DEPARTMENT OF THE NAVY
CRANE DIVISION
NAVAL SURFACE WARFARE CENTER
300 HIGHWAY 361
CRANE, INDIANA 47522-5000

IN REPLY REFER TO:

5090
Ser 095/2023
10 JAN 2002

U.S. Environmental Protection Agency, Region V
Waste, Pesticides, & Toxics Division
Waste Management Branch
Illinois, Indiana, and Michigan Section
ATTN: Mr. Peter Ramanauskas (DW-8J)
77 West Jackson Blvd.
Chicago, IL 60604

Dear Mr. Ramanauskas:

Crane Division, Naval Surface Warfare Center (NSWC Crane) submits the Risk Evaluation for Indiana Bats Consuming Insects Collected Along Little Sulphur Creek. This report utilizes a food chain risk evaluation model and was conducted in order to determine the need for a more costly and time consuming background insect collection. The report concludes that potential risks to bats consuming insects along Little Sulphur Creek are low, and therefore, a study to collect and analyze background insects is not necessary. Please review and comment. Two copies are provided as enclosure (1). The permit required Certification Statement is provided as enclosure (2).

NSWC Crane point of contact is Mr. Thomas J. Brent, Code 09510, telephone 812-854-6160.

Sincerely,

James M. Hunsicker
Director, Environmental
Protection Department
By direction of the Commander

Encl:
(1) Risk Evaluation for Indiana Bats Consuming Insects
(2) Certification Statement

Copy to:
ADMINISTRATIVE RECORD
SOUTHNAVFACENGCOM (Code ES324) (w/o encl)
USFWS (Lori Pruitt)
IDEM (Doug Griffin)
TTNUS (Ralph Basinski) (w/o encl)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

James Hunsicker

SIGNATURE

Environmental Protection Department Manager 1/09/02

TITLE DATE

RISK EVALUATION FOR INDIANA BATS CONSUMING INSECTS COLLECTED ALONG LITTLE SULPHUR CREEK

Background

In the summer of 2000, a study was conducted to determine concentrations of explosive chemicals, phosphorous, and metals in insects in the foraging area of the Indiana Bat at the Ammunition Burning Grounds (ABG) at NSWC Crane (NSWC, 2001). All study procedures were conducted in accordance with a QAPP approved by USEPA Region 5 (NSWC, 2000). A report describing the study procedures and results was prepared by the Navy and submitted to USEPA on August 27, 2001 (NSWC, 2001). The study consisted of collecting insects from three locations adjacent to Little Sulphur Creek immediately downstream of the ABG. Insects were collected from two locations using light traps, and insects were collected from a third location using a funnel trap known as a Malaise trap. The traps were operated for four nights each in the months of June, July, and August, 2000. The insects were separated into three groups prior to analysis: terrestrial insects (not including Lepidoptera), aquatic insects, and Lepidoptera insects.

The insect tissue samples were analyzed for explosive compounds, total phosphorous, and metals. None of the explosive compounds were detected in any of the insect samples. The concentrations of total phosphorous in the insects from the site were similar to the total phosphorous concentrations in the control insects (crickets). The metals concentrations in the insects from the site were greater than the concentrations in the control insects. Also, the concentrations of three metals (cadmium, copper, and lead) were greater than background levels from the literature for those three metals. No background levels were found in the literature for the other metals. The elevated levels of metals may have been caused by paint chips that peeled off the insect traps and became mixed with the insects. The metal concentrations in the insects were incorporated into a food chain model for the little brown bat to determine if there were any risks to bats from consuming the insects. This report describes the results of this risk evaluation.

Food Chain Model Procedure

The little brown bat model was used as a surrogate species for the Indiana bat, which has been known to forage in the riparian area south of the ABG at NSWC Crane, because exposure factors were available for the little brown bat.

Risks to the little brown bat from metals in the insects were determined by estimating the Chronic Daily Intake (CDI) and comparing the CDI to Toxicity Reference Values (TRVs) representing acceptable daily doses in mg/kg/day. The TRVs were developed from No-Observed-Adverse-Effect-Levels (NOAELs) and Lowest-Observed-Adverse-Effect-Levels (LOAELs) obtained from wildlife studies, if available. The majority of the TRVs are obtained from the ORNL Toxicological Benchmarks for Wildlife: 1996 Revision (Sample et al., 1996). Table 1 presents the TRVs that were used in this report and the derivation of the TRVs using the body-weight scaling equation presented below. Table 2 presents the sources and ecological endpoints for the TRVs. When a subchronic study was used to develop the TRV, the final value was multiplied by a factor of 0.1 to account for uncertainty between subchronic and chronic effects. Also, when a LOAEL study was used to develop the NOAEL TRV, the LOAEL was multiplied by a factor of 0.1 to obtain the NOAEL.

In accordance with U.S. Region 5 policy, the NOAEL (or LOAEL) from the test species (i.e., rat, mouse) was adjusted to a NOAEL (or LOAEL) for the surrogate species (the little brown bat) using the following body weight scaling equation from Sample et al., (1996):

$$NOAEL_w = NOAEL_t * (bw_t/bw_w)^{1/4}$$

Where: $NOAEL_w$ = No Observed Adverse Effect Level for the surrogate wildlife species
$NOAEL_t$ = No Observed Adverse Effect Level for the test species
bw_t = body weight of the test species
bw_w = body weight of the little brown bat

Exposure of the little brown bat to the metals in the insects was determined by estimating the daily doses in mg/kg-day using the following exposure equations.

$$\text{CDI Dose (mg/kg-day)} = \frac{(FI * FC)}{BW}$$

Where: CDI = Chronic Daily Intake (mg/kg-day)
FI = Food ingestion rate (mg/day)
FC = Food concentration (insect concentrations) (mg/kg)
BW = Body weight (kg)

The insect concentrations were reported in NSWC, (2001) on a dry weight basis. The ingestion rate of the little brown bat was reported on a wet weight basis, so the wet weight metal

concentrations were calculated by multiplying the dry weight concentration (mg/kg) by the percent solid for each insect group (see Table 3).

The lower bound of the threshold effects is based on consistently conservative assumptions and NOAEL toxicity values (U.S. EPA, 1997). This bound presents the highest potential risks. The upper bound is based on observed impacts or predictions that ecological effects could occur and is developed using consistent assumptions, site-specific data, LOAEL toxicity values, or an impact evaluation (U.S. EPA, 1997). This bound presents the average potential risk. Both the upper and lower bounds were evaluated to provide the overall range of potential risks as presented in the following table:

Conservative Scenario	**Average Scenario**
Highest receptor body weight for NOAEL calculation	Average receptor body weight for LOAEL calculation
Lowest receptor body weight for CDI equation	Average receptor body weight for CDI equation
Conservative receptor ingestion rate	Average receptor ingestion rate
Use NOAELS	Use LOAELs

The exposure assumptions (i.e., ingestion rate, body weight) for the little brown bat were obtained from Sample et al., (1997). Table 4 presents the exposure factors that were used for the food chain model and the values that were used to calculated the exposure factors. As indicated above, the little brown bat was used as a surrogate for the Indiana bat because more exposure factors were available for the little brown bat. However, because the Indiana bat is the ultimate receptor, the foraging area used by the Indiana bat is incorporated into this risk evaluation. An Indiana bat maternal colony has been reported to range from a linear strip of creek vegetation 0.8 km in length to a foraging area of 1.2 km in length (USFWS, 1999).

The risk characterization compares the exposure to the ecological effects. An Ecological Effects Quotient (EEQ) approach was used to characterize the risk to the bat. An EEQ of greater than "1.0" is considered to indicate a potential risk. The EEQ is not an expression of probability, and the meaning of values greater than 1.0 must be interpreted in light of attendant uncertainties in risk management. The EEQ for the bat wildlife model was calculated as follows:

$$EEQ = \frac{Dose}{TRV}$$

Where: EEQ = Ecological Effects Quotient, (unitless)

Dose = Daily Intake Dose, (mg/kg-day)

TRV = Toxicity Reference Value (NOAEL or LOAEL), (mg/kg-day)

Results

Tables 5 and 6 presents the results of the food chain models using the conservative and average scenarios for the three insect groups. The greatest EEQs were calculated for the model using the aquatic insects for both the conservative and average scenario. Five metals had EEQs that were greater than 1.0 based on the conservative inputs and using the NOAEL as the TRV for bats consuming the aquatic insects (Table 5). Two and three metals had EEQs that were greater than 1.0 for the bats consuming Lepidoptera and terrestrial insects, respectively, under the same conservative exposure scenario (Table 5).

Based on the average scenario, no metals had EEQs greater than 1.0 for bats that consumed Lepidoptera using either the NOAEL of LOAEL as the TRV (Table 6). Only two metals had EEQs greater than 1.0 for bats that consumed terrestrial insects using the NOAEL, but no EEQs were greater than 1.0 using the LOAEL. Finally, two metals had EEQs greater than 1.0 for bats that consumed terrestrial insects using the NOAEL, and one metal had an EEQs that was greater than 1.0 using the LOAEL (chromium).

Chromium was the only metal that had an EEQ greater than 1.0 using the average exposure factors and the LOAEL as the TRV. The TRV used for chromium is for chromium (VI) to be conservative, however, chromium in biological materials is usually in the chromium (III) form (Eisler, 1986). As listed on table 2, the NOAEL for chromium (III) is 2,737 mg/kg whereas the NOAEL for chromium (VI) is 3.28 mg/kg; no LOAEL was available for chromium (III) but if would be greater than the NOAEL. Therefore, had the NOAEL for chromium (III) been used in the food chain model, none of the chromium EEQs would have been greater than 1.0.

Summary/Conclusions/Recommendations

The two exposure scenarios (conservative and average) were presented to show the range of risks to bats. NOAELS are the highest concentrations in a particular study where no adverse effects were observed, whereas LOAELS are the lowest concentrations in a particular study where adverse effects were observed. Therefore, an EEQs that is greater than 1.0 using a NOAEL but less than 1.0 using the LOAEL is not likely to cause a significant risk to ecological receptors.

As presented in NSWC (2001), the total weight of the Lepidoptera (650 grams – wet weight) and terrestrial insects (439 grams – wet weight) that were collected were much greater than the weight of the aquatic insects (55 grams – wet weight). Although the bats consuming the aquatic insects had an EEQ slightly greater than 1.0 based on average exposure assumptions and the LOAEL for chromium [based on chromium (VI)](EEQ=1.2), aquatic insects should only comprise a small portion of the diet for the bats. Since none of the LOAEL EEQs for the bats that consume terrestrial insects and Lepidoptera exceeded 1.0, and these insects represent a larger percentage (by weight) of the insects collected, it is unlikely that the concentrations of metals in the insects will harm the bats. As indicated above, risks from chromium are expected to be low because most of the chromium in tissue is chromium (III), which is much less toxic than chromium (VI), which was used for the food chain model. Finally, these food chain models assume that the bats will consume all of their food from along Little Sulfur Creek but bats will obtain some of their food from other areas at the Base. Therefore, potential risks to bats from consuming insects along Little Sulphur Creek are low, and a study to obtain base-specific background concentrations of metals in insects does not appear to be necessary.

TABLE 1

TOXICITY REFERENCE VALUES FOR THE LITTLE BROWN BAT
AMMUNITION BURNING GROUNDS
NSWC CRANE, CRANE INDIANA

Parameter	Test Species				Little Brown Bat (conservative value)(1,2)		Little Brown Bat (average value)(1,3)	
	NOAEL	LOAEL	Species	Body Weight (kg)	NOAEL	LOAEL	NOAEL	LOAEL
Aluminum	1.93	19.3	mouse	0.03	2.5	25.2	2.8	27.6
Antimony	0.125	1.25	mouse	0.03	0.16	1.6	0.18	1.8
Arsenic	0.126	1.26	mouse	0.03	0.16	1.6	0.18	1.8
Barium	5.1	19.8	rat	0.435/0.35(1)	13.0	47.8	14.2	52.3
Beryllium	0.66	6.6	rat	0.35	1.6	15.9	1.7	17.4
Cadmium	1	10	rat	0.303	2.3	23.3	2.5	25.5
Chromium	3.28	13.14	rat	0.35	7.9	31.7	8.7	34.7
Hexavalent Chromium	3.28	13.14	rat	0.35	7.9	31.7	8.7	34.7
Cobalt	1.2	12	rat	0.35	2.9	29.0	3.2	31.7
Copper	11.71	15.14	mink	1	36.8	47.5	40.2	52.0
Cyanide	68.7	687	rat	0.273	156	1559	170	1705
Iron	50	500	rabbit	3.8	219	2191	240	2397
Lead	8	80	rat	0.35	19.3	193	21.1	211
Manganese	88	284	rat	0.35	212	686	232	750
Mercury	0.015	0.025	mink	1	0.047	0.078	0.05	0.09
Nickel	40	80	rat	0.35	96.6	193	105.6	211
Selenium	0.2	0.33	rat	0.35	0.48	0.80	0.53	0.87
Silver	1.81	18.1	mouse	0.03	2.4	23.6	2.6	25.9
Thallium	0.0074	0.074	rat	0.365	0.018	0.18	0.02	0.20
Vanadium	0.21	2.1	rat	0.26	0.47	4.7	0.5	5.1
Zinc	160	320	rat	0.35	386	773	422	845

Unite are mg/kg-day
NOAEL - No Observered Adverse Effect Level
LOAEL - Lowest Observered Adverse Effect Level
1 - The NOAEL and LOAEL for the bat was calculated using the following equation: $NOAEL_w$ (or $LOAEL_w$) $=NOAEL_t$ (or $LOAEL_t$)$*(bw_t/bw_w)^{0.25}$

Where: $NOAEL_w$ (or $LOAEL_w$) = NOAEL (or LOAEL) for the bat
$NOAEL_t$ (or $LOAEL_t$) = NOAEL (or LOAEL) for the test species
bw_w - body weight of the bat
bw_t - body weight of the test species

2 - The conservative values were calculated using the maximum body weight of 10.27 g for the bat (see Table 4).
3 - The average values were calculated using the average body weight of 7.2 g for the bat (see Table 4).

TABLE 2

ENDPOINTS AND SOURCES FOR TOXICITY REFERENCE VALUES FOR MAMMALS
AMMUNITION BURNING GROUNDS
NSWC CRANE, CRANE INDIANA

Parameters	Concentration (mg/kd-day)	Endpoint	Effect	Chronic/ Subchronic	Species	Primary Reference	Source of Reference
Aluminum	19.3	LOAEL	reproductive	chronic	mouse	Ondreicka et al., 1966	Sample et.al., 1996
Antimony	1.25	LOAEL	lifespan	chronic	mouse	Schroeder et al., 1968b	Sample et.al., 1996
Arsenic	1.261	LOAEL	reproductive	chronic	mouse	Schroeder and Mitchner, 1971	Sample et.al., 1996
Barium	5.1	NOAEL	growth	chronic	rat	Perry et al., 1983	Sample et.al., 1996
Barium	198	LOAEL	mortality	subchronic	rat	Borzelleca et al., 1988	Sample et.al., 1996
Cadmium	1	NOAEL	reproduction	chronic	rat	Sutou et al., 1980b	Sample et.al., 1996
Cadmium	10	LOAEL	reproduction	chronic	rat	Sutou et al., 1980b	Sample et.al., 1996
Chromium(III)	2737	NOAEL	reproduction	chronic	rat	Ivankovic and Preussmann, 1975	Sample et.al., 1996
Chromium(VI)	3.28	NOAEL	BW/food cons.	chronic	rat	Mackenzie, 1958	Sample et.al., 1996
Chromium(VI)	13.14	LOAEL	mortality	subchronic	rat	Steven et al., 1976	Sample et.al., 1996
Copper	11.71	NOAEL	reproduction	chronic	mink	Aulerich et al., 1982	Sample et.al., 1996
Copper	15.14	LOAEL	reproduction	chronic	mink	Aulerich et al., 1982	Sample et.al., 1996
Lead	8	NOAEL	reproductive	chronic	rat	Azar et al., 1973	Sample et.al., 1996
Lead	80	LOAEL	reproductive	chronic	rat	Azar et al., 1973	Sample et.al., 1996
Manganese	88	NOAEL	reproductive	chronic	rat	Laskey et al., 1982	Sample et.al., 1996
Manganese	284	LOAEL	reproductive	chronic	rat	Laskey et al., 1982	Sample et.al., 1996
Mercury	0.032	NOAEL	reproductive	chronic	rat	Verschuuren et al., 1976	Sample et.al., 1996
Mercury	0.16	LOAEL	reproductive	chronic	rat	Verschuuren et al., 1976	Sample et.al., 1996
Nickel	40	NOAEL	reproductive	chronic	rat	Ambrose et al., 1976	Sample et.al., 1996
Nickel	80	LOAEL	reproductive	chronic	rat	Ambrose et al., 1976	Sample et.al., 1996
Silver	18.1	NOAEL	systemic	subchronic	mouse	Rungby, 1984	ATSDR, 1989
Zinc	160	NOAEL	reproductive	chronic	rat	Schlicker and Cox, 1986	Sample et.al., 1996
Zinc	320	LOAEL	reproductive	chronic	rat	Schlicker and Cox, 1986	Sample et.al., 1996

TABLE 3

DRY WEIGHT TO WET WEIGHT CONVERSION FOR INSECTS
AMMUNITION BURNING GROUNDS
NSWC CRANE, INDIANA

	Terrestrial		Aquatic		Lepidoptera	
Inorganics	Dry Weight[1] mg/kg	Wet Weight[2] mg/kg	Dry Weight[1] mg/kg	Wet Weight[2] mg/kg	Dry Weight[1] mg/kg	Wet Weight[2] mg/kg
ALUMINUM	93.8	31.6	134	44.2	10.7	2.4
ANTIMONY	0.138	0.05	0.113	0.04	0.0205	0.005
ARSENIC	3.25	1.1	0.597	0.20	0.169	0.04
BARIUM	11.7	3.9	20.7	6.8	6.58	1.5
CADMIUM	0.871	0.29	0.83	0.27	0.698	0.16
CHROMIUM	38.6	13.0	209	69.0	28.6	6.4
COPPER	74.8	25.2	114	37.6	36.1	8.1
LEAD	16	5.4	16.5	5.4	1.75	0.39
MANGANESE	74.2	25.0	77.4	25.6	28.5	6.4
MERCURY	0.083	0.03	0.072	0.02	0.04	0.01
NICKEL	30.5	10.3	147	48.5	21.1	4.7
SILVER	0.0515	0.02	0.55	0.18	0.0942	0.02
ZINC	582	196	913	301	234	52.5
Percent Solid	0.3367		0.3302		0.2243	

1 - Source of data is NSWC, 2001

2 - The wet weight concentration was calculated by multpilying the dry weightconcentration by the percent solid.

TABLE 4

CALCULATION OF EXPOSURE PARAMETERS FOR THE LITTLE BROWN BAT
AMMUNITION BURNING GROUNDS
NSWC, CRANE, INDIANA

Exposure Parameters	Little Brown Bat
Body Weights (g)	6.15
	6.15
	6.03
	6.99
	10.27
	7.77
Minimum (Conservative)	***6.03***
Maximum	***10.27***
Average	***7.2***
Food Ingestion Rate (g/g-day) (1)	1.12
	0.23
	0.48
Minimum	***0.23***
Maximum	***1.12***
Average	***0.61***
Food Ingestion Rate (kg/day)	
Conservative	***0.0081***
Average	***0.0044***
Water Ingestion Rate (g/g-day)	0.177
	0.205
Minimum	***0.177***
Maximum	***0.205***
Average	***0.191***
Water Ingestion Rate (L/day)	
Conservative	***0.0015***
Average	***0.0014***
Home Range (km) (1)	0.80
	1.20
Minimum (km) (1)	***0.80***
Maximum (km) (1)	***1.20***
Average (km) (1)	***1.00***

Notes:

Source of the Little Brown Bat data is Sample et al., (1997) except for the home range, which is USFWS, (1999).

1 - Home range for the Indiana Bat is presented in km of shoreline.

Ingestion Rates (kg/day or L/day)

- Conservative value = Max Ingestion Rate (g/g-day)* Avg. Body Weight
- Average value = Avg. Ingestion Rate (g/g-day)*Avg. Body Weight

TABLE 5

TERRESTRIAL WILDLIFE MODEL ECOLOGICAL EFFECTS QUOTIENT CALCULATION
LITTLE BROWN BAT - CONSERVATIVE INPUTS
AMMUNITION BURNING GROUNDS
NSWC, CRANE, INDIANA

TERRESTRIAL INSECTS

Parameter	Insect Concentration[1] (mg/kg)	Dose[2] (mg/kg-day)	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	NOAEL EEQn	LOAEL EEQl
Inorganics						
ALUMINUM	32	43	2.5	25	17	1.7
ANTIMONY	0.046	0.063	0.16	1.63	0.38	0.038
ARSENIC	1.1	1.5	0.2	1.6	9.0	0.90
BARIUM	3.9	5.3	13	48	0.41	0.11
CADMIUM	0.3	0.40	2.3	23	0.17	0.017
CHROMIUM	13	18	7.9	32	2.2	0.55
COPPER	25	34	37	48	0.92	0.72
LEAD	5.4	7.3	19	193	0.38	0.038
MANGANESE	25	33.7	212	686	0.16	0.049
MERCURY	0.028	0.038	0.047	0.078	0.80	0.48
NICKEL	10	14	97	193	0.14	0.072
SILVER	0.017	0.023	2.4	23.6	0.010	0.0010
ZINC	196	265	386	773	0.68	0.34

AQUATIC INSECTS

Parameter	Insect Concentration (mg/kg)	Dose (mg/kg/day)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	NOAEL EEQn	LOAEL EEQl
Inorganics						
ALUMINUM	44	60	2.5	25	24	2.4
ANTIMONY	0.037	0.050	0.16	1.6	0.31	0.031
ARSENIC	0.20	0.27	0.16	1.6	1.6	0.16
BARIUM	6.8	9.2	13	48	0.71	0.19
CADMIUM	0.27	0.37	2.3	23	0.16	0.016
CHROMIUM	69	93	7.9	32	12	2.9
COPPER	38	51	37	48	1.4	1.1
LEAD	5.45	7.4	19	193	0.38	0.038
MANGANESE	26	35	212	686	0.16	0.05
MERCURY	0.024	0.032	0.047	0.078	0.68	0.41
NICKEL	49	66	97	193	0.68	0.34
SILVER	0.18	0.25	2.4	24	0.10	0.010
ZINC	301	407	386	773	1.1	0.53

LEPIDOPTERA

Parameter	Insect Concentration (mg/kg)	Dose (mg/kg/day)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	NOAEL EEQn	LOAEL EEQl
Inorganics						
ALUMINUM	2.4	3.2	2.5	25	1.3	0.13
ANTIMONY	0.0046	0.0062	0.16	1.6	0.038	0.0038
ARSENIC	0.038	0.051	0.16	1.6	0.31	0.031
BARIUM	1.5	2.0	13	48	0.15	0.042
CADMIUM	0.16	0.21	2.3	23	0.091	0.009
CHROMIUM	6.4	8.7	7.9	32	1.1	0.27
COPPER	8.1	11	37	48	0.30	0.23
LEAD	0.4	0.5	19	193	0.027	0.0027
MANGANESE	6.4	8.6	212	686	0.041	0.013
MERCURY	0.0090	0.012	0.047	0.1	0.26	0.15
NICKEL	4.7	6.4	97	193	0.066	0.033
SILVER	0.021	0.029	2.4	24	0.012	0.0012
ZINC	52	71	386	773	0.18	0.092

Cells are shaded if the EEQ is greater than 1.0.

Definitions:
NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level
EEQn - Ecological Effects Quotient based on the NOAEL
EEQl - Ecological Effects Quotient based on the LOAEL

TABLE 6

TERRESTRIAL WILDLIFE MODEL ECOLOGICAL EFFECTS QUOTIENT CALCULATION
LITTLE BROWN BAT - AVERAGE INPUTS
AMMUNITION BURNING GROUNDS
NSWC, CRANE, INDIANA

TERRESTRIAL INSECTS

Parameter	Insect Concentration[1] (mg/kg)	Dose[2] (mg/kg-day)	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	NOAEL EEQn	LOAEL EEQl
Inorganics						
ALUMINUM	32	19	2.8	28	7.0	0.70
ANTIMONY	0.046	0.0	0.2	1.8	0.16	0.016
ARSENIC	1.1	0.7	0.2	1.8	3.7	0.37
BARIUM	3.9	2.4	14	52	0.17	0.046
CADMIUM	0.29	0.2	2.5	25	0.070	0.0070
CHROMIUM	13	7.9	8.7	35	0.92	0.23
COPPER	25	15	40	52	0.38	0.30
LEAD	5.4	3.3	21	211	0.16	0.016
MANGANESE	25	15	232	750	0.066	0.020
MERCURY	0.028	0.0	0.1	0.1	0.33	0.20
NICKEL	10	6.3	106	211	0.059	0.030
SILVER	0.017	0.0	2.6	26	0.0041	0.00041
ZINC	196	120	422	845	0.28	0.14

AQUATIC INSECTS

Parameter	Insect Concentration (mg/kg)	Dose (mg/kg/day)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	NOAEL EEQn	LOAEL EEQl
Inorganics						
ALUMINUM	44	27	2.8	28	10	1.0
ANTIMONY	0.037	0.0	0.2	1.8	0.13	0.013
ARSENIC	0.20	0.1	0.2	1.8	0.67	0.067
BARIUM	6.8	4.2	14.2	52	0.29	0.08
CADMIUM	0.27	0.2	2.5	25	0.07	0.01
CHROMIUM	69	42	8.7	35	4.9	1.2
COPPER	38	23	40.2	52	0.57	0.44
LEAD	5.4	3.3	21.1	211	0.16	0.016
MANGANESE	26	16	232	750	0.07	0.021
MERCURY	0.024	0.0	0.1	0.1	0.28	0.17
NICKEL	49	30	106	211	0.28	0.14
SILVER	0.18	0.1	2.6	26	0.043	0.0043
ZINC	301	184	422	845	0.44	0.22

LEPIDOPTERA

Parameter	Insect Concentration (mg/kg)	Dose (mg/kg/day)	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	NOAEL EEQn	LOAEL EEQl
Inorganics						
ALUMINUM	2.4	1.5	2.8	28	0.5	0.1
ANTIMONY	0.0046	0.0	0.2	1.8	0.016	0.0016
ARSENIC	0.038	0.0	0.2	1.8	0.13	0.013
BARIUM	1.5	0.9	14	52	0.063	0.017
CADMIUM	0.16	0.1	2.5	25	0.04	0.004
CHROMIUM	6.4	3.9	8.7	35	0.5	0.11
COPPER	8.1	4.9	40	52	0.12	0.10
LEAD	0.39	0.2	21	211	0.011	0.0011
MANGANESE	6.4	3.9	232	750	0.017	0.0052
MERCURY	0.0090	0.0	0.1	0.1	0.11	0.064
NICKEL	4.7	2.9	106	211	0.027	0.014
SILVER	0.021	0.0	2.6	26	0.0050	0.00050
ZINC	52	32	422	845	0.076	0.038

Cells are shaded if the EEQ is greater than 1.0.

Definitions:
NOAEL - No Observed Adverse Effects Level
LOAEL - Lowest Observed Adverse Effects Level
EEQn - Ecological Effects Quotient based on the NOAEL
EEQl - Ecological Effects Quotient based on the LOAEL

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