11.3	Barred Owl	1.13	9.65	17.24		11.30	96.45	172.39	
Lead	lead acetate	Japanese quail	1.13	11.3	Red-tailed Hawk	1.13	11.67	19.88		11.30	116.73	198.81	
Lead	lead acetate	Japanese quail	1.13	11.3	Osprey	1.13	5.65	22.01	0.125	11.30	56.50	220.13	1.248
Lead	lead acetate	Japanese quail	1.13	11.3	Great Blue Heron	1.13	6.43	25.53	0.142	11.30	64.30	255.26	1.421
Lead	lead acetate	Japanese quail	1.13	11.3	Wild Turkey	1.13	37.67	34.49		11.30	376.67	344.95	
Lead	metallic	American kestrel	3.85		Rough-winged Swallow	3.85	5.10	16.54					
Lead	metallic	American kestrel	3.85		American Robin	3.85	3.19	27.97					
Lead	metallic	American kestrel	3.85		Belted Kingfisher	3.85	7.60	35.61	0.168				
Lead	metallic	American kestrel	3.85		American Woodcock	3.85	5.08	38.12					
Lead	metallic	American kestrel	3.85		Cooper's Hawk	3.85	22.24	49.71					
Lead	metallic	American kestrel	3.85		Barn Owl	3.85	14.35	51.26					

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Lead	metallic	American kestrel	3.85		Barred Owl	3.85	32.86	58.73					
Lead	metallic	American kestrel	3.85		Red-tailed Hawk	3.85	39.77	67.74					
Lead	metallic	American kestrel	3.85		Osprey	3.85	19.25	75.00	0.425				
Lead	metallic	American kestrel	3.85		Great Blue Heron	3.85	21.91	86.97	0.484				
Lead	metallic	American kestrel	3.85		Wild Turkey	3.85	128.33	117.53					
Lindane	Gamma-BHC	rat	8		Little Brown Bat	20.91	62.73	130.68					
Lindane	Gamma-BHC	rat	8		Short-tailed Shrew	17.58	29.30	79.92					
Lindane	Gamma-BHC	rat	8		White-footed Mouse	15.98	103.38	53.26					
Lindane	Gamma-BHC	rat	8		Meadow Vole	13.44	118.23	98.52					
Lindane	Gamma-BHC	rat	8		Mink	6.15	44.91	62.15	0.099				
Lindane	Gamma-BHC	rat	8		Cottontail Rabbit	5.88	29.77	60.82					
Lindane	Gamma-BHC	rat	8		Red Fox	4.22	42.25	50.03					
Lindane	Gamma-BHC	rat	8		River Otter	3.66	32.52	45.73	0.073				
Lindane	Gamma-BHC	rat	8		Whitetail Deer	2.24	72.88	34.27					
Lindane	Gamma-BHC	mallard duck	2	20	Rough-winged Swallow	2.00	2.65	8.59		20.00	26.50	85.95	
Lindane	Gamma-BHC	mallard duck	2	20	American Robin	2.00	1.66	14.53		20.00	16.56	145.28	
Lindane	Gamma-BHC	mallard duck	2	20	Belted Kingfisher	2.00	3.95	18.50	0.009	20.00	39.47	185.00	0.087

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Lindane	Gamma-BHC	mallard duck	2	20	American Woodcock	2.00	2.64	19.80		20.00	26.40	198.00	
Lindane	Gamma-BHC	mallard duck	2	20	Cooper's Hawk	2.00	11.55	25.82		20.00	115.53	258.24	
Lindane	Gamma-BHC	mallard duck	2	20	Barn Owl	2.00	7.46	26.63		20.00	74.56	266.29	
Lindane	Gamma-BHC	mallard duck	2	20	Barred Owl	2.00	17.07	30.51		20.00	170.71	305.11	
Lindane	Gamma-BHC	mallard duck	2	20	Red-tailed Hawk	2.00	20.66	35.19		20.00	206.61	351.88	
Lindane	Gamma-BHC	mallard duck	2	20	Osprey	2.00	10.00	38.96	0.022	20.00	100.00	389.61	0.220
Lindane	Gamma-BHC	mallard duck	2	20	Great Blue Heron	2.00	11.38	45.18	0.025	20.00	113.81	451.80	0.251
Lindane	Gamma-BHC	mallard duck	2	20	Wild Turkey	2.00	66.67	61.05		20.00	666.67	610.53	
Lithium	lithium carbonate	rat	9.4	18.8	Little Brown Bat	24.6	73.7	153.6		49.1	147.4	307.1	
Lithium	lithium carbonate	rat	9.4	18.8	Short-tailed Shrew	20.7	34.4	93.9		41.3	68.9	187.8	
Lithium	lithium carbonate	rat	9.4	18.8	White-footed Mouse	18.8	121.5	62.6		37.5	242.9	125.2	
Lithium	lithium carbonate	rat	9.4	18.8	Meadow Vole	15.8	138.9	115.8		31.6	277.8	231.5	
Lithium	lithium carbonate	rat	9.4	18.8	Mink	7.2	52.8	73.0		14.5	105.5	146.1	
Lithium	lithium carbonate	rat	9.4	18.8	Cottontail Rabbit	6.9	35.0	71.5		13.8	70.0	142.9	
Lithium	lithium carbonate	rat	9.4	18.8	Red Fox	5.0	49.6	58.8		9.9	99.3	117.6	
Lithium	lithium carbonate	rat	9.4	18.8	River Otter	4.3	38.2	53.7		8.6	76.4	107.5	
Lithium	lithium carbonate	rat	9.4	18.8	Whitetail Deer	2.6	85.6	40.3		5.3	171.3	80.5	
Manganese	Mn_3O_4	rat	88	284	Little Brown Bat	230	690	1438		742	2227	4639	
Manganese	Mn_3O_4	rat	88	284	Short-tailed Shrew	193	322	879		624	1040	2837	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Manganese	Mn_3O_4	rat	88	284	White-footed Mouse	176	1137	586		567	3670	1891	
Manganese	Mn_3O_4	rat	88	284	Meadow Vole	148	1301	1084		477	4197	3498	
Manganese	Mn_3O_4	rat	88	284	Mink	68	494	684		218	1594	2206	
Manganese	Mn_3O_4	rat	88	284	Cottontail Rabbit	65	327	669		209	1057	2159	
Manganese	Mn_3O_4	rat	88	284	Red Fox	46	465	550		150	1500	1776	
Manganese	Mn_3O_4	rat	88	284	River Otter	40	358	503		130	1155	1624	
Manganese	Mn_3O_4	rat	88	284	Whitetail Deer	25	802	377		80	2587	1217	
Manganese	Mn_3O_4	Japanese quail	997		Rough-winged Swallow	997	1321	4284					
Manganese	Mn_3O_4	Japanese quail	997		American Robin	997	825	7242					
Manganese	Mn_3O_4	Japanese quail	997		Belted Kingfisher	997	1967	9222					
Manganese	Mn_3O_4	Japanese quail	997		American Woodcock	997	1316	9870					
Manganese	Mn_3O_4	Japanese quail	997		Cooper's Hawk	997	5759	12873					
Manganese	Mn_3O_4	Japanese quail	997		Barn Owl	997	3717	13274					
Manganese	Mn_3O_4	Japanese quail	997		Barred Owl	997	8510	15210					
Manganese	Mn_3O_4	Japanese quail	997		Red-tailed Hawk	997	10299	17541					
Manganese	Mn_3O_4	Japanese quail	997		Osprey	997	4985	19422					
Manganese	Mn_3O_4	Japanese quail	997		Great Blue Heron	997	5673	22522					
Manganese	Mn_3O_4	Japanese quail	997		Wild Turkey	997	33233	30435					
Mercury	mercuric chloride	mink	1		Little Brown Bat	3.40	10.19	21.24					

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Mercury	mercuric chloride	mink	1		Short-tailed Shrew	2.86	4.76	12.99					
Mercury	mercuric chloride	mink	1		White-footed Mouse	2.60	16.80	8.66					
Mercury	mercuric chloride	mink	1		Meadow Vole	2.18	19.21	16.01					
Mercury	mercuric chloride	mink	1		Mink	1.00	7.30	10.10					
Mercury	mercuric chloride	mink	1		Cottontail Rabbit	0.96	4.84	9.88					
Mercury	mercuric chloride	mink	1		Red Fox	0.69	6.87	8.13					
Mercury	mercuric chloride	mink	1		River Otter	0.59	5.29	7.43					
Mercury	mercuric chloride	mink	1		Whitetail Deer	0.36	11.84	5.57					
Mercury	mercuric chloride	Japanese Quail	0.45	0.9	Rough-winged Swallow	0.45	0.60	1.93		0.90	1.19	3.87	
Mercury	mercuric chloride	Japanese Quail	0.45	0.9	American Robin	0.45	0.37	3.27		0.90	0.75	6.54	
Mercury	mercuric chloride	Japanese Quail	0.45	0.9	Belted Kingfisher	0.45	0.89	4.16		0.90	1.78	8.33	
Mercury	mercuric chloride	Japanese Quail	0.45	0.9	American Woodcock	0.45	0.59	4.46		0.90	1.19	8.91	
Mercury	mercuric chloride	Japanese Quail	0.45	0.9	Cooper's Hawk	0.45	2.60	5.81		0.90	5.20	11.62	
Mercury	mercuric chloride	Japanese Quail	0.45	0.9	Barn Owl	0.45	1.68	5.99		0.90	3.36	11.98	
Mercury	mercuric chloride	Japanese Quail	0.45	0.9	Barred Owl	0.45	3.84	6.86		0.90	7.68	13.73	
Mercury	mercuric chloride	Japanese Quail	0.45	0.9	Red-tailed Hawk	0.45	4.65	7.92		0.90	9.30	15.83	
Mercury	mercuric chloride	Japanese Quail	0.45	0.9	Osprey	0.45	2.25	8.77		0.90	4.50	17.53	
Mercury	mercuric chloride	Japanese Quail	0.45	0.9	Great Blue Heron	0.45	2.56	10.17		0.90	5.12	20.33	
Mercury	mercuric chloride	Japanese Quail	0.45	0.9	Wild Turkey	0.45	15.00	13.74		0.90	30.00	27.47	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Mercury	mercuric sulfide	mouse	13.2		Little Brown Bat	18.67	56.00	116.67					
Mercury	mercuric sulfide	mouse	13.2		Short-tailed Shrew	15.70	26.16	71.35					
Mercury	mercuric sulfide	mouse	13.2		White-footed Mouse	14.26	92.30	47.55					
Mercury	mercuric sulfide	mouse	13.2		Meadow Vole	11.99	105.55	87.96					
Mercury	mercuric sulfide	mouse	13.2		Mink	5.49	40.10	55.49					
Mercury	mercuric sulfide	mouse	13.2		Cottontail Rabbit	5.25	26.58	54.30					
Mercury	mercuric sulfide	mouse	13.2		Red Fox	3.77	37.72	44.67					
Mercury	mercuric sulfide	mouse	13.2		River Otter	3.27	29.04	40.83					
Mercury	mercuric sulfide	mouse	13.2		Whitetail Deer	2.00	65.06	30.60					
Mercury	Methyl Mercury Chloride	rat	0.032	0.16	Little Brown Bat	0.084	0.251	0.523		0.418	1.255	2.614	
Mercury	Methyl Mercury Chloride	rat	0.032	0.16	Short-tailed Shrew	0.070	0.117	0.320		0.352	0.586	1.598	
Mercury	Methyl Mercury Chloride	rat	0.032	0.16	White-footed Mouse	0.064	0.414	0.213		0.320	2.068	1.065	
Mercury	Methyl Mercury Chloride	rat	0.032	0.16	Meadow Vole	0.054	0.473	0.394		0.269	2.365	1.970	
Mercury	Methyl Mercury Chloride	mink	0.015	0.025	Mink	0.015	0.109	0.152	3.924e-06	0.025	0.182	0.253	6.540e-06
Mercury	Methyl Mercury Chloride	rat	0.032	0.16	Cottontail Rabbit	0.024	0.119	0.243		0.118	0.595	1.216	
Mercury	Methyl Mercury Chloride	mink	0.015	0.025	Red Fox	0.010	0.103	0.122		0.017	0.172	0.203	
Mercury	Methyl Mercury Chloride	mink	0.015	0.025	River Otter	0.009	0.079	0.111	1.576e-06	0.015	0.132	0.186	2.626e-06

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Mercury	Methyl Mercury Chloride	rat	0.032	0.16	Whitetail Deer	0.009	0.292	0.137		0.045	1.458	0.685	
Mercury	Methyl Mercury Dicyandiamide	mallard duck	0.0064	0.064	Rough-winged Swallow	0.006	0.008	0.028		0.064	0.085	0.275	
Mercury	Methyl Mercury Dicyandiamide	mallard duck	0.0064	0.064	American Robin	0.006	0.005	0.046		0.064	0.053	0.465	
Mercury	Methyl Mercury Dicyandiamide	mallard duck	0.0064	0.064	Belted Kingfisher	0.006	0.013	0.059	4.527e-07	0.064	0.126	0.592	4.527e-06
Mercury	Methyl Mercury Dicyandiamide	mallard duck	0.0064	0.064	American Woodcock	0.006	0.008	0.063		0.064	0.084	0.634	
Mercury	Methyl Mercury Dicyandiamide	mallard duck	0.0064	0.064	Cooper's Hawk	0.006	0.037	0.083		0.064	0.370	0.826	
Mercury	Methyl Mercury Dicyandiamide	mallard duck	0.0064	0.064	Barn Owl	0.006	0.024	0.085		0.064	0.239	0.852	
Mercury	Methyl Mercury Dicyandiamide	mallard duck	0.0064	0.064	Barred Owl	0.006	0.055	0.098		0.064	0.546	0.976	
Mercury	Methyl Mercury Dicyandiamide	mallard duck	0.0064	0.064	Red-tailed Hawk	0.006	0.066	0.113		0.064	0.661	1.126	
Mercury	Methyl Mercury Dicyandiamide	mallard duck	0.0064	0.064	Osprey	0.006	0.032	0.125	1.147e-06	0.064	0.320	1.247	1.147e-05
Mercury	Methyl Mercury Dicyandiamide	mallard duck	0.0064	0.064	Great Blue Heron	0.006	0.036	0.145	1.305e-06	0.064	0.364	1.446	1.305e-05
Mercury	Methyl Mercury Dicyandiamide	mallard duck	0.0064	0.064	Wild Turkey	0.006	0.213	0.195		0.064	2.133	1.954	
Methanol	n/a	rat	50	250	Little Brown Bat	130.7	392.1	816.8		653.4	1960.3	4083.9	
Methanol	n/a	rat	50	250	Short-tailed Shrew	109.9	183.2	499.5		549.5	915.8	2497.5	
Methanol	n/a	rat	50	250	White-footed Mouse	99.9	646.1	332.9		499.3	3230.7	1664.3	
Methanol	n/a	rat	50	250	Meadow Vole	84.0	738.9	615.8		419.8	3694.7	3078.9	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Methanol	n/a	rat	50	250	Mink	38.5	280.7	388.5	314.482	192.3	1403.6	1942.3	1572.411
Methanol	n/a	rat	50	250	Cottontail Rabbit	36.7	186.0	380.1		183.7	930.2	1900.6	
Methanol	n/a	rat	50	250	Red Fox	26.4	264.0	312.7		132.0	1320.2	1563.4	
Methanol	n/a	rat	50	250	River Otter	22.9	203.3	285.8	230.691	114.3	1016.3	1429.2	1153.457
Methanol	n/a	rat	50	250	Whitetail Deer	14.0	455.5	214.2		70.1	2277.4	1071.0	
Methoxychlor	n/a	rat	4	8	Little Brown Bat	10.5	31.4	65.3		20.9	62.7	130.7	
Methoxychlor	n/a	rat	4	8	Short-tailed Shrew	8.8	14.7	40.0		17.6	29.3	79.9	
Methoxychlor	n/a	rat	4	8	White-footed Mouse	8.0	51.7	26.6		16.0	103.4	53.3	
Methoxychlor	n/a	rat	4	8	Meadow Vole	6.7	59.1	49.3		13.4	118.2	98.5	
Methoxychlor	n/a	rat	4	8	Mink	3.1	22.5	31.1	0.001	6.2	44.9	62.2	0.003
Methoxychlor	n/a	rat	4	8	Cottontail Rabbit	2.9	14.9	30.4		5.9	29.8	60.8	
Methoxychlor	n/a	rat	4	8	Red Fox	2.1	21.1	25.0		4.2	42.2	50.0	
Methoxychlor	n/a	rat	4	8	River Otter	1.8	16.3	22.9	0.001	3.7	32.5	45.7	0.002
Methoxychlor	n/a	rat	4	8	Whitetail Deer	1.1	36.4	17.1		2.2	72.9	34.3	
Methylene Chloride	n/a	rat	5.85	50	Little Brown Bat	15.3	45.9	95.6		130.7	392.1	816.8	
Methylene Chloride	n/a	rat	5.85	50	Short-tailed Shrew	12.9	21.4	58.4		109.9	183.2	499.5	
Methylene Chloride	n/a	rat	5.85	50	White-footed Mouse	11.7	75.6	38.9		99.9	646.1	332.9	
Methylene Chloride	n/a	rat	5.85	50	Meadow Vole	9.8	86.5	72.0		84.0	738.9	615.8	
Methylene Chloride	n/a	rat	5.85	50	Mink	4.5	32.8	45.5	5.499	38.5	280.7	388.5	47.000

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Methylene Chloride	n/a	rat	5.85	50	Cottontail Rabbit	4.3	21.8	44.5		36.7	186.0	380.1	
Methylene Chloride	n/a	rat	5.85	50	Red Fox	3.1	30.9	36.6		26.4	264.0	312.7	
Methylene Chloride	n/a	rat	5.85	50	River Otter	2.7	23.8	33.4	3.990	22.9	203.3	285.8	34.098
Methylene Chloride	n/a	rat	5.85	50	Whitetail Deer	1.6	53.3	25.1		14.0	455.5	214.2	
Methyl Ethyl Ketone	n/a	rat	1771	4571	Little Brown Bat	4629	13886	28930		11947	35841	74669	
Methyl Ethyl Ketone	n/a	rat	1771	4571	Short-tailed Shrew	3892	6487	17693		10046	16744	45665	
Methyl Ethyl Ketone	n/a	rat	1771	4571	White-footed Mouse	3537	22886	11790		9129	59070	30430	
Methyl Ethyl Ketone	n/a	rat	1771	4571	Meadow Vole	2974	26173	21811		7677	67553	56295	
Methyl Ethyl Ketone	n/a	rat	1771	4571	Mink	1362	9943	13759	5909.176	3516	25663	35513	15251.748
Methyl Ethyl Ketone	n/a	rat	1771	4571	Cottontail Rabbit	1301	6590	13464		3359	17008	34750	
Methyl Ethyl Ketone	n/a	rat	1771	4571	Red Fox	935	9353	11075		2414	24139	28586	
Methyl Ethyl Ketone	n/a	rat	1771	4571	River Otter	810	7200	10124	4308.293	2091	18582	26132	11119.823
Methyl Ethyl Ketone	n/a	rat	1771	4571	Whitetail Deer	497	16133	7587		1282	41640	19582	
4-Methyl 2-Pentanone	methyl isobutyl ketone	rat	25		Little Brown Bat	65.3	196.0	408.4					
4-Methyl 2-Pentanone	methyl isobutyl ketone	rat	25		Short-tailed Shrew	54.9	91.6	249.8					
4-Methyl 2-Pentanone	methyl isobutyl ketone	rat	25		White-footed Mouse	49.9	323.1	166.4					
4-Methyl 2-Pentanone	methyl isobutyl ketone	rat	25		Meadow Vole	42.0	369.5	307.9					
4-Methyl 2-Pentanone	methyl isobutyl ketone	rat	25		Mink	19.2	140.4	194.2	25.789				

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
4-Methyl 2-Pentanone	methyl isobutyl ketone	rat	25		Cottontail Rabbit	18.4	93.0	190.1					
4-Methyl 2-Pentanone	methyl isobutyl ketone	rat	25		Red Fox	13.2	132.0	156.3					
4-Methyl 2-Pentanone	methyl isobutyl ketone	rat	25		River Otter	11.4	101.6	142.9	18.713				
4-Methyl 2-Pentanone	methyl isobutyl ketone	rat	25		Whitetail Deer	7.0	227.7	107.1					
Molybdenum	MoO_4	mouse	0.26	2.6	Little Brown Bat	0.37	1.10	2.30		3.68	11.03	22.98	
Molybdenum	MoO_4	mouse	0.26	2.6	Short-tailed Shrew	0.31	0.52	1.41		3.09	5.15	14.05	
Molybdenum	MoO_4	mouse	0.26	2.6	White-footed Mouse	0.28	1.82	0.94		2.81	18.18	9.37	
Molybdenum	MoO_4	mouse	0.26	2.6	Meadow Vole	0.24	2.08	1.73		2.36	20.79	17.33	
Molybdenum	MoO_4	mouse	0.26	2.6	Mink	0.11	0.79	1.09		1.08	7.90	10.93	
Molybdenum	MoO_4	mouse	0.26	2.6	Cottontail Rabbit	0.10	0.52	1.07		1.03	5.23	10.70	
Molybdenum	MoO_4	mouse	0.26	2.6	Red Fox	0.07	0.74	0.88		0.74	7.43	8.80	
Molybdenum	MoO_4	mouse	0.26	2.6	River Otter	0.06	0.57	0.80		0.64	5.72	8.04	
Molybdenum	MoO_4	mouse	0.26	2.6	Whitetail Deer	0.04	1.28	0.60		0.39	12.82	6.03	
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	Rough-winged Swallow	3.50	4.64	15.04		35.30	46.77	151.69	
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	American Robin	3.50	2.90	25.42		35.30	29.23	256.42	
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	Belted Kingfisher	3.50	6.91	32.38		35.30	69.66	326.53	
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	American Woodcock	3.50	4.62	34.65		35.30	46.60	349.47	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	Cooper's Hawk	3.50	20.22	45.19		35.30	203.90	455.79	
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	Barn Owl	3.50	13.05	46.60		35.30	131.60	469.99	
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	Barred Owl	3.50	29.88	53.39		35.30	301.31	538.51	
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	Red-tailed Hawk	3.50	36.16	61.58		35.30	364.66	621.06	
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	Osprey	3.50	17.50	68.18		35.30	176.50	687.66	
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	Great Blue Heron	3.50	19.92	79.06		35.30	200.87	797.42	
Molybdenum	sodium molybdate (MoO_4)	chicken	3.5	35.3	Wild Turkey	3.50	116.67	106.84		35.30	1176.67	1077.58	
Nickel	nickel sulfate hexahydrate	rat	40	80	Little Brown Bat	104.55	313.64	653.42		209.09	627.28	1306.84	
Nickel	nickel sulfate hexahydrate	rat	40	80	Short-tailed Shrew	87.91	146.52	399.61		175.83	293.04	799.21	
Nickel	nickel sulfate hexahydrate	rat	40	80	White-footed Mouse	79.89	516.91	266.29		159.77	1033.82	532.57	
Nickel	nickel sulfate hexahydrate	rat	40	80	Meadow Vole	67.18	591.15	492.62		134.35	1182.30	985.25	
Nickel	nickel sulfate hexahydrate	rat	40	80	Mink	30.77	224.57	310.77	2.104	61.53	449.14	621.54	4.209
Nickel	nickel sulfate hexahydrate	rat	40	80	Cottontail Rabbit	29.40	148.84	304.09		58.79	297.68	608.18	
Nickel	nickel sulfate hexahydrate	rat	40	80	Red Fox	21.12	211.24	250.15		42.25	422.48	500.30	
Nickel	nickel sulfate hexahydrate	rat	40	80	River Otter	18.29	162.61	228.67	1.524	36.59	325.22	457.35	3.048
Nickel	nickel sulfate hexahydrate	rat	40	80	Whitetail Deer	11.22	364.39	171.36		22.44	728.78	342.72	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Nickel	nickel sulfate	mallard duckling	77.4	107	Rough-winged Swallow	77.40	102.56	332.61		107.00	141.78	459.81	
Nickel	nickel sulfate	mallard duckling	77.4	107	American Robin	77.40	64.08	562.25		107.00	88.59	777.26	
Nickel	nickel sulfate	mallard duckling	77.4	107	Belted Kingfisher	77.40	152.74	715.95	1.438	107.00	211.15	989.75	1.988
Nickel	nickel sulfate	mallard duckling	77.4	107	American Woodcock	77.40	102.17	766.26		107.00	141.24	1059.30	
Nickel	nickel sulfate	mallard duckling	77.4	107	Cooper's Hawk	77.40	447.09	999.37		107.00	618.07	1381.56	
Nickel	nickel sulfate	mallard duckling	77.4	107	Barn Owl	77.40	288.55	1030.53		107.00	398.90	1424.63	
Nickel	nickel sulfate	mallard duckling	77.4	107	Barred Owl	77.40	660.66	1180.76		107.00	913.32	1632.32	
Nickel	nickel sulfate	mallard duckling	77.4	107	Red-tailed Hawk	77.40	799.56	1361.76		107.00	1105.34	1882.53	
Nickel	nickel sulfate	mallard duckling	77.4	107	Osprey	77.40	387.00	1507.79	3.642	107.00	535.00	2084.42	5.035
Nickel	nickel sulfate	mallard duckling	77.4	107	Great Blue Heron	77.40	440.44	1748.45	4.145	107.00	608.88	2417.11	5.731
Nickel	nickel sulfate	mallard duckling	77.4	107	Wild Turkey	77.40	2580.00	2362.74		107.00	3566.67	3266.32	
Niobium	sodium niobate	mouse	0.155	1.55	Little Brown Bat	0.219	0.658	1.370		2.192	6.576	13.700	
Niobium	sodium niobate	mouse	0.155	1.55	Short-tailed Shrew	0.184	0.307	0.838		1.843	3.072	8.379	
Niobium	sodium niobate	mouse	0.155	1.55	White-footed Mouse	0.167	1.084	0.558		1.675	10.838	5.583	
Niobium	sodium niobate	mouse	0.155	1.55	Meadow Vole	0.141	1.239	1.033		1.408	12.395	10.329	
Niobium	sodium niobate	mouse	0.155	1.55	Mink	0.065	0.471	0.652		0.645	4.709	6.516	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Niobium	sodium niobate	mouse	0.155	1.55	Cottontail Rabbit	0.062	0.312	0.638		0.616	3.121	6.376	
Niobium	sodium niobate	mouse	0.155	1.55	Red Fox	0.044	0.443	0.524		0.443	4.429	5.245	
Niobium	sodium niobate	mouse	0.155	1.55	River Otter	0.038	0.341	0.479		0.384	3.409	4.795	
Niobium	sodium niobate	mouse	0.155	1.55	Whitetail Deer	0.024	0.764	0.359		0.235	7.640	3.593	
Nitrate	potassium nitrate	guinea pig	507	1130	Little Brown Bat	1659	4977	10369		3698	11093	23111	
Nitrate	potassium nitrate	guinea pig	507	1130	Short-tailed Shrew	1395	2325	6341		3109	5182	14134	
Nitrate	potassium nitrate	guinea pig	507	1130	White-footed Mouse	1268	8203	4226		2826	18283	9418	
Nitrate	potassium nitrate	guinea pig	507	1130	Meadow Vole	1066	9381	7818		2376	20908	17424	
Nitrate	potassium nitrate	guinea pig	507	1130	Mink	488	3564	4932		1088	7943	10992	
Nitrate	potassium nitrate	guinea pig	507	1130	Cottontail Rabbit	466	2362	4826		1040	5264	10756	
Nitrate	potassium nitrate	guinea pig	507	1130	Red Fox	335	3352	3970		747	7471	8848	
Nitrate	potassium nitrate	guinea pig	507	1130	River Otter	290	2581	3629		647	5751	8088	
Nitrate	potassium nitrate	guinea pig	507	1130	Whitetail Deer	178	5783	2719		397	12888	6061	
1,2,3,4,8-Penta-chlorodibenzofuran	n/a	rat	0.048		Little Brown Bat	0.125	0.376	0.784					
1,2,3,4,8-Penta-chlorodibenzofuran	n/a	rat	0.048		Short-tailed Shrew	0.105	0.176	0.480					
1,2,3,4,8-Penta-chlorodibenzofuran	n/a	rat	0.048		White-footed Mouse	0.096	0.620	0.320					
1,2,3,4,8-Penta-chlorodibenzofuran	n/a	rat	0.048		Meadow Vole	0.081	0.709	0.591					
1,2,3,4,8-Penta-chlorodibenzofuran	n/a	rat	0.048		Mink	0.037	0.269	0.373					

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
1,2,3,4,8-Penta-chlorodibenzofuran	n/a	rat	0.048		Cottontail Rabbit	0.035	0.179	0.365					
1,2,3,4,8-Penta-chlorodibenzofuran	n/a	rat	0.048		Red Fox	0.025	0.253	0.300					
1,2,3,4,8-Penta-chlorodibenzofuran	n/a	rat	0.048		River Otter	0.022	0.195	0.274					
1,2,3,4,8-Penta-chlorodibenzofuran	n/a	rat	0.048		Whitetail Deer	0.013	0.437	0.206					
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Little Brown Bat	0.00042	0.00125	0.00261		0.00418	0.01255	0.02614	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Short-tailed Shrew	0.00035	0.00059	0.00160		0.00352	0.00586	0.01598	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	White-footed Mouse	0.00032	0.00207	0.00107		0.00320	0.02068	0.01065	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Meadow Vole	0.00027	0.00236	0.00197		0.00269	0.02365	0.01970	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Mink	0.00012	0.00090	0.00124		0.00123	0.00898	0.01243	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Cottontail Rabbit	0.00012	0.00060	0.00122		0.00118	0.00595	0.01216	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Red Fox	0.000084	0.00084	0.00100		0.00084	0.00845	0.01001	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	River Otter	0.000073	0.00065	0.00091		0.00073	0.00650	0.00915	
1,2,3,7,8-Penta-chlorodibenzofuran	n/a	rat	0.00016	0.0016	Whitetail Deer	0.000045	0.00146	0.00069		0.00045	0.01458	0.00685	
2,3,4,7,8-Penta-chlorodibenzofuran	n/a	rat	0.000016	0.00016	Little Brown Bat	0.000042	0.00013	0.00026		0.00042	0.00125	0.00261	
2,3,4,7,8-Penta-chlorodibenzofuran	n/a	rat	0.000016	0.00016	Short-tailed Shrew	0.000035	0.00006	0.00016		0.00035	0.00059	0.00160	
2,3,4,7,8-Penta-chlorodibenzofuran	n/a	rat	0.000016	0.00016	White-footed Mouse	0.000032	0.00021	0.00011		0.00032	0.00207	0.00107	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
2,3,4,7,8-Pentachlorodibenzofuran	n/a	rat	0.000016	0.00016	Meadow Vole	0.000027	0.00024	0.00020		0.00027	0.00236	0.00197	
2,3,4,7,8-Pentachlorodibenzofuran	n/a	rat	0.000016	0.00016	Mink	0.000012	0.00009	0.00012		0.00012	0.00090	0.00124	
2,3,4,7,8-Pentachlorodibenzofuran	n/a	rat	0.000016	0.00016	Cottontail Rabbit	0.000012	0.00006	0.00012		0.00012	0.00060	0.00122	
2,3,4,7,8-Pentachlorodibenzofuran	n/a	rat	0.000016	0.00016	Red Fox	0.000008	0.00008	0.00010		0.00008	0.00084	0.00100	
2,3,4,7,8-Pentachlorodibenzofuran	n/a	rat	0.000016	0.00016	River Otter	0.000007	0.00007	0.00009		0.00007	0.00065	0.00091	
2,3,4,7,8-Pentachlorodibenzofuran	n/a	rat	0.000016	0.00016	Whitetail Deer	0.000004	0.00015	0.00007		0.00004	0.00146	0.00069	
Pentachloronitrobenzene	n/a	chicken	7.07	70.7	Rough-winged Swallow	7.070	9.368	30.382		70.700	93.678	303.819	
Pentachloronitrobenzene	n/a	chicken	7.07	70.7	American Robin	7.070	5.854	51.358		70.700	58.537	513.575	
Pentachloronitrobenzene	n/a	chicken	7.07	70.7	Belted Kingfisher	7.070	13.951	65.398	0.004	70.700	139.515	653.975	0.036
Pentachloronitrobenzene	n/a	chicken	7.07	70.7	American Woodcock	7.070	9.332	69.993		70.700	93.324	699.930	
Pentachloronitrobenzene	n/a	chicken	7.07	70.7	Cooper's Hawk	7.070	40.839	91.286		70.700	408.386	912.862	
Pentachloronitrobenzene	n/a	chicken	7.07	70.7	Barn Owl	7.070	26.357	94.132		70.700	263.570	941.320	
Pentachloronitrobenzene	n/a	chicken	7.07	70.7	Barred Owl	7.070	60.348	107.855		70.700	603.475	1078.551	
Pentachloronitrobenzene	n/a	chicken	7.07	70.7	Red-tailed Hawk	7.070	73.035	124.388		70.700	730.350	1243.878	
Pentachloronitrobenzene	n/a	chicken	7.07	70.7	Osprey	7.070	35.350	137.727	0.009	70.700	353.500	1377.273	0.092
Pentachloronitrobenzene	n/a	chicken	7.07	70.7	Great Blue Heron	7.070	40.232	159.710	0.010	70.700	402.317	1597.098	0.104

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Pentachloronitrobenzene	n/a	chicken	7.07	70.7	Wild Turkey	7.070	235.667	215.821		70.700	2356.667	2158.211	
Pentachlorophenol	n/a	rat	0.24	2.4	Little Brown Bat	0.627	1.882	3.921		6.273	18.818	39.205	
Pentachlorophenol	n/a	rat	0.24	2.4	Short-tailed Shrew	0.527	0.879	2.398		5.275	8.791	23.976	
Pentachlorophenol	n/a	rat	0.24	2.4	White-footed Mouse	0.479	3.101	1.598		4.793	31.015	15.977	
Pentachlorophenol	n/a	rat	0.24	2.4	Meadow Vole	0.403	3.547	2.956		4.031	35.469	29.557	
Pentachlorophenol	n/a	rat	0.24	2.4	Mink	0.185	1.347	1.865	3.698e-04	1.846	13.474	18.646	3.698e-03
Pentachlorophenol	n/a	rat	0.24	2.4	Cottontail Rabbit	0.176	0.893	1.825		1.764	8.930	18.246	
Pentachlorophenol	n/a	rat	0.24	2.4	Red Fox	0.127	1.267	1.501		1.267	12.674	15.009	
Pentachlorophenol	n/a	rat	0.24	2.4	River Otter	0.110	0.976	1.372	2.750e-04	1.098	9.757	13.720	2.750e-03
Pentachlorophenol	n/a	rat	0.24	2.4	Whitetail Deer	0.067	2.186	1.028		0.673	21.863	10.282	
Selenium	Selenate (SeO_4)	rat	0.2	0.33	Little Brown Bat	0.523	1.568	3.267		0.863	2.588	5.391	
Selenium	Selenate (SeO_4)	rat	0.2	0.33	Short-tailed Shrew	0.440	0.733	1.998		0.725	1.209	3.297	
Selenium	Selenate (SeO_4)	rat	0.2	0.33	White-footed Mouse	0.399	2.585	1.331		0.659	4.265	2.197	
Selenium	Selenate (SeO_4)	rat	0.2	0.33	Meadow Vole	0.336	2.956	2.463		0.554	4.877	4.064	
Selenium	Selenate (SeO_4)	rat	0.2	0.33	Mink	0.154	1.123	1.554	4.318e-04	0.254	1.853	2.564	7.124e-04
Selenium	Selenate (SeO_4)	rat	0.2	0.33	Cottontail Rabbit	0.147	0.744	1.520		0.243	1.228	2.509	
Selenium	Selenate (SeO_4)	rat	0.2	0.33	Red Fox	0.106	1.056	1.251		0.174	1.743	2.064	
Selenium	Selenate (SeO_4)	rat	0.2	0.33	River Otter	0.091	0.813	1.143	2.363e-04	0.151	1.342	1.887	3.899e-04
Selenium	Selenate (SeO_4)	rat	0.2	0.33	Whitetail Deer	0.056	1.822	0.857		0.093	3.006	1.414	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Selenium	sodium selenite	mallard duck	0.5	1	Rough-winged Swallow	0.500	0.663	2.149		1.000	1.325	4.297	
Selenium	sodium selenite	mallard duck	0.5	1	American Robin	0.500	0.414	3.632		1.000	0.828	7.264	
Selenium	sodium selenite	mallard duck	0.5	1	Belted Kingfisher	0.500	0.987	4.625	3.795e-04	1.000	1.973	9.250	7.589e-04
Selenium	sodium selenite	mallard duck	0.5	1	American Woodcock	0.500	0.660	4.950		1.000	1.320	9.900	
Selenium	sodium selenite	mallard duck	0.5	1	Cooper's Hawk	0.500	2.888	6.456		1.000	5.776	12.912	
Selenium	sodium selenite	mallard duck	0.5	1	Barn Owl	0.500	1.864	6.657		1.000	3.728	13.314	
Selenium	sodium selenite	mallard duck	0.5	1	Barred Owl	0.500	4.268	7.628		1.000	8.536	15.255	
Selenium	sodium selenite	mallard duck	0.5	1	Red-tailed Hawk	0.500	5.165	8.797		1.000	10.330	17.594	
Selenium	sodium selenite	mallard duck	0.5	1	Osprey	0.500	2.500	9.740	9.614e-04	1.000	5.000	19.481	1.923e-03
Selenium	sodium selenite	mallard duck	0.5	1	Great Blue Heron	0.500	2.845	11.295	1.094e-03	1.000	5.690	22.590	2.188e-03
Selenium	sodium selenite	mallard duck	0.5	1	Wild Turkey	0.500	16.667	15.263		1.000	33.333	30.526	
Selenium	selanomethio-nine	mallard duck	0.4	0.8	Rough-winged Swallow	0.400	0.530	1.719		0.800	1.060	3.438	
Selenium	selanomethio-nine	mallard duck	0.4	0.8	American Robin	0.400	0.331	2.906		0.800	0.662	5.811	
Selenium	selanomethio-nine	mallard duck	0.4	0.8	Belted Kingfisher	0.400	0.789	3.700		0.800	1.579	7.400	
Selenium	selanomethio-nine	mallard duck	0.4	0.8	American Woodcock	0.400	0.528	3.960		0.800	1.056	7.920	
Selenium	selanomethio-nine	screech owl	0.44	1.5	Cooper's Hawk	0.440	2.542	5.681		1.500	8.664	19.368	
Selenium	selanomethio-nine	screech owl	0.44	1.5	Barn Owl	0.440	1.640	5.858		1.500	5.592	19.971	
Selenium	selanomethio-nine	screech owl	0.44	1.5	Barred Owl	0.440	3.756	6.712		1.500	12.804	22.883	
Selenium	selanomethio-nine	screech owl	0.44	1.5	Red-tailed Hawk	0.440	4.545	7.741		1.500	15.495	26.391	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Selenium	selanomethio-nine	screech owl	0.44	1.5	Osprey	0.440	2.200	8.571		1.500	7.500	29.221	
Selenium	selanomethio-nine	mallard duck	0.4	0.8	Great Blue Heron	0.400	2.276	9.036		0.800	4.552	18.072	
Selenium	selanomethio-nine	mallard duck	0.4	0.8	Wild Turkey	0.400	13.333	12.211		0.800	26.667	24.421	
Selenium	selanomethio-nine	black-crowned night-heron	1.8		Belted Kingfisher	1.800	3.552	16.650					
Selenium	selanomethio-nine	black-crowned night-heron	1.8		Great Blue Heron	1.800	10.243	40.662					
Strontium	stable strontium chloride	rat	263		Little Brown Bat	687	2062	4296					
Strontium	stable strontium chloride	rat	263		Short-tailed Shrew	578	963	2627					
Strontium	stable strontium chloride	rat	263		White-footed Mouse	525	3399	1751					
Strontium	stable strontium chloride	rat	263		Meadow Vole	442	3887	3239					
Strontium	stable strontium chloride	rat	263		Mink	202	1477	2043					
Strontium	stable strontium chloride	rat	263		Cottontail Rabbit	193	979	1999					
Strontium	stable strontium chloride	rat	263		Red Fox	139	1389	1645					
Strontium	stable strontium chloride	rat	263		River Otter	120	1069	1504					
Strontium	stable strontium chloride	rat	263		Whitetail Deer	74	2396	1127					
2,3,7,8-TCDD	n/a	rat	0.000001	0.00001	Little Brown Bat	0.0000001	0.0000003	0.0000007		0.0000011	0.0000032	0.0000067	
2,3,7,8-TCDD	n/a	rat	0.000001	0.00001	Short-tailed Shrew	0.0000022	0.0000037	0.0000100		0.0000220	0.0000366	0.0000999	
2,3,7,8-TCDD	n/a	rat	0.000001	0.00001	White-footed Mouse	0.0000020	0.0000129	0.0000067		0.0000200	0.0001292	0.0000666	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
2,3,7,8-TCDD	n/a	rat	0.000001	0.00001	Meadow Vole	0.0000017	0.0000148	0.0000123		0.0000168	0.0001478	0.0001232	
2,3,7,8-TCDD	n/a	rat	0.000001	0.00001	Mink	0.0000008	0.0000056	0.0000078	3.262e-11	0.0000077	0.0000561	0.0000777	3.262e-10
2,3,7,8-TCDD	n/a	rat	0.000001	0.00001	Cottontail Rabbit	0.0000007	0.0000037	0.0000076		0.0000073	0.0000372	0.0000760	
2,3,7,8-TCDD	n/a	rat	0.000001	0.00001	Red Fox	0.0000005	0.0000053	0.0000063		0.0000053	0.0000528	0.0000625	
2,3,7,8-TCDD	n/a	rat	0.000001	0.00001	River Otter	0.0000005	0.0000041	0.0000057	2.134e-11	0.0000046	0.0000407	0.0000572	2.134e-10
2,3,7,8-TCDD	n/a	rat	0.000001	0.00001	Whitetail Deer	0.0000003	0.0000091	0.0000043		0.0000028	0.0000911	0.0000428	
2,3,7,8-TCDD	n/a	ring-necked pheasant	0.000014	0.00014	Rough-winged Swallow	0.0000140	0.0000186	0.0000602		0.0001400	0.0001855	0.0006016	
2,3,7,8-TCDD	n/a	ring-necked pheasant	0.000014	0.00014	American Robin	0.0000140	0.0000116	0.0001017		0.0001400	0.0001159	0.0010170	
2,3,7,8-TCDD	n/a	ring-necked pheasant	0.000014	0.00014	Belted Kingfisher	0.0000140	0.0000276	0.0001295	1.605e-10	0.0001400	0.0002763	0.0012950	1.605e-09
2,3,7,8-TCDD	n/a	ring-necked pheasant	0.000014	0.00014	American Woodcock	0.0000140	0.0000185	0.0001386		0.0001400	0.0001848	0.0013860	
2,3,7,8-TCDD	n/a	ring-necked pheasant	0.000014	0.00014	Cooper's Hawk	0.0000140	0.0000809	0.0001808		0.0001400	0.0008087	0.0018076	
2,3,7,8-TCDD	n/a	ring-necked pheasant	0.000014	0.00014	Barn Owl	0.0000140	0.0000522	0.0001864		0.0001400	0.0005219	0.0018640	
2,3,7,8-TCDD	n/a	ring-necked pheasant	0.000014	0.00014	Barred Owl	0.0000140	0.0001195	0.0002136		0.0001400	0.0011950	0.0021357	
2,3,7,8-TCDD	n/a	ring-necked pheasant	0.000014	0.00014	Red-tailed Hawk	0.0000140	0.0001446	0.0002463		0.0001400	0.0014462	0.0024631	
2,3,7,8-TCDD	n/a	ring-necked pheasant	0.000014	0.00014	Osprey	0.0000140	0.0000700	0.0002727	4.067e-10	0.0001400	0.0007000	0.0027273	4.067e-09
2,3,7,8-TCDD	n/a	ring-necked pheasant	0.000014	0.00014	Great Blue Heron	0.0000140	0.0000797	0.0003163	4.629e-10	0.0001400	0.0007967	0.0031626	4.629e-09
2,3,7,8-TCDD	n/a	ring-necked pheasant	0.000014	0.00014	Wild Turkey	0.0000140	0.0004667	0.0004274		0.0001400	0.0046667	0.0042737	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Rough-winged Swallow	0.0000010	0.0000013	0.0000043		0.0000100	0.0000133	0.0000430	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	American Robin	0.0000010	0.0000008	0.0000073		0.0000100	0.0000083	0.0000726	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Belted Kingfisher	0.0000010	0.0000020	0.0000093		0.0000100	0.0000197	0.0000925	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	American Woodcock	0.0000010	0.0000013	0.0000099		0.0000100	0.0000132	0.0000990	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Cooper's Hawk	0.0000010	0.0000058	0.0000129		0.0000100	0.0000578	0.0001291	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Barn Owl	0.0000010	0.0000037	0.0000133		0.0000100	0.0000373	0.0001331	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Barred Owl	0.0000010	0.0000085	0.0000153		0.0000100	0.0000854	0.0001526	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Red-tailed Hawk	0.0000010	0.0000103	0.0000176		0.0000100	0.0001033	0.0001759	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Osprey	0.0000010	0.0000050	0.0000195		0.0000100	0.0000500	0.0001948	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Great Blue Heron	0.0000010	0.0000057	0.0000226		0.0000100	0.0000569	0.0002259	
2,3,7,8-Tetrachloro-dibenzofuran	n/a	1 day old chick	0.000001	0.00001	Wild Turkey	0.0000010	0.0000333	0.0000305		0.0000100	0.0003333	0.0003053	
1,1,2,2-Tetrachloro-ethylene	n/a	mouse	1.4	7	Little Brown Bat	1.98	5.94	12.37		9.90	29.70	61.87	
1,1,2,2-Tetrachloro-ethylene	n/a	mouse	1.4	7	Short-tailed Shrew	1.66	2.77	7.57		8.32	13.87	37.84	
1,1,2,2-Tetrachloro-ethylene	n/a	mouse	1.4	7	White-footed Mouse	1.51	9.79	5.04		7.56	48.95	25.21	
1,1,2,2-Tetrachloro-ethylene	n/a	mouse	1.4	7	Meadow Vole	1.27	11.20	9.33		6.36	55.98	46.65	
1,1,2,2-Tetrachloro-ethylene	n/a	mouse	1.4	7	Mink	0.58	4.25	5.89	0.066	2.91	21.26	29.43	0.331

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
1,1,2,2-Tetrachloroethylene	n/a	mouse	1.4	7	Cottontail Rabbit	0.56	2.82	5.76		2.78	14.09	28.79	
1,1,2,2-Tetrachloroethylene	n/a	mouse	1.4	7	Red Fox	0.40	4.00	4.74		2.00	20.00	23.69	
1,1,2,2-Tetrachloroethylene	n/a	mouse	1.4	7	River Otter	0.35	3.08	4.33	0.048	1.73	15.40	21.65	0.240
1,1,2,2-Tetrachloroethylene	n/a	mouse	1.4	7	Whitetail Deer	0.21	6.90	3.25		1.06	34.50	16.23	
Thallium	thallium sulfate	rat	0.0074	0.074	Little Brown Bat	0.020	0.059	0.122		0.195	0.586	1.222	
Thallium	thallium sulfate	rat	0.0074	0.074	Short-tailed Shrew	0.016	0.027	0.075		0.164	0.274	0.747	
Thallium	thallium sulfate	rat	0.0074	0.074	White-footed Mouse	0.015	0.097	0.050		0.149	0.966	0.498	
Thallium	thallium sulfate	rat	0.0074	0.074	Meadow Vole	0.013	0.111	0.092		0.126	1.105	0.921	
Thallium	thallium sulfate	rat	0.0074	0.074	Mink	0.006	0.042	0.058	0.001	0.058	0.420	0.581	0.012
Thallium	thallium sulfate	rat	0.0074	0.074	Cottontail Rabbit	0.005	0.028	0.057		0.055	0.278	0.569	
Thallium	thallium sulfate	rat	0.0074	0.074	Red Fox	0.004	0.039	0.047		0.039	0.395	0.468	
Thallium	thallium sulfate	rat	0.0074	0.074	River Otter	0.003	0.030	0.043	0.001	0.034	0.304	0.428	0.009
Thallium	thallium sulfate	rat	0.0074	0.074	Whitetail Deer	0.002	0.068	0.032		0.021	0.681	0.320	
Tin	bis(tributyltin)-oxide (TBTO)	mouse	23.4	35	Little Brown Bat	33.1	99.3	206.8		49.5	148.5	309.4	
Tin	bis(tributyltin)-oxide (TBTO)	mouse	23.4	35	Short-tailed Shrew	27.8	46.4	126.5		41.6	69.4	189.2	
Tin	bis(tributyltin)-oxide (TBTO)	mouse	23.4	35	White-footed Mouse	25.3	163.6	84.3		37.8	244.7	126.1	
Tin	bis(tributyltin)-oxide (TBTO)	mouse	23.4	35	Meadow Vole	21.3	187.1	155.9		31.8	279.9	233.2	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Tin	bis(tributyltin)-oxide (TBTO)	mouse	23.4	35	Mink	9.7	71.1	98.4		14.6	106.3	147.1	
Tin	bis(tributyltin)-oxide (TBTO)	mouse	23.4	35	Cottontail Rabbit	9.3	47.1	96.3		13.9	70.5	144.0	
Tin	bis(tributyltin)-oxide (TBTO)	mouse	23.4	35	Red Fox	6.7	66.9	79.2		10.0	100.0	118.4	
Tin	bis(tributyltin)-oxide (TBTO)	mouse	23.4	35	River Otter	5.8	51.5	72.4		8.7	77.0	108.3	
Tin	bis(tributyltin)-oxide (TBTO)	mouse	23.4	35	Whitetail Deer	3.6	115.3	54.2		5.3	172.5	81.1	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Rough-winged Swallow	6.8	9.0	29.2		16.9	22.4	72.6	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	American Robin	6.8	5.6	49.4		16.9	14.0	122.8	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Belted Kingfisher	6.8	13.4	62.9		16.9	33.3	156.3	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	American Woodcock	6.8	9.0	67.3		16.9	22.3	167.3	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Cooper's Hawk	6.8	39.3	87.8		16.9	97.6	218.2	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Barn Owl	6.8	25.4	90.5		16.9	63.0	225.0	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Barred Owl	6.8	58.0	103.7		16.9	144.3	257.8	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Red-tailed Hawk	6.8	70.2	119.6		16.9	174.6	297.3	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Osprey	6.8	34.0	132.5		16.9	84.5	329.2	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Great Blue Heron	6.8	38.7	153.6		16.9	96.2	381.8	
Tin	bis(tributyltin)-oxide (TBTO)	Japanese quail	6.8	16.9	Wild Turkey	6.8	226.7	207.6		16.9	563.3	515.9	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks Food[d] (mg/kg)	NOAEL-Based Benchmarks Water[e] (mg/L)	NOAEL-Based Benchmarks Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks Food[d] (mg/kg)	LOAEL-Based Benchmarks Water[e] (mg/L)	LOAEL-Based Benchmarks Piscivore[f] (mg/L)
Toluene	n/a	mouse	26	260	Little Brown Bat	36.8	110.3	229.8		367.7	1103.1	2298.1	
Toluene	n/a	mouse	26	260	Short-tailed Shrew	30.9	51.5	140.5		309.2	515.3	1405.4	
Toluene	n/a	mouse	26	260	White-footed Mouse	28.1	181.8	93.7		281.0	1818.0	936.5	
Toluene	n/a	mouse	26	260	Meadow Vole	23.6	207.9	173.3		236.3	2079.1	1732.6	
Toluene	n/a	mouse	26	260	Mink	10.8	79.0	109.3	1.050	108.2	789.8	1093.0	10.504
Toluene	n/a	mouse	26	260	Cottontail Rabbit	10.3	52.3	107.0		103.4	523.5	1069.5	
Toluene	n/a	mouse	26	260	Red Fox	7.4	74.3	88.0		74.3	742.9	879.8	
Toluene	n/a	mouse	26	260	River Otter	6.4	57.2	80.4	0.764	64.3	571.9	804.3	7.638
Toluene	n/a	mouse	26	260	Whitetail Deer	3.9	128.2	60.3		39.5	1281.6	602.7	
Toxaphene	n/a	rat	8		Little Brown Bat	20.9	62.7	130.7					
Toxaphene	n/a	rat	8		Short-tailed Shrew	17.6	29.3	79.9					
Toxaphene	n/a	rat	8		White-footed Mouse	16.0	103.4	53.3					
Toxaphene	n/a	rat	8		Meadow Vole	13.4	118.2	98.5					
Toxaphene	n/a	rat	8		Mink	6.2	44.9	62.2	0.001				
Toxaphene	n/a	rat	8		Cottontail Rabbit	5.9	29.8	60.8					
Toxaphene	n/a	rat	8		Red Fox	4.2	42.2	50.0					
Toxaphene	n/a	rat	8		River Otter	3.7	32.5	45.7	0.001				
Toxaphene	n/a	rat	8		Whitetail Deer	2.2	72.9	34.3					
1,1,1-Trichloroeth-ane	n/a	mouse	1000		Little Brown Bat	1470	4409	9186					

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
1,1,1-Trichloroeth-ane	n/a	mouse	1000		Short-tailed Shrew	1236	2060	5618					
1,1,1-Trichloroeth-ane	n/a	mouse	1000		White-footed Mouse	1123	7267	3744					
1,1,1-Trichloroeth-ane	n/a	mouse	1000		Meadow Vole	944	8311	6926					
1,1,1-Trichloroeth-ane	n/a	mouse	1000		Mink	433	3157	4369	68.126				
1,1,1-Trichloroeth-ane	n/a	mouse	1000		Cottontail Rabbit	413	2092	4275					
1,1,1-Trichloroeth-ane	n/a	mouse	1000		Red Fox	297	2970	3517					
1,1,1-Trichloroeth-ane	n/a	mouse	1000		River Otter	257	2286	3215	49.419				
1,1,1-Trichloroeth-ane	n/a	mouse	1000		Whitetail Deer	158	5123	2409					
Trichloroethylene	n/a	mouse	0.7	7	Little Brown Bat	0.990	2.970	6.187		9.899	29.698	61.872	
Trichloroethylene	n/a	mouse	0.7	7	Short-tailed Shrew	0.832	1.387	3.784		8.324	13.874	37.838	
Trichloroethylene	n/a	mouse	0.7	7	White-footed Mouse	0.756	4.895	2.521		7.564	48.946	25.215	
Trichloroethylene	n/a	mouse	0.7	7	Meadow Vole	0.636	5.598	4.665		6.361	55.975	46.646	
Trichloroethylene	n/a	mouse	0.7	7	Mink	0.291	2.126	2.943	0.031	2.913	21.265	29.427	0.308
Trichloroethylene	n/a	mouse	0.7	7	Cottontail Rabbit	0.278	1.409	2.879		2.783	14.093	28.794	
Trichloroethylene	n/a	mouse	0.7	7	Red Fox	0.200	2.000	2.369		2.000	20.002	23.687	
Trichloroethylene	n/a	mouse	0.7	7	River Otter	0.173	1.540	2.165	0.022	1.732	15.398	21.653	0.224
Trichloroethylene	n/a	mouse	0.7	7	Whitetail Deer	0.106	3.450	1.623		1.063	34.504	16.226	
Uranium	Uranyl acetate	mouse	3.07	6.13	Little Brown Bat	4.267	12.802	26.671		8.521	25.563	53.256	
Uranium	Uranyl acetate	mouse	3.07	6.13	Short-tailed Shrew	3.588	5.981	16.311		7.165	11.942	32.569	

Table 12. (continued)

Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	NOAEL-Based Benchmarks			Estimated Wildlife LOAEL[c] (mg/kg/d)	LOAEL-Based Benchmarks		
							Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)		Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Uranium	Uranyl acetate	mouse	3.07	6.13	White-footed Mouse	3.261	21.099	10.869		6.511	42.130	21.703	
Uranium	Uranyl acetate	mouse	3.07	6.13	Meadow Vole	2.742	24.129	20.108		5.475	48.180	40.150	
Uranium	Uranyl acetate	mouse	3.07	6.13	Mink	1.256	9.167	12.685		2.508	18.303	25.329	
Uranium	Uranyl acetate	mouse	3.07	6.13	Cottontail Rabbit	1.200	6.075	12.412		2.396	12.131	24.784	
Uranium	Uranyl acetate	mouse	3.07	6.13	Red Fox	0.862	8.622	10.211		1.722	17.217	20.388	
Uranium	Uranyl acetate	mouse	3.07	6.13	River Otter	0.747	6.637	9.334		1.491	13.253	18.637	
Uranium	Uranyl acetate	mouse	3.07	6.13	Whitetail Deer	0.458	14.874	6.995		0.915	29.699	13.966	
Uranium	depleted metallic U	black duck	16		Rough-winged Swallow	16.0	21.2	68.8					
Uranium	depleted metallic U	black duck	16		American Robin	16.0	13.2	116.2					
Uranium	depleted metallic U	black duck	16		Belted Kingfisher	16.0	31.6	148.0					
Uranium	depleted metallic U	black duck	16		American Woodcock	16.0	21.1	158.4					
Uranium	depleted metallic U	black duck	16		Cooper's Hawk	16.0	92.4	206.6					
Uranium	depleted metallic U	black duck	16		Barn Owl	16.0	59.6	213.0					
Uranium	depleted metallic U	black duck	16		Barred Owl	16.0	136.6	244.1					
Uranium	depleted metallic U	black duck	16		Red-tailed Hawk	16.0	165.3	281.5					
Uranium	depleted metallic U	black duck	16		Osprey	16.0	80.0	311.7					
Uranium	depleted metallic U	black duck	16		Great Blue Heron	16.0	91.0	361.4					

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Uranium	depleted metallic U	black duck	16		Wild Turkey	16.0	533.3	488.4					
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	Little Brown Bat	0.510	1.529	3.185		5.096	15.287	31.848	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	Short-tailed Shrew	0.428	0.714	1.948		4.285	7.141	19.477	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	White-footed Mouse	0.389	2.519	1.298		3.894	25.194	12.979	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	Meadow Vole	0.327	2.881	2.401		3.274	28.813	24.010	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	Mink	0.150	1.095	1.515		1.500	10.946	15.147	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	Cottontail Rabbit	0.143	0.725	1.482		1.433	7.254	14.821	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	Red Fox	0.103	1.030	1.219		1.030	10.296	12.192	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	River Otter	0.089	0.793	1.115		0.892	7.926	11.146	
Vanadium	sodium metavanadate ($NaVO_3$)	rat	0.21	2.1	Whitetail Deer	0.055	1.776	0.835		0.547	17.760	8.352	
Vanadium	vanadyl sulfate	mallard duck	11.4		Rough-winged Swallow	11.400	15.105	48.989					
Vanadium	vanadyl sulfate	mallard duck	11.4		American Robin	11.400	9.439	82.811					

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Vanadium	vanadyl sulfate	mallard duck	11.4		Belted Kingfisher	11.400	22.496	105.450					
Vanadium	vanadyl sulfate	mallard duck	11.4		American Woodcock	11.400	15.048	112.860					
Vanadium	vanadyl sulfate	mallard duck	11.4		Cooper's Hawk	11.400	65.850	147.194					
Vanadium	vanadyl sulfate	mallard duck	11.4		Barn Owl	11.400	42.499	151.783					
Vanadium	vanadyl sulfate	mallard duck	11.4		Barred Owl	11.400	97.307	173.911					
Vanadium	vanadyl sulfate	mallard duck	11.4		Red-tailed Hawk	11.400	117.765	200.569					
Vanadium	vanadyl sulfate	mallard duck	11.4		Osprey	11.400	57.000	222.078					
Vanadium	vanadyl sulfate	mallard duck	11.4		Great Blue Heron	11.400	64.871	257.524					
Vanadium	vanadyl sulfate	mallard duck	11.4		Wild Turkey	11.400	380.000	348.000					
Vinyl Chloride	n/a	rat	0.17	1.7	Little Brown Bat	0.444	1.333	2.777		4.443	13.330	27.770	
Vinyl Chloride	n/a	rat	0.17	1.7	Short-tailed Shrew	0.374	0.623	1.698		3.736	6.227	16.983	
Vinyl Chloride	n/a	rat	0.17	1.7	White-footed Mouse	0.340	2.197	1.132		3.395	21.969	11.317	
Vinyl Chloride	n/a	rat	0.17	1.7	Meadow Vole	0.285	2.512	2.094		2.855	25.124	20.937	
Vinyl Chloride	n/a	rat	0.17	1.7	Mink	0.131	0.954	1.321	0.108	1.308	9.544	13.208	1.078
Vinyl Chloride	n/a	rat	0.17	1.7	Cottontail Rabbit	0.125	0.633	1.292		1.249	6.326	12.924	
Vinyl Chloride	n/a	rat	0.17	1.7	Red Fox	0.090	0.898	1.063		0.898	8.978	10.631	
Vinyl Chloride	n/a	rat	0.17	1.7	River Otter	0.078	0.691	0.972	0.078	0.777	6.911	9.719	0.782
Vinyl Chloride	n/a	rat	0.17	1.7	Whitetail Deer	0.048	1.549	0.728		0.477	15.486	7.283	
Xylene	mixed isomers	mouse	2.1	2.6	Little Brown Bat	2.970	8.910	18.562		3.677	11.031	22.981	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	Form	Test Species	Test Species NOAEL[a] (mg/kg/d)	Test Species LOAEL[a] (mg/kg/d)	Endpoint Species[b]	Estimated Wildlife NOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)	Estimated Wildlife LOAEL[c] (mg/kg/d)	Food[d] (mg/kg)	Water[e] (mg/L)	Piscivore[f] (mg/L)
Xylene	mixed isomers	mouse	2.1	2.6	Short-tailed Shrew	2.497	4.162	11.352		3.092	5.153	14.054	
Xylene	mixed isomers	mouse	2.1	2.6	White-footed Mouse	2.269	14.684	7.564		2.810	18.180	9.365	
Xylene	mixed isomers	mouse	2.1	2.6	Meadow Vole	1.908	16.793	13.994		2.363	20.791	17.326	
Xylene	mixed isomers	mouse	2.1	2.6	Mink	0.874	6.379	8.828	0.038	1.082	7.898	10.930	0.047
Xylene	mixed isomers	mouse	2.1	2.6	Cottontail Rabbit	0.835	4.228	8.638		1.034	5.235	10.695	
Xylene	mixed isomers	mouse	2.1	2.6	Red Fox	0.600	6.001	7.106		0.743	7.429	8.798	
Xylene	mixed isomers	mouse	2.1	2.6	River Otter	0.520	4.619	6.496	0.028	0.643	5.719	8.043	0.035
Xylene	mixed isomers	mouse	2.1	2.6	Whitetail Deer	0.319	10.351	4.868		0.395	12.816	6.027	
Zinc	zinc oxide	rat	160	320	Little Brown Bat	418.2	1254.6	2613.7		836.4	2509.1	5227.4	
Zinc	zinc oxide	rat	160	320	Short-tailed Shrew	351.7	586.1	1598.4		703.3	1172.2	3196.8	
Zinc	zinc oxide	rat	160	320	White-footed Mouse	319.5	2067.6	1065.1		639.1	4135.3	2130.3	
Zinc	zinc oxide	rat	160	320	Meadow Vole	268.7	2364.6	1970.5		537.4	4729.2	3941.0	
Zinc	zinc oxide	rat	160	320	Mink	123.1	898.3	1243.1	0.929	246.1	1796.6	2486.2	1.858
Zinc	zinc oxide	rat	160	320	Cottontail Rabbit	117.6	595.4	1216.4		235.2	1190.7	2432.7	
Zinc	zinc oxide	rat	160	320	Red Fox	84.5	845.0	1000.6		169.0	1689.9	2001.2	
Zinc	zinc oxide	rat	160	320	River Otter	73.2	650.4	914.7	0.673	146.4	1300.9	1829.4	1.346
Zinc	zinc oxide	rat	160	320	Whitetail Deer	44.9	1457.6	685.4		89.8	2915.1	1370.9	
Zinc	zinc sulfate	white leghorn hen	14.5	131	Rough-winged Swallow	14.5	19.2	62.3		131.0	173.6	562.9	
Zinc	zinc sulfate	white leghorn hen	14.5	131	American Robin	14.5	12.0	105.3		131.0	108.5	951.6	

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Zinc	zinc sulfate	white leghorn hen	14.5	131	Belted Kingfisher	14.5	28.6	134.1	0.030	131.0	258.5	1211.8	0.268
Zinc	zinc sulfate	white leghorn hen	14.5	131	American Woodcock	14.5	19.1	143.6		131.0	172.9	1296.9	
Zinc	zinc sulfate	white leghorn hen	14.5	131	Cooper's Hawk	14.5	83.8	187.2		131.0	756.7	1691.4	
Zinc	zinc sulfate	white leghorn hen	14.5	131	Barn Owl	14.5	54.1	193.1		131.0	488.4	1744.2	
Zinc	zinc sulfate	white leghorn hen	14.5	131	Barred Owl	14.5	123.8	221.2		131.0	1118.2	1998.4	
Zinc	zinc sulfate	white leghorn hen	14.5	131	Red-tailed Hawk	14.5	149.8	255.1		131.0	1353.3	2304.8	
Zinc	zinc sulfate	white leghorn hen	14.5	131	Osprey	14.5	72.5	282.5	0.075	131.0	655.0	2551.9	0.678
Zinc	zinc sulfate	white leghorn hen	14.5	131	Great Blue Heron	14.5	82.5	327.6	0.085	131.0	745.5	2959.3	0.771
Zinc	zinc sulfate	white leghorn hen	14.5	131	Wild Turkey	14.5	483.3	442.6		131.0	4366.7	3998.9	
Zirconium	zirconium sulfate	mouse	1.74		Little Brown Bat	2.461	7.382	15.380					
Zirconium	zirconium sulfate	mouse	1.74		Short-tailed Shrew	2.069	3.449	9.406					
Zirconium	zirconium sulfate	mouse	1.74		White-footed Mouse	1.880	12.167	6.268					
Zirconium	zirconium sulfate	mouse	1.74		Meadow Vole	1.581	13.914	11.595					
Zirconium	zirconium sulfate	mouse	1.74		Mink	0.724	5.286	7.315					
Zirconium	zirconium sulfate	mouse	1.74		Cottontail Rabbit	0.692	3.503	7.157					
Zirconium	zirconium sulfate	mouse	1.74		Red Fox	0.497	4.972	5.888					
Zirconium	zirconium sulfate	mouse	1.74		River Otter	0.431	3.827	5.382					

Table 12. (continued)

							NOAEL-Based Benchmarks				LOAEL-Based Benchmarks		
Analyte	**Form**	**Test Species**	**Test Species NOAEL[a] (mg/kg/d)**	**Test Species LOAEL[a] (mg/kg/d)**	**Endpoint Species[b]**	**Estimated Wildlife NOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**	**Estimated Wildlife LOAEL[c] (mg/kg/d)**	**Food[d] (mg/kg)**	**Water[e] (mg/L)**	**Piscivore[f] (mg/L)**
Zirconium	zirconium sulfate	mouse	1.74		Whitetail Deer	0.264	8.577	4.033					

Notes:

[a] See Appendix A for derivation, Study Duration, and study endpoint.

[b] See Appendix B for body weights, food and water consumption rates.

[c] Calculated using Eq. 4 or 6.

[d] Calculated using Eq. 10.

[e] Calculated using Eq. 22.

[f] Combined food and water benchmark for aquatic-feeding species. Calculated using Eq. 28.

Appendix E

SUMMARIES OF STUDIES EVALUATED IN DEVELOPMENT OF NEW BENCHMARKS

E. SUMMARIES OF STUDIES EVALUATED IN DEVELOPMENT OF NEW BENCHMARKS

Compound: Cadmium
Form: soluble salt
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)
Study Duration: 2 generations (>1 yr and during a critical lifestage = chronic)
Endpoint: reproduction
Exposure Route: oral in water (+incidental in food)
Dosage: one dose level:
10 ppm Cd (in water) + 0.1 ppm Cd (in food) = LOAEL
Calculations:

$$\left(\frac{10\,\text{mg Cd}}{\text{L water}} \text{ x } \frac{7.5\,\text{mL water}}{\text{day}} \text{ x } \frac{1\,\text{L}}{1000\,\text{mL}} \right) \;/\; 0.03 \text{ kg BW} = 2.5 \text{ mg/kg/d}$$

$$\left(\frac{0.1\,\text{mg Cd}}{\text{kg food}} \text{ x } \frac{5.5\,\text{g food}}{\text{day}} \text{ x } \frac{1\,\text{kg}}{1000\,\text{g}} \right) \;/\; 0.03 \text{ kg BW} = 0.018 \text{ mg/kg/d}$$

Total Exposure = 2.5 mg/kg/d + 0.018 mg/kg/d = 2.518 mg/kg/d

Comments: Because mice exposed to Cd displayed reduced reproductive success (the strain did not survive to the third generation) and congenital deformities, 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: 0.252 mg/kg/d
Final LOAEL: 2.52 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 from EPA 1988a)
Study 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:

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

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

Comments: While no reduction in the growth or survivorship of offspring or in the fertility of the first two generations of rats was observed at any dose level, fertility (no. litters/no. females) was reduced by 63% in the third generation of rats receiving the 0.125 ppm Cd diet and 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 chronic NOAELs and LOAELs, respectively.

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

Compound: Cadmium
Form: $CdCl_2$
Reference: Machemer and Lorke (1981)
Test Species: Rat
Body weight: 0.33 kg (mean ♂+♀ from study)
Study Duration: days 6 to 15 of gestation (during a critical lifestage = chronic)
Endpoint: reproduction
Exposure Route: oral gavage
Dosage: four dose levels: 1.82, 6.13, 18.39, and 61.32 mg Cd/kg/d
6.13 mg/kg/d = NOAEL
18.39 mg/kg/d = LOAEL
Calculations: NA

Comments: Rats exposed to 61.32 mg Cd/kg/d did not reproduce. At the next lower dose, 18.39 mg/kg/d, the number of stunted and malformed fetuses were significantly greater than controls, and fetal weights were significantly decreased. No adverse effects on reproduction were observed at the 6.13 mg/kg/d dose level. Because the study considered oral exposure during reproduction, the 6.13 mg/kg/d and 18.39 mg/kg/d doses were considered to be chronic NOAELs and LOAELs, respectively. It should be noted that this study also dosed rats through their diets at doses of 1.2, 3.5, and 12.5 mg/kg/d through gestation. No adverse effects were observed at any dose level.

Final NOAEL: 6.1 mg/kg/d
Final LOAEL: 18.4 mg/kg/d

Compound: Cadmium
Form: $CdCl_2$
Reference: Baranski et al. (1983)
Test Species: Rat
Body weight: 0.192 kg (from study)
Study Duration: 5 days a week for 5 weeks through mating and gestation (during a critical lifestage = chronic)
Endpoint: reproduction
Exposure Route: oral gavage
Dosage: three dose levels: 0.04, 0.4, and 4 mg Cd/kg/d
4 mg/kg/d = NOAEL
Calculations: to convert 5 d/wk exposure to 7 d/wk exposure:
(4 mg/kg/d x 25d)/35 d = 2.86 mg/kg/d

Comments: No adverse effects were observed at any dose level. Because the study considered oral exposure during reproduction, the 2.86 mg/kg/d dose was considered to be a chronic NOAEL.

Final NOAEL: 2.86 mg/kg/d

Compound: Cadmium
Form: $CdCl_2$
Reference: Webster (1978)
Test Species: mouse
Body weight: 0.027 kg (from study)
Study Duration: day 1 through 19 of pregnancy (during a critical lifestage = chronic)
Endpoint: reproduction
Exposure Route: oral in water
Dosage: three dose levels: 10, 20, and 40 ppm Cd in water
40 ppm = LOAEL
Calculations:

$$\text{NOAEL: } \left(\frac{40\,\text{mg Cd}}{\text{L water}} \times \frac{0.0038\,\text{L water}}{\text{day}} \right) / 0.027 \text{ kg BW} = 5.63 \text{ mg/kg/d}$$

Comments: While fetal weight was significantly reduced among all three dose levels, the magnitude of weight reduction ranged from 6% to 13% of the controls. Because the magnitude of weight reduction was <20% of the controls, they were not considered to be biologically significant. Therefore, maximum dose level was determined to represent a chronic NOAEL.

Final NOAEL: 5.63 mg/kg/d

Compound: Cadmium
Form: $CdCl_2$
Reference: Sutou et al. (1980b)
Test Species: Rat
Body weight: 0.303 kg (mean from all dose levels; from Sutou et al. 1980a)
Study Duration: 6 weeks through mating and gestation (during a critical lifestage = chronic)
Endpoint: reproduction
Exposure Route: oral gavage
Dosage: four dose levels: 0, 0.1, 1.0, and 10.0 Cd/kg/d
1 mg/kg/d = NOAEL
10 mg/kg/d = LOAEL
Calculations: NA

Comments: While no adverse effects were observed at the 1 mg/kg/d dose level, fetal implantations were reduced by 28%, fetal survivorship was reduced by 50% and fetal resorptions increased by 400% amongst the 10 mg/kg/d group. Because the study considered oral exposure during reproduction, the 1 and 10 mg/kg/d doses were considered to be chronic NOAELs and LOAELs, respectively.

Final NOAEL: 1 mg/kg/d
Final LOAEL: 10 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)
Study 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:

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

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

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: Potassium Selanate (SeO_4)

Reference: Rosenfeld and Beath 1954

Test Species: rat
Body weight: 0.35 kg (EPA 1988a)
Water Consumption: 0.046 L/d
(calculated using allometric equation from EPA 1988a)

Study Duration: 1 year, through 2 generations (1 yr and during critical lifestage=chronic)

Endpoint: reproduction

Exposure Route: oral in water

Dosage: three dose levels:
1.5, 2.5, and 7.5 mg Se/L
2.5 mg/L = LOAEL

Calculations:

$$\text{NOAEL:} \left(\frac{1.5\,\text{mg Se}}{\text{L water}} \text{ x } \frac{46\,\text{mL water}}{\text{day}} \text{ x } \frac{1\,\text{L}}{1000\,\text{mL}} \right) / \ 0.35 \text{ kg BW} = 0.20\,\text{mg/kg/d}$$

$$\text{LOAEL:} \left(\frac{2.5\ \text{Se}}{\text{L water}} \text{ x } \frac{46\,\text{water}}{\text{day}} \text{ x } \frac{1\,\text{L}}{1000\,\text{mL}} \right) / \ 0.35 \text{ kg BW} = 0.33\,\text{mg/kg/d}$$

Comments: While no adverse effects on reproduction were observed among rats exposed to 1.5 mg Se/L in drinking water, the number of second-generation young was reduced by 50% among females in the 2.5 mg/L group. In the 7.5 mg/L group, fertility, juvenile growth, and survival were all reduced. Because the study considered exposure over multiple generations, the 1.5 and 2.5 mg/L doses were considered to be chronic NOAELs and LOAELs, respectively.

Final NOAEL: 0.20 mg/kg/d

Final LOAEL: 0.33 mg/kg/d

Compound: Selenium

Form: Sodium Selenite (Na_2SeO_3•$5H_2O$) (30% Se)

Reference: Nobunga et al. 1979

Test Species: mouse
Body weight: 0.03 kg (EPA 1988a)
Water Consumption: 0.0035 L/d (from study)
Study Duration: 30 d prior to reproduction and through d 18 of gestation (during critical lifestage=chronic)
Endpoint: reproduction
Exposure Route: oral in water
Dosage: two dose levels:
0.9 and 1.8 mg Se/L
1.8 mg/L = NOAEL
Calculations:

$$\text{NOAEL: } \left(\frac{1.8\,\text{mg Se}}{\text{L water}} \text{ x } \frac{3.5\,\text{mL water}}{\text{day}} \text{ x } \frac{1\,\text{L}}{1000\,\text{mL}} \right) / \ 0.03 \ \text{kg BW} = 0.21\,\text{mg/kg/d}$$

Comments: While no adverse effects on reproduction were observed among mice exposed to 0.9 mg Se /L in drinking water, offspring weight was reduced by 8% among the 1.8 mg/L group. The effect was not considered to be biologically significant. Because the study considered exposure through reproduction, the 1.8 mg/L dose was considered to be a chronic NOAEL.

Final NOAEL: 0.21 mg/kg/d

Compound: Selenium
Form: k-selenocarageenan
Reference: Chiachun et al. 1991
Test Species: mouse
Body weight: 0.034 kg (from study)
Water Consumption: 0.0075 L/d
(calculated using allometric equation from EPA 1988a)
Study Duration: unclear—appears to be through of gestation (during critical lifestage=chronic)
Endpoint: reproduction
Exposure Route: oral in water
Dosage: one dose level:
0.25 mg Se/L = NOAEL
Calculations:

$$\text{NOAEL: } \left(\frac{0.25\,\text{mg Se}}{\text{L water}} \text{ x } \frac{7.5\,\text{mL water}}{\text{day}} \text{ x } \frac{1\,\text{L}}{1000\,\text{mL}} \right) / \ 0.034 \ \text{kg BW} = 0.055\,\text{mg/kg/d}$$

Comments: Mice exposed to 0.25 mg Se /L in drinking water displayed reduced gestation periods and produced larger litters than controls. Because the study (apparently) considered exposure through reproduction, the 0.25 mg/L dose was considered to be a chronic NOAEL.

Final NOAEL: 0.055 mg/kg/d

Compound: Selenium
Form: L-selenomethionine
Reference: Tarantal et al. (1991)
Test Species: long-tailed macaques
Body weight: 4.25 kg (from study)
Water Consumption: 0.0075 L/d
(calculated using allometric equation from EPA 1988a)
Study Duration: days 20 to 50 of gestation (during critical lifestage=chronic)
Endpoint: reproduction

Exposure Route: nasogastric intubation
Dosage: three dose levels:
0.025, 0.15, and 0.3 mg/kg/d selenomethionine
0.025 mg/kg/d= NOAEL
Calculations: NA

Comments: No adverse effects were observed among macaques exposed to 0.025 mg/kg/d selenomethionine. In contrast, fetal mortality was 30% and 20%, and adult toxicity was observed in the 0.15 and 0.3 mg/kg/d groups. The reproductive effects, however, are within the range observed among the macaque colony at large. Because the study considered exposure through reproduction, the 0.025 mg/kg/d dose was considered to be a chronic NOAEL. The 0.15 mg/kg/d dose may represent a chronic LOAEL; however, because the fetal mortality observed at this level is within the range observed among the colony as a whole, it may not represent an Se-related effect.

Final NOAEL: 0.025 mg/kg/d

Compound: Selenium
Form: Sodium Selenite (Na_2SeO_3) (46% Se)
Reference: Chernoff and Kavlock 1982
Test Species: mouse
Body weight: 0.03 kg (EPA 1988a)
Study Duration: days 8 to 12 of gestation (during critical lifestage=chronic)
Endpoint: reproduction
Exposure Route: oral gavage
Dosage: one dose level:
10 mg Na_2SeO_3 /kg/d or
4.6 mg Se /kg/d = LOAEL
Calculations: NA

Comments: Exposure of pregnant mice to 4.6 mg Se/kg/d produced a statistically significant 17% reduction in litter size. Because the study considered exposure through reproduction, the 4.6 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: 0.46 mg/kg/d
Final LOAEL: 4.6 mg/kg/d