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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF:

March 22, 1999

DW-8J

Mr. Tom Brent
Env. Protection Dept. (Code 095)
Naval Surface Warfare Center
300 Highway 361
Crane, Indiana 47522

RE: Soil Ecological Screening Levels
Base-wide Background Soil Study
Naval Surface Warfare Center
Crane, Indiana

Dear Mr. Brent:

The purpose of this letter is to follow up on conversations with Mr. Keith Hehn, from your contractor Tetra Tech NUS, concerning soil screening levels to be used for the base-wide background soil study. Keith requested background data on how the Region 5 Ecological Data Quality Limits were established. Attached is the data from our ecologist Dan Mazur, for the metals of concern for the study. We are still working with Tetra Tech on the release of the rest of the database. As soon as that arrangement can be made, we will transfer data for all other parameters you may be concerned about for other studies.

Please note that there are new EDQLs for Lead and Mercury in the attachment. If you have any questions regarding this matter, please contact me at (312) 886-6146. Or, for database questions you may contact Dan Mazur directly at (312) 353-7997, for assistance.

Sincerely,

Carol Witt-Smith
Corrective Action Expert
WMB, IL/IN/MI Section

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cc: Core Team Members: Bill Gates, SOUTHDIV
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Jim Ferro, SOUTHDIV
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Project Team Members: Keith Hehn, Tetra Tech NUS
Al Debus, WMB
Meagan Smith, WMB
Dan Mazur, WMB
Mario Mangino, WMB
George Bollweg, WMB

Attachment
Background Soil Study Ecological Soil Levels
Naval Surface Warfare Center

Calculations:

For the metals listed in the Crane project (3/5/99 e-mail, see Table attached), the majority of soil ecological data quality levels (i.e., EDQL) are based on a shrew ecological screening level. The following example calculation of a shrew ecological screening level for lead and antimony in soil uses an adjusted toxicity reference value (TRV) within a simplified food chain model. Since the TRV requires a no observed effect level (NOAEL) based on a chronic study of a target species, a TRV is often adjusted using three uncertainty factors (UF).

UF_1: scaling factor (test species → target species)
UF_2: endpoint (test endpoint → NOAEL)
UF_3: duration (test duration → chronic exposure)

The adjusted TRV is calculated as follows:

$$TRV_a = \frac{TRV \times UF_1}{UF_2 \times UF_3}$$

The **shrew soil ecological screening level** is calculated by incorporating the adjusted TRV into the following food chain model.

$$= \frac{TRV_a \times BW}{IR_{soil} + (IR_{prey} \times BCF)}$$

$BW = 0.004$
$IR_{soil} = 0.0007$
$IR_{prey} = 0.012$
$BCF = 0.10$ (lead) $= 0.45$

(antimony)

Where:

BW	=	Receptor-specific body weight (kg)
TRV_a	=	Adjusted toxicity reference value (ug/kg/day)
IR_{soil}	=	Receptor-specific soil ingestion rate (kg/day)
IR_{prey}	=	Receptor-specific prey ingestion rate (kg/day)
BCF	=	Soil-to-prey bio-concentration factor (kg soil/kg prey)

Dan Mazur developed a table of uncertainty and bio-concentration factors used in the EDQL database for the above-mentioned list of metals. One should note that the scaling factor (2.2) for lead is based on a rat test species transposed to the shrew target species. This same EDQL database developed for U.S. EPA by Tetra Tech EM Inc. consistently uses a scaling factor of 3.1 for the remaining metals where a rat test species is transposed to the shrew target species. It is unclear why a scaling factor of 2.2 was used for lead and EPA may revise both the scaling factor and the shrew soil ecological screening level in the future.

The **invertebrate soil ecological screening level** for two metals (e.g., mercury and zinc) is the default screening level or EDQL and was calculated as follows.

$$= \frac{TRV \times UF_1}{UF_2 \times UF_3}$$

The same three uncertainty factors described for the shrew screening level are also applied in the above equation for the invertebrate screening level and the plant screening level equation.

The **plant soil ecological screening level** is the default screening level or EDQL for copper and was calculated as follows.

$$= \left[\left(\frac{TRVplant}{UF1 \times UF2 \times UF3}\right) \times CF\right] + B$$

$$= 60 + 13.2$$

$$= 73.2 \text{ ug/kg}$$

Where:

UF_1	=	1	
UF_2	=	5	
UF_3	=	1	
CF	=		Conversion factor (1 L/kg)
B	=	13.2	Background concentration (ug/kg)

This plant screening level of 73.2 ug/kg for copper did not compute correctly within the EDQL database and an incorrect value of 313.2 ug/kg was generated. EPA will review this error and will revise incorrect plant soil ecological screening level reported in the EDQL database.

Table of Uncertainty and Bio-concentration Factors used in the EDQL Database
by Dan Mazur, Region 5 WMB

Species = Default species used
TRV = Toxicity reference value (ug/kg/day)
UF1 = Uncertainty factor 1 (Scaling factor, test species to target species)
rat to shrew = 3.1 sheep to shrew = 10.7
dog to shrew = 6.3 rat to shrew = 2.2
mouse to shrew = 1.7 mink to shrew = 2.9
UF2 = Uncertainty factor 2 (endpoint, test endpoint to No observed effect level (NOAEL))
UF3 = Uncertainty factor 3 (duration, test duration to chronic exposure)
TRVa = Toxicity reference value (ug/kg/day, adjusted by calculation)
BCF = Bio-concentration factor (kg soil/kg prey)
EDQL = Ecological data quality level (mg/kg)
DR = Driver where there may be a problem meeting level

Chemical	Species	TRV	UF1	UF2	UF3	TRVa
Aluminum	------	------	------	------	------	-----
Antimony	Shrew	350	3.1	5	1	217
Arsenic	Shrew	3100	6.3	5	1	3.91E3
Barium	Shrew	510	3.1	1	1	1.58E3
Beryllium	Shrew	950	1.7	1	1	1.62E3
Cadmium	Shrew	5.5	3.1	1	1	17.05
Calcium	------	-----	-----	-----	-----	-----
Chromium	Invert.	10000	1	5	5	-----
Cobalt	Shrew	2000	10.7	1	100	214
Copper	Plant	300	1	5	1	-----
Iron	-----	-----	-----	-----	-----	-----
Lead	Shrew	290	2.2	5	5	25.52

Magnesium	-----	------	-----	-----	-----	-----
Manganese	-----	-----	-----	-----	-----	-----
Mercury	Invert.	500	1	5	1	-----
Methyl Mercury	Shrew	70	2.9	1	5	40.60
Nickel	Shrew	1120	3.1	1	1	3.47E3
Potassium	-----	-----	-----	-----	-----	-----
Selenium	Shrew	340	3.1	5	5	42.16
Silver	Shrew	18100	1.7	5	1	6.15E3
Sodium	------	-----	-----	-----	-----	-----
Thallium	Shrew	700	3.1	5	5	86.80
Tin	Shrew	3750	3.1	1	1	1.16E4
Vanadium	Shrew	3900	3.1	5	1	2.42E3
Zinc	Invert.	662000	1	100	1	-----

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UF3 = Uncertainty factor 3 (duration, test duration to chronic exposure)
TRVa = Toxicity reference value (ug/kg/day, adjusted by calculation)
BCF = Bio-concentration factor (kg soil/kg prey)
EDQL = Ecological data quality level (mg/kg)
DR = Driver where there may be a problem meeting level (default screen is lower than standard MRL)

Chemical	Species	TRVa	BCF	EDQL	MRL	DR?
Aluminum	-----	-----	-----	-----	-----	
Antimony	Shrew	217	0.45	142	300	Yes
Arsenic	Shrew	3.91E3	0.17	5.7E3	100	
Barium	Shrew	1.58E3	0.45	1.04E3	200	
Beryllium	Shrew	1.62E3	0.45	1.06E3	20	
Cadmium	Shrew	17.05	2.5	2.2	10	yes
Calcium	------	-----	-----	------	------	
Chromium	Invert.	-----	-----	400	100	
Cobalt	Shrew	214	0.45	140	100	
Copper	Plant	-----	------	313	600	yes
Iron	------	-----	-----	-----	-----	
Lead	Shrew	25.52	0.10	53.73	100	yes

Magnesium	------	-----	-----	-----	-----	
Manganese	------	-----	------	-----	-----	
Mercury	Invert.	-----	-----	100	100	
Methyl Mercury	Shrew	40.60	8.5	1.58	Var.	? ABG
Nickel	Shrew	3.47E3	0.027	1.36E4	1500	
Potassium	------	-----	-----	-----	-----	
Selenium	Shrew	42.16	0.45	27.65	200	? ORR
Silver	Shrew	6.15E3	0.45	4.04E3	700	
Sodium	------	-----	-----	-----	-----	
Thallium	Shrew	86.80	0.45	56.92	100	yes
Tin	Shrew	1.16E4	0.45	7.62E3	2000	
Vanadium	Shrew	2.42E3	0.45	1.59E3	?	?
Zinc	Invert.	-----	-----	6.62E3	200	

TRV DATA

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Methyl Mercury
CAS Number: 22967-92-6

Class:	Mammal
Organism:	Mink
Exposure Route:	Oral
Endpoint:	NOAEL
Value:	0.07 mg/kg/day
Duration:	93 days; mortality, weight loss, and behavioral abnormalties

Class:	Mammal
Organism:	Rat
Exposure Route:	Oral
Endpoint:	NOAEL
Value:	0.032 mg/kg/day
Duration:	3 generations; reproduction

Class:	Mammal
Organism:	Dog
Exposure Route:	Oral
Endpoint:	LOAEL
Value:	0.1 mg/kg/day
Duration:	Subchronic; increased incidence of still births

The TRV of 70 ug/kg/day is based on a subchronic (93-day) study of mink exposed to methyl mercury chloride as presented in Wobeser, G., and others. 1976. "Mercury and Mink II. Experimental Methyl Mercury Intoxication." Can. J. Comp. Med. Pages 34-45. As cited in Sample, B.E., and others. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3. Risk Assessment Program, Health Sciences Division, Oak Ridge National Laboratory. Oak Ridge, Tennesse. June. The TRV was selected because it met three of the major selection criteria: (1) relevant test species (mink), (2) prefered endpoint (NOAEL), and (3) ecologically significant effects (mortality, weight loss, and behavioral abnormalties).

Wobeser, G., N.O. Nielson, and B. Schiefer. 1976. Mercury and Mink II. Experimental Methyl Mercury Intoxication.

Can. J. Comp. Med. Pages 34-45. Cited in Toxicological Benchmarks for Wildlife. Page 36. September 1993.

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Mercury (Total)
CAS Number: 7439-97-6

Class:	Invertebrates
Organism:	Earthworm
Exposure Route:	Growth medium
Endpoint:	LOAEL
Value:	500 ug/kg
Duration:	60 days; reduced cocoon production

The TRV of 500 ug/kg is based on a chronic (60-day) study of earthworms as presented in Abbasi, S.A., and R. Soni. 1983. "Stress Enduced Enhancement of Reproduction in Earthworm, Octochaetus pattoni, Exposed to Chromium (VI) and Mercury (II) - Implications in Environmental Management." International Journal of Environmetal Studies. Volume 22. Pages 43-47. Cocoon production was reduced by 40 percent at the lowest concentration (500 ug/kg) of divalent mercury tested.

The invertebrate TRV of 0.79 mg/kg for the soil exposure route is based on a subchronic LD50 study of earthworms (Abbasi and Soni 1983, as cited in U.S. Department of the Interior Fish and Wildlife Service 1989). Toxicity information files only contained one invertebrate study and it involved earthworms. The endpoint reported is an LD50 and a value of 0.79 mg/kg. The duration of the study was subchronic. The toxicity effect in the study was mortality. The TRV was selected because it was the only invertebrate study available.

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Chromium (Total)
CAS Number: 7440-47-3

Class:	Invertebrates
Organism:	Earthworm
Exposure Route:	Oral
Endpoint:	LOAEL
Value:	10 mg/kg/day
Duration:	58 days

The invertebrate TRV of 10 to 15 ppm for soil exposure route is based on a subchronic LOAEL study of earthworms (Soni and Abbasi 1981, as cited in U.S. Department of the Interior Fish and Wildlife Service 1986). Toxicity information files contained no other studies. The toxic effect observed during this study was mortality. The TRV was selected because it was the only invertebrate study available.

Soni and Abbasi. 1981. Cited in U.S. Department of the Interior Fish and Wildlife Service. Chromium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Page 25. January 1986.

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Arsenic (Total)
CAS Number: 7440-38-2

Class:	Mammal
Organism:	Dog
Exposure Route:	Oral
Endpoint:	LOAEL
Value:	3.1 mg/kg/day
Duration:	2 years

Class:	Mammal
Organism:	Mouse
Exposure Route:	Oral
Endpoint:	NOAEL
Value:	1 mg/kg/day
Duration:	3 generations

Class:	Mammal
Organism:	Rabbit
Exposure Route:	Oral
Endpoint:	LD50
Value :	8 mg/kg
Duration:	Single dose

Byron, W.R., and others. 1967. Pathological Changes in Rats and Dogs from Two-Year Feeding of Sodium Arsenite or Sodium Arsenate. Toxicol. Appl. Pharmacol. 10:132:147. Cited in Agency for Toxic Substances and Disease Registry. Toxicological Profile for Arsenic. Page 26. April 1993.

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Zinc (total)
CAS Number: 7440-66-6

Class:	Invertebrates
Organism:	Earthworm (Eisenia foetida)
Exposure Route:	Oral
Endpoint:	LC50
Value:	662 mg/kg
Duration:	2 weeks; mortality

The invertebrate TRV of 662 mg/kg for the artificial soil exposure route is based on an acute LC50 study of earthworms (Neuhauser, E.F., and others 1985, as cited in U.S. Department of the Interior Fish and Wildlife Service 1993). This was the only invertebrate study contained in the toxicity files. The endpoint was reported as an LC50 and a value of 662 mg/kg. The duration of the study was acute. The toxic effect was mortality. The TRV was selected because it was the only invertebrate study available.

Neuhauser, E.F., and others. 1985. Toxicity of Metals to the Earthworm Eisenia fetida. Biology and Fertility of Soils. 1:149-152. Cited in U.S. Department of the Interior Fish and Wildlife Service. Zinc Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Page 51. April 1993.