

Lower Subbase Remedial Investigation

for

Naval Submarine Base

New London

Groton, Connecticut

Volume V - Appendices I-J



Northern Division
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298

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APPENDIX I.1
BACKGROUND SOIL

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BACKGROUND SOIL CONCENTRATIONS**

Parameter	Naval Submarine Base Site-Specific Background ¹ (ppm)		Site-Specific ² Background (July 1994 Data Report)	Published Background ³ (ppm)
	(0-2 feet)	(0-4 feet)		
Aluminum	17,600	17,600	21,100	272,000
Antimony	2.05 ⁶	2.05 ⁶	ND	2.95
Arsenic	3.6	3.6	4.60	31.5
Barium	39	57.2	69.1	1,600
Beryllium	0.72	0.72	1.00	3.52
Boron	3.1 ⁶	3.1 ⁶	6.85	109
Cadmium	0.24 ⁶	0.24 ⁶	4.54	7 ⁴
Calcium	314	499	1,190	32,300
Chromium	19.3	21.5	25.3	223
Cobalt	7	8	12.9	39
Copper	17.9	25.6	34.5	102
Iron	16,800	17,200	20,500	115,000
Lead	17.5	17.5	19.3	53.2
Magnesium	2,460	3,650	5,620	26,500
Manganese	172	188	245	3,790
Mercury	0.055 ⁶	0.05	0.0379	0.51
Nickel	5.0 ⁶	5.95 ⁶	21.1	76.7
Potassium	669	2,580	3,045	12,000
Selenium	0.445 ⁶	0.445 ⁶	0.824	1.79
Silver	0.385 ⁶	0.385 ⁵	ND	5
Sodium	16.5 ⁶	20.5 ⁶	142	51,800
Thallium	0.105 ⁶	0.29	0.21	5 ⁵
Vanadium	33.3	35.1	42.3	271
Zinc	25.6	31.3	83.6	178

Notes:

1. The site-specific background value is the highest value detected from among all the background soil samples collected in April 1993.
2. The site-specific background value is the upper tolerance limit of the upper 95% confidence limit for the true 95th percentile for the background soil sample results using the April 1993 results and select samples from the Phase I RI as reported in the July 1994 data report.
3. The published background value is the upper limit of the range which contains 95% of the sample results from Shacklette and Boerngen USGS Paper 1270 using the formula $M \times D^2$, where M is the geometric mean and D is the geometric deviation, except as noted.
4. Dragun (1988)
5. Lisk (1972)
6. Value based on one-half of the highest detection level from among all the background soil samples collected in April 1993.

**TABLE 2-5
NEW LONDON SUBBASE BACKGROUND**

Parameter	NSB-NLON			Eastern U.S. (Shacklette)		
	Arithmetic Mean	Range	Upper 95% Value ¹	Arithmetic Mean	Range	Upper 95% Value ²
Aluminum	13,427	7,630 - 17,600	17,929	57,000	7,000 - >100,000	271,817
Antimony	ND	---	---	0.76	<1 - 8.8	2.95
Arsenic	2.3	0.53 - 3.6	4.0	7.4	<0.1 - 73	31.5
Barium	29.4	2.413.6 - 57.2	49.7	420	10 - 1,500	1,601
Beryllium	0.39	ND - 0.72	---	0.85	<1 - 7	3.5
Boron	ND	---	---	38	<20 - 150	110
Cadmium	ND	---	---	NR	---	---
Calcium	241	102 - 499	392.5	6,300	100 - 280,000	32,253
Chromium	15.8	10.2 - 21.5	20.9	52	1 - 1,000	223
Cobalt	6.0	4.0 - 8.0	3.5	9.2	<0.3 - 70	39
Copper	11.9	4.5 - 25.6	24.4	22	<1 - 700	102
Cyanide	ND	---	---	NR	---	---
Iron	13,341	8,360 - 17,200	17,570	25,000	100 - >100,000	115,317
Lead	8.0	2.8 - 17.5	15.3	17	<10 - 300	53
Magnesium	2,290	1,410 - 3,650	3,355.1	4,600	50 - 50,000	26,465
Manganese	114	63.6 - 188	181.3	640	<2 - 7,000	3,794
Nickel	ND	---	---	18	<5 - 700	77
Potassium	635	229 - 2,580	1,612	12,000	50 - 37,000	21,333
Mercury	ND	---	---	0.12	0.01 - 3.4	0.51
Selenium	ND	---	---	0.45	<0.1 - 3.9	1.8
Silver	ND	---	---	NR	---	---
Sodium	ND	---	---	7,800	<500 - 50,000	51,756
Thallium	2.45	0.20 - 0.29	0.344	NR	---	---
Vanadium	25.5	16.0 - 35.1	34.3	66	<7 - 300	271
Zinc	21.2	13.9 - 31.3	27.9	52	<5 - 2,900	178

Notes:

1. The upper 95% value is calculated as follows: $\bar{x} + 1.65S$, where \bar{x} is the mean and S is the standard deviation.
2. The value is the upper limit of the range which contains 95% of the sample results from Shacklette and Boerngen USGS Paper 1270 using the formula $M \times D^2$, where M is the geometric mean and D is the geometric deviation.
3. ND - not detected.

3.0 SUMMARY AND CONCLUSIONS

Based on the results of analysis of 16 samples collected from the 0 to 2 foot depth and the 2 to 4 foot depth at 8 locations in and near NSB-NLON, background levels (as shown in Table 3-1) were established to be used to screen site analytical data to identify areas where releases of pollutants may have occurred at NSB-NLON.

TABLE 3-1 BACKGROUND SOIL CONCENTRATIONS		
Parameter	Naval Submarine Base Site-Specific Background ¹ (ppm)	
	(0-2 feet)	(0-4 feet)
Aluminum	17,600	17,600
Arsenic	3.6	3.6
Antimony	2.05 ²	2.05 ²
Barium	39	57.2
Beryllium	0.72	0.72
Boron	3.1 ²	3.1 ²
Cadmium	0.24 ²	0.24 ²
Calcium	314	499
Chromium	19.3	21.5
Cobalt	7	8
Copper	17.9	25.6
Iron	16,800	17,200
Lead	17.5	17.5
Magnesium	2,460	3,650
Manganese	172	188
Mercury	0.055 ²	0.05
Nickel	5.0 ²	5.95 ²
Potassium	669	2,580
Selenium	0.445 ²	0.445 ²
Silver	0.385 ²	0.385 ²
Sodium	16.56 ²	20.56 ²
Thallium	0.105 ²	0.29
Vanadium	33.3	35.1
Zinc	25.6	31.3

Notes:

1. The site-specific background value is the highest value detected from among all the background soil samples collected in April 1993.
2. Value based on one-half of the highest detection level from among all the background soil samples collected in April 1993.

APPENDIX I.2

**EPA REGION III RISK-BASED SCREENING CONCENTRATIONS
CONNECTICUT REMEDIATION STANDARDS**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Region III
841 Chestnut Street
Philadelphia, Pennsylvania 19107

October 22, 1997

SUBJECT: Risk-Based Concentration Table

FROM: Eric W. Johnson, Chief
Technical Support Section (3HW41)

TO: RBC Table Recipients

Attached is the EPA Region III Risk-Based Concentration (RBC) table, which we distribute periodically to all interested parties.

IMPORTANT MESSAGE

EPA Region III's Internet website now includes the RBC Table as a readable file for on-screen use and as "zipped" files, in Lotus and Excel. These can be found at <http://www.epa.gov/reg3hwmd/riskmenu.htm>. (Once there, I suggest you set a bookmark to ease future access.) The cover memo and background information are also included in both formats.

We encourage all RBC Table users with Internet access to obtain the table electronically rather than on paper. In this way, users can access the most current RBC table immediately in a form that can be used directly for comparisons with data or risk estimates. This distribution method also saves hundreds of pounds of paper per year and costs substantially less.

CONTENTS, USES, AND LIMITATIONS OF THE RBC TABLE

The Table contains reference doses and carcinogenic potency slopes (obtained from IRIS through September 1, 1997, HEAST through July 1997, the EPA-NCEA Superfund Health Risk Technical Support Center, and other EPA sources) for about 600 chemicals. These toxicity constants have been combined with "standard" exposure scenarios to calculate RBCs--chemical concentrations corresponding to fixed levels of risk (*i.e.*, a hazard quotient of one, or lifetime cancer risk of 10^{-6} , whichever occurs at a lower concentration) in water, air, fish tissue, and soil.

The RBC table formerly included soil screening levels (SSLs) for protection of groundwater and air. We have discontinued these to avoid conflicts with EPA/OSWER's SSL guidance document, now in general use. To consider intermedia transfers of contaminants at the screening stage of risk assessment, we suggest that you use this guidance (available from NTIS as document numbers 9355.4-1, PB95-965530, or EPA540/R-94/105).

The Region III toxicologists use RBCs to screen sites not yet on the NPL, respond rapidly to citizen inquiries, and spot-check formal baseline risk assessments. The background materials provide the complete basis for all the calculations, with the intent of showing users exactly how the RBCs were developed. Simply put, RBCs are risk assessments run in reverse. For a single contaminant in a single medium, under standard default exposure assumptions, the RBC corresponds to the target risk or hazard quotient.

RBCs also have several important limitations. Specifically excluded from consideration are (1) transfers from soil to air and groundwater, and (2) cumulative risk from multiple contaminants or media. Also, the toxicity information in the table has been assembled by hand, and (despite extensive checking and years of use) may contain errors. It's advisable to cross-check before relying on any RfDs or CPSs in the table. If you find any errors, please send me a note.

Many users want to know if the risk-based concentrations can be used as valid no-action levels or cleanup levels, especially for soils. The answer is a bit complex. First, it is important to realize that the RBC table does not constitute regulation or guidance, and should not be viewed as a substitute for a site-specific risk assessment. For sites where:

1. A single medium is contaminated;
2. A single contaminant contributes nearly all of the health risk;
3. Volatilization or leaching of that contaminant from soil is expected not to be significant;
4. The exposure scenarios used in the RBC table are appropriate for the site;
5. The fixed risk levels used in the RBC table are appropriate for the site; and
6. Risk to ecological receptors is expected not to be significant;

the risk-based concentrations would probably be protective as no-action levels or cleanup goals. However, to the extent that a site deviates from this description, as most do, the RBCs would not necessarily be appropriate.

To summarize, the table should generally not be used to (1) set cleanup or no-action levels at CERCLA sites or RCRA Corrective Action sites, (2) substitute for EPA guidance for preparing baseline risk assessments, or (3) determine if a waste is hazardous under RCRA.

ANSWERS TO FREQUENTLY ASKED QUESTIONS

To help you better understand the RBC table, here are answers to our most often-asked questions:

1. How can the age-adjusted inhalation factor (11.66) be less than the inhalation rate for either a child (12) or an adult (20)?

Age-adjusted factors are not intake rates, but rather partial calculations which have different units than intake rates do. The fact that these partial calculations have values similar to intake rates is really coincidental, an artifact of the similar magnitude of years of exposure and time-averaged body weight.

2. Why does arsenic appear in the RBC table separately as a carcinogen and a non-carcinogen, while other contaminants do not?

Arsenic is double-entered to ensure that the risk assessor realizes that non-carcinogenic concerns are significant for arsenic. Otherwise, it might be tempting to accept a $1e-4$ risk (43 ppm in residential soil), when the oral reference dose would be exceeded at 23 ppm.

Also, EPA has a little-known risk management policy for arsenic (dating from 1988) that suggests that arsenic-related cancer risks of up to $1e-3$ can be accepted because the cancers are squamous cell carcinomas with a low mortality rate. Thus, non-carcinogenic RBCs represent an important limitation on acceptable arsenic concentrations.

3. Many contaminants have no inhaled reference dose or carcinogenic potency slope in IRIS, yet these numbers appear in the RBC table with IRIS given as the source. Where did the numbers come from?

Most inhaled reference doses and potency slopes in the RBC table are converted from reference concentrations and unit risk values which do appear in IRIS. These conversions assume 70-kg persons inhaling $20 \text{ m}^3/\text{d}$. For example, the inhalation unit risk for arsenic ($4.3e-3$ risk per $\mu\text{g}/\text{m}^3$) is divided by $20 \text{ m}^3/\text{d}$ and multiplied by 70 kg times 1000 $\mu\text{g}/\text{mg}$, yielding a CPSi of 15.1 risk per $\text{mg}/\text{kg}/\text{d}$.

4. Why does the RBC table base soil RBCs for cadmium on a reference dose that applies only to drinking water?

The RBC table's use of the drinking water RfDs for cadmium reflects (1) the limited space available in the already-crowded table, and (2) the intended use of the table as a screening tool rather than a source of cleanup levels (thereby making false positives acceptable). For a formal risk assessment, Region III would use the food RfD for soil ingestion.

At this time, only cadmium (as far as we know) has distinct oral RfDs for water and food. Adding the food RfD to the table would require an entire column, which would be about 99.9% blank. The table has become so crowded that it would be difficult to accommodate another column. Also, we've given this problem a relatively low priority because the table's primary purpose is to

identify environmental problems needing further study. RBCs were never intended for uncritical use as cleanup levels, merely to identify potential problems which need a closer look.

5. For manganese, IRIS shows an oral reference dose of 0.14 mg/kg/d, but the RBC table uses $2.3e-2$ mg/kg/d. Why? The IRIS RfD includes manganese from all sources, including diet. The explanatory text in IRIS recommends using a modifying factor of 3 when calculating risks associated with ingesting soil or drinking water, and the table follows this recommendation. I have also incorporated a factor of 2 for relative source contribution on the assumption that a typical individual will obtain half of the RfD (5 mg/d, or 0.07 mg/kg/d) from her diet, thereby limiting the acceptable contribution from soil and water to only half of the IRIS RfD. Thus, the IRIS RfD has been lowered by a factor of 2×3 , or 6.

7. What is the source of the child's inhalation rate of 12 m³/d?

The calculation comes from basic physiology. It's a scaling of the mass-specific 20 m³/d rate for adults from a body mass of 70 kg to 15 kg, using the two-thirds power of mass, as follows:

$$\begin{aligned} \text{Let: } \text{IRcm} &= \text{mass-specific child inhalation rate (m}^3\text{/kg/d)} \\ \text{IRc} &= \text{child inhalation rate (m}^3\text{/d)} \end{aligned}$$

$$20 \text{ m}^3\text{/d} \div 70\text{kg} = 0.286 \text{ m}^3\text{/kg/d (mass-specific adult inhalation rate)}$$

$$0.286 \text{ m}^3\text{/kg/d} \times (70^{67}) = (\text{IRcm}) \times (15^{67})$$

$$\text{IRcm} = (0.286) \times (70^{67}) \div (15^{67}) = 0.286 \times 2.807 = 0.803 \text{ m}^3\text{/kg/d}$$

$$\text{IRc} = \text{IRcm} \times 15\text{kg} = 0.803 \text{ m}^3\text{/kg/d} \times 15\text{kg} = 12.04 \text{ m}^3\text{/d}$$

A short (but algebraically equivalent) way to do the conversion:

$$20 \times (15 \div 70)^{333} = 11.97 \text{ (different from, but actually more correct than, 12.04 because of rounding error in calculating by the long form).}$$

8. Can the oral RfDs in the RBC table be applied to dermal exposure?

Not directly. EPA's Office of Research and Development is working on dermal RfDs for some substances, but has not yet produced any final values. When dermal RfDs do appear, they will undoubtedly be based on absorbed dose rather than administered dose. Oral RfDs are (usually) based on administered dose and therefore tacitly include a GI absorption factor. Thus, any use of oral RfDs in dermal risk calculations would have to involve removing this absorption factor. Consult the Risk Assessment Guidance for Superfund, Part A, Appendix A, for further details on how to do this.

9. The exposure variables table in the RBC background document lists the averaging time for non-carcinogens as "ED*365". What does that mean?

ED is exposure duration, in years, and '*' is the computer-ese symbol for multiplication. Multiplying ED by 365 simply converts the duration to days. In fact, the ED term is included in both

the numerator and denominator of the RBC algorithms for non-cancer risk, canceling it altogether. We expressed the algorithm this way to allow users to realize this. The total exposure is really adjusted only by EF (days exposed per year) divided by 365. (Note that this explanation applies to non-carcinogenic risk only; for carcinogens, exposure is pro-rated over the number of days in a 70-year life span.)

10. Why is inorganic lead not included in the RBC table?

The reason that lead is missing from the RBC table is simple, and fundamental: EPA has no reference dose or potency slope for inorganic lead, so it wasn't possible to calculate risk-based concentrations. EPA considers lead a special case because:

- (1) Lead is ubiquitous in all media, so human exposure comes from multiple sources. Comparing single-medium exposures with a reference dose would be misleading.
- (2) If EPA did develop a reference dose for lead by the same methods other reference doses, we would probably find that most people already exceed it. Since EPA already knows this and is moving aggressively to lower lead releases nationally, such findings at individual sites would be irrelevant and unduly alarming.
- (3) EPA decided to take a new approach to distinguish important lead exposures from trivial ones. EPA developed a computer model (the IEUBK model) which predicts children's blood lead concentrations using lead levels in various media as inputs. The idea is to evaluate a child's entire environment, and reduce lead exposures in the most cost-effective way.

On the practical side, there are several EPA policies on lead which effectively substitute for RBCs. The EPA Office of Solid Waste has released a detailed directive on risk assessment and cleanup of residential soil lead. The directive recommends that soil lead levels less than 400 ppm be considered safe for residential use. Above that level, the document suggests collecting certain types of data and modeling children's blood lead with the IEUBK model. For the purposes of the RBC table, the *de facto* residential soil number would be 400 mg/kg. For water, we suggest 15 ppb (from the national EPA Action Level), and for air, the National Ambient Air Quality Standard.

11. Where did the potency slopes for carcinogenic PAHs come from?

The source of the potency slopes for PAHs is "Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons," Final Draft, EPA Environmental Criteria and Assessment Office, Cincinnati, OH. It's available from NTIS as document number ECAO-CIN-842 (March, 1993). The slopes are expressed in terms of order-of-magnitude equivalence factors relating the compounds to benzo[a]pyrene; we have converted these TEQs to potency slopes to fit the format of the table.

12. May I please have a copy of the January 1991 RBC table?

We're sorry, but no. The RBC table doesn't represent regulation or guidance, so past issues have no legal importance. Each time we update the table we destroy all obsolete copies, electronic and paper. We do this to ensure that only one set of RBCs, the one based on current information,

exists at any time.

13. I've noticed that some soil RBCs are one million parts per million. Since some of these substances are liquids, that's obviously ridiculous. What is that basis for these calculations?

A soil RBC of one million parts per million means that no amount of the contaminant in soil will cause a receptor to exceed the oral reference dose by incidental ingestion of soil. In fact, some contaminants would have RBCs of more than one million ppm, but the algorithms cap concentrations at 100%. The reason we retain these admittedly impossible numbers is to let users see that the contaminant is not a threat via soil ingestion.

However, it's important to realize that the RBC calculations do not consider the potential of soil contaminants to leach to groundwater or escape to air by volatilization or dust entrainment. To consider these inter-media transfers, it's necessary to either monitor air and groundwater, or to use a mathematical model. Measured or modeled air and groundwater concentrations should then be compared to the RBCs for air and tap water.

Inter-media transfers are considered more fully in the soil screening level (SSL) guidance. The SSL guidance also incorporates sampling recommendations and statistical application of the SSLs. However, EPA Headquarters has proposed only about a hundred SSLs so far, so the list is still rather short.

14. Please elaborate on the meaning of the 'W' source code in the table.

The "W" code means that a reference dose or potency slope for a contaminant is currently not present on either IRIS or HEAST, but that it once was present on either IRIS or HEAST and was removed. Such withdrawal usually indicates that consensus on the number no longer exists among EPA scientists, but not that EPA believes the contaminant to be unimportant. Older versions of the RBC table had separate codes for IRIS and HEAST withdrawals, but we changed to a single code for both because, after all, it hardly matters.

We retain withdrawn numbers in the table because we still need to deal with these contaminants during the sometimes very long delays before replacement numbers are ready. We take the position that for the purpose of screening an obsolete RBC is better than none at all. The 'W' code should serve as a clear warning that before making any serious decision involving that contaminant you will need to develop an interim value based on current scientific understanding.

If you are assessing risks at a site where a major contaminant is coded "W," consider working with your Regional EPA risk assessor to develop a current toxicity constant. If the site is being studied under CERCLA, the EPA-NCEA Regional Technical Support group may be able to assist.

15. Can I get copies of supporting documents for interim toxicity constants which are coded "E" in the RBC table?

Unfortunately, Region 3 does not have a complete set of supporting documents. The EPA-NCEA Superfund Health Risk Technical Support Center prepares these interim toxicity constants in response to site-specific requests from Regional risk assessors, and sends the documentation only to

the requestor. The RBC tables contain only the interim values (those with "E" codes) that we've either requested ourselves or otherwise obtained copies of. There may be many more interim values of which we are unaware. Also, we don't receive automatic updates when NCEA revisits a contaminant, so it's likely that some interim values in the RBC table are obsolete.

It has been NCEA's policy to deny requests for documentation of interim toxicity constants when the documentation is more than two years old. Furthermore, since NCEA's Superfund Technical Support Center is mainly for the support of Superfund, it usually cannot develop new toxicity criteria unless authorized to do so for a specific Superfund project. Although Region 3 has sometimes provided documentation to support numbers we use in risk assessments, for the above-stated reasons we have no assurance that the assessments, or even the interim numbers, are current. We've decided to discontinue distributing information that may be misleading. If an "E"-coded contaminant is a major risk contributor at your site, we strongly suggest that you work with EPA to develop an up-to-date reference dose or slope factor.

CHANGES IN THIS ISSUE OF THE RBC TABLE

Substances having new or revised EPA toxicity constants that result in a change in a revised RBC are now flagged marked with "***" before the contaminant name. This is to help users quickly pick out substances with new RBCs.

QUESTIONS, COMMENTS AND ADVICE

If you have a question about the RBC Table, please call EPA Region III's Superfund Technical Support Section at 215-566-3041. We'll do our best to answer your questions about how the Table was prepared and what the numbers mean. If you have a question about applying the RBC Table to a specific site, please contact the EPA Regional Office handling the project. Thanks for your help and cooperation, and we hope that the RBC Table continues to be a useful resource.

Attachment

EPA Region III Risk-Based Concentration Table

Background Information

U. S. E P A -- Region III
 Superfund Technical Support Section
 October 22, 1997

Development of Risk-Based Concentrations

General

Separate carcinogenic and non-carcinogenic risk-based concentrations were calculated for each compound for each pathway. The concentration in the table is the lower of the two, rounded to two significant figures. The following terms and values were used in the calculations:

Exposure variables	Value	Symbol
<i>General:</i>		
Carcinogenic potency slope oral (risk per mg/kg/d):	*	CPSo
Carcinogenic potency slope inhaled (risk per mg/kg/d):	*	CPSi
Reference dose oral (mg/kg/d):	*	RfDo
Reference dose inhaled (mg/kg/d):	*	RfDi
Target cancer risk:	1e-06	TR
Target hazard quotient:	1	THQ
Body weight, adult (kg):	70	BWa
Body weight, age 1-6 (kg):	15	BWc
Averaging time carcinogens (d):	25550	ATc
Averaging time non-carcinogens (d):	ED*365	ATn
Inhalation, adult (m ³ /d):	20	IRAA
Inhalation, child (m ³ /d):	12	IRAc
Inhalation factor, age-adjusted (m ³ -y/kg-d):	11.66	IFAadj
Tap water ingestion, adult (L/d):	2	IRWa
Tap water ingestion, age 1-6 (L/d):	1	IRWc
Tap water ingestion factor, age-adjusted (L-y/kg-d):	1.09	IFWadj
Fish ingestion (g/d):	54	IRF
Soil ingestion, adult (mg/d):	100	IRSa
Soil ingestion, age 1-6 (mg/d):	200	IRSc
Soil ingestion factor, age adjusted (mg-y/kg-d):	114.29	IFSadj
<i>Residential:</i>		
Exposure frequency (d/y):	350	EFr
Exposure duration, total (y):	30	EDtot
Exposure duration, age 1-6 (y):	6	EDc
Volatilization factor (L/m ³):	0.5	K
<i>Occupational:</i>		

Exposure variables	Value	Symbol
Exposure frequency (d/y):	250	EFo
Exposure duration (y):	25	EDo
Fraction of contaminated soil ingested (unitless)	0.5	FC

*: Contaminant-specific toxicological constants. The priority among sources of toxicological constants was as follows: (1) IRIS, (2) HEAST, (3) EPA-NCEA Superfund Health Risk Technical Support Center, (4) HEAST alternative method, (5) withdrawn from IRIS or HEAST, and (6) other EPA documents. Each source was used only if numbers from higher-priority sources were unavailable. The EPA Superfund Health Risk Technical Support Center, part of the EPA National Center for Environmental Assessment in Cincinnati, develops provisional RfDs and CPSs on request for contaminants not in IRIS or HEAST. These provisional values are labeled "E = EPA-NCEA provisional" in the table. It is possible they may be obsolete. If one of the "E" constants is important to a Superfund risk assessment, consider requesting, through a Regional risk assessor, a new provisional value.

Age-adjusted factors

Because contact rates with tap water, ambient air, and residential soil are different for children and adults, carcinogenic risks during the first 30 years of life were calculated using age-adjusted factors. These factors approximated the integrated exposure from birth until age 30 by combining contact rates, body weights, and exposure durations for two age groups - small children and adults. The age-adjusted factor for soil was obtained from RAGS IB; the others were developed by analogy.

Air inhalation

$$IFA_{adj} \frac{m^3 \cdot v}{kg \cdot d} = \frac{EDc \cdot IRAc}{BWC} + \frac{(ED_{tot} - EDc) \cdot IRAa}{BWA}$$

Tap water ingestion

$$IFW_{adj} \frac{L \cdot v}{kg \cdot d} = \frac{EDc \cdot IRWc}{BWC} + \frac{(ED_{tot} - EDc) \cdot IRWa}{BWA}$$

Soil ingestion

$$IFS_{adj} \frac{mg \cdot y}{kg \cdot d} = \frac{EDc \cdot IRSc}{BWC} + \frac{(ED_{tot} - EDc) \cdot IRSa}{BWA}$$

Residential water

Volatilization terms were calculated only for compounds with a mark in the "VOC" column. Compounds having a Henry's Law constant greater than 10^{-5} were considered volatile. The list may be incomplete, but is unlikely to include false positives. The equations and the volatilization factor (K, above) were obtained from RAGS IB. Oral potency slopes and reference doses were used for both oral and inhaled exposures for volatile compounds lacking inhalation values. Inhaled potency slopes were substituted for unavailable oral potency slopes only for volatile compounds; inhaled RfDs were substituted for unavailable oral RfDs for both volatile and non-volatile compounds. RBCs for carcinogens were based on combined childhood and adult exposure; for non-carcinogens RBCs were based on adult exposure.

Carcinogens

$$RBC \frac{\mu\text{g}}{\text{L}} = \frac{TR \cdot ATc \cdot 1000 \frac{\mu\text{g}}{\text{mg}}}{E\text{Fr} \cdot ([K \cdot I\text{FAadj} \cdot \text{CPSi}] + [I\text{FWadj} \cdot \text{CPSo}])}$$

Non-carcinogens

$$RBC \frac{\mu\text{g}}{\text{L}} = \frac{THQ \cdot B\text{Wa} \cdot ATn \cdot 1000 \frac{\mu\text{g}}{\text{mg}}}{E\text{Fr} \cdot E\text{Dtot} \cdot \left(\frac{K \cdot I\text{RAa}}{R\text{fDi}} + \frac{I\text{R}\text{Wa}}{R\text{fDo}} \right)}$$

Ambient air

Oral potency slopes and references were used where inhalation values were not available. RBCs for carcinogens were based on combined childhood and adult exposure; for non-carcinogens RBCs were based on adult exposure.

Carcinogens

$$RBC \frac{\mu\text{g}}{\text{m}^3} = \frac{TR \cdot ATc \cdot 1000 \frac{\mu\text{g}}{\text{mg}}}{E\text{Fr} \cdot I\text{FAadj} \cdot \text{CPSi}}$$

Non-carcinogens

$$RBC \frac{\mu\text{g}}{\text{m}^3} = \frac{THQ \cdot R\text{fDi} \cdot B\text{Wa} \cdot ATn \cdot 1000 \frac{\mu\text{g}}{\text{mg}}}{E\text{Fr} \cdot E\text{Dtot} \cdot I\text{RAa}}$$

Edible fish

All RBCs were based on adult exposure.

Carcinogens

$$RBC \frac{\text{mg}}{\text{kg}} = \frac{TR \cdot B\text{Wa} \cdot ATc}{E\text{Fr} \cdot E\text{Dtot} \cdot \frac{I\text{RF}}{1000 \frac{\text{g}}{\text{kg}}} \cdot \text{CPSo}}$$

Non-carcinogens

$$RBC \frac{\text{mg}}{\text{kg}} = \frac{THQ \cdot R\text{fDo} \cdot B\text{Wa} \cdot ATn}{E\text{Fr} \cdot E\text{Dtot} \cdot \frac{I\text{RF}}{1000 \frac{\text{g}}{\text{kg}}}}$$

Commercial/industrial soil ingestion

RBCs were based on adult occupational exposure, including an assumption that only 50% of total soil ingestion is work-related.

Carcinogens

$$RBC \frac{mg}{kg} = \frac{TR \cdot BWa \cdot ATc}{EFo \cdot EDo \cdot \frac{IRSa}{10^6 \frac{mg}{kg}} \cdot FC \cdot CPSo}$$

Non-carcinogens

$$RBC \frac{mg}{kg} = \frac{THQ \cdot RfDo \cdot BWa \cdot ATn}{EFo \cdot EDo \cdot \frac{IRSa}{10^6 \frac{mg}{kg}} \cdot FC}$$

Residential soil ingestion

RBCs for carcinogens were based on combined childhood and adult exposure; RBCs for non-carcinogens were based on childhood exposure only.

Carcinogens

$$RBC \frac{mg}{kg} = \frac{TR \cdot ATc}{EFr \cdot \frac{IFSadj}{10^6 \frac{mg}{kg}} \cdot CPSo}$$

Non-carcinogens

$$RBC \frac{mg}{kg} = \frac{THQ \cdot RfDo \cdot BWc \cdot ATn}{EFr \cdot EDC \cdot \frac{IRSc}{10^6 \frac{mg}{kg}}}$$

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Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg·d/mg	CPSi kg/d/mg	V O C	Risk-Based Concentrations				
							Tap Water µg/L	Ambient Air µg/m ³	Fish mg/kg	Soil Ingestion	
										Industrial mg/kg	Residential mg/kg
Acephate	30560191	4.00E-03		8.70E-03			7.7 c	0.72 c	0.36 c	660 c	73 c
Acetaldehyde	75070		2.57E-03		7.70E-03		94 n	0.81 c	0	0	0
Acetochlor	34256821	2.00E-02					730 n	73 n	27 n	41000 n	1600 n
Acetone	67641	1.00E-01					3700 n	370 n	140 n	200000 n	7800 n
**Acetone cyanohydrin	75865	8.00E-04	2.86E-03				29 n	10 n	1.1 n	1600 n	63 n
Acetonitrile	75078	6.00E-03	1.43E-02				220 n	52 n	8.1 n	12000 n	470 n
Acetophenone	98862	1.00E-01	5.71E-06			☒	0.042 n	0.021 n	140 n	200000 n	7800 n
Acifluorfen	62476599	1.30E-02					470 n	47 n	18 n	27000 n	1000 n
Acrolein	107028	2.00E-02	5.71E-06				730 n	0.021 n	27 n	41000 n	1600 n
Acrylamide	79061	2.00E-04		4.50E+00	4.55E+00		0.015 c	0.0014 c	0.0007 c	1.3 c	0.14 c
Acrylic acid	79107	5.00E-01	2.86E-04				18000 n	1 n	680 n	1000000 n	39000 n
Acrylonitrile	107131	1.00E-03	5.71E-04	5.40E-01	2.38E-01		0.12 c	0.026 c	0.0058 c	11 c	1.2 c
Alachlor	15972608	1.00E-02		8.00E-02			0.84 c	0.078 c	0.039 c	72 c	8 c
Alar	1596845	1.50E-01					5500 n	550 n	200 n	310000 n	12000 n
Aldicarb	116063	1.00E-03					37 n	3.7 n	1.4 n	2000 n	78 n
Aldicarb sulfone	1646884	1.00E-03					37 n	3.7 n	1.4 n	2000 n	78 n
Aldrin	309002	3.00E-05		1.70E+01	1.71E+01		0.004 c	0.00037 c	0.00019 c	0.34 c	0.038 c
Allyl	74223646	2.50E-01					9100 n	910 n	340 n	510000 n	20000 n
Allyl alcohol	107186	5.00E-03					180 n	18 n	6.8 n	10000 n	390 n
Allyl chloride	107051	5.00E-02	2.86E-04				1800 n	1 n	68 n	100000 n	3900 n
**Aluminum	7429905	1.00E+00	1.00E-03				37000 n	3.7 n	1400 n	1000000 n	78000 n
Aluminum phosphide	20859738	4.00E-04					15 n	1.5 n	0.54 n	820 n	31 n
Amdro	67485294	3.00E-04					11 n	1.1 n	0.41 n	610 n	23 n
Ametryn	834128	9.00E-03					330 n	33 n	12 n	18000 n	700 n
**Aminodinitrotoluenes	0	6.00E-05					2.2 n	0.22 n	0.081 n	120 n	4.7 n
m-Aminophenol	591275	7.00E-02					2600 n	260 n	95 n	140000 n	5500 n
4-Aminopyridine	504245	2.00E-05					0.73 n	0.073 n	0.027 n	41 n	1.6 n
Amitraz	33089611	2.50E-03					91 n	9.1 n	3.4 n	5100 n	200 n
Ammonia	7664417		2.86E-02				1000 n	100 n	0	0	0
Ammonium sulfamate	7773060	2.00E-01					7300 n	730 n	270 n	410000 n	16000 n
Aniline	62533		2.86E-04	5.70E-03			10 n	1 n	0.55 c	1000 c	110 c
Antimony and compounds	7440360	4.00E-04					15 n	1.5 n	0.54 n	820 n	31 n
Antimony pentoxide	1314609	5.00E-04					18 n	1.8 n	0.68 n	1000 n	39 n
Antimony potassium tartrate	304610	9.00E-04					33 n	3.3 n	1.2 n	1800 n	70 n
Antimony tetroxide	1332316	4.00E-04					15 n	1.5 n	0.54 n	820 n	31 n
**Antimony trioxide	1309644	4.00E-04	5.71E-05				15 n	0.21 n	0.54 n	820 n	31 n
Apollo	74115245	1.30E-02					470 n	47 n	18 n	27000 n	1000 n
Aramite	140578	5.00E-02		2.50E-02	2.49E-02		2.7 c	0.25 c	0.13 c	230 c	26 c
Arsenic	7440382	3.00E-04					11 n	1.1 n	0.41 n	610 n	23 n

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							Tap Water µg/L	Ambient Air µg/m3	Fish mg/kg	Soil Ingestion	
										Industrial mg/kg	Residential mg/kg
Arsenic (as carcinogen)	7440382			1.50E+00	1.51E+01		0.045 c	0.00041 c	0.0021 c	3.8 c	0.43 c
Arsine	7784421		1.43E-05				0.52 n	0.052 n	0	0	0
Assure	76578148	9.00E-03					330 n	33 n	12 n	18000 n	700 n
Asulam	3337711	5.00E-02					1800 n	180 n	68 n	100000 n	3900 n
Atrazine	1912249	3.50E-02		2.22E-01			0.3 c	0.028 c	0.014 c	26 c	2.9 c
Avermectin B1	65195553	4.00E-04					15 n	1.5 n	0.54 n	820 n	31 n
Azobenzene	103333			1.10E-01	1.08E-01		0.61 c	0.058 c	0.029 c	52 c	5.8 c
Barium and compounds	7440393	7.00E-02	1.43E-04				2600 n	0.52 n	95 n	140000 n	5500 n
Baygon	114261	4.00E-03					150 n	15 n	5.4 n	8200 n	310 n
Bayleton	43121433	3.00E-02					1100 n	110 n	41 n	61000 n	2300 n
Baythroid	68359375	2.50E-02					910 n	91 n	34 n	51000 n	2000 n
Benefin	1861401	3.00E-01					11000 n	1100 n	410 n	610000 n	23000 n
Benomyl	17804352	5.00E-02					1800 n	180 n	68 n	100000 n	3900 n
Bentazon	25057890	2.50E-03					91 n	9.1 n	3.4 n	5100 n	200 n
Benzaldehyde	100527	1.00E-01				☒	610 n	370 n	140 n	200000 n	7800 n
Benzene	71432	3.00E-03	1.71E-03	2.90E-02	2.90E-02	☒	0.36 c	0.22 c	0.11 c	200 c	22 c
Benzenethiol	108985	1.00E-05					0.37 n	0.037 n	0.014 n	20 n	0.78 n
Benzidine	92875	3.00E-03		2.30E+02	2.35E+02		0.00029 c	0.000027 c	0.000014 c	0.025 c	0.0028 c
Benzoic acid	65850	4.00E+00					150000 n	15000 n	5400 n	1000000 n	310000 n
Benzotrichloride	98077			1.30E+01			0.0052 c	0.00048 c	0.00024 c	0.44 c	0.049 c
Benzyl alcohol	100516	3.00E-01					11000 n	1100 n	410 n	610000 n	23000 n
Benzyl chloride	100447			1.70E-01		☒	0.062 c	0.037 c	0.019 c	34 c	3.8 c
Beryllium and compounds	7440417	5.00E-03		4.30E+00	8.40E+00		0.016 c	0.00075 c	0.00073 c	1.3 c	0.15 c
Bidrin	141662	1.00E-04					3.7 n	0.37 n	0.14 n	200 n	7.8 n
Biphenthrin (Talstar)	82657043	1.50E-02					550 n	55 n	20 n	31000 n	1200 n
1,1-Biphenyl	92524	5.00E-02					1800 n	180 n	68 n	100000 n	3900 n
Bis(2-chloroethyl)ether	111444			1.10E+00	1.16E+00	☒	0.0092 c	0.0054 c	0.0029 c	5.2 c	0.58 c
Bis(2-chloroisopropyl)ether	39638329	4.00E-02		7.00E-02	3.50E-02	☒	0.26 c	0.18 c	0.045 c	82 c	9.1 c
Bis(chloromethyl)ether	542881			2.20E+02	2.17E+02	☒	0.000049 c	0.000029 c	0.000014 c	0.026 c	0.0029 c
**Bis(2-chloro-1-methylethyl)ether	0			7.00E-02	3.50E-02		0.96 c	0.18 c	0.045 c	82 c	9.1 c
Bis(2-ethylhexyl)phthalate (DEHP)	117817	2.00E-02		1.40E-02	1.40E-02	E	4.8 c	0.45 c	0.23 c	410 c	46 c
Bisphenol A	80057	5.00E-02					1800 n	180 n	68 n	100000 n	3900 n
Boron (and borates)	7440428	9.00E-02	5.71E-03				3300 n	21 n	120 n	180000 n	7000 n
Boron trifluoride	7637072		2.00E-04				7.3 n	0.73 n	0	0	0
Bromodichloromethane	75274	2.00E-02		6.20E-02		☒	0.17 c	0.1 c	0.051 c	92 c	10 c
Bromoethene	593602				1.10E-01	H ☒	0.096 c	0.057 c	0	0	0
Bromoform (tribromomethane)	75252	2.00E-02		7.90E-03	3.85E-03	☒	2.4 c	1.6 c	0.4 c	720 c	81 c
Bromomethane	74839	1.40E-03	1.43E-03			☒	8.7 n	5.2 n	1.9 n	2900 n	110 n
4-Bromophenyl phenyl ether	101553	5.80E-02					2100 n	210 n	78 n	120000 n	4500 n

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Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg-d/mg	CPSi kg-d/mg	V O C	Risk-Based Concentrations				
							Tap Water µg/L	Ambient Air µg/m ³	Fish mg/kg	Soil Ingestion	
										Industrial mg/kg	Residential mg/kg
Bromophos	2104963	5.00E-03	H				180	18	6.8	10000	390
Bromoxynil	1689845	2.00E-02	I				730	73	27	41000	1600
Bromoxynil octanoate	1689992	2.00E-02	I				730	73	27	41000	1600
1,3-Butadiene	106990				9.80E-01	I	0.011	0.0064	0	0	0
1-Butanol	71363	1.00E-01	I				3700	370	140	200000	7800
Butyl benzyl phthalate	85687	2.00E-01	I				7300	730	270	410000	16000
Butylate	2008415	5.00E-02	I				1800	180	68	100000	3900
**n-Butylbenzene	104518	1.00E-02	E				61	37	14	20000	780
sec-Butylbenzene	135988	1.00E-02	E				61	37	14	20000	780
tert-Butylbenzene	104518	1.00E-02	E				61	37	14	20000	780
Butylphthalyl butylglycolate	85701	1.00E+00	I				37000	3700	1400	1000000	78000
Cacodylic acid	75605	3.00E-03	H				110	11	4.1	6100	230
Cadmium and compounds	7440439	5.00E-04	I	5.71E-05	W		18	0.00099	0.68	1000	39
Caprolactam	105602	5.00E-01	I				18000	1800	680	1000000	39000
Captafol	2425061	2.00E-03	I		8.60E-03	H	7.8	0.73	0.37	670	74
Captan	133062	1.30E-01	I		3.50E-03	H	19	1.8	0.9	1600	180
Carbaryl	63252	1.00E-01	I				3700	370	140	200000	7800
Carbofuran	1563662	5.00E-03	I				180	18	6.8	10000	390
Carbon disulfide	75150	1.00E-01	I	2.00E-01	I		1000	730	140	200000	7800
Carbon tetrachloride	56235	7.00E-04	I	5.71E-04	E	1.30E-01	0.16	0.12	0.024	44	4.9
Carbosulfan	55285148	1.00E-02	I				370	37	14	20000	780
Carboxin	5234684	1.00E-01	I				3700	370	140	200000	7800
Chloral	75876	2.00E-03	I				73	7.3	2.7	4100	160
Chloramben	133904	1.50E-02	I				550	55	20	31000	1200
Chloranil	118752				4.03E-01	H	0.17	0.016	0.0078	14	1.6
**Chlordane	57749	5.00E-04	I		3.50E-01	I	0.19	0.018	0.009	16	1.8
Chlorimuron-ethyl	90982324	2.00E-02	I				730	73	27	41000	1600
Chlorine	7782505	1.00E-01	I				3700	370	140	200000	7800
Chlorine dioxide	10049044			5.71E-05	I		2.1	0.21	0	0	0
Chloroacetaldehyde	107200	6.90E-03	O				250	25	9.3	14000	540
Chloroacetic acid	79118	2.00E-03	H				73	7.3	2.7	4100	160
2-Chloroacetophenone	532274			8.57E-06	I		0.31	0.031	0	0	0
4-Chloroaniline	106478	4.00E-03	I				150	15	5.4	8200	310
Chlorobenzene	108907	2.00E-02	I	5.71E-03	A		39	21	27	41000	1600
Chlorobenzilate	510156	2.00E-02	I		2.70E-01	H	0.25	0.023	0.012	21	2.4
p-Chlorobenzoic acid	74113	2.00E-01	H				7300	730	270	410000	16000
4-Chlorobenzotrifluoride	98566	2.00E-02	H				730	73	27	41000	1600
2-Chloro-1,3-butadiene (chloroprene)	126998	2.00E-02	A	2.00E-03	H		14	7.3	27	41000	1600
1-Chlorobutane	109693	4.00E-01	H				2400	1500	540	820000	31000

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Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg-d/mg	CPSi kg-d/mg	V O C	Risk-Based Concentrations				
							Tap Water µg/L	Ambient Air µg/m ³	Fish mg/kg	Soil Ingestion	
										Industrial mg/kg	Residential mg/kg
Chlorodibromomethane	124481	2.00E-02		8.40E-02		☒	0.13 c	0.075 c	0.038 c	68 c	7.6 c
1-Chloro-1,1-difluoroethane	75683		1.43E+01			☒	87000 N	52000 N	0	0	0
Chlorodifluoromethane	75456		1.43E+01			☒	87000 N	52000 N	0	0	0
**Chloroethane	75003	4.00E-01	2.86E+00	2.90E-03		☒	3.6 c	2.2 c	1.1 c	2000 c	220 c
2-Chloroethyl vinyl ether	110758	2.50E-02				☒	150 N	91 N	34 N	51000 N	2000 N
Chloroform	67663	1.00E-02		6.10E-03	8.05E-02	☒	0.15 c	0.078 c	0.52 c	940 c	100 c
Chloromethane	74873			1.30E-02	6.30E-03	☒	1.4 c	0.99 c	0.24 c	440 c	49 c
4-Chloro-2-methylaniline hydrochloride	3165933			4.60E-01			0.15 c	0.014 c	0.0069 c	12 c	1.4 c
4-Chloro-2-methylaniline	95692			5.80E-01			0.12 c	0.011 c	0.0054 c	9.9 c	1.1 c
beta-Chloronaphthalene	91587	8.00E-02					2900 N	290 N	110 N	160000 N	6300 N
o-Chloronitrobenzene	88733			2.50E-02		☒	0.42 c	0.25 c	0.13 c	230 c	26 c
p-Chloronitrobenzene	100005			1.80E-02		☒	0.59 c	0.35 c	0.18 c	320 c	35 c
2-Chlorophenol	95578	5.00E-03					180 N	18 N	6.8 N	10000 N	390 N
2-Chloropropane	75296		2.86E-02			☒	170 N	100 N	0	0	0
Chloroethalonil	1897456	1.50E-02		1.10E-02			6.1 c	0.57 c	0.29 c	520 c	58 c
o-Chlorotoluene	95498	2.00E-02				☒	120 N	73 N	27 N	41000 N	1600 N
Chlorpropham	101213	2.00E-01					7300 N	730 N	270 N	410000 N	16000 N
Chlorpyrifos	2921882	3.00E-03					110 N	11 N	4.1 N	6100 N	230 N
Chlorpyrifos-methyl	5598130	1.00E-02					370 N	37 N	14 N	20000 N	780 N
Chlorsulfuron	64902723	5.00E-02					1800 N	180 N	68 N	100000 N	3900 N
Chlorthiophos	60238564	8.00E-04					29 N	2.9 N	1.1 N	1600 N	63 N
Chromium III and compounds	16065831	1.00E+00	5.71E-07				37000 N	0.0021 N	1400 N	1000000 N	78000 N
Chromium VI and compounds	18540299	5.00E-03			4.20E+01		180 N	0.00015 c	6.8 N	10000 N	390 N
Coal tar	8001589				2.20E+00		0	0.0028 c	0	0	0
Cobalt	7440484	6.00E-02					2200 N	220 N	81 N	120000 N	4700 N
Coke Oven Emissions	8007452				2.17E+00		0	0.0029 c	0	0	0
**Copper and compounds	7440508	4.00E-02					1500 N	150 N	54 N	82000 N	3100 N
Crotonaldehyde	123739	1.00E-02		1.90E+00	1.90E+00		0.035 c	0.0033 c	0.0017 c	3 c	0.34 c
**Cumene	98828	1.00E-01	1.14E-01				3700 N	420 N	140 N	200000 N	7800 N
Cyanides:	0						0	0	0	0	0
Barium cyanide	542621	1.00E-01					3700 N	370 N	140 N	200000 N	7800 N
Calcium cyanide	592018	4.00E-02					1500 N	150 N	54 N	82000 N	3100 N
Chlorine cyanide	506774	5.00E-02					1800 N	180 N	68 N	100000 N	3900 N
Copper cyanide	544923	5.00E-03					180 N	18 N	6.8 N	10000 N	390 N
Cyanazine	21725462	2.00E-03		8.40E-01			0.08 c	0.0075 c	0.0038 c	6.8 c	0.76 c
Cyanogen	460195	4.00E-02					1500 N	150 N	54 N	82000 N	3100 N
Cyanogen bromide	506683	9.00E-02					3300 N	330 N	120 N	180000 N	7000 N
Cyanogen chloride	506774	5.00E-02					1800 N	180 N	68 N	100000 N	3900 N
Free cyanide	57125	2.00E-02					730 N	73 N	27 N	41000 N	1600 N

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							Tap Water µg/L	Ambient Air µg/m ³	Fish mg/kg	Soil Ingestion			
										Industrial mg/kg	Residential mg/kg		
Hydrogen cyanide	74908	2.00E-02	8.57E-04				730 N	3.1 N	27 N	41000 N	1600 N		
Potassium cyanide	151508	5.00E-02					1800 N	180 N	68 N	100000 N	3900 N		
Potassium silver cyanide	506616	2.00E-01					7300 N	730 N	270 N	410000 N	16000 N		
Silver cyanide	506649	1.00E-01					3700 N	370 N	140 N	200000 N	7800 N		
Sodium cyanide	143339	4.00E-02					1500 N	150 N	54 N	82000 N	3100 N		
**Thiocyanate	0	1.00E-01	E				3700 N	370 N	140 N	200000 N	7800 N		
Zinc cyanide	557211	5.00E-02					1800 N	180 N	68 N	100000 N	3900 N		
Cyclohexanone	108941	5.00E+00				☒	30000 N	18000 N	6800 N	1000000 N	390000 N		
Cyclohexamine	108918	2.00E-01					7300 N	730 N	270 N	410000 N	16000 N		
Cyhalothrin/Karate	6808588	5.00E-03					180 N	18 N	6.8 N	10000 N	390 N		
Cypermethrin	52315078	1.00E-02					370 N	37 N	14 N	20000 N	780 N		
Cyromazine	66215278	7.50E-03					270 N	27 N	10 N	15000 N	590 N		
Dacthal	1861321	1.00E-02					370 N	37 N	14 N	20000 N	780 N		
Dalapon	75990	3.00E-02					1100 N	110 N	41 N	61000 N	2300 N		
Danitol	39515418	2.50E-02					910 N	91 N	34 N	51000 N	2000 N		
DDD	72548			2.40E-01			0.28 C	0.026 C	0.013 C	24 C	2.7 C		
DDE	72559			3.40E-01			0.2 C	0.018 C	0.0093 C	17 C	1.9 C		
DDT	50293	5.00E-04		3.40E-01	3.40E-01		0.2 C	0.018 C	0.0093 C	17 C	1.9 C		
Decabromodiphenyl ether	1163195	1.00E-02				☒	61 N	37 N	14 N	20000 N	780 N		
Demeton	8065483	4.00E-05					1.5 N	0.15 N	0.054 N	82 N	3.1 N		
Diallate	2303164			6.10E-02	H	☒	0.17 C	0.1 C	0.052 C	94 C	10 C		
Diazinon	333415	9.00E-04	H				33 N	3.3 N	1.2 N	1800 N	70 N		
Dibenzofuran	132649	4.00E-03	E				150 N	15 N	5.4 N	8200 N	310 N		
1,4-Dibromobenzene	106376	1.00E-02				☒	61 N	37 N	14 N	20000 N	780 N		
1,2-Dibromo-3-chloropropane	96128		5.71E-05	I	1.40E+00	H	☒	0.048 C	0.21 N	0.0023 C	4.1 C	0.46 C	
1,2-Dibromoethane	106934		5.71E-05	H	8.50E+01	I	☒	0.00075 C	0.0081 C	0.000037 C	0.067 C	0.0075 C	
Dibutyl phthalate	84742	1.00E-01					3700 N	370 N	140 N	200000 N	7800 N		
Dicamba	1918009	3.00E-02					1100 N	110 N	41 N	61000 N	2300 N		
**1,2-Dichlorobenzene	95501	9.00E-02	I	9.00E-03	E		☒	64 N	33 N	120 N	180000 N	7000 N	
1,3-Dichlorobenzene	541731	8.90E-02	O				☒	540 N	320 N	120 N	180000 N	7000 N	
1,4-Dichlorobenzene	106467		2.29E-01	I	2.40E-02	H	☒	0.44 C	0.26 C	0.13 C	240 C	27 C	
3,3'-Dichlorobenzidine	91941				4.50E-01	I		0.15 C	0.014 C	0.007 C	13 C	1.4 C	
1,4-Dichloro-2-butene	764410					9.30E+00	H	☒	0.0011 C	0.00067 C	0	0	
Dichlorodifluoromethane	75718	2.00E-01	I	5.71E-02	A		☒	390 N	210 N	270 N	410000 N	16000 N	
1,1-Dichloroethane	75343	1.00E-01	H	1.43E-01	A		☒	810 N	520 N	140 N	200000 N	7800 N	
1,2-Dichloroethane (EDC)	107062	3.00E-02	E	1.40E-03	E	9.10E-02	I	☒	0.12 C	0.069 C	0.035 C	63 C	7 C
1,1-Dichloroethylene	75354	9.00E-03	I			6.00E-01	I	☒	0.044 C	0.036 C	0.0053 C	9.5 C	1.1 C
1,2-Dichloroethylene (cis)	156592	1.00E-02	H				☒	61 N	37 N	14 N	20000 N	780 N	
1,2-Dichloroethylene (trans)	156605	2.00E-02	I				☒	120 N	73 N	27 N	41000 N	1600 N	

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Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg-d/mg	CPSi kg-d/mg	V O C	Risk-Based Concentrations				
							Tap Water µg/L	Ambient Air µg/m3	Fish mg/kg	Soil Ingestion	
										Industrial mg/kg	Residential mg/kg
1,2-Dichloroethylene (mixture)	540590	9.00E-03 H				☒	55 N	33 N	12 N	18000 N	700 N
2,4-Dichlorophenol	120832	3.00E-03 I					110 N	11 N	4.1 N	6100 N	230 N
2,4-Dichlorophenoxyacetic Acid (2,4-D)	94757	1.00E-02 I				☒	61 N	37 N	14 N	20000 N	780 N
4-(2,4-Dichlorophenoxy)butyric Acid	94826	8.00E-03 I					290 N	29 N	11 N	16000 N	630 N
1,2-Dichloropropane	78875		1.14E-03 I	6.80E-02 H		☒	0.16 C	0.092 C	0.046 C	84 C	9.4 C
2,3-Dichloropropanol	616239	3.00E-03 I					110 N	11 N	4.1 N	6100 N	230 N
1,3-Dichloropropene	542756	3.00E-04 I	5.71E-03 I	1.80E-01 H	1.30E-01 H	☒	0.077 C	0.048 C	0.018 C	32 C	3.5 C
Dichlorvos	62737	5.00E-04 I	1.43E-04 I	2.90E-01 I			0.23 C	0.022 C	0.011 C	20 C	2.2 C
Dicofol	115322			4.40E-01 W			0.15 C	0.014 C	0.0072 C	13 C	1.5 C
Dicyclopentadiene	77736	3.00E-02 H	5.71E-05 A			☒	0.42 N	0.21 N	41 N	61000 N	2300 N
Dieldrin	60571	5.00E-05 I		1.60E+01 I	1.61E+01 I		0.0042 C	0.00039 C	0.0002 C	0.36 C	0.04 C
Diesel emissions	0		1.43E-03 I				52 N	5.2 N	0	0	0
Diethyl phthalate	84662	8.00E-01 I					29000 N	2900 N	1100 N	1000000 N	63000 N
Diethylene glycol, monobutyl ether	112345		5.71E-03 H				210 N	21 N	0	0	0
Diethylene glycol, monoethyl ether	111900	2.00E+00 H					73000 N	7300 N	2700 N	1000000 N	160000 N
Diethylforamide	617845	1.10E-02 H					400 N	40 N	15 N	22000 N	860 N
Di(2-ethylhexyl)adipate	103231	6.00E-01 I		1.20E-03 I			56 C	5.2 C	2.6 C	4800 C	530 C
Diethylstilbestrol	56531			4.70E+03 H			0.000014 C	1.3E-06 C	7E-07 C	0.0012 C	0.00014 C
Difenzoquat (Avenge)	43222486	8.00E-02 I					2900 N	290 N	110 N	160000 N	6300 N
Diflubenzuron	35367385	2.00E-02 I					730 N	73 N	27 N	41000 N	1600 N
1,1-Difluoroethane	75376		1.14E+01 I			☒	69000 N	42000 N	0	0	0
Diisopropyl methylphosphonate (DIMP)	1445756	8.00E-02 I					2900 N	290 N	110 N	160000 N	6300 N
Dimethipin	55290647	2.00E-02 I					730 N	73 N	27 N	41000 N	1600 N
Dimethoate	60515	2.00E-04 I					7.3 N	0.73 N	0.27 N	410 N	16 N
3,3'-Dimethoxybenzidine	119904			1.40E-02 H			4.8 C	0.45 C	0.23 C	410 C	46 C
Dimethylamine	124403		5.71E-06 W				0.21 N	0.021 N	0	0	0
2,4-Dimethylaniline hydrochloride	21436964			5.80E-01 H			0.12 C	0.011 C	0.0054 C	9.9 C	1.1 C
2,4-Dimethylaniline	95681			7.50E-01 H			0.09 C	0.0083 C	0.0042 C	7.6 C	0.85 C
N,N-Dimethylaniline	121697	2.00E-03 I					73 N	7.3 N	2.7 N	4100 N	160 N
3,3'-Dimethylbenzidine	119937			9.20E+00 H			0.0073 C	0.00068 C	0.00034 C	0.62 C	0.069 C
N,N-Dimethylformamide	68122	1.00E-01 H	8.57E-03 I				3700 N	31 N	140 N	200000 N	7800 N
1,1-Dimethylhydrazine	57147			2.60E+00 W	3.50E+00 W		0.026 C	0.0018 C	0.0012 C	2.2 C	0.25 C
1,2-Dimethylhydrazine	540738			3.70E+01 W	3.70E+01 W		0.0018 C	0.00017 C	0.000085 C	0.15 C	0.017 C
2,4-Dimethylphenol	105679	2.00E-02 I					730 N	73 N	27 N	41000 N	1600 N
2,6-Dimethylphenol	576261	6.00E-04 I					22 N	2.2 N	0.81 N	1200 N	47 N
3,4-Dimethylphenol	95658	1.00E-03 I					37 N	3.7 N	1.4 N	2000 N	78 N
Dimethyl phthalate	131113	1.00E+01 W					370000 N	37000 N	14000 N	1000000 N	780000 N
Dimethyl terephthalate	120616	1.00E-01 I					3700 N	370 N	140 N	200000 N	7800 N
1,2-Dinitrobenzene	528290	4.00E-04 H					15 N	1.5 N	0.54 N	820 N	31 N

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Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg·d/mg	CPSi kg·d/mg	V O C	Risk-Based Concentrations				
							Tap Water µg/L	Ambient Air µg/m ³	Fish mg/kg	Soil Ingestion	
										Industrial mg/kg	Residential mg/kg
1,3-Dinitrobenzene	99650	1.00E-04	I				3.7 N	0.37 N	0.14 N	200 N	7.8 N
1,4-Dinitrobenzene	100254	4.00E-04	H				15 N	1.5 N	0.54 N	820 N	31 N
4,6-Dinitro-o-cyclohexyl phenol	131895	2.00E-03	I				73 N	7.3 N	2.7 N	4100 N	160 N
**4,6-Dinitro-2-methylphenol	534521	1.00E-04	E				3.7 N	0.37 N	0.14 N	200 N	7.8 N
2,4-Dinitrophenol	51285	2.00E-03	I				73 N	7.3 N	2.7 N	4100 N	160 N
Dinitrotoluene mixture	0			6.80E-01	I		0.099 C	0.0092 C	0.0046 C	8.4 C	0.94 C
2,4-Dinitrotoluene	121142	2.00E-03	I				73 N	7.3 N	2.7 N	4100 N	160 N
2,6-Dinitrotoluene	606202	1.00E-03	H				37 N	3.7 N	1.4 N	2000 N	78 N
Dinoseb	88857	1.00E-03	I				37 N	3.7 N	1.4 N	2000 N	78 N
di-n-Octyl phthalate	117840	2.00E-02	H				730 N	73 N	27 N	41000 N	1600 N
1,4-Dioxane	123911			1.10E-02	I		6.1 C	0.57 C	0.29 C	520 C	58 C
Diphenamid	957517	3.00E-02	I				1100 N	110 N	41 N	61000 N	2300 N
Diphenylamine	122394	2.50E-02	I				910 N	91 N	34 N	51000 N	2000 N
1,2-Diphenylhydrazine	122667			8.00E-01	I	7.70E-01	0.084 C	0.0081 C	0.0039 C	7.2 C	0.8 C
Diquat	85007	2.20E-03	I				80 N	8 N	3 N	4500 N	170 N
Direct black 38	1937377			8.60E+00	H		0.0078 C	0.00073 C	0.00037 C	0.67 C	0.074 C
Direct blue 6	2602462			8.10E+00	H		0.0083 C	0.00077 C	0.00039 C	0.71 C	0.079 C
Direct brown 95	16071866			9.30E+00	H		0.0072 C	0.00067 C	0.00034 C	0.62 C	0.069 C
Disulfoton	298044	4.00E-05	I				1.5 N	0.15 N	0.054 N	82 N	3.1 N
1,4-Dithiane	505293	1.00E-02	I				370 N	37 N	14 N	20000 N	780 N
Diuron	330541	2.00E-03	I				73 N	7.3 N	2.7 N	4100 N	160 N
Dodine	2439103	4.00E-03	I				150 N	15 N	5.4 N	8200 N	310 N
Endosulfan	115297	6.00E-03	I				220 N	22 N	8.1 N	12000 N	470 N
Endothall	145733	2.00E-02	I				730 N	73 N	27 N	41000 N	1600 N
Endrin	72208	3.00E-04	I				11 N	1.1 N	0.41 N	610 N	23 N
Epichlorohydrin	106898	2.00E-03	H	2.86E-04	I	9.90E-03	6.8 C	1 N	0.32 C	580 C	65 C
1,2-Epoxybutane	106887			5.71E-03	I		210 N	21 N	0	0	0
Ethephon (2-chloroethyl phosphonic acid)	16672870	5.00E-03	I				180 N	18 N	6.8 N	10000 N	390 N
Ethion	563122	5.00E-04	I				18 N	1.8 N	0.68 N	1000 N	39 N
2-Ethoxyethanol acetate	111159	3.00E-01	A				11000 N	1100 N	410 N	610000 N	23000 N
2-Ethoxyethanol	110805	4.00E-01	H	5.71E-02	I		15000 N	210 N	540 N	820000 N	31000 N
Ethyl acrylate	140885			4.80E-02	H		1.4 C	0.13 C	0.066 C	120 C	13 C
EPTC (S-Ethyl dipropylthiocarbamate)	759944	2.50E-02	I				910 N	91 N	34 N	51000 N	2000 N
Ethyl acetate	141786	9.00E-01	I				33000 N	3300 N	1200 N	1000000 N	70000 N
Ethylbenzene	100414	1.00E-01	I	2.86E-01	I	☒	1300 N	1000 N	140 N	200000 N	7800 N
Ethylene cyanohydrin	109784	3.00E-01	H				11000 N	1100 N	410 N	610000 N	23000 N
Ethylene diamine	107153	2.00E-02	H				730 N	73 N	27 N	41000 N	1600 N
Ethylene glycol	107211	2.00E+00	I				73000 N	7300 N	2700 N	1000000 N	160000 N
Ethylene glycol, monobutyl ether	111762			5.71E-03	H		210 N	21 N	0	0	0

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Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg-d/mg	CPSi kg-d/mg	V O C	Risk-Based Concentrations					
							Tap Water µg/L	Ambient Air µg/m ³	Fish mg/kg	Soil Ingestion		
										Industrial mg/kg	Residential mg/kg	
Ethylene oxide	75218			1.02E+00 H	3.50E-01 H		0.066 c	0.018 c	0.0031 c	5.6 c	0.63 c	
Ethylene thiourea (ETU)	96457	8.00E-05 I		1.19E-01 H			0.57 c	0.053 c	0.027 c	48 c	5.4 c	
Ethyl ether	60297	2.00E-01 I				☒	1200 N	730 N	270 N	410000 N	16000 N	
Ethyl methacrylate	97632	9.00E-02 H					3300 N	330 N	120 N	180000 N	7000 N	
Ethyl p-nitrophenyl phenylphosphorothioat	2104645	1.00E-05 I					0.37 N	0.037 N	0.014 N	20 N	0.78 N	
Ethylphthalyl ethyl glycolate	84720	3.00E+00 I					110000 N	11000 N	4100 N	1000000 N	230000 N	
Express	10120	8.00E-03 I					290 N	29 N	11 N	16000 N	630 N	
Fenamiphos	22224926	2.50E-04 I					9.1 N	0.91 N	0.34 N	510 N	20 N	
Fluometuron	2164172	1.30E-02 I					470 N	47 N	18 N	27000 N	1000 N	
Fluoride	7782414	6.00E-02 I					2200 N	220 N	81 N	120000 N	4700 N	
Fluoridone	59756604	8.00E-02 I					2900 N	290 N	110 N	160000 N	6300 N	
Flurprimidol	56425913	2.00E-02 I					730 N	73 N	27 N	41000 N	1600 N	
Flutolanil	66332965	6.00E-02 I					2200 N	220 N	81 N	120000 N	4700 N	
Fluvalinate	69409945	1.00E-02 I					370 N	37 N	14 N	20000 N	780 N	
Folpet	133073	1.00E-01 I		3.50E-03 I			19 c	1.8 c	0.9 c	1600 c	180 c	
Fomesafen	72178020			1.90E-01 I			0.35 c	0.033 c	0.017 c	30 c	3.4 c	
Fonofos	944229	2.00E-03 I					73 N	7.3 N	2.7 N	4100 N	160 N	
Formaldehyde	50000	2.00E-01 I			4.55E-02 I		7300 N	0.14 c	270 N	410000 N	16000 N	
Formic Acid	64186	2.00E+00 H					73000 N	7300 N	2700 N	1000000 N	160000 N	
Fosetyl-al	39148248	3.00E+00 I					110000 N	11000 N	4100 N	1000000 N	230000 N	
Furan	110009	1.00E-03 I					37 N	3.7 N	1.4 N	2000 N	78 N	
Furazolidone	67458			3.80E+00 H			0.018 c	0.0016 c	0.00083 c	1.5 c	0.17 c	
Furfural	98011	3.00E-03 I	1.43E-02 A				110 N	52 N	4.1 N	6100 N	230 N	
Furium	531828			5.00E+01 H			0.0013 c	0.00013 c	0.000063 c	0.11 c	0.013 c	
Furmecyclox	60568050			3.00E-02 I			2.2 c	0.21 c	0.11 c	190 c	21 c	
Glufosinate-ammonium	77182822	4.00E-04 I					15 N	1.5 N	0.54 N	820 N	31 N	
Glycidaldehyde	765344	4.00E-04 I	2.86E-04 H				15 N	1 N	0.54 N	820 N	31 N	
Glyphosate	1071836	1.00E-01 I					3700 N	370 N	140 N	200000 N	7800 N	
Haloxypop-methyl	69806402	5.00E-05 I					1.8 N	0.18 N	0.068 N	100 N	3.9 N	
Harmony	79277273	1.30E-02 I					470 N	47 N	18 N	27000 N	1000 N	
HCH (alpha)	319846			6.30E+00 I	6.30E+00 I		0.011 c	0.00099 c	0.0005 c	0.91 c	0.1 c	
HCH (beta)	319857			1.80E+00 I	1.80E+00 I		0.037 c	0.0035 c	0.0018 c	3.2 c	0.35 c	
HCH (gamma) Lindane	58899	3.00E-04 I		1.30E+00 H			0.052 c	0.0048 c	0.0024 c	4.4 c	0.49 c	
HCH-technical	608731			1.80E+00 I	1.79E+00 I		0.037 c	0.0035 c	0.0018 c	3.2 c	0.35 c	
Heptachlor	76448	5.00E-04 I		4.50E+00 I	4.55E+00 I	☒	0.0023 c	0.0014 c	0.0007 c	1.3 c	0.14 c	
Heptachlor epoxide	1024573	1.30E-05 I		9.10E+00 I	9.10E+00 I	☒	0.0012 c	0.00069 c	0.00035 c	0.63 c	0.07 c	
Hexabromobenzene	87821	2.00E-03 I				☒	12 N	7.3 N	2.7 N	4100 N	160 N	
Hexachlorobenzene	118741	8.00E-04 I		1.60E+00 I	1.61E+00 I	☒	0.0066 c	0.0039 c	0.002 c	3.6 c	0.4 c	
Hexachlorobutadiene	87683	2.00E-04 H		7.80E-02 I	7.70E-02 I	☒	0.14 c	0.081 c	0.04 c	73 c	8.2 c	

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							Tap Water µg/L	Ambient Air µg/m ³	Fish mg/kg	Soil Ingestion	
										Industrial mg/kg	Residential mg/kg
Hexachlorocyclopentadiene	77474	7.00E-03	2.00E-05			☒	0.15	0.073	9.5	14000	550
Hexachlorodibenzo-p-dioxin mixture	19408743			6.20E+03	4.55E+03		0.000011	1.4E-06	5E-07	0.00092	0.0001
Hexachloroethane	67721	1.00E-03		1.40E-02	1.40E-02	☒	0.75	0.45	0.23	410	46
Hexachlorophene	70304	3.00E-04					11	1.1	0.41	610	23
Hexahydro-1,3,5-trinitro-1,3,5-triazine	121824	3.00E-03		1.10E-01			0.61	0.057	0.029	52	5.8
1,6-Hexamethylene diisocyanate	822060		2.86E-06				0.1	0.01	0	0	0
n-Hexane	110543	6.00E-02	5.71E-02			☒	350	210	81	120000	4700
**2-Hexanone	73663715	4.00E-02					1500	150	54	82000	3100
Hexazinone	51235042	3.30E-02					1200	120	45	67000	2600
Hydrazine, hydrazine sulfate	302012			3.00E+00	1.71E+01		0.022	0.00037	0.0011	1.9	0.21
Hydrogen chloride	7647010		5.71E-03				210	21	0	0	0
Hydrogen sulfide	7783064	3.00E-03	2.85E-04				110	1	4.1	6100	230
Hydroquinone	123319	4.00E-02					1500	150	54	82000	3100
Imazalil	35554440	1.30E-02					470	47	18	27000	1000
Imazaquin	81335377	2.50E-01					9100	910	340	510000	20000
Iprodione	36734197	4.00E-02					1500	150	54	82000	3100
Iron	7439896	3.00E-01					11000	1100	410	610000	23000
Isobutanol	78831	3.00E-01				☒	1800	1100	410	610000	23000
Isophorone	78591	2.00E-01		9.50E-04			71	6.6	3.3	6000	670
Isopropalin	33820530	1.50E-02					550	55	20	31000	1200
Isopropyl methyl phosphonic acid	1832548	1.00E-01					3700	370	140	200000	7800
Isoxaben	82558507	5.00E-02					1800	180	68	100000	3900
Kepone	143500			1.80E+01			0.0037	0.00035	0.00018	0.32	0.035
Lactofen	77501634	2.00E-03					73	7.3	2.7	4100	160
Linuron	330552	2.00E-03					73	7.3	2.7	4100	160
Lithium	7439932	2.00E-02					730	73	27	41000	1600
Londax	83056996	2.00E-01					7300	730	270	410000	16000
Malathion	121755	2.00E-02					730	73	27	41000	1600
Maleic anhydride	108316	1.00E-01					3700	370	140	200000	7800
Maleic hydrazide	123331	5.00E-01					18000	1800	680	1000000	39000
Malononitrile	109773	2.00E-05					0.73	0.073	0.027	41	1.6
Mancozeb	8018017	3.00E-02					1100	110	41	61000	2300
Maneb	12427382	5.00E-03					180	18	6.8	10000	390
Manganese and compounds	7439965	2.30E-02	1.43E-05				840	0.052	31	47000	1800
Mephsolan	950107	9.00E-05					3.3	0.33	0.12	180	7
Mepiquat chloride	24307264	3.00E-02					1100	110	41	61000	2300
Mercuric chloride	7487947	3.00E-04					11	1.1	0.41	610	23
Mercury (inorganic)	7439976	3.00E-04	8.57E-05				11	0.31	0.41	610	23
Mercury (methyl)	22967926	1.00E-04					3.7	0.37	0.14	200	7.8

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Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg-d/mg	CPSi kg-d/mg	V O C	Risk-Based Concentrations						
							Tap Water µg/L	Ambient Air µg/m3	Fish mg/kg	Soil Ingestion			
										Industrial mg/kg	Residential mg/kg		
Merphos	150505	3.00E-05					1.1 N	0.11 N	0.041 N	61 N	2.3 N		
Merphos oxide	78488	3.00E-05					1.1 N	0.11 N	0.041 N	61 N	2.3 N		
Metalaxyl	57837191	6.00E-02					2200 N	220 N	81 N	120000 N	4700 N		
Methacrylonitrile	126987	1.00E-04	2.00E-04	A			3.7 N	0.73 N	0.14 N	200 N	7.8 N		
Methamidophos	10265926	5.00E-05					1.8 N	0.18 N	0.068 N	100 N	3.9 N		
Methanol	67561	5.00E-01					18000 N	1800 N	680 N	1000000 N	39000 N		
Methidathion	950378	1.00E-03					37 N	3.7 N	1.4 N	2000 N	78 N		
Methomyl	16752775	2.50E-02					910 N	91 N	34 N	51000 N	2000 N		
Methoxychlor	72435	5.00E-03					180 N	18 N	6.8 N	10000 N	390 N		
2-Methoxyethanol acetate	110496	2.00E-03					73 N	7.3 N	2.7 N	4100 N	160 N		
2-Methoxyethanol	109864	1.00E-03	5.71E-03	I			37 N	21 N	1.4 N	2000 N	78 N		
2-Methoxy-5-nitroaniline	99592				4.60E-02	H	1.5 C	0.14 C	0.069 C	120 C	14 C		
Methyl acetate	79209	1.00E+00					37000 N	3700 N	1400 N	1000000 N	78000 N		
Methyl acrylate	96333	3.00E-02					1100 N	110 N	41 N	61000 N	2300 N		
2-Methylaniline hydrochloride	636215				1.80E-01	H	0.37 C	0.035 C	0.018 C	32 C	3.5 C		
2-Methylaniline	95534				2.40E-01	H	0.28 C	0.026 C	0.013 C	24 C	2.7 C		
Methyl chlorocarbonate	79221	1.00E+00					37000 N	3700 N	1400 N	1000000 N	78000 N		
4-(2-Methyl-4-chlorophenoxy) butyric acid	94815	1.00E-02					370 N	37 N	14 N	20000 N	780 N		
2-Methyl-4-chlorophenoxyacetic acid	94746	5.00E-04					18 N	1.8 N	0.68 N	1000 N	39 N		
2-(2-Methyl-14-chlorophenoxy)propionic a	93652	1.00E-03					37 N	3.7 N	1.4 N	2000 N	78 N		
Methylcyclohexane	108872		8.57E-01	H			31000 N	3100 N	0	0	0		
Methylene bromide	74953	1.00E-02					61 N	37 N	14 N	20000 N	780 N		
Methylene chloride	75092	6.00E-02	8.57E-01	H	7.50E-03	I	1.64E-03	I	4.1 C	3.8 C	0.42 C	760 C	85 C
4,4'-Methylene bis(2-chloroaniline)	101144	7.00E-04			1.30E-01	H	1.30E-01	H	0.52 C	0.048 C	0.024 C	44 C	4.9 C
4,4'-Methylenebisbenzeneamine	101779				2.50E-01	W			0.27 C	0.025 C	0.013 C	23 C	2.6 C
4,4'-Methylene bis(N,N'-dimethyl)aniline	101611				4.60E-02	I			1.5 C	0.14 C	0.069 C	120 C	14 C
4,4'-Methylenediphenyl isocyanate	101688		5.71E-06	I					0.035 N	0.021 N	0	0	0
Methyl ethyl ketone	78933	6.00E-01	2.86E-01	I					1900 N	1000 N	810 N	1000000 N	47000 N
Methyl hydrazine	60344				1.10E+00	W			0.061 C	0.0057 C	0.0029 C	5.2 C	0.58 C
Methyl isobutyl ketone	108101	8.00E-02	2.29E-02	A					2900 N	84 N	110 N	160000 N	6300 N
Methyl methacrylate	80626	8.00E-02							2900 N	290 N	110 N	160000 N	6300 N
2-Methyl-5-nitroaniline	99558				3.30E-02	H			2 C	0.19 C	0.096 C	170 C	19 C
Methyl parathion	298000	2.50E-04							9.1 N	0.91 N	0.34 N	510 N	20 N
2-Methylphenol (o-cresol)	95487	5.00E-02							1800 N	180 N	68 N	100000 N	3900 N
3-Methylphenol (m-cresol)	103394	5.00E-02							1800 N	180 N	68 N	100000 N	3900 N
4-Methylphenol (p-cresol)	106445	5.00E-03							180 N	18 N	6.8 N	10000 N	390 N
Methyl styrene (mixture)	25013154	6.00E-03	1.14E-02	A					60 N	42 N	8.1 N	12000 N	470 N
Methyl styrene (alpha)	98839	7.00E-02							430 N	260 N	95 N	140000 N	5500 N
Methyl tert-butyl ether (MTBE)	1634044	5.00E-03	8.57E-01	I					180 N	3100 N	6.8 N	10000 N	390 N

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Metolaclor (Dual)	51218452	1.50E-01	H				5500 N	550 N	200 N	310000 N	12000 N
Metribuzin	21087649	2.50E-02	I				910 N	91 N	34 N	51000 N	2000 N
Mirex	2385855	2.00E-04	I		1.80E+00	W	0.037 C	0.0035 C	0.0018 C	3.2 C	0.35 C
Molinate	2212671	2.00E-03	I				73 N	7.3 N	2.7 N	4100 N	160 N
Molybdenum	7439987	5.00E-03	I				180 N	18 N	6.8 N	10000 N	390 N
Monochloramine	10599903	1.00E-01	I				3700 N	370 N	140 N	200000 N	7800 N
Naled	300765	2.00E-03	I				73 N	7.3 N	2.7 N	4100 N	160 N
2-Naphthylamine	91598				1.30E+02	E	0.00052 C	0.000048 C	0.000024 C	0.044 C	0.0049 C
Napropamide	15299997	1.00E-01	I				3700 N	370 N	140 N	200000 N	7800 N
Nickel refinery dust	0				8.40E-01	I	0	0.0075 C	0	0	0
Nickel and compounds	7440020	2.00E-02	I				730 N	73 N	27 N	41000 N	1600 N
Nickel subsulfide	12035722				1.70E+00	I	0	0.0037 C	0	0	0
Nitrapyrin	1929824	1.50E-03	W				55 N	5.5 N	2 N	3100 N	120 N
Nitrate	14797558	1.60E+00	I				58000 N	5800 N	2200 N	1000000 N	130000 N
Nitric oxide	10102439	1.00E-01	W				3700 N	370 N	140 N	200000 N	7800 N
Nitrite	14797650	1.00E-01	I				3700 N	370 N	140 N	200000 N	7800 N
2-Nitroaniline	88744	6.00E-05	W	5.71E-05	H		2.2 N	0.21 N	0.081 N	120 N	4.7 N
3-Nitroaniline	99092	3.00E-03	O				110 N	11 N	4.1 N	6100 N	230 N
4-Nitroaniline	100016	3.00E-03	O				110 N	11 N	4.1 N	6100 N	230 N
Nitrobenzene	98953	5.00E-04	I	5.71E-04	A		3.4 N	2.1 N	0.68 N	1000 N	39 N
Nitrofurantoin	67209	7.00E-02	H				2600 N	260 N	95 N	140000 N	5500 N
Nitrofurazone	59870			1.50E+00	H	9.40E+00	0.045 C	0.00067 C	0.0021 C	3.8 C	0.43 C
Nitrogen dioxide	10102440	1.00E+00	W				37000 N	3700 N	1400 N	1000000 N	78000 N
Nitroguanidine	556887	1.00E-01	I				3700 N	370 N	140 N	200000 N	7800 N
**4-Nitrophenol	100027	8.00E-03	E				290 N	29 N	11 N	16000 N	630 N
2-Nitropropane	79469			5.71E-03	I		210 N	0.00067 C	0	0	0
N-Nitrosodi-n-butylamine	924163			5.40E+00	I	5.60E+00	0.012 C	0.0011 C	0.00058 C	1.1 C	0.12 C
N-Nitrosodiethanolamine	1116547			2.80E+00	I		0.024 C	0.0022 C	0.0011 C	2 C	0.23 C
N-Nitrosodiethylamine	55185			1.50E+02	I	1.51E+02	0.00045 C	0.000041 C	0.000021 C	0.038 C	0.0043 C
N-Nitrosodimethylamine	62759			5.10E+01	I	4.90E+01	0.0013 C	0.00013 C	0.000062 C	0.11 C	0.013 C
N-Nitrosodiphenylamine	86306			4.90E-03	I		14 C	1.3 C	0.64 C	1200 C	130 C
N-Nitroso di-n-propylamine	621647			7.00E+00	I		0.0096 C	0.00089 C	0.00045 C	0.82 C	0.091 C
N-Nitroso-N-ethylurea	759739			1.40E+02	H		0.00048 C	0.000045 C	0.000023 C	0.041 C	0.0046 C
N-Nitroso-N-methylethylamine	10595956			2.20E+01	I		0.0031 C	0.00028 C	0.00014 C	0.26 C	0.029 C
N-Nitrosopyrrolidine	930552			2.10E+00	I	2.13E+00	0.032 C	0.0029 C	0.0015 C	2.7 C	0.3 C
m-Nitrotoluene	99081	2.00E-02	H				120 N	73 N	27 N	4100 N	1600 N
o-Nitrotoluene	88722	1.00E-02	H				61 N	37 N	14 N	20000 N	780 N
p-Nitrotoluene	99990	1.00E-02	H				61 N	37 N	14 N	20000 N	780 N
Norflurazon	27314132	4.00E-02	I				1500 N	150 N	54 N	82000 N	3100 N

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NuStar	85509199	7.00E-04					26 N	2.6 N	0.95 N	1400 N	55 N
Octabromodiphenyl ether	32536520	3.00E-03					110 N	11 N	4.1 N	6100 N	230 N
Octahydro-1357-tetranitro-1357-tetrazocine	2691410	5.00E-02					1800 N	180 N	68 N	100000 N	3900 N
Octamethylpyrophosphoramidate	152169	2.00E-03					73 N	7.3 N	2.7 N	4100 N	160 N
Oryzalin	19044883	5.00E-02					1800 N	180 N	68 N	100000 N	3900 N
Oxadiazon	19666309	5.00E-03					180 N	18 N	6.8 N	10000 N	390 N
Oxamyl	23135220	2.50E-02					910 N	91 N	34 N	51000 N	2000 N
Oxyfluorfen	42874033	3.00E-03					110 N	11 N	4.1 N	6100 N	230 N
Paclobutrazol	76738620	1.30E-02					470 N	47 N	18 N	27000 N	1000 N
Paraquat	1910425	4.50E-03					160 N	16 N	6.1 N	9200 N	350 N
Parathion	56382	6.00E-03					220 N	22 N	8.1 N	12000 N	470 N
Pebulate	1114712	5.00E-02					1800 N	180 N	68 N	100000 N	3900 N
Pendimethalin	40487421	4.00E-02					1500 N	150 N	54 N	82000 N	3100 N
Pentabromo-6-chlorocyclohexane	87843			2.30E-02	H		2.9 C	0.27 C	0.14 C	250 C	28 C
Pentabromodiphenyl ether	32534819	2.00E-03					73 N	7.3 N	2.7 N	4100 N	160 N
Pentachlorobenzene	608935	8.00E-04				☒	4.9 N	2.9 N	1.1 N	1600 N	63 N
Pentachloronitrobenzene	82688	3.00E-03		2.60E-01	H	☒	0.041 C	0.024 C	0.012 C	22 C	2.5 C
Pentachlorophenol	87865	3.00E-02		1.20E-01	I		0.56 C	0.052 C	0.026 C	48 C	5.3 C
Permethrin	52645531	5.00E-02					1800 N	180 N	68 N	100000 N	3900 N
Phenmedipham	13684634	2.50E-01					9100 N	910 N	340 N	510000 N	20000 N
Phenol	108952	6.00E-01					22000 N	2200 N	810 N	1000000 N	47000 N
m-Phenylenediamine	108452	6.00E-03					220 N	22 N	8.1 N	12000 N	470 N
**o-Phenylenediamine	95545	6.00E-03		4.70E-02	H		1.4 C	0.13 C	0.067 C	120 C	14 C
p-Phenylenediamine	106503	1.90E-01					6900 N	690 N	260 N	390000 N	15000 N
Phenylmercuric acetate	62384	8.00E-05					2.9 N	0.29 N	0.11 N	160 N	6.3 N
2-Phenylphenol	90437			1.94E-03	H		35 C	3.2 C	1.6 C	3000 C	330 C
Phorate	298022	2.00E-04					7.3 N	0.73 N	0.27 N	410 N	16 N
Phosmet	732116	2.00E-02					730 N	73 N	27 N	41000 N	1600 N
Phosphine	7803512	3.00E-04	8.57E-05				11 N	0.31 N	0.41 N	610 N	23 N
Phosphoric acid	7664382		2.86E-03				100 N	10 N	0	0	0
Phosphorus (white)	7723140	2.00E-05					0.73 N	0.073 N	0.027 N	41 N	1.6 N
p-Phthalic acid	100210	1.00E+00					37000 N	3700 N	1400 N	1000000 N	78000 N
Phthalic anhydride	85449	2.00E+00	3.43E-02				73000 N	130 N	2700 N	1000000 N	160000 N
Picloram	1918021	7.00E-02					2600 N	260 N	95 N	140000 N	5500 N
Pirimiphos-methyl	29232937	1.00E-02					370 N	37 N	14 N	20000 N	780 N
Polybrominated biphenyls	0	7.00E-06		8.90E+00	H		0.0076 C	0.0007 C	0.00035 C	0.64 C	0.072 C
**Polychlorinated biphenyls (PCBs)	1336363			2.00E+00	I	4.00E-01	0.034 C	0.016 C	0.0016 C	2.9 C	0.32 C
Aroclor 1016	12674112	7.00E-05					2.6 N	0.26 N	0.095 N	140 N	5.5 N
Aroclor 1254	11097691	2.00E-05					0.73 N	0.073 N	0.027 N	41	1.6 N

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Polychlorinated terphenyls (PCTs)				4.50E+00	E		0.015	0.0014	0.0007	1.3	0.14
Polynuclear aromatic hydrocarbons											
Acenaphthene	83329	6.00E-02					2200	220	81	120000	4700
Anthracene	120127	3.00E-01					11000	1100	410	610000	23000
**Benz[a]anthracene	56553			7.30E-01	E	3.10E-01	0.092	0.02	0.0043	7.8	0.88
**Benzo[b]fluoranthene	205992			7.30E-01	E	3.10E-01	0.092	0.02	0.0043	7.8	0.88
**Benzo[k]fluoranthene	207089			7.30E-02	E	3.10E-02	0.92	0.2	0.043	78	8.8
**Benzo[a]pyrene	50328			7.30E+00	I	3.10E+00	0.0092	0.002	0.00043	0.78	0.088
Carbazole	86748			2.00E-02	H		3.4	0.31	0.16	290	32
**Chrysene	218019			7.30E-03	E	3.10E-03	9.2	2	0.43	780	88
**Dibenz[ah]anthracene	53703			7.30E+00	E	3.10E+00	0.0092	0.002	0.00043	0.78	0.088
Fluoranthene	206440	4.00E-02					1500	150	54	82000	3100
Fluorene	86737	4.00E-02					1500	150	54	82000	3100
**Indeno[1,2,3-cd]pyrene	193395			7.30E-01	E	3.10E-01	0.092	0.02	0.0043	7.8	0.88
**2-Methylnaphthalene	91576	4.00E-02					1500	150	54	82000	3100
Naphthalene	91203	4.00E-02					1500	150	54	82000	3100
Pyrene	129000	3.00E-02					1100	110	41	61000	2300
Prochloraz	67747095	9.00E-03		1.50E-01	I		0.45	0.042	0.021	38	4.3
Profluralin	26399360	6.00E-03					220	22	8.1	12000	470
Prometon	1610180	1.50E-02					550	55	20	31000	1200
Prometryn	7287196	4.00E-03					150	15	5.4	8200	310
Pronamide	23950585	7.50E-02					2700	270	100	150000	5900
Propachlor	1918167	1.30E-02					470	47	18	27000	1000
Propanil	709988	5.00E-03					180	18	6.8	10000	390
Propargite	2312358	2.00E-02					730	73	27	41000	1600
Propargyl alcohol	107197	2.00E-03					73	7.3	2.7	4100	160
Propazine	139402	2.00E-02					730	73	27	41000	1600
Propham	122429	2.00E-02					730	73	27	41000	1600
Propiconazole	60207901	1.30E-02					470	47	18	27000	1000
**n-Propylbenzene	98066	1.00E-02				☒	61	37	14	20000	780
Propylene glycol	57556	2.00E+01					730000	73000	27000	1000000	1000000
Propylene glycol, monoethyl ether	52125538	7.00E-01					26000	2600	950	1000000	55000
Propylene glycol, monomethyl ether	107982	7.00E-01		5.71E-01	I		26000	2100	950	1000000	55000
Propylene oxide	75569		8.57E-03		2.40E-01	I	0.28	0.49	0.013	24	2.7
Pursuit	81335775	2.50E-01					9100	910	340	510000	20000
Pydrin	51630581	2.50E-02					910	91	34	51000	2000
Pyridine	110861	1.00E-03					37	3.7	1.4	2000	78
Quinalphos	13593038	5.00E-04					18	1.8	0.68	1000	39
Quinoline	91225			1.20E+01	H		0.0056	0.00052	0.00026	0.48	0.053

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Resmethrin	10463868	3.00E-02					1100 N	110 N	41 N	61000 N	2300 N
Ronnel	299843	5.00E-02					1800 N	180 N	68 N	100000 N	3900 N
Rotenone	83794	4.00E-03					150 N	15 N	5.4 N	8200 N	310 N
Savey	78587050	2.50E-02					910 N	91 N	34 N	51000 N	2000 N
Selenious Acid	7783008	5.00E-03					180 N	18 N	6.8 N	10000 N	390 N
Selenium	7782492	5.00E-03					180 N	18 N	6.8 N	10000 N	390 N
Selenourea	630104	5.00E-03					180 N	18 N	6.8 N	10000 N	390 N
Sethoxydim	74051802	9.00E-02					3300 N	330 N	120 N	180000 N	7000 N
Silver and compounds	7440224	5.00E-03					180 N	18 N	6.8 N	10000 N	390 N
Simazine	122349	5.00E-03		1.20E-01	H		0.56 C	0.052 C	0.026 C	48 C	5.3 C
Sodium azide	26628228	4.00E-03					150 N	15 N	5.4 N	8200 N	310 N
Sodium diethyldithiocarbamate	148185	3.00E-02		2.70E-01	H		0.25 C	0.023 C	0.012 C	21 C	2.4 C
Sodium fluoroacetate	62748	2.00E-05					0.73 N	0.073 N	0.027 N	41 N	1.6 N
Sodium metavanadate	13718268	1.00E-03					37 N	3.7 N	1.4 N	2000 N	78 N
Strontium, stable	7440246	6.00E-01					22000 N	2200 N	810 N	1000000 N	47000 N
Strychnine	57249	3.00E-04					11 N	1.1 N	0.41 N	610 N	23 N
Styrene	100425	2.00E-01	2.86E-01			☒	1600 N	1000 N	270 N	410000 N	16000 N
Systhane	88671890	2.50E-02					910 N	91 N	34 N	51000 N	2000 N
**2,3,7,8-TCDD (dioxin)	1746016			1.50E+05	H	1.50E+05 H	0.00000045 C	4.2E-08 C	0 C	0.000038 C	0.000043 C
Tebuthiuron	34014181	7.00E-02					2600 N	260 N	95 N	140000 N	5500 N
Temephos	3383968	2.00E-02					730 N	73 N	27 N	41000 N	1600 N
Terbacil	5902512	1.30E-02					470 N	47 N	18 N	27000 N	1000 N
Terbufos	13071799	2.50E-05					0.91 N	0.091 N	0.034 N	51 N	2 N
Terbutryn	886500	1.00E-03					37 N	3.7 N	1.4 N	2000 N	78 N
1,2,4,5-Tetrachlorobenzene	95943	3.00E-04				☒	1.8 N	1.1 N	0.41 N	610 N	23 N
1,1,1,2-Tetrachloroethane	630206	3.00E-02		2.60E-02	I	2.59E-02 I	0.41 C	0.24 C	0.12 C	220 C	25 C
1,1,2,2-Tetrachloroethane	79345			2.00E-01	I	2.03E-01 I	0.052 C	0.031 C	0.016 C	29 C	3.2 C
Tetrachloroethylene (PCE)	127184	1.00E-02		5.20E-02	E	2.03E-03 E	1.1 C	3.1 C	0.061 C	110 C	12 C
2,3,4,6-Tetrachlorophenol	58902	3.00E-02					1100 N	110 N	41 N	61000 N	2300 N
p,a,a,Tetrachlorotoluene	5216251			2.00E+01	H		0.00053 C	0.00031 C	0.00016 C	0.29 C	0.032 C
Tetrachlorovinphos	961115	3.00E-02		2.40E-02	H		2.8 C	0.26 C	0.13 C	240 C	27 C
Tetraethyldithiopyrophosphate	3689245	5.00E-04					18 N	1.8 N	0.68 N	1000 N	39 N
Tetraethyl lead	78002	1.00E-07					0.0037 N	0.00037 N	0.00014 N	0.2 N	0.0078 N
1,1,1,2-Tetrafluoroethane	811972		2.29E+01			☒	140000 N	84000 N	0	0	0
Thallic oxide	1314325	7.00E-05					2.6 N	0.26 N	0.095 N	140 N	5.5 N
Thallium	0						0	0	0	0	0
Thallium acetate	563688	9.00E-05					3.3 N	0.33 N	0.12 N	180 N	7 N
Thallium carbonate	6533739	8.00E-05					2.9 N	0.29 N	0.11 N	160 N	6.3 N
Thallium chloride	7791120	8.00E-05					2.9 N	0.29 N	0.11 N	160 N	6.3 N

Sources: I=IRIS H=HEAST A=HEAST alternate W=Withdrawn from IRIS or HEAST E=EPA-NCEA Regional Support provisional value O=Other EPA documents.										Basis: C=carcinogenic effects N=non-carcinogenic effects				
Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg-d/mg	CPSi kg-d/mg	V O C	Risk-Based Concentrations							
							Tap Water µg/L	Ambient Air µg/m ³	Fish mg/kg	Soil Ingestion				
										Industrial mg/kg	Residential mg/kg			
Thallium nitrate	10102451	9.00E-05	I				3.3 N	0.33 N	0.12 N	180 N	7 N			
Thallium selenite	12039520	9.00E-05	W				3.3 N	0.33 N	0.12 N	180 N	7 N			
Thallium sulfate	7446186	8.00E-05	I				2.9 N	0.29 N	0.11 N	160 N	6.3 N			
Thiobencarb	28249776	1.00E-02	I				370 N	37 N	14 N	20000 N	780 N			
2-(Thiocyanomethylthio)-benzothiazole	21564170	3.00E-02	H				1100 N	110 N	41 N	61000 N	2300 N			
Thiofanox	39196184	3.00E-04	H				11 N	1.1 N	0.41 N	610 N	23 N			
Thiophanate-methyl	23564058	8.00E-02	I				2900 N	290 N	110 N	160000 N	6300 N			
Thiram	137268	5.00E-03	I				180 N	18 N	6.8 N	10000 N	390 N			
Tin and compounds	0	6.00E-01	H				22000 N	2200 N	810 N	1000000 N	47000 N			
**Titanium	7440326	4.00E+00	E	8.60E-03	E		150000 N	31 N	5400 N	1000000 N	310000 N			
**Titanium dioxide	13643677	4.00E+00	E	8.60E-03	E		150000 N	31 N	5400 N	1000000 N	310000 N			
Toluene	108883	2.00E-01	I	1.14E-01	I	☒	750 N	420 N	270 N	410000 N	16000 N			
Toluene-2,4-diamine	95807				3.20E+00	H	0.021 C	0.002 C	0.00099 C	1.8 C	0.2 C			
Toluene-2,5-diamine	95705	6.00E-01	H				22000 N	2200 N	810 N	1000000 N	47000 N			
Toluene-2,6-diamine	823405	2.00E-01	H				7300 N	730 N	270 N	410000 N	16000 N			
p-Toluidine	106490				1.90E-01	H	0.35 C	0.033 C	0.017 C	30 C	3.4 C			
Toxaphene	8001352				1.10E+00	I	1.12E+00	I						
Tralometrin	66841256	7.50E-03	I				270 N	27 N	10 N	15000 N	590 N			
Triallate	2303175	1.30E-02	I				470 N	47 N	18 N	27000 N	1000 N			
Triasulfuron	82097505	1.00E-02	I				370 N	37 N	14 N	20000 N	780 N			
1,2,4-Tribromobenzene	615543	5.00E-03	I			☒	30 N	18 N	6.8 N	10000 N	390 N			
Tributyltin oxide (TBTO)	56359	3.00E-04	I				11 N	1.1 N	0.41 N	610 N	23 N			
2,4,6-Trichloroaniline hydrochloride	33663502				2.90E-02	H	2.3 C	0.22 C	0.11 C	200 C	22 C			
2,4,6-Trichloroaniline	634935				3.40E-02	H	2 C	0.18 C	0.093 C	170 C	19 C			
1,2,4-Trichlorobenzene	120821	1.00E-02	I	5.71E-02	H	☒	190 N	210 N	14 N	20000 N	780 N			
**1,1,1-Trichloroethane	71556	2.00E-02	E	2.86E-01	W	☒	540 N	1000 N	27 N	41000 N	1600 N			
1,1,2-Trichloroethane	79005	4.00E-03	I		5.70E-02	I	5.60E-02	I	☒	0.19 C	0.11 C	0.055 C	100 C	11 C
Trichloroethylene (TCE)	79016	6.00E-03	E		1.10E-02	W	6.00E-03	E	☒	1.6 C	1 C	0.29 C	520 C	58 C
Trichlorofluoromethane	75694	3.00E-01	I	2.00E-01	A	☒	1300 N	730 N	410 N	610000 N	23000 N			
2,4,5-Trichlorophenol	95954	1.00E-01	I				3700 N	370 N	140 N	200000 N	7800 N			
2,4,6-Trichlorophenol	88062				1.10E-02	I	1.09E-02	I		6.1 C	0.57 C	0.29 C	520 C	58 C
2,4,5-Trichlorophenoxyacetic acid	93765	1.00E-02	I				370 N	37 N	14 N	20000 N	780 N			
2-(2,4,5-Trichlorophenoxy)propionic acid	93721	8.00E-03	I				290 N	29 N	11 N	16000 N	630 N			
1,1,2-Trichloropropane	598776	5.00E-03	I			☒	30 N	18 N	6.8 N	10000 N	390 N			
1,2,3-Trichloropropane	96184	6.00E-03	I		7.00E+00	H	☒	0.0015 C	0.00089 C	0.00045 C	0.82 C	0.091 C		
1,2,3-Trichloropropene	96195	5.00E-03	H			☒	30 N	18 N	6.8 N	10000 N	390 N			
1,1,2-Trichloro-1,2,2-trifluoroethane	76131	3.00E+01	I	8.57E+00	H	☒	59000 N	31000 N	41000 N	1000000 N	1000000 N			
Tridiphane	58138082	3.00E-03	I				110 N	11 N	4.1 N	6100 N	230 N			
Triethylamine	121448			2.00E-03	I		73 N	7.3 N	0	0	0			

Sources: I=IRIS H=HEAST A=HEAST alternate W=Withdrawn from IRIS or HEAST E=EPA-NCEA Regional Support provisional value O=Other EPA documents.						Basis: C=carcinogenic effects N=non-carcinogenic effects					
Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg-d/mg	CPSi kg-d/mg	V O C	Risk-Based Concentrations				
							Tap Water µg/L	Ambient Air µg/m3	Fish mg/kg	Soil Ingestion	
										Industrial mg/kg	Residential mg/kg
Trifluralin	1582098	7.50E-03 I		7.70E-03 I			8.7 C	0.81 C	0.41 C	740 C	83 C
**1,2,4-Trimethylbenzene	95636	5.00E-02 E	1.70E-03 E			☒	12 N	6.2 N	68 N	100000 N	3900 N
**1,3,5-Trimethylbenzene	108678	5.00E-02 E	1.70E-03 E			☒	12 N	6.2 N	68 N	100000 N	3900 N
Trimethyl phosphate	512561			3.70E-02 H			1.8 C	0.17 C	0.085 C	150 C	17 C
**1,3,5-Trinitrobenzene	99354	3.00E-02 E					1100 N	110 N	41 N	61000 N	2300 N
Trinitrophenylmethylnitramine	479458	1.00E-02 H					370 N	37 N	14 N	20000 N	780 N
2,4,6-Trinitrotoluene	118967	5.00E-04 I		3.00E-02 I			2.2 C	0.21 C	0.11 C	190 C	21 C
Uranium (soluble salts)	7440611	3.00E-03 I					110 N	11 N	4.1 N	6100 N	230 N
Vanadium	7440622	7.00E-03 H					260 N	26 N	9.5 N	14000 N	550 N
Vanadium pentoxide	1314621	9.00E-03 I					330 N	33 N	12 N	18000 N	700 N
Vanadium sulfate	36907423	2.00E-02 H					730 N	73 N	27 N	41000 N	1600 N
Vernam	1929777	1.00E-03 I					37 N	3.7 N	1.4 N	2000 N	78 N
Vinclozolin	50471448	2.50E-02 I					910 N	91 N	34 N	51000 N	2000 N
Vinyl acetate	108054	1.00E+00 H	5.71E-02 I				37000 N	210 N	1400 N	1000000 N	78000 N
Vinyl bromide	593602		8.57E-04 I			☒	5.2 N	3.1 N	0	0	0
Vinyl chloride	75014			1.90E+00 H	3.00E-01 H	☒	0.019 C	0.021 C	0.0017 C	3 C	0.34 C
Warfarin	81812	3.00E-04 I					11 N	1.1 N	0.41 N	610 N	23 N
m-Xylene	108323	2.00E+00 H				☒	12000 N	7300 N	2700 N	1000000 N	160000 N
o-Xylene	95476	2.00E+00 H				☒	12000 N	7300 N	2700 N	1000000 N	160000 N
p-Xylene	106423					☒	0	0	0	0	0
Xylene (mixed)	1330207	2.00E+00 I				☒	12000 N	7300 N	2700 N	1000000 N	160000 N
Zinc	7440666	3.00E-01 I					11000 N	1100 N	410 N	610000 N	23000 N
Zinc phosphide	1314847	3.00E-04 I					11 N	1.1 N	0.41 N	610 N	23 N
Zineb	12122677	5.00E-02 I					1800 N	180 N	68 N	100000 N	3900 N



Brown & Root Environmental

A Division of Halliburton NUS Corporation

Foster Plaza VII
661 Andersen Drive
Pittsburgh, PA 15220-2745

(412) 921-7090
FAX: (412) 921-4040

C-49-03-8-156

March 20, 1998

Brown & Root Environmental Project Number 7237

Mr. Mark Lewis
Connecticut Department of Environmental Protection
Water Management Bureau
Permitting, Enforcement, and Remediation Division
Federal Remediation Program
79 Elm Street
Hartford, Connecticut 06106-5127

Reference: CLEAN Contract No. N62472-90-D-1298
Contract Task Order No. 0260

Subject: Responses to CTDEP's Comments on Calculated Remediation Standards
Lower Subbase Remedial Investigation
Naval Submarine Base - New London, Groton, Connecticut

Dear Mr. Lewis:

Brown & Root (B&R) Environmental and the Navy received your February 27, 1998 comment letter regarding the Remediation Standards that were calculated for use in the Lower Subbase Remedial Investigation. Responses to CTDEP's comments have been prepared and the appropriate revisions have been made to Tables 1 and 2, which were previously enclosed in B&R Environmental's December 23, 1997 letter. B&R Environmental, on the behalf of the United States Navy, Northern Division Facilities Engineering Command and Naval Submarine Base - New London, has enclosed the Navy's responses to CTDEP's comments and the revised tables for your review and approval.

If you have any questions regarding the responses or the information provided in the revised tables, please contact Mr. Mark Evans at (610) 595-0567 (ext. 162) or me at (412) 921-8244. It is anticipated that any remaining issues can be resolved during a conference call.

Very truly yours,

Corey A. Rich, P.E.
Project Manager

Enclosure(s)

c: Mr. Roger Boucher, NORTHDIV (letter only)
Mr. Mark Evans, NORTHDIV
Mr. Andy Stackpole, NSB-NLON Environmental
Mr. John Trepanowski, B&R Environmental
Mr. Daryl Hutson, B&R Environmental (letter only)
Ms. Karen Smecker, B&R Environmental
File: CTO 0260

**RESPONSES TO CTDEP'S COMMENTS (2/27/98)
ON THE CALCULATED CTDEP REMEDIATION STANDARDS (12/23/97)
CTO 260 - LOWER SUBBASE REMEDIAL INVESTIGATION
NAVAL SUBMARINE BASE-NEW LONDON, GROTON, CONNECTICUT
MARCH 20, 1998**

I. SURROGATE CHEMICALS USED TO SUPPLY TOXICITY VALUES

Comment:

1. The Navy has used naphthalene as a surrogate to represent the toxicity of benzo(g,h,i)perylene. As noted in Dr. Ginsberg's memorandum, pyrene (RfD 0.03 mg/kg/d) is a more appropriate surrogate. The RfD for naphthalene has been withdrawn from IRIS. Please recalculate the direct exposure, pollutant mobility, and ground water protection criteria for benzo(g,h,i)perylene using this approach. This approach is appropriate for a screening level risk assessment. However, the uncertainties involved with this approach should be acknowledged if these two chemicals are found to be major risk drivers at the site.

Response:

The direct exposure, pollutant mobility, and groundwater protection criteria for benzo(g,h,i)perylene will be recalculated using pyrene as a surrogate. Benzo(g,h,i)perylene was detected in soil and groundwater at the Lower Subbase but was not found to be a major risk driver at any of the zones that were evaluated in the risk assessment. Benzo(g,h,i)perylene was only identified as a COC in groundwater at Zone 4 where it was detected in one sample at a concentration exceeding the State's Ambient Water Quality Criteria (AWQC) for the protection of human health. Consequently, this does not have any impact on the human health risk assessment.

Comment:

2. It is unclear why the Navy calculated criteria for phenanthrene since the regulations list direct exposure, pollutant mobility, and groundwater protection criteria for this compound. Please use the criteria listed in the Regulations for this compound. The Navy should either withdraw their request for approval of criteria for phenanthrene, or, if the Navy is requesting approval of alternative criteria for this compound under the Regulations, the Navy should so state.

Response:

The Navy retracts its request for approval of criteria for phenanthrene. The promulgated criteria for phenanthrene were used in the selection of COCs in the human health risk assessment. Consequently, this does not have any impact on the human health risk assessment.

Comment:

- 3. Bromodichloromethane should be used as a surrogate for bromochloromethane. Please use the criteria calculated for bromodichloromethane in place of those calculated using chloromethane as a surrogate.**

Response:

Bromodichloromethane will be used as a surrogate for bromochloromethane. Bromodichloromethane was not detected in soil and groundwater samples for any of the zones evaluated in the human health risk assessment, consequently this does not have any impact on the analysis.

Comment:

- 4. The Navy's proposal to use 3-methylphenol as a surrogate for 4-chloro-3-methylphenol is not appropriate, due to structural differences between the two compounds. The use of a qualitative risk assessment would be acceptable assuming that concentrations of this chemical do not exceed the low part-per-billion range. Please see Dr. Ginsberg's comments for additional details.**

Response:

No criteria will be developed for 4-chloro-3-methylphenol. Instead, as suggested, 4-chloro-3-methylphenol will be evaluated qualitatively. 4-Chloro-3-methylphenol was only detected in one soil sample at the Lower Subbase and at a low concentration (34 ppb), consequently, this does not have any impact on the human health risk assessment.

II. INCORRECT OR UNSUPPORTED POTENCY VALUES

Comment:

- 5. Several of the CSFs or RfDs used by the Navy appeared to be incorrect, based on a comparison to the values listed in the EPA Region III Risk Based Concentrations table, IRIS, or HEAST. Please recalculate the direct exposure, pollutant mobility, and ground water protection criteria using correct values for total 1,2-dichloroethene. Please assume that this value pertains to the mixture of *cis* and *trans* isomers. The RfD for the mixture should be 9E-3 mg/kg/d.**

Response:

The direct exposure, pollutant mobility, and groundwater protection criteria for total 1,2-dichloroethene will be recalculated using an oral reference dose of 9E-3 mg/kg/day. This revision does not impact the human health risk assessment since all detected concentrations of total 1,2-dichloroethene are less than the recalculated criteria.

Comment:

6. The Department was unable to verify the potency factors listed by the Navy for several chemicals. Please either provide references to support the listed potency factors, or derive criteria using acceptable surrogates for the following compounds: chloroethane, 4,6-dinitro-2-methylphenol, 2-hexanone, and 2-methylnaphthalene. Please note that naphthalene is not an appropriate surrogate for 2-methylnaphthalene as the RfD for naphthalene has been withdrawn from IRIS. Please refer to Dr. Ginsberg's memo for additional guidance.

Response:

The toxicity criteria for chloroethane, 4,6-dinitro-2-methylphenol, 2-hexanone, and 2-methylnaphthalene were obtained from the current U.S. EPA Region III Risk-based Concentration (RBC) Table dated October 22, 1997. The RBC table cites EPA's National Center for Environmental Assessment (NCEA) as the source for the values for chloroethane, 4,6-dinitro-2-methylphenol, and 2-methylnaphthalene. Although not cited in the RBC table, EPA Region III stated in telephone call on March 12, 1998, that NCEA is also the source for the toxicity criteria for 2-hexanone. Therefore, there are no changes necessary to the proposed values.

Comment:

7. The Department was unable to verify the RfD listed by the Navy for 4-nitrophenol (8.00E-3 mg/kg/d). Please either provide a reference for the listed value, or use the default RfD currently listed in the RBC tables (6.2E-2 mg/kg/d).

Response:

The current RBC table lists 8.00E-3 mg/kg/day as the oral RfD for 4-nitrophenol and cites EPA's NCEA as the source for the value. The value of 6.2E-2 mg/kg/day was listed in the previous, outdated version of the RBC table. Therefore, there are no changes necessary to the proposed criteria.

III. POLLUTANT MOBILITY CRITERIA FOR METALS

Comment:

8. The ground water protection criterion for cobalt was calculated correctly by the Navy. However, the approach used by the Navy in calculating pollutant mobility criteria for cobalt is unacceptable. Rather than using the calculated ground water protection criterion (420 µg/l) to establish a pollutant mobility criterion for cobalt, the Navy used the EPA Region III Risk Based Criteria for tap water (2,200 µg/L) as the GAA/GA pollutant mobility criterion. This approach is less conservative than using the calculated ground water protection criterion. The correct pollutant mobility criteria for cobalt, based on the groundwater protection criteria calculated by the Navy, are 420 µg/L for a GAA/GA area, and 4,200 µg/L for a GB area (measurement by TCLP or SPLP).

Response:

The pollutant mobility criteria for cobalt will be changed to 420 µg/L for a GAA/GA area and 4,200 µg/L for a GB area. This revision has no impact on the human health risk assessment because of the following reasons: (1) none of the historical soil samples that were analyzed by TCLP had leachates that were analyzed for cobalt, and (2) only the soil samples from Zone 6 had SPLP leachates that were analyzed for cobalt and all of the results were nondetects.

Comment:

9. The ground water protection criterion for manganese was calculated correctly by the Navy. Rather than using the calculated ground water protection criterion (160 µg/l) to establish a pollutant mobility criterion for manganese, the Navy used the EPA Secondary MCL for drinking water (50 µg/L) as the GAA/GA pollutant mobility criterion. This approach is acceptable as it is more conservative than using the calculated ground water protection criterion.

Response:

No response required.

IV. GB POLLUTANT MOBILITY CRITERIA FOR DIMETHYLPHthalATE

Comment:

10. The GB pollutant mobility criteria listed for dimethylphthalate (1,400 mg/kg) in the Navy's Table 2 appears to be a typo. The correct value should be listed as 14,000 mg/kg.

Response:

The GB pollutant mobility criteria for dimethylphthalate will be corrected to 14,000 mg/kg. This revision has no impact on the analysis since dimethylphthalate was not detected in soil samples in any of the zones that were evaluated in the human health risk assessment.

V. BIS(2-CHLOROETHOXY)METHANE

Comment:

11. The Navy proposes a qualitative risk assessment for this compound. This approach is acceptable provided that the compound is not present at concentrations above the low part-per-billion range. As noted by Dr. Ginsberg, if it is present above this range, a more quantitative risk assessment may be required.

Response:

Bis(2-chloroethoxy)methane was not detected in soil or groundwater samples for any of the zones evaluated in the human health risk assessment, consequently this does not have any impact on the analysis.

TABLE 1

**SOURCE OF CONNECTICUT REMEDIATION STANDARDS
CTO 260 LOWER SUBBASE RI
NEW LONDON, GROTON, CONNECTICUT
PAGE 1 OF 4**

Chemical	CAS Number	Chemical Fraction	Basis of Value to be Used in RI Report		
			Promulgated Value ⁽¹⁾	Calculated Value ⁽²⁾	Surrogate Calculated Value ⁽³⁾
Acenaphthene	83329	SVOC		X	
Acenaphthylene	208968	SVOC	X		
Anthracene	120127	SVOC	X		
Acetone	67641	VOC	X		
Aldrin	309002	PEST		X	
Aluminum	7429905	INORG	(4)	(4)	(4)
Antimony	7440360	INORG	X		
Arsenic	7440382	INORG	X		
Barium	7440393	INORG	X		
Benzene	71432	VOC	X		
Benzo(a)anthracene	56553	SVOC	X		
Benzo(b)fluoranthene	205992	SVOC	X		
Benzo(k)fluoranthene	207089	SVOC	X		
Benzo(g,h,i)perylene	191242	SVOC			X (pyrene)
Benzo(a)pyrene	50328	SVOC	X		
Beryllium	7440417	INORG	X		
BCH (alpha-)	319846	PEST		X	
BCH (beta-)	319857	PEST		X	
BCH (delta-)	319868	PEST			X (alpha-BHC)
BCH (gamma-: Lindane)	58899	PEST	X (5)	(5)	(5)
Bis(2-chloroethoxy)methane	111911	SVOC			
Bis(2-chloroethyl)ether	111444	SVOC	X		
Bis(2-ethylhexyl)phthalate	117817	SVOC	X		
Bromochloromethane	74975	VOC			X (bromodichloro- methane)
Bromodichloromethane	75274	VOC		X	
Bromoform	75252	VOC	X		
Bromomethane	74839	VOC		X	
4-Bromophenyl-phenylether	101553	SVOC		X	
2-Butanone	78933	VOC	X		
Butylbenzylphthalate	85687	SVOC	X		
Cadmium	7440439	INORG	X (6)	(6)	(6)
Calcium	7440702	INORG			
Carbazole	86748	SVOC		X	
Carbon disulfide	75150	VOC		X	
Carbon tetrachloride	56235	VOC	X		
Chlordane (alpha-)	57749	PEST	X ⁽⁷⁾		
Chlordane (gamma-)	57749	PEST	X ⁽⁷⁾		
4-Chloroaniiline	106478	SVOC		X	
Chlorobenzene	108907	VOC	X		
Chlorodibromomethane	124481	VOC	X		
Chloroethane	75003	VOC		X	
Chloroform	67663	VOC	X		
Chloromethane	74873	VOC		X	
4-Chloro-3-methylphenol	59507	SVOC	(5)	(5)	(5)

TABLE 1

**SOURCE OF CONNECTICUT REMEDIATION STANDARDS
CTO 260 LOWER SUBBASE RI
NEW LONDON, GROTON, CONNECTICUT
PAGE 2 OF 4**

Chemical	CAS Number	Chemical Fraction	Basis of Value to be Used in RI Report		
			Promulgated Value ⁽¹⁾	Calculated Value ⁽²⁾	Surrogate Calculated Value ⁽³⁾
2-Chloronaphthalene	91587	SVOC		X	
2-Chlorophenol	95578	SVOC	X		
4-Chlorophenyl-phenylether	7005723	SVOC			X (4-Bromophenyl-phenylether)
Chromium (total)		INORG	X ⁽⁶⁾		
Chrysene	218019	SVOC		X	
Cobalt	7440484	INORG		X	
Copper	7440508	INORG	(4)	(4)	(4)
4,4'-DDD	72548	PEST		X	
4,4'-DDE	72559	PEST		X	
4,4'-DDT	50293	PEST		X	
Dibenzofuran	132649	SVOC		X	
Dibenz(a,h)anthracene	53703	SVOC		X	
1,2-Dibromo-3-chloropropane	96128	VOC		X	
1,2-Dibromoethane	106934	VOC		X	
1,2-Dichlorobenzene	95501	VOC/SVOC	X		
1,3-Dichlorobenzene	541731	VOC/SVOC	X		
1,4-Dichlorobenzene	106467	VOC/SVOC	X		
3,3'-Dichlorobenzidine	91941	SVOC		X	
1,1-Dichloroethane	75343	VOC	X		
1,2-Dichloroethane	107062	VOC	X		
1,1-Dichloroethene	75354	VOC	X		
1,2-Dichloroethene (cis-)	156592	VOC	X		
1,2-Dichloroethene (trans-)	156605	VOC	X		
1,2-Dichloroethene (total)	156605	VOC		X	
2,4-Dichlorophenol	120832	SVOC	X		
1,2-Dichloropropane	78875	VOC	X		
1,3-Dichloropropene (cis-)	542756	VOC	X		
1,3-Dichloropropene (trans-)	542756	VOC	X		
Dieldrin	60571	PEST	X		
Diethyl phthalate	84662	SVOC		X	
2,4-Dimethylphenol	105679	SVOC		X	
Dimethylphthalate	131113	SVOC		X	
Di-n-butylphthalate	84742	SVOC	X		
Di-n-octylphthalate	117840	SVOC	X		
4,6-Dinitro-2-methylphenol	534521	SVOC		X	
2,4-Dinitrophenol	51285	SVOC		X	
2,4-Dinitrotoluene	121142	SVOC		X	
2,6-Dinitrotoluene	606202	SVOC		X	
Endosulfan I	115297	PEST		X ⁽⁹⁾	
Endosulfan II	115297	PEST		X ⁽⁹⁾	
Endosulfan sulfate	1031078	PEST			X (endosulfan)
Endrin	72208	PEST	X		
Endrin aldehyde	7421363	PEST			X (endrin)
Endrin ketone	53494705	PEST			X (endrin)

TABLE 1

**SOURCE OF CONNECTICUT REMEDIATION STANDARDS
CTO 260 LOWER SUBBASE RI
NEW LONDON, GROTON, CONNECTICUT
PAGE 3 OF 4**

Chemical	CAS Number	Chemical Fraction	Basis of Value to be Used in RI Report		
			Promulgated Value ⁽¹⁾	Calculated Value ⁽²⁾	Surrogate Calculated Value ⁽³⁾
Ethylbenzene	100414	VOC	X		
Fluoranthene	206440	SVOC	X		
Fluorene	86737	SVOC	X		
Heptachlor	76448	PEST	X		
Heptachlor epoxide	1024573	PEST	X		
Hexachlorobenzene	118741	SVOC	X		
Hexachlorobutadiene	87683	SVOC		X	
Hexachlorocyclopentadiene	77474	SVOC		X	
Hexachloroethane	67721	SVOC	X		
2-Hexanone	73663715	VOC		X	
Indeno(1,2,3-cd)pyrene	193395	SVOC		X	
Iron	7439896	INORG	(4)	(4)	(4)
Isophorone	78591	SVOC		X	
Lead	7439291	INORG	X		
Magnesium	7439954	INORG	(6)	(6)	(6)
Manganese	7439965	INORG		X	
Mercury	7439976	INORG	X		
Methoxychlor	72435	PEST	X		
Methylene chloride	75092	VOC	X		
2-Methylnaphthalene	91576	SVOC		X	
4-Methyl-2-pentanone	108101	VOC	X		
2-Methylphenol	95487	SVOC		X	
4-Methylphenol	106445	SVOC		X	
Naphthalene	91203	SVOC	X		
Nickel	7440020	INORG	X		
2-Nitroaniline	88744	SVOC		X	
3-Nitroaniline	99092	SVOC		X	
4-Nitroaniline	100016	SVOC		X	
Nitrobenzene	98953	SVOC		X	
2-Nitrophenol	88755	SVOC			X (4-nitrophenol)
4-Nitrophenol	100027	SVOC		X	
N-Nitrosodiphenylamine	86306	SVOC		X	
N-Nitrosodi-n-propylamine	621647	SVOC		X	
2,2'-Oxybis(1-chloropropane)	108601	SVOC	(5)	(5)	(5)
Pentachlorophenol	87865	SVOC	X		
Phenanthrene	85018	SVOC	X		
Phenol	108952	SVOC	X		
Potassium	7440097	INORG	(6)	(6)	(6)
Pyrene	129000	SVOC	X		
Selenium	7782492	INORG	X		
Silver	7440224	INORG	X		
Sodium	7440235	INORG	(6)	(6)	(6)
Styrene	100425	VOC	X		
1,1,2,2-Tetrachloroethane	79345	VOC	X		
Tetrachloroethylene	127184	VOC	X		
Thallium	6533739	INORG	X		
Toluene	108883	VOC	X		
Toxaphene	8001352	PEST	X		

TABLE 1

**SOURCE OF CONNECTICUT REMEDIATION STANDARDS
CTO 260 LOWER SUBBASE RI
NEW LONDON, GROTON, CONNECTICUT
PAGE 4 OF 4**

Chemical	CAS Number	Chemical Fraction	Basis of Value to be Used in RI Report		
			Promulgated Value ⁽¹⁾	Calculated Value ⁽²⁾	Surrogate Calculated Value ⁽³⁾
1,2,4-Trichlorobenzene	120821	SVOC		X	
1,1,1-Trichloroethane	71556	VOC	X		
1,1,2-Trichloroethane	79005	VOC	X		
Trichloroethylene	79016	VOC	X		
2,4,5-Trichlorophenol	95954	SVOC		X	
2,4,6-Trichlorophenol	88062	SVOC		X	
Vanadium	7440622	INORG	X		
Vinyl chloride	75014	VOC	X		
Xylene (total)	1330207	VOC	X		
Zinc	7440666	INORG	X		

INORG Inorganic
 PEST Pesticide
 SVOC Semivolatile organic compound
 VOC Volatile organic compound

- 1 State of Connecticut Remediation Standard Regulations, Section 22a-133k (January 1996).
- 2 Published toxicity criteria is available. Toxicity criteria from the current USEPA Region III Risk-Based Concentration Table (October 22, 1997) will be used to calculate a value using the methodology presented in the State guidance (January 1996).
- 3 No toxicity criteria is available. Toxicity criteria for a similarly structured chemical (noted in parentheses) will be used to calculate a value.
- 4 Region I does not advocate a quantitative evaluation of this chemical. Exposure to this chemical will be addressed in a qualitative fashion.
- 5 No promulgated value or published toxicity criteria are available. A similarly structured chemical with published toxicity criteria could not be identified. Exposure to this chemical will be addressed in a qualitative fashion.
- 6 Chemical is an essential nutrient.
- 7 Value for chlordane is used.
- 8 Value for hexavalent chromium is used for conservative purposes.
- 9 Value for endosulfan is used.

TABLE 2
CALCULATED AND SURROGATE CALCULATED VALUES
CTO 260 LOWER SUBBASE RI
NEW LONDON, GROTON, CONNECTICUT
PAGE 1 OF 3

Chemical	Published Toxicological Criteria ⁽¹⁾		Calculated Remediation Standards ⁽²⁾				
	RfD _{oral} (mg/kg/day)	CSF _{oral} (kg/day/mg)	Soil (mg/kg)				Groundwater (ug/L)
			RES DE ⁽³⁾	I/C DE ⁽³⁾	GA/GAA PM	GB PM	GA/GAA GP
Acenaphthene	6.00E-02	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	8.4	84	420
Aldrin	3.00E-05	1.70E+01	0.036	0.34	0.000041	0.00041	0.0021
Benzo(g,h,i)perylene	NA	NA	1000 ⁽⁵⁾	2500 ⁽⁵⁾	4 ⁽⁵⁾	40 ⁽⁵⁾	200 ⁽⁵⁾
BCH (alpha-)	NA	6.30E+00	0.097	0.91	0.00011	0.0011	0.0056
BCH (beta-)	NA	1.80E+00	0.34	3.2	0.00039	0.0039	0.0194
BCH (delta-)	NA	NA	0.097 ⁽⁶⁾	0.91 ⁽⁶⁾	0.00011 ⁽⁶⁾	0.0011 ⁽⁶⁾	0.0056 ⁽⁶⁾
Bromochloromethane	NA	NA	9.9 ⁽⁷⁾	92 ⁽⁷⁾	0.011 ⁽⁷⁾	0.11 ⁽⁷⁾	0.56 ⁽⁷⁾
Bromodichloromethane	2.00E-02	6.20E-02	9.9	92	0.011	0.11	0.56
Bromomethane	1.40E-03	NA	95	1000 ⁽⁴⁾	0.2	2	9.8
4-Bromophenyl-phenylether	5.80E-02	NA	500 ⁽⁴⁾	1000 ⁽⁴⁾	8.2	82	410
Carbazole	NA	2.00E-02	31	290	0.036	0.36	1.8
Carbon disulfide	1.00E-01	NA	500 ⁽⁴⁾	1000 ⁽⁴⁾	14	140	700
4-Chloroaniline	4.00E-03	NA	270	2500 ⁽⁴⁾	0.56	5.6	28
Chloroethane	4.00E-01	2.90E-03	210	1000 ⁽⁴⁾	0.24	2.4	12
Chloromethane	NA	1.30E-02	47	440	0.054	0.54	2.7
4-Chloro-3-methylphenol	NA	NA	NA ⁽⁸⁾	NA ⁽⁸⁾	NA ⁽⁸⁾	NA ⁽⁸⁾	NA ⁽⁸⁾
2-Chloronaphthalene	8.00E-02	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	11	110	560
4-Chlorophenyl-phenylether	NA	NA	500 ⁽⁹⁾	1000 ⁽⁹⁾	8.2 ⁽⁹⁾	82 ⁽⁹⁾	410 ⁽⁹⁾
Chrysene	NA	7.30E-03	84	780	0.096	0.96	4.8
Cobalt	6.00E-02	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	420 ⁽¹⁰⁾	4200 ⁽¹⁰⁾	420
4,4'-DDD	NA	2.40E-01	2.6	24	0.0029	0.029	0.15
4,4'-DDE	NA	3.40E-01	1.8	17	0.0021	0.021	0.1
4,4'-DDT	5.00E-04	3.40E-01	1.8	17	0.0021	0.021	0.1
Dibenzofuran	4.00E-03	NA	270	2500 ⁽⁴⁾	0.56	5.6	28
Dibenz(a,h)anthracene	NA	7.30E+00	0.084	0.78	0.000096	0.00096	0.0048
1,2-Dibromo-3-chloropropane	NA	1.40E+00	0.44	4.1	0.0005	0.005	0.025
1,2-Dibromoethane	NA	8.50E+01	0.0072	0.067	0.0000082	0.000082	0.00041
3,3'-Dichlorobenzidine	NA	4.50E-01	1.4	13	0.0016	0.016	0.078
1,2-Dichloroethene (total)	9.00E-03	NA	500 ⁽⁴⁾	1000 ⁽⁴⁾	1.2	12	63
Diethyl phthalate	8.00E-01	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	110	1100	5600
2,4-Dimethylphenol	2.00E-02	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	2.8	28	140
Dimethylphthalate	1.00E+01	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	1400	14000	70000

TABLE 2

CALCULATED AND SURROGATE CALCULATED VALUES
CTO 260 LOWER SUBBASE RI
NEW LONDON, GROTON, CONNECTICUT
PAGE 2 OF 3

Chemical	Published Toxicological Criteria ⁽¹⁾		Calculated Remediation Standards ⁽²⁾				Groundwater (ug/L)
	RfD _{oral} (mg/kg/day)	CSF _{oral} (kg/day/mg)	Soil (mg/kg)				
			RES DE ⁽³⁾	I/C DE ⁽³⁾	GA/GAA PM	GB PM	GA/GAA GP
4,6-Dinitro-2-methylphenol	1.00E-04	NA	6.8	200	0.014	0.14	0.7
2,4-Dinitrophenol	2.00E-03	NA	140	2500 ⁽⁴⁾	0.28	2.8	14
2,4-Dinitrotoluene	2.00E-03	NA	140	2500 ⁽⁴⁾	0.28	2.8	14
2,6-Dinitrotoluene	1.00E-03	NA	68	2000	0.14	1.4	7
Endosulfan I	6.00E-03	NA	410	1200	0.84	8.4	42
Endosulfan II	6.00E-03	NA	410	1200	0.84	8.4	42
Endosulfan sulfate	NA	NA	410 ⁽¹²⁾	1200 ⁽¹²⁾	0.84 ⁽¹²⁾	8.4 ⁽¹²⁾	42 ⁽¹²⁾
Endrin aldehyde	NA	NA	20 ⁽¹³⁾	610 ⁽¹³⁾	NE ⁽¹³⁾	NE ⁽¹³⁾	NE ⁽¹³⁾
Endrin ketone	NA	NA	20 ⁽¹³⁾	610 ⁽¹³⁾	NE ⁽¹³⁾	NE ⁽¹³⁾	NE ⁽¹³⁾
Hexachlorobutadiene	2.00E-04	7.80E-02	7.9	73	0.009	0.09	0.45
Hexachlorocyclopentadiene	7.00E-03	NA	470	2500 ⁽⁴⁾	0.98	9.8	49
2-Hexanone	4.00E-02	NA	500 ⁽⁴⁾	1000 ⁽⁴⁾	5.6	56	280
Indeno(1,2,3-cd)pyrene	NA	7.30E-01	0.84	7.8	0.00096	0.0096	0.045
Isophorone	2.00E-01	9.50E-04	640	2500 ⁽⁴⁾	0.74	7.4	37
Manganese	2.30E-02	NA	1600	47000	50 ⁽¹⁰⁾⁽¹⁴⁾	500 ⁽¹⁰⁾⁽¹⁴⁾	160
2-Methylnaphthalene	4.00E-02	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	5.6	56	280
2-Methylphenol	5.00E-02	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	7	70	350
4-Methylphenol	5.00E-03	NA	340	2500 ⁽⁴⁾	0.7	7	35
2-Nitroaniline	6.00E-05	NA	4.1	1200	0.0084	0.084	0.42
3-Nitroaniline	3.00E-03	NA	200	2500 ⁽⁴⁾	0.42	4.2	21
4-Nitroaniline	3.00E-03	NA	200	2500 ⁽⁴⁾	0.42	4.2	21
Nitrobenzene	5.00E-04	NA	34	1000	0.07	0.7	3.5
2-Nitrophenol	NA	NA	540 ⁽¹⁵⁾	2500 ⁽¹⁵⁾	1.1 ⁽¹⁵⁾	11 ⁽¹⁵⁾	56 ⁽¹⁵⁾
4-Nitrophenol	8.00E-03	NA	540	2500 ⁽⁴⁾	1.1	11	56
N-Nitrosodiphenylamine	NA	4.90E-03	130	1200	0.14	1.4	7.1
N-Nitrosodi-n-propylamine	NA	7.00E+00	0.088	0.82	0.0001	0.001	0.005
1,2,4-Trichlorobenzene	1.00E-02	NA	680	2500 ⁽⁴⁾	1.4	14	70
2,4,5-Trichlorophenol	1.00E-01	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	14	140	700
2,4,6-Trichlorophenol	NA	1.10E-02	56	520	0.064	0.64	3.2

RfD Reference dose
CSF Cancer slope factor

TABLE 2

CALCULATED AND SURROGATE CALCULATED VALUES
CTO 260 LOWER SUBBASE RI
NEW LONDON, GROTON, CONNECTICUT
PAGE 3 OF 3

RES DE	Direct exposure criteria for residential land use
I/C DE	Direct exposure criteria for industrial/commercial land use.
GA/GAA PM	Pollutant mobility criteria for a GA/GAA classified area
GB PM	Pollutant mobility criteria for a GB classified area
GA/GAA GP	Groundwater protection criteria for a GA/GAA classified area
NA	Not available
NE	None established by Connecticut DEP (January 1996)

- 1 Values obtained from current USEPA Region III Risk-Based Concentration Table (October 22, 1997)
- 2 Calculated using methodologies presented in State guidance (January 1996).
- 3 Calculated value for direct exposure for volatile and semivolatile organics is replaced with the appropriate ceiling limit if the calculated value exceeds the ceiling limit. Ceiling limit for volatiles is 500 mg/kg for residential exposure and 1000 mg/kg for industrial/commercial exposure. Ceiling limit for semivolatiles is 1000 mg/kg for residential exposure and 2500 mg/kg for industrial/commercial exposure.
- 4 Ceiling limit. Calculated value exceeds the ceiling limit.
- 5 Value for pyrene is used.
- 6 Value for alpha-BHC is used.
- 7 Value for bromodichloromethane is used.
- 8 Chemical will be addressed qualitatively at CTEP's request
- 9 Value for 4-bromophenyl-phenylether is used.
- 10 Value is for aqueous units (ug/L) and is based on SPLP or TCLP analytical results.
- 11 Value is based on the Region III RBC for tap water (2200 ug/L).
- 12 Value for endosulfan is used.
- 13 Value for endrin is used.
- 14 Value is based on the secondary Federal MCL for drinking water (50 ug/L).
- 15 Value for 4-nitrophenol is used.



Brown & Root Environmental

Foster Plaza VII
501 Andersen Drive
Pittsburgh, PA 15220-2745

(412) 921-7090
FAX: (412) 921-4040

C-49-12-7-188

December 23, 1997

Brown & Root Environmental Project Number 7237

Mr. Mark Lewis
Connecticut Department of Environmental Protection
Water Management Bureau
Permitting, Enforcement, and Remediation Division
Federal Remediation Program
79 Elm Street
Hartford, Connecticut 06106-5127

Reference: CLEAN Contract No. N62472-90-D-1298
Contract Task Order No. 0260

Subject: Calculated CTDEP Remediation Standards
Lower Subbase Remedial Investigation
Naval Submarine Base - New London, Groton, Connecticut

Dear Mr. Lewis:

In preparation of the Lower Subbase Remedial Investigation (RI) Report, Brown & Root (B&R) Environmental has calculated Remediation Standards following the State of Connecticut Remediation Standard Regulations of January 1996. Standards were developed for all chemicals that were analyzed for during the RI sampling and analysis program that did not have previously established CTDEP standards. The intent of this memo is to identify the sources of the standards to be used in the RI Report and to identify those values which have been developed by B&R Environmental using the State guidance.

Background information and the calculated Remediation Standards are provided in Table 1 and Table 2, respectively, which are enclosed. Table 1 summarizes the basis for the chemical-specific remediation standards (i.e., promulgated, calculated, or calculated using a surrogate) to be included in the RI. The calculated soil Direct Exposure and Pollutant Mobility standards, as well as the Groundwater Standard, are provided in Table 2.

It should be noted that pollutant mobility and groundwater standards for GA classified groundwater are provided in Table 2 for completeness. The groundwater at the Lower Subbase is classified as GB, therefore standards applicable to GB classified groundwater will be emphasized in the Lower Subbase RI Report.



Mr. Mark Lewis
Connecticut Department of Environmental Protection
December 23, 1997 - Page 2

B&R Environmental intends on using these criteria, as well as Region III RBCs, as part of the human health risk assessment for the Lower Subbase RI to screen for chemicals of potential concern. Therefore, B&R Environmental, on the behalf of the United States Navy, requests that the CTDEP review and approve the standards in Table 2. It is hoped that prior approval of the criteria will alleviate unnecessary revisions to the RI Report in the future and expedite any additional risk-related work required by the State (i.e., application for use of alternative criteria).

Due to the current time constraints for preparing the Lower Subbase RI, it is requested that the CTDEP complete their review by no later than January 16, 1997. If you have any questions regarding the information provided in the tables or the schedule for the review please contact Mr. Mark Evans at (610) 595-0567 (ext. 162) or me at (412) 921-8244.

Very truly yours,

Corey A. Rich, P.E.
Project Manager

Enclosure(s)

c: Mr. Mark Evans, NORTHDIV
Mr. Richard Conant, NSB-NLON Environmental
Ms. Karen Smecker, B&R Environmental
File: CTO 0260

TABLE 1

SOURCE OF CONNECTICUT REMEDIATION STANDARDS
CTO 260 LOWER SUBBASE RI
NEW LONDON, GROTON, CONNECTICUT
PAGE 1 OF 4

Chemical	CAS Number	Chemical Fraction	Basis of Value to be Used in RI Report		
			Promulgated Value ⁽¹⁾	Calculated Value ⁽²⁾	Surrogate Calculated Value ⁽³⁾
Acenaphthene	83329	SVOC		X	
Acenaphthylene	208968	SVOC	X		
Anthracene	120127	SVOC	X		
Acetone	67641	VOC	X		
Aldrin	309002	PEST		X	
Aluminum	7429905	INORG	(4)	(4)	(4)
Antimony	7440360	INORG	X		
Arsenic	7440382	INORG	X		
Barium	7440393	INORG	X		
Benzene	71432	VOC	X		
Benz(a)anthracene	56553	SVOC	X		
Benzo(b)fluoranthene	205992	SVOC	X		
Benzo(k)fluoranthene	207089	SVOC	X		
Benzo(g,h,i)perylene	191242	SVOC			X (naphthalene)
Benzo(a)pyrene	50328	SVOC	X		
Beryllium	7440417	INORG	X		
BCH (alpha-)	319846	PEST		X	
BCH (beta-)	319857	PEST		X	
BCH (delta-)	319868	PEST			X (alpha-BHC)
BCH (gamma-; Lindane)	58899	PEST	X		
Bis(2-chloroethoxy)methane	111911	SVOC	(5)	(5)	(5)
Bis(2-chloroethyl)ether	111444	SVOC	X		
Bis(2-ethylhexyl)phthalate	117817	SVOC	X		
Bromochloromethane	74975	VOC			X (chloromethane)
Bromodichloromethane	75274	VOC		X	
Bromoform	75252	VOC	X		
Bromomethane	74839	VOC		X	
4-Bromophenyl-phenylether	101553	SVOC		X	
2-Butanone	78933	VOC	X		
Butylbenzylphthalate	85687	SVOC	X		
Cadmium	7440439	INORG	X		
Calcium	7440702	INORG	(6)	(6)	(6)
Carbazole	86748	SVOC		X	
Carbon disulfide	75150	VOC		X	
Carbon tetrachloride	56235	VOC	X		
Chlordane (alpha-)	57749	PEST	X ⁽⁷⁾		
Chlordane (gamma-)	57749	PEST	X ⁽⁷⁾		
4-Chloroaniline	106478	SVOC		X	
Chlorobenzene	108907	VOC	X		
Chlorodibromomethane	124481	VOC	X		
Chloroethane	75003	VOC		X	
Chloroform	67663	VOC	X		
Chloromethane	74873	VOC		X	

TABLE 1

SOURCE OF CONNECTICUT REMEDIATION STANDARDS
CTO 260 LOWER SUBBASE RI
NEW LONDON, GROTON, CONNECTICUT
PAGE 2 OF 4

Chemical	CAS Number	Chemical Fraction	Basis of Value to be Used in RI Report		
			Promulgated Value ⁽¹⁾	Calculated Value ⁽²⁾	Surrogate Calculated Value ⁽³⁾
4-Chloro-3-methylphenol	59507	SVOC			X (3-methylphenol)
2-Chloronaphthalene	91587	SVOC		X	
2-Chlorophenol	95578	SVOC	X		
4-Chlorophenyl-phenylether	7005723	SVOC			X (4-Bromophenyl-phenylether)
Chromium (total)		INORG	X ⁽⁸⁾		
Chrysene	218019	SVOC		X	
Cobalt	7440484	INORG		X	
Copper	7440508	INORG	(4)	(4)	(4)
4,4'-DDD	72548	PEST		X	
4,4'-DDE	72559	PEST		X	
4,4'-DDT	50293	PEST		X	
Dibenzofuran	132649	SVOC		X	
Dibenz(a,h)anthracene	53703	SVOC		X	
1,2-Dibromo-3-chloropropane	96128	VOC		X	
1,2-Dibromoethane	106934	VOC		X	
1,2-Dichlorobenzene	95501	VOC/SVOC	X		
1,3-Dichlorobenzene	541731	VOC/SVOC	X		
1,4-Dichlorobenzene	106467	VOC/SVOC	X		
3,3'-Dichlorobenzidine	91941	SVOC		X	
1,1-Dichloroethane	75343	VOC	X		
1,2-Dichloroethane	107062	VOC	X		
1,1-Dichloroethene	75354	VOC	X		
1,2-Dichloroethene (cis-)	156592	VOC	X		
1,2-Dichloroethene (trans-)	156605	VOC	X		
1,2-Dichloroethene (total)	156605	VOC		X	
2,4-Dichlorophenol	120832	SVOC	X		
1,2-Dichloropropane	78875	VOC	X		
1,3-Dichloropropene (cis-)	542756	VOC	X		
1,3-Dichloropropene (trans-)	542756	VOC	X		
Dieldrin	60571	PEST	X		
Diethyl phthalate	84662	SVOC		X	
2,4-Dimethylphenol	105679	SVOC		X	
Dimethylphthalate	131113	SVOC		X	
Di-n-butylphthalate	84742	SVOC	X		
Di-n-octylphthalate	117840	SVOC	X		
4,6-Dinitro-2-methylphenol	534521	SVOC		X	
2,4-Dinitrophenol	51285	SVOC		X	
2,4-Dinitrotoluene	121142	SVOC		X	
2,6-Dinitrotoluene	606202	SVOC		X	
Endosulfan I	115297	PEST		X ⁽⁹⁾	
Endosulfan II	115297	PEST		X ⁽⁹⁾	
Endosulfan sulfate	1031078	PEST			X (endosulfan)

TABLE 1

SOURCE OF CONNECTICUT REMEDIATION STANDARDS
CTO 260 LOWER SUBBASE RI
NEW LONDON, GROTON, CONNECTICUT
PAGE 3 OF 4

Chemical	CAS Number	Chemical Fraction	Basis of Value to be Used in RI Report		
			Promulgated Value ⁽¹⁾	Calculated Value ⁽²⁾	Surrogate Calculated Value ⁽³⁾
Endrin	72208	PEST	X		
Endrin aldehyde	7421363	PEST			X (endrin)
Endrin ketone	53494705	PEST			X (endrin)
Ethylbenzene	100414	VOC	X		
Fluoranthene	206440	SVOC	X		
Fluorene	86737	SVOC	X		
Heptachlor	76448	PEST	X		
Heptachlor epoxide	1024573	PEST	X		
Hexachlorobenzene	118741	SVOC	X		
Hexachlorobutadiene	87683	SVOC		X	
Hexachlorocyclopentadiene	77474	SVOC		X	
Hexachloroethane	67721	SVOC	X		
2-Hexanone	73663715	VOC		X	
Indeno(1,2,3-cd)pyrene	193395	SVOC		X	
Iron	7439896	INORG	(4)	(4)	(4)
Isophorone	78591	SVOC		X	
Lead	7439291	INORG	X		
Magnesium	7439954	INORG	(6)	(6)	(6)
Manganese	7439965	INORG		X	
Mercury	7439976	INORG	X		
Methoxychlor	72435	PEST	X		
Methylene chloride	75092	VOC	X		
2-Methylnaphthalene	91576	SVOC		X	
4-Methyl-2-pentanone	108101	VOC	X		
2-Methylphenol	95487	SVOC		X	
4-Methylphenol	106445	SVOC		X	
Naphthalene	91203	SVOC	X		
Nickel	7440020	INORG	X		
2-Nitroaniline	88744	SVOC		X	
3-Nitroaniline	99092	SVOC		X	
4-Nitroaniline	100016	SVOC		X	
Nitrobenzene	98953	SVOC		X	
2-Nitrophenol	88755	SVOC			X (4-nitrophenol)
4-Nitrophenol	100027	SVOC		X	
N-Nitrosodiphenylamine	86306	SVOC		X	
N-Nitrosodi-n-propylamine	621647	SVOC		X	
2,2'-Oxybis(1-chloropropane)	108601	SVOC	(5)	(5)	(5)
Pentachlorophenol	87865	SVOC	X		
Phenanthrene	85018	SVOC			X (naphthalene)
Phenol	108952	SVOC	X		
Potassium	7440097	INORG	(6)	(6)	(6)
Pyrene	129000	SVOC	X		

TABLE 1

**SOURCE OF CONNECTICUT REMEDIATION STANDARDS
CTO 260 LOWER SUBBASE RI
NEW LONDON, GROTON, CONNECTICUT
PAGE 4 OF 4**

Chemical	CAS Number	Chemical Fraction	Basis of Value to be Used in RI Report		
			Promulgated Value ⁽¹⁾	Calculated Value ⁽²⁾	Surrogate Calculated Value ⁽³⁾
Selenium	7782492	INORG	X		
Silver	7440224	INORG	X		
Sodium	7440235	INORG	(6)	(6)	(6)
Styrene	100425	VOC	X		
1,1,2,2-Tetrachloroethane	79345	VOC	X		
Tetrachloroethylene	127184	VOC	X		
Thallium	6533739	INORG	X		
Toluene	108883	VOC	X		
Toxaphene	8001352	PEST	X		
1,2,4-Trichlorobenzene	120821	SVOC		X	
1,1,1-Trichloroethane	71556	VOC	X		
1,1,2-Trichloroethane	79005	VOC	X		
Trichloroethylene	79016	VOC	X		
2,4,5-Trichlorophenol	95954	SVOC		X	
2,4,6-Trichlorophenol	88062	SVOC		X	
Vanadium	7440622	INORG	X		
Vinyl chloride	75014	VOC	X		
Xylene (total)	1330207	VOC	X		
Zinc	7440666	INORG	X		

INORG Inorganic
PEST Pesticide
SVOC Semivolatile organic compound
VOC Volatile organic compound

- 1 State of Connecticut Remediation Standard Regulations, Section 22a-133k (January 1996).
- 2 Published toxicity criteria is available. Toxicity criteria from the current USEPA Region III Risk-Based Concentration Table (October 22, 1997) will be used to calculate a value using the methodology presented in the State guidance (January 1996).
- 3 No toxicity criteria is available. Toxicity criteria for a similarly structured chemical (noted in parentheses) will be used to calculate a value.
- 4 Region I does not advocate a quantitative evaluation of this chemical. Exposure to this chemical will be addressed in a qualitative fashion.
- 5 No promulgated value or published toxicity criteria are available. A similarly structured chemical with published toxicity criteria could not be identified. Exposure to this chemical will be addressed in a qualitative fashion.
- 6 Chemical is an essential nutrient.
- 7 Value for chlordane is used.
- 8 Value for hexavalent chromium is used for conservative purposes.
- 9 Value for endosulfan is used.

TABLE 2

CALCULATED AND SURROGATE CALCULATED VALUES
CTO 260 LOWER SUBBASE RI
NEW LONDON, GROTON, CONNECTICUT
PAGE 1 OF 3

Chemical	Published Toxicological Criteria ⁽¹⁾		Calculated Remediation Standards ⁽²⁾				Groundwater (ug/L)
	RfD _{oral} (mg/kg/day)	CSF _{oral} (kg/day/mg)	Soil (mg/kg)				
			RES DE ⁽³⁾	IC DE ⁽³⁾	GA/GAA PM	GB PM	GA/GAA GP
Acenaphthene	6.00E-02	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	8.4	84	420
Aldrin	3.00E-05	1.70E+01	0.036	0.34	0.000041	0.00041	0.0021
Benzo(g,h,i)perylene	NA	NA	1000 ⁽⁵⁾	2500 ⁽⁵⁾	5.6 ⁽⁵⁾	56 ⁽⁵⁾	280 ⁽⁵⁾
BCH (alpha-)	NA	6.30E+00	0.097	0.91	0.00011	0.0011	0.0056
BCH (beta-)	NA	1.80E+00	0.34	3.2	0.00039	0.0039	0.0194
BCH (delta-)	NA	NA	0.097 ⁽⁶⁾	0.91 ⁽⁶⁾	0.00011 ⁽⁶⁾	0.0011 ⁽⁶⁾	0.0056 ⁽⁶⁾
Bromochloromethane	NA	NA	47 ⁽⁷⁾	440 ⁽⁷⁾	0.054 ⁽⁷⁾	0.54 ⁽⁷⁾	2.7 ⁽⁷⁾
Bromodichloromethane	2.00E-02	6.20E-02	9.9	92	0.011	0.11	0.56
Bromomethane	1.40E-03	NA	95	1000 ⁽⁴⁾	0.2	2	9.8
4-Bromophenyl-phenylether	5.80E-02	NA	500 ⁽⁴⁾	1000 ⁽⁴⁾	8.2	82	410
Carbazole	NA	2.00E-02	31	290	0.036	0.36	1.8
Carbon disulfide	1.00E-01	NA	500 ⁽⁴⁾	1000 ⁽⁴⁾	14	140	700
4-Chloroaniline	4.00E-03	NA	270	2500 ⁽⁴⁾	0.56	5.6	28
Chloroethane	4.00E-01	2.90E-03	210	1000 ⁽⁴⁾	0.24	2.4	12
Chloromethane	NA	1.30E-02	47	440	0.054	0.54	2.7
4-Chloro-3-methylphenol	NA	NA	1000 ⁽⁸⁾	2500 ⁽⁸⁾	7 ⁽⁸⁾	70 ⁽⁸⁾	350 ⁽⁸⁾
2-Chloronaphthalene	8.00E-02	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	11	110	560
4-Chlorophenyl-phenylether	NA	NA	500 ⁽⁹⁾	1000 ⁽⁹⁾	8.2 ⁽⁹⁾	82 ⁽⁹⁾	410 ⁽⁹⁾
Chrysene	NA	7.30E-03	84	780	0.096	0.96	4.8
Cobalt	6.00E-02	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	2200 ⁽¹⁰⁾⁽¹¹⁾	22000 ⁽¹⁰⁾⁽¹¹⁾	420
4,4'-DDD	NA	2.40E-01	2.6	24	0.0029	0.029	0.15
4,4'-DDE	NA	3.40E-01	1.8	17	0.0021	0.021	0.1
4,4'-DDT	5.00E-04	3.40E-01	1.8	17	0.0021	0.021	0.1
Dibenzofuran	4.00E-03	NA	270	2500 ⁽⁴⁾	0.56	5.6	28
Dibenz(a,h)anthracene	NA	7.30E+00	0.084	0.78	0.000096	0.00096	0.0048
1,2-Dibromo-3-chloropropane	NA	1.40E+00	0.44	4.1	0.0005	0.005	0.025
1,2-Dibromoethane	NA	8.50E+01	0.0072	0.067	0.0000082	0.000082	0.00041
3,3'-Dichlorobenzidine	NA	4.50E-01	1.4	13	0.0016	0.016	0.078
1,2-Dichloroethene (total)	2.00E-02	NA	500 ⁽⁴⁾	1000 ⁽⁴⁾	2.8	28	140
Diethyl phthalate	8.00E-01	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	110	1100	5600

TABLE 2

CALCULATED AND SURROGATE CALCULATED VALUES
CTO 260 LOWER SUBBASE RI
NEW LONDON, GROTON, CONNECTICUT
PAGE 2 OF 3

Chemical	Published Toxicological Criteria ⁽¹⁾		Calculated Remediation Standards ⁽²⁾				
	RfD _{oral} (mg/kg/day)	CSF _{oral} (kg/day/mg)	Soil (mg/kg)				Groundwater (ug/L)
			RES DE ⁽³⁾	I/C DE ⁽³⁾	GA/GAA PM	GB PM	GA/GAA GP
2,4-Dimethylphenol	2.00E-02	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	2.8	28	140
Dimethylphthalate	1.00E+01	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	1400	1400	70000
4,6-Dinitro-2-methylphenol	1.00E-04	NA	6.8	200	0.014	0.14	0.7
2,4-Dinitrophenol	2.00E-03	NA	140	2500 ⁽⁴⁾	0.28	2.8	14
2,4-Dinitrotoluene	2.00E-03	NA	140	2500 ⁽⁴⁾	0.28	2.8	14
2,6-Dinitrotoluene	1.00E-03	NA	68	2000	0.14	1.4	7
Endosulfan I	6.00E-03	NA	410	1200	0.84	8.4	42
Endosulfan II	6.00E-03	NA	410	1200	0.84	8.4	42
Endosulfan sulfate	NA	NA	410 ⁽¹²⁾	1200 ⁽¹²⁾	0.84 ⁽¹²⁾	8.4 ⁽¹²⁾	42 ⁽¹²⁾
Endrin aldehyde	NA	NA	20 ⁽¹³⁾	610 ⁽¹³⁾	NE ⁽¹³⁾	NE ⁽¹³⁾	NE ⁽¹³⁾
Endrin ketone	NA	NA	20 ⁽¹³⁾	610 ⁽¹³⁾	NE ⁽¹³⁾	NE ⁽¹³⁾	NE ⁽¹³⁾
Hexachlorobutadiene	2.00E-04	7.80E-02	7.9	73	0.009	0.09	0.45
Hexachlorocyclopentadiene	7.00E-03	NA	470	2500 ⁽⁴⁾	0.98	9.8	49
2-Hexanone	4.00E-02	NA	500 ⁽⁴⁾	1000 ⁽⁴⁾	5.6	56	280
Indeno(1,2,3-cd)pyrene	NA	7.30E-01	0.84	7.8	0.00096	0.0096	0.045
Isophorone	2.00E-01	9.50E-04	640	2500 ⁽⁴⁾	0.74	7.4	37
Manganese	2.30E-02	NA	1600	47000	50 ⁽¹⁰⁾⁽¹⁴⁾	500 ⁽¹⁰⁾⁽¹⁴⁾	160
2-Methylnaphthalene	4.00E-02	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	5.6	56	280
2-Methylphenol	5.00E-02	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	7	70	350
4-Methylphenol	5.00E-03	NA	340	2500 ⁽⁴⁾	0.7	7	35
2-Nitroaniline	6.00E-05	NA	4.1	1200	0.0084	0.084	0.42
3-Nitroaniline	3.00E-03	NA	200	2500 ⁽⁴⁾	0.42	4.2	21
4-Nitroaniline	3.00E-03	NA	200	2500 ⁽⁴⁾	0.42	4.2	21
Nitrobenzene	5.00E-04	NA	34	1000	0.07	0.7	3.5
2-Nitrophenol	NA	NA	540 ⁽¹⁵⁾	2500 ⁽¹⁵⁾	1.1 ⁽¹⁵⁾	11 ⁽¹⁵⁾	56 ⁽¹⁵⁾
4-Nitrophenol	8.00E-03	NA	540	2500 ⁽⁴⁾	1.1	11	56
N-Nitrosodiphenylamine	NA	4.90E-03	130	1200	0.14	1.4	7.1
N-Nitrosodi-n-propylamine	NA	7.00E+00	0.088	0.82	0.0001	0.001	0.005
Phenanthrene	NA	NA	1000 ⁽⁵⁾	2500 ⁽⁵⁾	5.6 ⁽⁵⁾	56 ⁽⁵⁾	280 ⁽⁵⁾
1,2,4-Trichlorobenzene	1.00E-02	NA	680	2500 ⁽⁴⁾	1.4	14	70

TABLE 2

**CALCULATED AND SURROGATE CALCULATED VALUES
CTO 260 LOWER SUBBASE RI
NEW LONDON, GROTON, CONNECTICUT
PAGE 3 OF 3**

Chemical	Published Toxicological Criteria ⁽¹⁾		Calculated Remediation Standards ⁽²⁾				Groundwater (ug/L)
	RfD _{oral} (mg/kg/day)	CSF _{oral} (kg/day/mg)	Soil (mg/kg)				
			RES DE ⁽³⁾	I/C DE ⁽³⁾	GA/GAA PM	GB PM	GA/GAA GP
2,4,5-Trichlorophenol	1.00E-01	NA	1000 ⁽⁴⁾	2500 ⁽⁴⁾	14	140	700
2,4,6-Trichlorophenol	NA	1.10E-02	56	520	0.064	0.64	3.2

RfD	Reference dose
CSF	Cancer slope factor
RES DE	Direct exposure criteria for residential land use
I/C DE	Direct exposure criteria for industrial/commercial land use.
GA/GAA PM	Pollutant mobility criteria for a GA/GAA classified area
GB PM	Pollutant mobility criteria for a GB classified area
GA/GAA GP	Groundwater protection criteria for a GA/GAA classified area
NA	Not available
NE	None established by Connecticut DEP (January 1996)

- 1 Values obtained from current USEPA Region III Risk-Based Concentration Table (October 22, 1997)
- 2 Calculated using methodologies presented in State guidance (January 1996).
- 3 Calculated value for direct exposure for volatile and semivolatile organics is replaced with the appropriate ceiling limit if the calculated value exceeds the ceiling limit. Ceiling limit for volatiles is 500 mg/kg for residential exposure and 1000 mg/kg for industrial/commercial exposure. Ceiling limit for semivolatiles is 1000 mg/kg for residential exposure and 2500 mg/kg for industrial/commercial exposure.
- 4 Ceiling limit. Calculated value exceeds the ceiling limit.
- 5 Value for naphthalene is used.
- 6 Value for alpha-BHC is used.
- 7 Value for chloromethane is used.
- 8 Value for 3-methylphenol is used.
- 9 Value for 4-bromophenyl-phenylether is used.
- 10 Value is for aqueous units (ug/L) and is based on SPLP or TCLP analytical results.
- 11 Value is based on the Region III RBC for tap water (2200 ug/L).
- 12 Value for endosulfan is used.
- 13 Value for endrin is used.
- 14 Value is based on the secondary Federal MCL for drinking water (50 ug/L).
- 15 Value for 4-nitrophenol is used.

APPENDIX I.3
SAMPLE CALCULATIONS

CLIENT NSB-NLON Groton, CT		JOB NUMBER 7237	
SUBJECT Calculation of the UCL for Log-Normal Distribution			
BASED ON		DRAWING NUMBER	
BY PAK	CHECKED BY LHJ	APPROVED BY	DATE 2/13/98

Objective: To calculate the 95% Upper Confidence Limit (UCL) of the transformed data for a set of log-normally distributed data.

Relevant Equation:

$$UCL = e^{\bar{x} + 0.55^2 + \frac{5H_{(1-\alpha)}}{\sqrt{n-1}}} \text{ and } S = \sqrt{\frac{\sum (\ln x_i - \bar{x})^2}{n-1}}$$

Where: \bar{x} = mean of the transformed data

x_i = individual sample value

n = population of a data set

UCL = Upper Confidence Limit of transformed data

S = Standard Deviation

$H_{1-\alpha}$ = H statistic for computing one-sided confidence limit ($1 - \alpha = 95\%$)

Sample Calculation:

For benzo(a) pyrene in "all soil" from Zone 4, $n = 11$

and $H_{0.95} = 3.815 \checkmark$

CLIENT NS3-NLON Groton CT		JOB NUMBER 7237	
SUBJECT Calculation of the UCL for Log-Normal Distribution			
BASED ON		DRAWING NUMBER	
BY PAK	CHECKED BY LHJ	APPROVED BY	DATE 2/13/98

Sample	x_i (ug/Kg)	$\ln x_i$	$(\ln x_i - \bar{x})^2$
1	4300	8.3664 ✓	10.7860 ✓
2	73	4.2905	0.6268
3	59	4.0775	1.0094
4	41	3.7136	1.8731
5	410	6.0162	0.8724
6	64	4.1589 ✓	0.8525 ✓
7	120	4.7875	0.80868 ✓
8	680	6.5221	2.0733
9	110	4.7005	0.1457
10	59	4.0775	1.0094
11	3600/2 = 180	5.1930	0.0123
		$\Sigma = 55.9037$ ✓	$\Sigma = 19.3477$ ✓

$$\bar{x} = 55.9037 / 11 = 5.0822 \checkmark$$

$$S = \sqrt{\frac{19.3477}{10}} = 1.391 \checkmark$$

$$H_{0.95} = 3.815 \checkmark \text{ for } S_y \text{ of } 1.391 \text{ and } n = 11$$

$$UCL = e^{5.0822 + 0.5(1.391)^2 + \frac{(1.391)(3.815)}{\sqrt{10}}}$$

$$UCL = e^{7.7277} = \boxed{2270.4 \text{ ug/Kg}} \checkmark$$

CLIENT NSB-NLON, Groton, CT		JOB NUMBER 7237	
SUBJECT Calculation of the UCL for Log-Normal Distribution			
BASED ON		DRAWING NUMBER	
BY PAK	CHECKED BY LHJ	APPROVED BY	DATE 2/13/98

Table A12 Values of $H_{1-\alpha} = H_{0.95}$ for Computing a One-Sided Upper 95% Confidence Limit on a Lognormal Mean

n	3	5	7	10	12	15	21	31	51	101
0.10	2.730	2.035	1.886	1.802	1.775	1.748	1.722	1.701	1.684	1.670
0.20	3.295	2.198	1.992	1.881	1.843	1.809	1.771	1.742	1.718	1.697
0.30	4.109	2.402	2.125	1.977	1.927	1.882	1.833	1.793	1.761	1.733
0.40	5.220	2.631	2.282	2.089	2.026	1.968	1.908	1.856	1.813	1.777
0.50	6.495	2.947	2.465	2.220	2.141	2.068	1.989	1.928	1.876	1.830
0.60	7.807	3.287	2.673	2.368	2.271	2.181	2.085	2.018	1.946	1.891
0.70	9.120	3.662	2.906	2.532	2.416	2.306	2.191	2.102	2.023	1.960
0.80	10.43	4.062	3.155	2.710	2.570	2.441	2.307	2.202	2.112	2.035
0.90	11.74	4.478	3.420	2.902	2.738	2.589	2.432	2.310	2.206	2.117
1.00	13.05	4.905	3.698	3.103	2.915	2.744	2.564	2.423	2.306	2.205
1.25	16.33	6.001	4.476	3.639	3.389	3.183	2.923	2.737	2.580	2.447
1.50	19.60	7.120	5.184	4.202	3.896	3.612	3.311	3.077	2.881	2.713
1.75	22.87	8.250	5.960	4.795	4.422	4.081	3.719	3.437	3.200	2.997
2.00	26.14	9.387	6.767	5.396	4.962	4.566	4.191	3.852	3.533	3.295
2.50	32.69	11.67	8.339	6.621	6.067	5.537	5.013	4.588	4.228	3.920
3.00	39.23	13.97	9.945	7.864	7.191	6.570	5.907	5.388	4.947	4.549
3.50	45.77	16.27	11.56	9.118	8.326	7.596	6.815	6.201	5.681	5.233
4.00	52.31	18.58	13.18	10.38	9.469	8.630	7.731	7.024	6.424	5.908
4.50	58.85	20.88	14.80	11.64	10.62	9.669	8.652	7.856	7.174	6.590
5.00	65.39	23.19	16.43	12.91	11.77	10.71	9.579	8.688	7.929	7.277
6.00	78.47	27.81	19.68	15.45	14.08	12.81	11.64	10.36	9.449	8.661
7.00	91.55	32.43	22.94	18.00	16.39	14.90	13.31	12.05	10.98	10.05
8.00	104.6	37.06	26.20	20.55	18.71	17.01	15.18	13.74	12.51	11.45
9.00	117.7	41.68	29.46	23.10	21.03	19.11	17.05	15.43	14.05	12.85
10.00	130.8	46.31	32.73	25.64	23.35	21.22	18.93	17.13	15.59	14.26

Source: Alter Land, 1975.
This table is used in Section 13.2.

CLIENT NSB-NLON, Groton, CT		JOB NUMBER 7237	
SUBJECT Calculation of average concentrations for groundwater			
BASED ON		DRAWING NUMBER	
BY PAK	CHECKED BY LHJ	APPROVED BY	DATE 2/18/98

Objective : To calculate the average chemical concentration in a groundwater well over several sampling rounds. Then to utilize the average concentration for each groundwater well to calculate an average of all average well concentrations. The average of all average concentrations is representative of all groundwater at a given site over all sampling rounds and all phases of investigation. The average of all averages will be utilized in risk assessment.

Relevant Equations :

$$\bar{x}_w = \frac{\sum x_1 + x_2 \dots}{n_s}$$

$$\bar{x}_a = \frac{\sum \bar{x}_{w1} + \bar{x}_{w2} + \bar{x}_{w3} \dots}{n_w}$$

Where : \bar{x}_w = average chemical concentration in a groundwater well
 x_1 = chemical concentration in a well during Sampling round 1
 x_2 = chemical concentration in a well during sampling round 2
 n_s = number of sampling rounds

\bar{x}_a = average of all average concentrations
 \bar{x}_{w1} = average chemical concentration in well 1
 \bar{x}_{w2} = average chemical concentration in well 2

n_w = number of wells in site being evaluated

CLIENT NSB-NLON, Groton, CT		JOB NUMBER 7237	
SUBJECT Calculation of average concentrations for groundwater			
BASED ON		DRAWING NUMBER	
BY PAK	CHECKED BY LHJ	APPROVED BY	DATE 2/18/98

The number of x_i values used depends on how many rounds of data were collected. Similarly, the number \bar{x}_w value used depends on how many groundwater wells are in a given site.

The following assumptions are made:

- 1) Nondetected results were utilized in average calculations by using $\frac{1}{2}$ of the detection limit.
- 2) Field duplicate samples were averaged and treated as one sample.

Sample Calculation:

For Zone 5,
for barium in unfiltered groundwater for monitoring well 19MW2
where:

x_1 = concentration of barium in 19MW2 collected on 4/29/93 = 43.7 $\mu\text{g/L}$
 x_2 = concentration of barium in 19MW2 collected on 10/28/97 = 324 $\mu\text{g/L}$
 n_s = 2 sampling "rounds"

$$\bar{x}_w = \frac{\sum \frac{1}{2}(43.7) \mu\text{g/L} + 324 \mu\text{g/L}}{2}$$

$$\bar{x}_w = \boxed{172.925 \mu\text{g/L}} \checkmark$$

For barium in all unfiltered groundwater monitoring wells for Zone 5 where:

Well	\bar{x}_i		\bar{x}_a
$w_1 = 19\text{MW}2$	172.925 $\mu\text{g/L}$ \checkmark		$\bar{x}_a = \frac{172.925 + 106.7 + 33.05}{3}$
$w_2 = 19\text{MW}3$	106.7 $\mu\text{g/L}$ \checkmark		
$w_3 = 19\text{MW}4$	33.05 $\mu\text{g/L}$ \checkmark		$\bar{x}_a = \boxed{104.225 \mu\text{g/L}} \checkmark$

CLIENT NSB-NLON, Groton, CT		JOB NUMBER 7237	
SUBJECT Calculation of Intakes/Risks for Dermal Contact with Groundwater			
BASED ON		DRAWING NUMBER	
BY PAK	CHECKED BY LHJ	APPROVED BY	DATE 2/12/98

Purpose: To calculate estimated exposure intakes and noncarcinogenic and carcinogenic risks associated with dermal contact with groundwater. Reasonable Maximum Exposures are calculated.

Relevant Equations:

$$DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$$

where: DAD = dermally absorbed dose (mg/Kg/day)

DA_{event} = absorbed dose per event (mg/cm²/event)

EV = event frequency (events/day)

ED = exposure duration (years)

EF = exposure frequency (days/year)

A = skin surface area available for contact (cm²)

BW = body weight (Kg)

AT = averaging time (days)

where: DA_{event}

for inorganics: $DA_{event} = K_p \times C \times t_{event} \times CF$

for organics: If $t_{event} < t^*$, $DA_{event} = 2K_p \times C \times CF \times \frac{(6T \times t_{event})}{\pi}$

If $t_{event} > t^*$, $DA_{event} = K_p \times C \times CF \times ((t_{event}/(1+B)) + (2T \times ((1+3B)/(1+B)))$

where: K_p = permeability coefficient (cm/hour)

C = concentration of contaminant or chemical in water (mg/l)

t_{event} = duration of event (hour/event)

CF = conversion factor (l/1000 cm³)

t* = time it takes to reach steady-state (hour)

T = lag time (hour)

B = partitioning constant derived by Bunge Model (dimensionless)

CLIENT NSB - NLON, Groton, CT		JOB NUMBER 7237	
SUBJECT Calculation of Intakes/Risks for Dermal Contact with Groundwater			
BASED ON		DRAWING NUMBER	
BY PAK	CHECKED BY LHJ	APPROVED BY	DATE 2/12/98

Sample Calculations (Using Reasonable Maximum Exposure Assumptions):

For a construction worker, the following assumptions are made,

C = chemical specific

EV = 1 event / day

ED = 1 year

EF = 120 days / year

A = 3800 cm²

t_{event} = 8 hours / event

BW = 70 Kg

AT = 365 days x ED, for noncarcinogenic effects

AT = 365 days x 70 years = 25550 days, for carcinogenic effect

For beryllium at a maximum concentration of 0.00062 mg/L in groundwater in Zone 1.

Since $DA_{event} = K_p \times C \times t_{event} \times CF$ for an inorganic compound

$$DA_{event} = (1.00E-3 \text{ cm/hr}) (0.00062 \text{ mg/L}) (8 \text{ hours/event}) (1 \text{ L}/1000 \text{ cm}^3)$$

$$= 4.96E-9 \text{ mg/cm}^2/\text{event} \checkmark$$

DAD for noncarcinogenic effect is

$$DAD_n = \frac{(4.96E-9 \text{ mg/cm}^2/\text{event})(1 \text{ event/day})(1 \text{ yr})(120 \text{ d/yr})(3800 \text{ cm}^2)}{(70 \text{ Kg})(365 \text{ days})}$$

$$= 8.85E-8 \text{ mg/Kg/day} \checkmark$$

CLIENT NSB - NLGN, Groton, CT		JOB NUMBER	
SUBJECT Calculation of Intakes/Risks for Dermal Contact with Groundwater			
BASED ON		DRAWING NUMBER	
BY PAK	CHECKED BY LHJ	APPROVED BY	DATE 2/12/98

DAD for carcinogenic effect,

$$DAD_c = \frac{(4.96E-9 \text{ mg/cm}^2/\text{event})(1 \text{ event/day})(1 \text{ yr})(120 \text{ d/yr})(3800 \text{ cm}^2)}{(70 \text{ Kg})(25550 \text{ days})}$$

$$= 1.26E-9 \text{ mg/Kg/day} \quad \checkmark$$

For beryllium,

$$CSF_{\text{dermal}} = \frac{CSF_{\text{oral}}}{\text{Gastrointestinal Absorption Factor}}$$

$$= \frac{4.3E+0}{0.05} = 8.6E+1 \text{ (mg/Kg/day)}^{-1} \quad \checkmark$$

Carcinogenic Risk = $DAD_c \times CSF_{\text{dermal}}$

$$= (1.26E-9 \text{ mg/Kg/day}) \times (8.6E+1 \text{ (mg/Kg/day)}^{-1})$$

$$= \boxed{1.08E-7} \quad \checkmark$$

For beryllium,

$$RFD_{\text{dermal}} = RFD_{\text{oral}} \times \text{Gastrointestinal Absorption Factor}$$

$$= (5E-3 \text{ mg/Kg/day}) \times (0.05)$$

$$= 2.5E-4 \text{ mg/Kg/day} \quad \checkmark$$

Hazard Index for

Noncarcinogenic Risk = DAD_n / RFD

$$= \frac{8.85E-8 \text{ mg/Kg/day}}{2.5E-4 \text{ mg/Kg/day}}$$

$$= \boxed{3.54E-04} \quad \checkmark$$

CLIENT NSB-NLCN, Groton, CT		JOB NUMBER 7237	
SUBJECT Calculation of Intakes/Risks for Incidental Ingestion of Soil			
BASED ON USEPA, December 1989		DRAWING NUMBER	
BY PAK	CHECKED BY LHJ	APPROVED BY	DATE 2/12/98

Purpose: To calculate estimated exposure intakes and noncarcinogenic and carcinogenic risks associated with incidental ingestion of soil. Reasonable Maximum Exposures (RME) are calculated.

Relevant Equations:

$$\text{Dose (mg/kg/day)} = (C \times IR \times F_i \times BIC \times EF \times ED) / (BW \times AT \times 1E+6)$$

- where:
- C = concentration of chemical in soil (mg/kg)
 - IR = soil ingestion rate (mg/event)
 - F_i = fraction from contaminated source
 - BIC = bioavailability
 - EF = exposure frequency (events/year)
 - ED = exposure duration (years)
 - BW = body weight (Kg)
 - AT = averaging time (days)

Sample Calculations:

For a Full-Time Employee, the following assumptions are made,

- C = chemical specific
- IR = 100 mg/event
- F_i = 1
- EF = 150 events/year
- ED = 25 years
- BIC = chemical specific
- BW = 70 Kg
- AT = 365 days × ED, for noncarcinogenic effects
- AT = 365 $\frac{\text{days}}{\text{yr}}$ × 70 years = 25550 days, for carcinogenic effects

CLIENT NSB-NLON, Groton, CT		JOB NUMBER 7237	
SUBJECT Calculation of Intakes/Risks for Incidental Ingestion of Soil			
BASED ON		DRAWING NUMBER	
BY PAK	CHECKED BY LHJ	APPROVED BY	DATE 2/12/98

For arsenic at a 95% UCL concentration in surface soil of 2.5 mg/Kg in Zone 7:

$$\begin{aligned} \text{Noncarcinogenic Dose (mg/Kg/day)} &= \frac{(2.5 \text{ mg/Kg})(100 \text{ mg/event})(1)(1)(150 \text{ events/yr})(25 \text{ years})}{(70 \text{ Kg})(365 \text{ days/yr})(25 \text{ years})(1E+6 \text{ mg/Kg})} \\ &= 1.47E-6 \text{ mg/Kg/day} \quad \checkmark \end{aligned}$$

$$\begin{aligned} \text{Carcinogenic Dose (mg/Kg/day)} &= \frac{(2.5 \text{ mg/Kg})(100 \text{ mg/event})(1)(1)(150 \text{ events/yr})(25 \text{ years})}{(70 \text{ Kg})(25550 \text{ days})(1E+6 \text{ mg/Kg})} \\ &= 5.24E-7 \text{ mg/Kg/day} \quad \checkmark \end{aligned}$$

For arsenic,

$$\begin{aligned} \text{CSF}_{\text{oral}} &= 1.50E+0 (\text{mg/Kg/day})^{-1} \\ \text{RfD}_{\text{oral}} &= 3.00E-04 \text{ mg/Kg/day} \end{aligned}$$

Hazard Index (HI) for Noncarcinogenic Risk

$$\begin{aligned} &= \text{Dose}_{\text{noncarcinogenic}} / \text{RfD}_{\text{oral}} \\ &= (1.47E-6 \text{ mg/Kg/day}) / (3.00E-04 \text{ mg/Kg/day}) \\ &= \boxed{4.90E-3} \quad \checkmark \end{aligned}$$

Incremental Cancer Risk (ICR) = Dose_{carcinogenic} × CSF_{oral}

$$\begin{aligned} &= (5.24E-7 \text{ mg/Kg/day})(1.50E+0 (\text{mg/Kg/d})^{-1}) \\ &= \boxed{7.86E-7} \quad \checkmark \end{aligned}$$

CLIENT NSB-NLON, Groton, CT		JOB NUMBER 7237	
SUBJECT Calculation of Intakes/Risks for Dermal Contact with Soil			
BASED ON US EPA, December 1989, Jan 1992		DRAWING NUMBER	
BY RJJ	CHECKED BY Rm	APPROVED BY 1	DATE 10/6/98

Purpose: To calculate estimated exposure intakes and noncarcinogenic and carcinogenic risks associated with dermal contact with soil. Reasonable Maximum Exposure (RME) are calculated.

Relevant Equations:

$$\text{Dose (mg/Kg/day)} = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 10^6)$$

- where:
- C = concentration of chemical in soil (mg/kg)
 - SA = skin surface area (cm²/day)
 - AF = Soil adherence factor (mg/cm²)
 - ABS = Chemical specific absorption factor
 - EF = Exposure frequency (days/yr)
 - ED = Exposure duration (yr)
 - AT = Averaging time (days)

Sample Calculations:

For a full-time employee, the following assumptions are made,

- C = chemical specific
- SA = 3800 cm²/day
- AF = 1 mg/cm²
- ABS = chemical specific
- EF = 150 days/yr
- ED = 25 years
- AT = 365 days/yr for noncarcinogenic effects
- AT = 365 days/yr × 70 years = 25550 days for carcinogenic effects

CLIENT NSB-NLON, Groton, CT		JOB NUMBER 7237	
SUBJECT Calculation of Intakes/Risks for Dermal Contact with Soil			
BASED ON USEPA December 1989 January 1992		DRAWING NUMBER	
BY RJJ	CHECKED BY Rm	APPROVED BY	DATE 10/6/88

For arsenic at a 95% UCL concentration in surface soil of 2.5 mg/kg in Zone 7:

$$\begin{aligned} \text{Non carcinogenic Dose (mg/kg/dy)} &= \frac{(2.5 \text{ mg/kg})(3800 \text{ cm}^2/\text{dy})(1 \text{ m}^2/\text{cm}^2)(0.03)(150 \text{ dy/yr})(25 \text{ yr})}{(70 \text{ kg})(365 \text{ dy/yr})(25 \text{ yrs})(1 \text{ E}+6 \text{ mg/kg})} \\ &= 1.67 \times 10^{-6} \frac{\text{mg}}{\text{kg-dy}} \end{aligned}$$

$$\begin{aligned} \text{Carcinogenic Dose (mg/kg/dy)} &= \frac{(2.5 \text{ mg/kg})(3800 \text{ cm}^2/\text{dy})(1 \text{ m}^2/\text{cm}^2)(0.03)(150 \text{ dy/yr})(25 \text{ yr})}{(70 \text{ kg})(25350 \text{ dy})(1 \text{ E}+6 \text{ mg/kg})} \\ &= 5.98 \times 10^{-7} \frac{\text{mg}}{\text{kg-dy}} \end{aligned}$$

For arsenic

$$\begin{aligned} \text{CSF}_{\text{derm}} &= 1.6 (\text{mg/kg/dy})^{-1} \\ \text{RFD}_{\text{derm}} &= 2.8 \text{ E}-4 \text{ mg/kg/dy} \end{aligned}$$

Hazard Index (HI) for Noncarcinogenic Risk
= Dose_{noncarcinogenic} / RFD_{derm}

$$\begin{aligned} &= (1.67 \times 10^{-6} \text{ mg/kg/dy}) / (2.8 \text{ E}-4 \text{ mg/kg/dy}) \\ &= \boxed{5.96 \text{ E}-3} \end{aligned}$$

Incremental Cancer Risk (ICR) = Dose_{carcinogenic} × CSF_{derm}

$$\begin{aligned} &= (5.98 \times 10^{-7} \text{ mg/kg/dy})(1.6) (\text{mg/kg/dy})^{-1} \\ &= \boxed{9.57 \times 10^{-7}} \end{aligned}$$

CLIENT NSB-NLCN		JOB NUMBER 7237	
SUBJECT Calculation of 95th Percentile Fetal Blood Lead Concentrations for Adult Exposure to Soil			
BASED ON USEPA, December 1996		DRAWING NUMBER	
BY PAK	CHECKED BY LHJ	APPROVED BY	DATE 2/23/98

Objective: To calculate the 95th percentile fetal blood lead concentrations for adult exposure to soil.

Relevant Equations:

$$PbB_{adult, central} = PbB_{adult, c} + ((PbS \times BKSF \times IR_s \times AF_s \times EF_s) / AT)$$

$$PbB_{fetal, 0.95} = PbB_{adult, central} \times GSD_{i, adult}^{1.645} \times R_{fetal/maternal}$$

Where:

$PbB_{adult, c}$ = typical blood lead concentration in adult women of child-bearing age in absence of site exposures (ug/dL)

PbS = site-specific soil lead concentration (mg / Kg)

$BKSF$ = biokinetic slope factor (ug/dL) / (ug/day)

IR_s = intake rate of soil, includes outdoor soil and indoor soil-derived dust (g/day)

AF_s = absolute gastrointestinal absorption fraction (unitless)

EF_s = exposure frequency (days / year)

AT = averaging time (days / year)

$GSD_{i, adult}$ = estimate of individual geometric standard deviation among adults (unitless)

$R_{fetal/maternal}$ = constant of proportionality between fetal blood lead concentration at birth and maternal blood lead concentration (unitless)

CLIENT NSB - NLGN		JOB NUMBER 7237	
SUBJECT Calculation of 95th Percentile Fetal Blood Lead Concentrations for Adult Exposure to Soil			
BASED ON USEPA December 1996		DRAWING NUMBER	
BY PAK	CHECKED BY LHJ	APPROVED BY	DATE 2/23/98

For a construction worker, RME scenario in Zone 2

Where:

$$PbB_{adult, c} = 2.0 \mu g / dL$$

$$PbS = 404 \text{ mg} / \text{kg}$$

$$BKSF = (0.4 \mu g / dL) / (\mu g / \text{day})$$

$$IR_s = 0.48 \text{ g} / \text{day}$$

$$AF_s = 0.12$$

$$EF_s = 120 \text{ days} / \text{year}$$

$$AT = 365 \text{ days} / \text{year}$$

$$GSD_{i, adult} = 2.1$$

$$R_{fetal / maternal} = 0.9$$

$$PbB_{adult, central} = 2.0 \frac{\mu g}{dL} + \left(\frac{404 \text{ mg}}{\text{kg}} \times \frac{0.4 \mu g / dL}{\mu g / \text{day}} \times \frac{0.48 \text{ g}}{\text{day}} \times 0.12 \times \frac{120 \text{ days}}{\text{year}} \right) \frac{1}{365 \text{ days} / \text{year}}$$

$$= 2.0 \mu g / dL + 3.06 \mu g / dL$$

$$= \boxed{5.06 \mu g / dL} \checkmark$$

$$PbB_{fetal, c.95} = 5.06 \frac{\mu g}{dL} \times 2.1^{1.645} \times 0.9$$

$$= \boxed{15.43 \mu g / dL} \checkmark$$

EPA/600/8-91/011B
January 1992
Interim Report

**DERMAL EXPOSURE ASSESSMENT:
PRINCIPLES AND APPLICATIONS**

Exposure Assessment Group
Office of Health and Environmental Assessment
U.S. Environmental Protection Agency
Washington, D.C. 20460

Table 5-8. K_p , τ , t^* , and B for Common Pollutants

Chemical	CAS No.	Measured	Estimated	τ (hr)	t^* (hr)	B
		K_p (cm/hr)	K_p (cm/hr)			
ORGANICS:						
Acetaldehyde	75070		7.2e-04	1.6e-01	3.9e-01	6.0e-05
Acetamide	60355		1.1e-04	2.0e-01	4.8e-01	5.5e-06
Acetylaminofluorene, 2-	53963		1.7e-02	2.0e+00	7.7e+00	1.7e-01
Acrolein	107028		7.4e-04	1.9e-01	4.6e-01	7.9e-05
Acrylamide	79061		2.4e-04	2.4e-01	5.7e-01	2.1e-05
Acrylonitrile	107131		1.4e-03	1.8e-01	4.4e-01	1.8e-04
Aldrin	309002		1.6e-03	1.5e+01	3.6e+01	1.0e-01
Allyl chloride	107051		7.0e-03	2.6e-01	6.2e-01	2.8e-03
Amino-2-methylantraquinone, 1-	82280		6.6e-03	2.4e+00	5.9e+00	6.3e-02
Aminoanthraquinone, 2-	117793		2.8e-03	2.0e+00	4.8e+00	1.4e-02
Aminoazobenzene, p-	60093		8.7e-03	1.4e+00	3.3e+00	4.2e-02
Aminoazotoluene, o-	97563		4.9e-02	2.1e+00	1.6e+01	8.3e-01
Aminobiphenyl, 4-	92671		1.7e-02	9.4e-01	2.3e+00	6.3e-02
Aniline	62533	4.1e-02	2.2e-03	3.2e-01	7.8e-01	7.9e-04
Anisidine, o-	90040		1.7e-03	6.7e-01	1.6e+00	1.5e-03
Auramine	492808		1.5e-02	3.7e+00	2.1e+01	3.5e-01
* Benzene	71432	1.1e-01	2.1e-02	2.6e-01	6.3e-01	1.3e-02
Benzidine	92875		1.3e-03	1.2e+00	2.8e+00	2.2e-03
* Benzo-a-anthracene	56553		8.1e-01	2.2e+00	1.0e+01	4.6e+01
* Benzo-a-pyrene	50328		1.2e+00	2.9e+00	1.4e+01	1.3e+02
* Benzo-b-fluoranthene	205992		1.2e+00	3.0e+00	1.4e+01	1.3e+02
Benzoic acid	65850		7.3e-03	4.9e-01	1.2e+00	7.4e-03
Benzotrichloride	98077		1.5e-02	1.4e+00	3.2e+00	8.3e-02
Benzyl chloride	100447		1.4e-02	5.2e-01	1.2e+00	2.0e-02
Bis(2-chloroethyl)ether	111444		2.1e-03	6.5e-01	1.6e+00	1.9e-03

* - Indicates chemicals that were evaluated in the human health risk assessment.

Table 5-8. (continued)

Chemical	CAS No.	Measured	Estimated	τ (hr)	t^* (hr)	B
		Kp (cm/hr)	Kp (cm/hr)			
Bromodichloromethane	75274		5.8e-03	8.7e-01	2.1e+00	1.2e-02
Bromoform	75252		2.6e-03	3.0e+00	7.3e+00	2.3e-02
Bromomethane	74839		3.5e-03	3.3e-01	8.0e-01	1.5e-03
Bromophenol, p-	106412	3.6e-02	1.3e-02	9.9e-01	2.4e+00	4.5e-02
Butadiene, 1,3-	106990		2.3e-02	1.9e-01	4.5e-01	9.8e-03
Butanediol, 2,3-	513859	5.0e-05	1.2e-04	3.1e-01	7.4e-01	1.2e-05
Butanol, n-	71363	2.5e-03	1.9e-03	2.5e-01	5.9e-01	4.5e-04
Butoxyethanol, 2-	111762	1.2e-02	1.4e-03	4.6e-01	1.1e+00	6.8e-04
Captan	133062		1.3e-03	5.9e+00	1.4e+01	2.2e-02
Carbon disulfide	75150	5.0e-01	2.4e-02	2.7e-01	6.5e-01	1.7e-02
Carbon tetrachloride	56235		2.2e-02	7.6e-01	1.8e+00	6.8e-02
Chlordane	57749		5.2e-02	2.8e+01	1.3e+02	3.5e+01
Chlordane (cis)	5103719		4.6e-02	2.8e+01	1.3e+02	3.0e+01
Chlordane (trans)	5103742		4.6e-02	2.8e+01	1.3e+02	3.0e+01
Chlorobenzene	108907		4.1e-02	4.3e-01	1.0e+00	6.9e-02
Chlorocresol	59507	5.0e-02	4.1e-02	6.5e-01	1.9e+00	1.3e-01
Chlorodibromomethane	124481		3.9e-03	1.6e+00	3.9e+00	1.7e-02
Chloroethane	75003		8.0e-03	2.2e-01	5.2e-01	2.7e-03
* Chloroform	67663	1.3e-01	8.9e-03	4.7e-01	1.1e+00	9.3e-03
Chloromethane	74873		4.2e-03	1.8e-01	4.3e-01	8.1e-04
Chlorophenol, o-	95578	3.3e-02	1.1e-02	5.3e-01	1.3e+00	1.4e-02
Chlorophenol, p-	106489	3.6e-02	1.6e-02	5.3e-01	1.3e+00	2.5e-02
Chlorothalonil	1897456		2.5e-02	3.7e+00	2.8e+01	7.2e-01
Chloroxylenol		6.0e-02	3.0e-04	5.6e-01	1.3e+00	1.0e-04
Chrysene	218019		8.1e-01	2.2e+00	1.0e+01	4.6e+01
Cresidine, p-	120718		4.3e-03	6.0e-01	1.4e+00	4.7e-03
Cresol, m-	108394	1.5e-02	1.0e-02	4.0e-01	9.6e-01	9.1e-03

Table 5-8. (continued)

Chemical	CAS No.	Measured	Estimated	τ (hr)	t^* (hr)	B
		Kp (cm/hr)	Kp (cm/hr)			
Cresol, o-	95487	1.6e-02	1.0e-02	4.0e-01	9.6e-01	8.9e-03
Cresol, p-	106445	1.8e-02	1.0e-02	4.0e-01	9.6e-01	8.7e-03
DDD	72548		2.8e-01	7.8e+00	3.7e+01	6.3e+01
DDE	72559		2.4e-01	7.6e+00	3.6e+01	4.9e+01
DDT	50293		4.3e-01	1.3e+01	6.0e+01	2.3e+02
Decanol	112301	8.0e-02	1.7e-01	8.1e-01	5.6e+00	1.3e+00
* Di-2-ethylhexyl phthalate	117817		3.3e-02	2.1e+01	1.0e+02	1.3e+01
Diaminoanisole, 2,4-	615054		2.3e-04	6.1e-01	1.5e+00	7.6e-05
Diaminotoluene	95807		6.0e-04	4.9e-01	1.2e+00	2.2e-04
Diaminotoluene, 2,4-	101804		3.3e-03	1.5e+00	3.5e+00	1.1e-02
Dibenzo(a,h)anthracene	53703		2.7e+00	4.4e+00	2.1e+01	6.9e+02
Dibutyl phthalate	84742		3.3e-02	4.3e+00	2.9e+01	1.3e+00
Dichlorobenzene, 1,2-	95501		6.1e-02	6.9e-01	3.2e+00	2.4e-01
Dichlorobenzene, 1,3-	541731		8.7e-02	6.9e-01	4.1e+00	4.0e-01
Dichlorobenzene, 1,4-	106467		6.2e-02	6.9e-01	3.3e+00	2.5e-01
Dichlorobenzidine, 3,3'	91941		1.7e-02	3.1e+00	1.7e+01	3.2e-01
Dichlorodifluoromethane	75718		1.2e-02	4.8e-01	1.1e+00	1.4e-02
Dichloroethane, 1,1-	75343		8.9e-03	3.5e-01	8.4e-01	6.2e-03
Dichloroethane, 1,2-	107062		5.3e-03	3.5e-01	8.4e-01	3.0e-03
* Dichloroethylene, 1,1-	75354		1.6e-02	3.4e-01	8.2e-01	1.3e-02
Dichloroethylene, 1,2- (trans)	540590		1.0e-02	3.4e-01	8.2e-01	7.2e-03
Dichlorophenol, 2,4-	120832	6.0e-02	2.3e-02	8.6e-01	2.1e+00	8.3e-02
Dichloropropane, 1,2-	78875		1.0e-02	4.3e-01	1.0e+00	1.0e-02
Dichloropropene, 1,3-	542756		5.5e-03	4.2e-01	1.0e+00	4.0e-03
Dichlorvos	62737		9.5e-04	1.9e+00	4.7e+00	3.0e-03
Dieldrin	60571		1.6e-02	1.8e+01	9.4e+01	3.6e+00
Diepoxybutane	1464535		2.8e-05	2.9e-01	7.0e-01	1.4e-06

Table 5-8. (continued)

Chemical	CAS No.	Measured	Estimated	τ (hr)	t^* (hr)	B
		Kp (cm/hr)	Kp (cm/hr)			
Diethyl phthalate	84662		4.8e-03	2.0e+00	4.7e+00	3.0e-02
Diethyl sulfate	64675		1.4e-03	7.6e-01	1.8e+00	1.4e-03
Dimethoxybenzidine, 3,3'-	119904		1.0e-03	3.1e+00	7.5e+00	6.5e-03
Dimethyl phthalate	131113		1.6e-03	1.3e+00	3.2e+00	3.6e-03
Dimethyl sulfate	77781		2.2e-03	5.1e-01	1.2e+00	1.4e-03
Dimethylamine, n-nitroso-	62759		2.7e-04	2.5e-01	5.9e-01	2.7e-05
Dimethylaminoazobenzene, 4-	60117		1.4e-01	2.1e+00	1.0e+01	3.8e+00
Dimethylbenzidine, 3,3'-	119937		4.4e-03	1.7e+00	4.1e+00	2.2e-02
Dimethylcarbonyl chloride	79447		4.2e-04	4.0e-01	9.5e-01	1.0e-04
Dimethylhydrazine, 1,1-	57147		7.1e-05	2.0e-01	4.9e-01	3.2e-06
Dimethylphenol, 2,4-	105679	1.1e-01	1.5e-02	4.9e-01	1.2e+00	2.0e-02
Dimethylphenol, 3,4-	95658	4.0e-02	1.3e-02	4.9e-01	1.2e+00	1.7e-02
Dinitrophenol, 2,4-	51285	3.2e-03	1.8e-03	1.2e+00	2.8e+00	3.5e-03
Dinitrotoluene, 2,4-	121142		3.8e-03	1.1e+00	2.7e+00	9.5e-03
Dinitrotoluene, 2,6-	606202		2.5e-03	1.1e+00	2.7e+00	5.2e-03
Dioxane, 1,4-	123911	4.0e-04	3.6e-04	3.0e-01	7.2e-01	5.4e-05
Diphenylamine, n-nitroso-	86306		2.0e-02	1.4e+00	4.5e+00	1.3e-01
Diphenylhydrazine, 1,2-	122667		1.8e-02	1.2e+00	2.8e+00	8.7e-02
Dipropylamine, n-nitroso-	621647		2.8e-03	5.4e-01	1.3e+00	2.3e-03
Endrin	72208		1.6e-02	1.8e+01	9.4e+01	3.6e+00
Epichlorohydrin	106898		3.7e-04	3.2e-01	7.6e-01	6.2e-05
Ethanol	64175	8.0e-04	6.0e-04	1.7e-01	4.0e-01	4.9e-05
Ethanol, 2-(2-butoxyethoxy)-	112345		4.4e-05	8.5e-01	2.0e+00	1.2e-05
Ethanol, 2-(2-ethoxyethoxy)-	111900		2.5e-04	5.7e-01	1.4e+00	8.3e-05
Ethanol, 2-(2-methoxyethoxy)-	111773		1.8e-04	4.7e-01	1.1e+00	3.8e-05
Ethoxyethanol, 2-	110805	3.0e-04	4.6e-04	3.1e-01	7.4e-01	7.9e-05
Ethoxyethyl acetate, 2-	111159		8.6e-04	5.6e-01	1.3e+00	4.5e-04

Table 5-8. (continued)

Chemical	CAS No.	Measured	Estimated	τ (hr)	t^* (hr)	B
		Kp (cm/hr)	Kp (cm/hr)			
Ethyl acrylate	140885		4.0e-03	3.6e-01	8.6e-01	2.1e-03
Ethyl carbamate	51796		4.3e-04	3.1e-01	7.3e-01	7.1e-05
Ethyl ether	60297	1.7e-02	2.9e-03	2.5e-01	5.9e-01	7.8e-04
Ethylbenzene	100414	1.0e+00	7.4e-02	3.9e-01	1.3e+00	1.4e-01
Ethylene oxide	75218		6.3e-04	1.6e-01	3.9e-01	5.0e-05
Ethylenedibromide	106934		3.3e-03	1.2e+00	2.9e+00	9.1e-03
Ethyleneimine	151564		1.7e-04	1.6e-01	3.8e-01	7.6e-06
Ethylenethiourea	96457		1.7e-04	3.4e-01	8.1e-01	2.2e-05
Ethylphenol, p-	123079	3.5e-02	1.4e-02	4.7e-01	1.1e+00	1.8e-02
Fluoranthene	206440		3.6e-01	1.5e+00	7.3e+00	8.9e+00
Formaldehyde	50000		2.2e-03	1.3e-01	3.2e-01	2.2e-04
Glycerol	56815	1.4e-04	2.9e-05	3.2e-01	7.7e-01	1.7e-06
Heptachlor	76448		1.1e-02	1.7e+01	9.4e+01	1.9e+00
Heptanol	111706	3.8e-02	1.9e-02	4.5e-01	1.1e+00	2.6e-02
Hexachlorobenzene	118741		2.1e-01	4.8e+00	2.3e+01	2.0e+01
Hexachlorobutadiene	87683		1.2e-01	3.4e+00	1.7e+01	6.0e+00
Hexachloroethane	67721		4.2e-02	2.4e+00	1.9e+01	8.5e-01
Hexamethylphosphoramide	680319		1.6e-04	1.1e+00	2.6e+00	1.1e-04
Hexanol	111273	3.0e-02	1.3e-02	3.7e-01	8.8e-01	1.1e-02
Hydrazine/Hydrazine sulfate	302012		4.1e-05	1.4e-01	3.3e-01	8.5e-07
* Indeno(1,2,3-CD)pyrene	193395		1.9e+00	4.2e+00	2.0e+01	3.8e+02
Isophorone	78591		4.2e-03	6.1e-01	1.5e+00	4.7e-03
Lindane	58899		1.4e-02	5.2e+00	3.5e+01	5.2e-01
Mechlorethamine	51752		1.2e-03	7.8e-01	1.9e+00	1.2e-03
Methanol	67561	1.6e-03	3.5e-04	1.4e-01	3.3e-01	1.7e-05
Methoxyethanol, 2-	109864		1.9e-04	2.5e-01	6.1e-01	1.7e-05
Methoxypropan-2-ol, 1-	107982		4.0e-04	3.1e-01	7.4e-01	6.6e-05

Table 5-8. (continued)

Chemical	CAS No.	Measured	Estimated	τ (hr)	t^* (hr)	B
		Kp (cm/hr)	Kp (cm/hr)			
Methyl ethyl ketone	78933	5.0e-03	1.1e-03	2.4e-01	5.8e-01	1.9e-04
Methyl hydroxybenzoate	99763	9.1e-03	5.2e-03	7.4e-01	1.8e+00	8.3e-03
Methyl iodide	74884		3.1e-03	6.4e-01	1.5e+00	3.2e-03
Methylaziridine, 2-	75558		3.2e-04	1.9e-01	4.7e-01	2.5e-05
Methylene bis(2-chloroaniline), 4,4'-	101144		2.8e-02	3.7e+00	3.0e+01	8.7e-01
Methylene bis(N,N'-dimethyl)aniline, 4,4'-	101611		1.3e-01	3.1e+00	1.5e+01	5.6e+00
* Methylene chloride	75092		4.5e-03	2.9e-01	6.9e-01	1.8e-03
Methylenedianiline, 4,4'-	101779		1.6e-03	1.4e+00	3.4e+00	3.9e-03
Michler's ketone	90948		3.4e-02	3.8e+00	ERR	1.2e+00
Mustard Gas	505602		5.6e-03	8.2e-01	2.0e+00	1.1e-02
Naphthalene	91203		6.9e-02	5.3e-01	2.2e+00	2.0e-01
Naphthol, b-	135193	2.8e-02	2.6e-02	6.6e-01	1.6e+00	6.9e-02
Naphthylamine, 1-	134327		1.0e-02	6.5e-01	1.6e+00	1.8e-02
Naphthylamine, 2-	91598		1.1e-02	6.5e-01	1.6e+00	1.9e-02
Nitrilotriacetic acid	139139		9.7e-05	1.3e+00	3.1e+00	6.6e-05
Nitro-o-anisidine, 5-	99592		2.5e-03	7.5e-01	1.8e+00	2.9e-03
Nitrobiphenyl, 4-	92933		5.5e-02	1.4e+00	1.0e+01	5.9e-01
Nitrofen	1836755		3.0e-01	4.7e+00	2.2e+01	3.4e+01
Nitrophenol, 2-	88755	1.0e-01	5.0e-03	6.2e-01	1.5e+00	6.2e-03
Nitrophenol, 2-amino-4-	99570	7.0e-04	2.0e-03	7.6e-01	1.8e+00	2.3e-03
Nitrophenol, 3-	554847	5.6e-03	7.1e-03	6.2e-01	1.5e+00	1.0e-02
Nitrophenol, 4-	100027	5.6e-03	6.1e-03	6.2e-01	1.5e+00	8.1e-03
Nitrophenol, 4-amino-2-	119346	3.0e-03	1.1e-03	7.6e-01	1.8e+00	9.1e-04
Nitropropane, 2-	79469		1.0e-03	4.1e-01	9.8e-01	3.6e-04
Nitroso-di-n-butylamine, n-	924163		4.8e-03	8.1e-01	1.9e+00	8.3e-03
Nitroso-N-ethylurea, n-	759739		5.4e-04	4.5e-01	1.1e+00	1.7e-04

Table 5-8. (continued)

Chemical	CAS No.	Measured	Estimated	τ (hr)	t^* (hr)	B
		Kp (cm/hr)	Kp (cm/hr)			
Nitroso-N-methylurea, n-	684935		4.3e-04	3.7e-01	8.9e-01	9.3e-05
Nitrosodiethanolamine, n-	1116547	5.0e-06	2.2e-05	5.7e-01	1.4e+00	2.6e-06
Nitrosodiethylamine, n-	55185		1.2e-03	3.0e-01	7.2e-01	3.0e-04
Nitrosodiphenylamine, p-	156105		3.6e-02	1.4e+00	7.6e+00	3.2e-01
Nitrosomethylvinylamine, n-	4549400		5.7e-04	2.9e-01	7.0e-01	9.9e-05
Nitrosomorpholine, n-	59892		1.8e-04	4.5e-01	1.1e+00	3.6e-05
Nitrosornicotine, n-	16543558		1.7e-04	1.1e+00	2.5e+00	1.1e-04
Nitrosopiperidine, n-	100754		2.5e-05	1.2e+01	2.9e+01	2.3e-04
Nonanol	143088	6.0e-02	7.3e-02	6.6e-01	3.4e+00	2.9e-01
Octanol	111875	6.1e-02	3.9e-02	5.4e-01	1.3e+00	9.3e-02
Parathion	56382		1.7e-02	5.2e+00	3.8e+01	6.8e-01
PCB-chlorobiphenyl, 4-	2051629		1.3e+00	5.3e+00	2.5e+01	3.2e+02
PCB-hexachlorobiphenyl	26601649		7.1e-01	1.4e+01	6.6e+01	5.2e+02
Pentachloronitrobenzene	82688		5.9e-02	5.5e+00	2.8e+01	4.4e+00
Pentachlorophenol	87865		6.5e-01	3.7e+00	1.7e+01	7.2e+01
Pentanol	71410	6.0e-03	7.1e-03	3.0e-01	7.2e-01	3.6e-03
Pentanone, 4-methyl-2-	108101		3.3e-03	3.6e-01	8.6e-01	1.5e-03
Phenanthrene	85018		2.3e-01	1.1e+00	5.6e+00	2.9e+00
Phenol	108952	8.2e-03	5.5e-03	3.3e-01	7.9e-01	2.9e-03
Phenol, 4,6-dinitro-2-methyl-	534521		3.8e-03	1.4e+00	3.4e+00	1.3e-02
Propanol	71238	1.7e-03	1.3e-03	2.0e-01	4.9e-01	2.0e-04
Propiolactone, beta-	57578		3.3e-04	2.4e-01	5.8e-01	3.5e-05
Propylene oxide	75569		8.9e-04	2.0e-01	4.7e-01	1.1e-04
Resorcinol	108463	2.4e-04	1.5e-03	4.1e-01	9.9e-01	6.3e-04
Safrole	94597		1.5e-02	8.5e-01	2.0e+00	4.6e-02
Styrene	100425	6.7e-01	5.5e-02	3.8e-01	9.1e-01	8.9e-02
Styrene oxide	96093		4.9e-03	4.7e-01	1.1e+00	4.1e-03

Table 5-8. (continued)

Chemical	CAS No.	Measured	Estimated	τ (hr)	t^* (hr)	B
		Kp (cm/hr)	Kp (cm/hr)			
TCDD	1746016		1.4e+00	8.1e+00	3.8e+01	6.3e+02
* Tetrachlorethylene	127184	3.7e-01	4.8e-02	9.0e-01	4.3e+00	2.5e-01
Tetrachloroethane, 1,1,2,2-	79345		9.0e-03	9.2e-01	2.2e+00	2.5e-02
Thioacetamide	62555		2.1e-03	2.5e-01	6.0e-01	5.1e-04
Thiodianiline, 4,4'-	139651		2.5e-03	1.8e+00	4.4e+00	1.1e-02
Thiourea	62566	9.6e-05	1.4e-04	2.5e-01	6.1e-01	1.1e-05
Thymol	89838	5.3e-02	5.1e-02	7.2e-01	3.0e+00	2.0e-01
Toluene	108883	1.0e+00	4.5e-02	3.2e-01	7.7e-01	5.4e-02
Toluidine hydrochloride, o-	636215		2.1e-03	6.5e-01	1.6e+00	1.9e-03
Toluidine, o-	95534		3.7e-03	3.9e-01	9.4e-01	2.1e-03
Toxaphene	8001352		1.5e-02	2.9e+01	1.4e+02	6.6e+00
Trichlorobenzene, 1,2,4-	120821		1.0e-01	1.1e+00	9.3e+00	9.5e-01
Trichloroethane, 1,1,1-	71556		1.7e-02	5.7e-01	1.4e+00	3.1e-02
Trichloroethane, 1,1,2-	79005		8.4e-03	5.7e-01	1.4e+00	1.1e-02
Trichloroethylene	79016	2.3e-01	1.6e-02	5.5e-01	1.3e+00	2.6e-02
Trichlorofluoromethane	75694		1.7e-02	6.0e-01	1.4e+00	3.4e-02
Trichlorophenol, 2,4,6-	88062	5.9e-02	5.0e-02	1.4e+00	9.2e+00	4.9e-01
Tris(2,3-dibromopropyl)phosphate	126727		3.6e-04	1.6e+03	7.6e+03	9.5e+00
Tris(aziridinyl)-para-benzoquinone	68768		8.3e-06	2.3e+00	5.4e+00	4.6e-06
Urea	57136	1.2e-04	2.6e-05	2.0e-01	4.9e-01	7.8e-07
Vinyl bromide	593602		5.5e-03	3.9e-01	9.4e-01	3.7e-03
* Vinyl chloride	75014		7.3e-03	2.1e-01	5.1e-01	2.3e-03
Water	7732185	1.5e-03	1.6e-04	1.1e-01	2.7e-01	4.2e-06
Xylene, m-	108383		8.0e-02	3.9e-01	1.4e+00	1.6e-01

APPENDIX I.4

TOXICOLOGICAL PROFILES

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1.0 ANTIMONY

1.1 PHARMACOKINETICS

Ingested antimony is absorbed slowly and incompletely from the gastrointestinal (GI) tract (Iffland, 1988). Within a few days of acute exposure, highest tissue concentrations are found in the liver, kidney, and thyroid. Organs of storage include skin, bone, and teeth. Highest concentrations in deceased smelter workers (inhalation exposure) occurred in the lungs and skeleton. Excretion is largely via the urine or feces, although some is incorporated into the hair.

1.2 NONCANCER TOXICITY

Acute intoxication from ingestion of large doses of antimony induces GI disturbances, dehydration, and cardiac effects in humans (Iffland, 1988). Chronic effects from occupational exposure include irritation of the respiratory tract, pneumoconiosis, pustular eruptions of the skin called "antimony spots," allergic contact dermatitis, and cardiac effects, including abnormalities of the electrocardiograph (ECG) and myocardial changes. Cardiac effects were also observed in rats and rabbits exposed by inhalation for six weeks and in animals (dogs, and possibly other species) treated by intravenous injection (Elinder and Friberg, 1986).

Chronic oral exposure studies in laboratory animals include two briefly reported lifetime drinking water studies in rats and mice (USEPA, July 1997). The only dose tested, 5 ppm potassium antimony tartrate, resulted in reduced longevity in both species and in reduced mean heart weight in the rats. The USEPA (July 1997) verified an RfD of 0.0004 mg/kg/day for chronic oral exposure to antimony from the LOAEL of 5 ppm potassium antimony tartrate (0.35 mg antimony/kg body weight-day) in the lifetime study in rats (USEPA, July 1997). An uncertainty factor of 1000 was applied; factors of 10 each for inter- and intraspecies variation and to estimate an NOAEL from an LOAEL. The heart is considered a likely target organ for chronic oral exposure of humans.

1.3 CARCINOGENICITY

Data were not located regarding the carcinogenicity of antimony to humans. Antimony fed to rats did not produce an excess of tumors (Goyer, 1991), but a high frequency of lung tumors was observed in rats exposed by inhalation to antimony trioxide for one year (Elinder and Friberg, 1986). Antimony is classified in USEPA cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans) (USEPA, 1987).

2.0 ARSENIC

2.1 PHARMACOKINETICS

Several studies confirm that soluble inorganic arsenic compounds and organic arsenic compounds are almost completely (>90 percent) absorbed from the GI tract in both animals and humans (Ishinishi et al., 1986). The absorption efficiency of insoluble inorganic arsenic compounds depends on particle size and stomach pH. Initial distribution of absorbed arsenic is to the liver, kidneys, and lungs, followed by redistribution to hair, nails, teeth, bone, and skin, which are considered tissues of accumulation. Arsenic has a longer half-life in the blood of rats, compared with other animals and humans, because of firm binding to the hemoglobin in erythrocytes.

Metabolism of inorganic arsenic includes reversible oxidation-reduction so that both arsenite (valence of 3) and arsenate (valence of 5) are present in the urine of animals treated with arsenic of either valence (Ishinishi et al., 1986). Arsenite is subsequently oxidized and methylated by a saturable mechanism to form mono- or dimethylarsenate; the latter is the predominant metabolite in the urine of animals or humans. Organic arsenic compounds (arsenilic acid, cacodylic acid) are not readily converted to inorganic arsenic. Excretion of organic or inorganic arsenic is largely via the urine, but considerable species variation exists. Continuously exposed humans appear to excrete 60 to 70 percent of their daily intake of arsenate or arsenite via the urine.

2.2 NONCANCER TOXICITY

A lethal dose of arsenic trioxide in humans is 70 to 180 mg (approximately 50 to 140 mg arsenic; Ishinishi et al., 1986). Acute oral exposure of humans to high doses of arsenic produce liver swelling, skin lesions, disturbed heart function, and neurological effects. The only noncancer effects in humans clearly attributable to chronic oral exposure to arsenic are dermal hyperpigmentation and keratosis, as revealed by studies of several hundred Chinese exposed to naturally occurring arsenic in well water (USEPA, October 1998). Similar effects were observed in persons exposed to high levels of arsenic in water in Utah and the northern part of Mexico (USEPA, October 1998). Occupational (predominantly inhalation) exposure is also associated with neurological deficits, anemia, and cardiovascular effects (Ishinishi et al., 1986), but concomitant exposure to other chemicals cannot be ruled out. The USEPA (July 1997) derived an RfD of 0.0003 mg/kg/day for chronic oral exposure, based on an NOAEL of 0.009 mg/kg/day for skin lesions from the Chinese data. The principal target organ for arsenic appears to be the skin. The nervous system and cardiovascular systems appear to be less significant target organs. Inorganic arsenic may be

an essential nutrient, exerting beneficial effects on growth, health, and feed conversion efficiency (Underwood, 1977).

2.3 CARCINOGENICITY

Inorganic arsenic is clearly a carcinogen in humans. Inhalation exposure is associated with increased risk of lung cancer in persons employed as smelter workers, in arsenical pesticide applicators, and in a population residing near a pesticide manufacturing plant (USEPA, July 1997). Oral exposure to high levels in well water is associated with increased risk of skin cancer (USEPA, July 1997). Extensive animal testing with various forms of arsenic given by many routes of exposure to several species, however, has not demonstrated the carcinogenicity of arsenic. The USEPA (July 1997) classifies inorganic arsenic in cancer weight-of-evidence Group A (human carcinogen), and recommends an oral unit risk of 0.00005 $\mu\text{g/L}$ in drinking water, based on the incidence of skin cancer. The USEPA (July 1997) notes that the uncertainties associated with the oral unit risk are considerably less than those for most carcinogens, so that the unit risk might be reduced an order of magnitude. The USEPA (July 1997) presented a chronic oral slope factor of 15 per mg/kg/day . An inhalation unit risk of 0.0043 per $\mu\text{g/m}^3$ was derived for inorganic arsenic from the incidence of lung cancer in occupationally exposed men (USEPA, July 1997), which is equivalent to a CSF of 15.1 per mg/kg/day .

3.0 BARIUM

3.1 NONCANCER TOXICITY

Barium is a naturally occurring alkaline earth metal that comprises approximately 0.04 percent of the earth's crust (Reeves, 1986a). Acute oral toxicity was manifested by GI upset, altered cardiac performance, and transient hypertension, convulsions, and muscular paralysis. Repeated oral exposures were associated with hypertension. Occupational exposure to insoluble barium sulfate induced benign pneumoconiosis (ACGIH, 1991). The USEPA (July 1997) presented a verified chronic oral RfD of 0.07 mg/kg/day , based on an NOAEL of 0.21 mg/kg/day in a ten-week study in humans exposed to barium in drinking water and an uncertainty factor of 3. The USEPA (July 1997) presented the same value as a provisional RfD for subchronic oral exposure. A provisional chronic inhalation RfC of 0.0005 mg/m^3 and a provisional subchronic inhalation RfC of 0.005 were based on an NOEL for fetotoxicity in a four-month intermittent-exposure inhalation study in rats (USEPA, July 1997). Uncertainty factors of 1000 and 100 were used for the chronic and subchronic RfC values, respectively. The chronic and subchronic inhalation RfC values are equivalent to 0.0001 and 0.001 mg/kg/day , assuming a human inhalation rate of 20 m^3/day .

and body weight of 70 kg. Barium is principally a muscle toxin. Its targets are the GI system, skeletal muscle, the cardiovascular system, and the fetus.

3.2 CARCINOGENICITY

The USEPA (October 1998) classifies barium as a cancer weight-of-evidence Group D substance (not classifiable as to carcinogenicity in humans). Cancer risk is not estimated for Group D substances.

4.0 BENZENE

4.1 NONCANCER TOXICITY

In humans, short-term inhalation exposure to benzene induced CNS effects such as drowsiness, dizziness, and headaches; long-term exposure induced anemia (ACGIH, 1991). Oral dosing in animals induced hematopoietic effects (ATSDR, 1995a). The lowest LOAEL identified for this effect are at 10 ppm (32 mg/m³) in mice exposed to benzene subchronically (Baarson et al., 1984). A provisional RfC of 0.006 mg/m³ was derived from this LOAEL which is equivalent to 0.0017 mg/kg/day. The CNS and the hematopoietic system are the target organs of benzene. The USEPA (September 21, 1994) presented a verified chronic oral RfD value of 0.003 mg/kg/day.

4.2 CARCINOGENICITY

The USEPA (October 1998) classifies benzene in cancer weight-of-evidence Group A (human carcinogen) based on several studies of increased risk of nonlymphocytic leukemia associated with occupational exposure, supported by an increased incidence of neoplasia in rats and mice exposed by inhalation and gavage. A verified oral slope factor of 0.029 per mg/kg/day is based on the increased incidence of leukemia in several occupational (inhalation exposure) studies. The inhalation unit risk is equivalent to 0.029 per mg/kg/day, assuming an inhalation rate of 20 m³/day and a body weight of 70 kg for humans.

5.0 BERYLLIUM

5.1 NONCANCER TOXICITY

Beryllium has a low order of toxicity when ingested because it is poorly absorbed from the GI tract (Reeves, 1986b). Occupational exposure was associated with dermatitis, acute pneumonitis, and chronic pulmonary granulomatosis (berylliosis). Berylliosis was also observed in humans living in the vicinity of a beryllium plant. Similar pulmonary effects were observed in laboratory animals subjected to inhalation exposure. A verified chronic oral RfD value of 0.002 mg/kg/day was based on a NOAEL in a lifetime drinking water study in rats and an uncertainty factor of 100 (USEPA, October 1998). The USEPA also presented the same value as the subchronic oral RfD. The chronic inhalation RfC value is equivalent to 0.0000057 mg/kg/day, assuming a human inhalation rate of 20 m³/day and body weight of 70 kg. The target organ for inhalation exposure appears to be the lung; a target organ is not identified for oral exposure.

5.2 CARCINOGENICITY

The USEPA (October 1998) classifies beryllium as a Group B2 carcinogen (probable human carcinogen) based on inadequate human (occupational) cancer data and sufficient animal data. A significant increase in lung tumors occurred in rats and in rhesus monkeys subjected to inhalation exposure or intratracheal instillation of a variety of beryllium compounds. Osteogenic sarcomas were induced in rabbits and mice, but not in rats or guinea pigs, injected intravenously with various beryllium compounds. Oral studies in animals yielded inconclusive results. The USEPA (October 1998) has withdrawn the oral slope factor from IRIS. An inhalation unit risk of 0.0024 per mg/m³, equivalent to 8.4 per mg/kg/day (assuming an inhalation rate of 20 m³/day and body weight of 70 kg for humans) was derived from an occupational study (USEPA, October 1998).

6.0 BIS(2-ETHYLHEXYL)PHTHALATE (DI[2-ETHYLHEXYL]PHTHALATE)

6.1 NONCANCER TOXICITY

The acute oral toxicity of bis(2-ethylhexyl)phthalate is very low; oral LD_{50/30} (lethal dose to 50 percent of population within 30 days without medical treatment) values in rats and mice were 33,800 and 26,300 mg/kg, respectively (ACGIH, 1991). Repeated high-dose oral exposures were associated with decreased growth, altered organ weights, testicular degeneration, and developmental effects. The USEPA (July

1997) presented a verified chronic oral RfD of 0.02 mg/kg/day based on an LOAEL for increased relative liver weight in guinea pigs and an uncertainty factor of 1000. The USEPA adopted the chronic oral RfD as the provisional subchronic oral RfD. The principal target organs for the toxicity of bis(2-ethylhexyl)phthalate are the liver and testis.

6.2 CARCINOGENICITY

The USEPA (October 1998) classifies bis(2-ethylhexyl)phthalate in cancer weight-of-evidence Group B2 (probable human carcinogen), based on inadequate human cancer data (one limited occupational study) and sufficient cancer data in laboratory animals. A USEPA oral slope factor of 0.014 per mg/kg/day was based on the increased incidence of liver tumors in a dietary study in male mice. The USEPA (October 22, 1997) presented an inhalation slope factor of 0.014 per mg/kg/day.

7.0 BORON

7.1 NONCANCER TOXICITY

Acute exposure to boron compounds was associated with GI irritation and CNS depression (ACGIH 1991). Occupational exposure induced respiratory tract irritation. Several dietary and drinking water studies with boron (chemical form not specified) in dogs, rats, and mice identified testicular atrophy and impaired spermatogenesis as the critical effect of oral exposure (USEPA, October 1998). Other effects included reduced body and organ weights, reduced ovulation in female rats, and possibly increased extramedullary hematopoiesis in the spleen. The USEPA (July 1997) presented a verified RfD of 0.09 mg/kg/day for chronic oral exposure to boron, based on an NOAEL in a two-year dietary study in dogs (form of boron not specified). An uncertainty factor of 100 was used. USEPA (July 1997) presents an inhalation RfC of 0.02 mg/m³ based on respiratory effects in humans. This is equivalent to an RfD of 0.0057 mg/kg/day. The chronic oral RfD was adopted as the provisional subchronic oral RfD. The principal target organs of boron are the testis, respiratory mucosa, and CNS.

7.2 CARCINOGENICITY

Data were not located regarding the carcinogenicity of boron.

8.0 CADMIUM

8.1 PHARMACOKINETICS

Estimates of cadmium uptake by the respiratory tract range from 10 to 50 percent; uptake is greatest for fumes and small particles and least for large dust particles (Friberg et al., 1986; Goyer, 1991). GI absorption of ingested cadmium is ordinarily 5 to 8 percent, but may reach 20 percent in cases of serious dietary iron deficiency. Highest tissue levels are normally found in the kidneys followed by the liver, although levels in the liver may exceed those in the kidneys of persons suffering from cadmium-induced renal dysfunction. The half-life of cadmium in the kidneys and liver may be as long as 10-30 years. Fecal and urinary excretion of cadmium are approximately equivalent in normal humans exposed to small amounts. Urinary excretion increases markedly in humans with cadmium-induced renal disease.

8.2 NONCANCER TOXICITY

Acute inhalation exposure to fumes or particles of cadmium induces respiratory symptoms, general weakness, and, in severe cases, respiratory insufficiency, shock, and death (Friberg et al., 1986). Acute oral exposure induces GI disturbances. Chronic inhalation exposure induces pulmonary emphysema, and chronic exposure by either route consistently produces renal tubular disease in humans and laboratory animals. Proteinuria is a reliable early indicator of cadmium-induced kidney disease. The combination of pulmonary emphysema and renal tubular disease, if severe, may result in early mortality. Painful osteomalacia and osteoporosis may arise from altered metabolism of bone minerals secondary to renal damage. The combination of renal and skeletal damage is called itai-itai disease in Japan. Cadmium exposure has been associated with liver damage, but the liver appears to be less sensitive than the kidney. The kidney is the primary target organ of cadmium toxicity. The USEPA (July 1997) derived chronic oral RfD values of 0.5 $\mu\text{g}/\text{kg}/\text{day}$ for cadmium ingested in water and 1 $\mu\text{g}/\text{kg}/\text{day}$ for cadmium ingested in food, based on a toxicokinetic model that predicted NOAELs from renal cortical concentrations of cadmium. The different RfD values reflect assumed differences in GI absorption of cadmium from water (5 percent) and food (2.5 percent).

8.3 CARCINOGENICITY

Carcinogenicity data in humans consist of several occupational studies that associate cadmium exposure with lung cancer, but concomitant exposure to other carcinogenic chemicals and smoking were not adequately controlled. Other occupational studies reported significantly increased risk of prostatic cancer, but this effect was not observed in the largest occupational study of workers exposed to high levels

(USEPA, July 1997). The animal data consist of an inhalation study in rats that showed a significant increase in lung tumors, and several parenteral injection studies that produced injection site tumors. No evidence of carcinogenicity, however, was observed in seven oral studies in rats and mice. The USEPA (October 1998) classifies cadmium a cancer weight-of-evidence Group B1 substance for inhalation exposure on the basis of limited evidence of carcinogenicity in humans and sufficient evidence in animals. The data were insufficient to classify cadmium as carcinogenic to humans exposed by the oral route. The USEPA (October 1998) derived an inhalation unit risk of 0.0018 mg/m³ (6.3 per mg/kg/day) from an occupational exposure study.

9.0 CHLOROFORM

9.1 NONCANCER TOXICITY

Oral or inhalation exposure of animals to chloroform was associated with liver and kidney damage (ACGIH, 1991; USEPA, October 1998). In humans, acute inhalation exposure to high levels induced narcosis, ventricular fibrillation, and death (ACGIH, 1991). Limited occupational data associated chronic exposure to chloroform with CNS depression, digestive disturbances, and enlarged livers. The USEPA (July 1997) presented a verified chronic oral RfD of 0.01 mg/kg/day based on a LOAEL for fatty cyst formation in the livers of dogs treated orally for 7.5 years and an uncertainty factor of 1000. The same value was presented as a provisional subchronic oral RfD. Target organs for the toxicity of chloroform include the liver and kidney for oral and inhalation exposure, and the heart and CNS for inhalation exposure.

9.2 CARCINOGENICITY

Chloroform is classified as a cancer weight-of evidence Group B2 compound (probable human carcinogen), based on increased incidence of several tumor types in rats and liver tumors in mice (USEPA, October 1998). Human carcinogenicity data are inadequate. An oral slope factor of 0.0061 per mg/kg/day was derived from the incidence of kidney tumors in rats treated with chloroform in drinking water for two years. An inhalation unit risk of 2.3E-05 per µg/m³ was based on the incidence of hepatocellular carcinomas in mice treated by gavage for 78 weeks. The inhalation unit risk is equivalent to 0.081 per mg/kg/day, assuming an inhalation rate of 20 m³/day and a body weight of 70 kg for humans (USEPA, July 1997).

10.0 CHROMIUM

10.1 NONCANCER TOXICITY

In nature, chromium (III) predominates over chromium (VI) (Langård and Norseth, 1986). Little chromium (VI) exists in biological materials, except shortly after exposure, because reduction to chromium (III) occurs rapidly. Chromium (III) is considered a nutritionally essential trace element and is considerably less toxic than chromium (VI). No effects were observed in rats consuming 1800 mg chromium (III)/kg/day in the diet for over two years (USEPA, October 1998). The NOEL of 1800 mg/kg/day and an uncertainty factor of 1000 was the basis for a verified chronic oral RfD of 1 mg/kg/day (USEPA, July 1997). The chronic oral RfD was adopted as the subchronic RfD.

Acute oral exposure of humans to high doses of chromium (VI) induced neurological effects, GI hemorrhage and fluid loss, and kidney and liver effects. Parenteral dosing of animals with chromium (VI) is selectively toxic to the kidney tubules. A NOAEL of 2.4 mg chromium (VI)/kg/day in a one-year drinking water study in rats and an uncertainty factor of 500 was the basis of a verified RfD of 0.003 mg/kg/day for chronic oral exposure (USEPA, July 1997). The same NOAEL and an uncertainty factor of 100 was the basis of a provisional subchronic oral RfD of 0.02 mg/kg/day.

Occupational (inhalation and dermal) exposure to chromium (III) compounds induced dermatitis (ACGIH, 1991). Similar exposure to chromium (VI) induced ulcerative and allergic contact dermatitis, irritation of the upper respiratory tract including ulceration of the mucosa and perforation of the nasal septum, and possibly kidney effects. Inhalation RfC values were not located.

A target organ was not identified for chromium (III). The kidney appears to be the principal target organ for repeated oral dosing with chromium (VI). Additional target organs for dermal and inhalation exposure include the skin and respiratory tract.

10.2 CARCINOGENICITY

Data were not located regarding the carcinogenicity of chromium (III). The USEPA (October 1998) classifies chromium (VI) in cancer weight-of-evidence Group A (human carcinogen), based on the consistent observation of increased risk of lung cancer in occupational studies of workers in chromate production or the chrome pigment industry. Parenteral dosing of animals with chromium (VI) compounds consistently induced injection-site tumors. There is no evidence that oral exposure to chromium (VI) induces cancer. An inhalation unit risk of 0.012 per mg/m³, equivalent to 42 per mg/kg/day, assuming

humans inhale 20 m³/day and weigh 70 kg, was based on increased risk of lung cancer deaths in chromate production workers (USEPA, July 1997).

11.0 1,1-DICHLOROETHENE

11.1 NONCANCER TOXICITY

Chronic oral exposure of laboratory animals to 1,1-dichloroethene induced liver effects (USEPA, July 1997). In animals, inhalation exposure induced degenerative changes in the liver and kidneys (ATSDR, 1989b). No health effects were observed in a limited study of 138 exposed workers (ACGIH, 1986). The USEPA (July 1997) presented a verified RfD for chronic oral exposure of 0.009 mg/kg/day, based on an NOAEL for liver effects in a chronic drinking water study in rats and an uncertainty factor of 1000. The USEPA presented the same value as a provisional subchronic oral RfD. The chronic inhalation RfC value is equivalent to 0.0000286 mg/kg/day, assuming a human inhalation rate of 20 m³/day and body weight of 70 kg. The liver and kidneys are the target organs for exposure to 1,1-dichloroethene.

11.2 CARCINOGENICITY

USEPA classifies 1,1-dichloroethene as a cancer weight-of-evidence Group C compound (possible human carcinogen), based on an inadequate occupational exposure cancer study, limited data in several animal studies, its mutagenicity and ability to alkylate deoxyribonucleic acid (DNA), and its structural similarity to vinyl chloride, a known human carcinogen (USEPA, October 1998). The eighteen available animal studies (11 by inhalation exposure, 5 by oral exposure, and 1 each by dermal application and subcutaneous injection) were limited in sensitivity by various deficiencies in design. Credible evidence that 1,1-dichloroethene was a complete carcinogen was provided only by one 12-month inhalation study in mice, in which the incidence of kidney adenocarcinomas was significantly greater in the high-dose males than in the control males. A slope factor of 0.6 per mg/kg/day for oral exposure was based on the increased incidence of adrenal pheochromocytomas in male rats treated by gavage for two years, even though the increase was not statistically significant (USEPA, October 1998). USEPA presented an inhalation slope factor of 0.175 per mg/kg/day (USEPA, October 1998).

12.0 LEAD

12.1 PHARMACOKINETICS

Studies in humans indicate that an average of 10 percent of ingested lead is absorbed, but estimates as high as 40 percent were obtained in some individuals (Tsuchiya, 1986). Nutritional factors have a profound effect on GI absorption efficiency. Children absorb ingested lead more efficiently than adults; absorption efficiencies up to 53 percent were recorded for children three months to eight years of age. Similar results were obtained for laboratory animals; absorption efficiencies of 5 to 10 percent were obtained for adults and 50 percent were obtained for young animals. The deposition rate of inhaled lead averages approximately 30 to 50 percent, depending on particle size, with as much as 60 percent deposition of very small particles (0.03 μ m) near highways. All lead deposited in the lungs is eventually absorbed.

Approximately 95 percent of the lead in the blood is located in the erythrocytes (USEPA, 1990). Lead in the plasma exchanges with several body compartments, including the internal organs, bone, and several excretory pathways. In humans, lead concentrations in bone increase with age (Tsuchiya, 1986). About 90 percent of the body burden of lead is located in the skeleton. Neonatal blood concentrations are about 85 percent of maternal concentrations (USEPA, 1990). Excretion of absorbed lead is principally through the urine, although GI secretion, biliary excretion, and loss through hair, nails, and sweat are also significant.

12.2 NONCANCER TOXICITY

The noncancer toxicity of lead to humans has been well characterized through decades of medical observation and scientific research (USEPA, October 1998). The principal effects of acute oral exposure are colic with diffuse paroxysmal abdominal pain (probably due to vagal irritation), anemia, and, in severe cases, acute encephalopathy, particularly in children (Tsuchiya, 1986). The primary effects of long-term exposure are neurological and hematological. Limited occupational data indicate that long-term exposure to lead may induce kidney damage. The principal target organs of lead toxicity are the erythrocyte and the nervous system. Some of the effects on the blood, particularly changes in levels of certain blood enzymes, and subtle neurobehavioral changes in children, appear to occur at levels so low as to be considered nonthreshold effects.

USEPA (July 1997) presented no inhalation RfC for lead, but referred to the National Ambient Air Quality Standard (NAAQS) for lead, which could be used in lieu of an inhalation RfC. The NAAQSs are based

solely on human health considerations and are designed to protect the most sensitive subgroup of the human population. The NAAQS for lead is 1.5 mg/m³, averaged quarterly.

The USEPA (1990; July 1995) determined that it is inappropriate to derive an RfD for oral exposure to lead for several reasons. First, the use of an RfD assumes that a threshold for toxicity exists, below which adverse effects are not expected to occur; however, the most sensitive effects of lead exposure, impaired neurobehavioral development in children and altered blood enzyme levels associated with anemia, may occur at blood lead concentrations so low as to be considered practically nonthreshold in nature. Second, RfD values are specific for the route of exposure for which they are derived. Lead, however, is ubiquitous, so that exposure occurs from virtually all media and by all pathways simultaneously, making it practically impossible to quantify the contribution to blood lead from any one route of exposure. Finally, the dose-response relationships common to many toxicants, and upon which derivation of an RfD is based, do not hold true for lead. This is because the fate of lead within the body depends, in part, on the amount and rate of previous exposures, the age of the recipient, and the rate of exposure. There is, however, a reasonably good correlation between blood lead concentration and effect. Therefore, blood lead concentration is the appropriate parameter on which to base the regulation of lead.

The USEPA IEUBK lead model is an iterated set of equations that estimate blood lead concentration in children aged 0 to 7 years (USEPA, February 1994). The biokinetic part of the model describes the movement of lead between the plasma and several body compartments and estimates the resultant blood lead concentration. The rate of the movement of lead between the plasma and each compartment is a function of the transition or residence time (i.e., the mean time for lead to leave the plasma and enter a given compartment, or the mean residence time for lead in that compartment). Compartments modeled include the erythrocytes, liver, kidneys, all the other soft tissue of the body, cortical bone, and trabecular bone. Excretory pathways and their rates are also modeled. These include the mean time for excretion from the plasma to the urine, from the liver to the bile, and from the other soft tissues to the hair, skin, sweat, etc. The model permits the user to adjust the transition and residence times.

USEPA guidance (USEPA, July 1994) recommends using 400 mg/kg as a screening level for lead in soil for residential scenarios at CERCLA sites and at RCRA Corrective Action sites. Residential areas with soil lead below 400 mg/kg generally require no further action. However, in some special situations, further study is warranted below the screening level (e.g., wetlands, agricultural areas).

12.3 CARCINOGENICITY

USEPA (October 1998) classifies lead in cancer weight-of-evidence Group B2 (probable human carcinogen), based on inadequate evidence of cancer in humans and sufficient animal evidence. The human data consist of several epidemiologic occupational studies that yielded confusing results. All of the studies lacked quantitative exposure data and failed to control for smoking and concomitant exposure to other possibly carcinogenic metals. Rat and mouse bioassays showed statistically significant increases in renal tumors following dietary and subcutaneous exposure to several soluble lead salts. Various lead compounds were observed to induce chromosomal alterations in vivo and in vitro, sister chromatic exchange in exposed workers, and cell transformation in Syrian hamster embryo cells; to enhance simian adenovirus induction; and to alter molecular processes that regulate gene expression. USEPA (July 1997) declined to estimate risk for oral exposure to lead because many factors (e.g., age, general health, nutritional status, existing body burden and duration of exposure) influence the bioavailability of ingested lead, introducing a great deal of uncertainty into any estimate of risk.

13.0 MANGANESE

13.1 NONCANCER TOXICITY

Manganese is nutritionally required in humans for normal growth and health (USEPA, October 1998). Humans exposed to approximately 0.8 mg manganese/kg/day in drinking water exhibited lethargy, mental disturbances (1/16 committed suicide), and other neurologic effects. The elderly appeared to be more sensitive than children. Oral treatment of laboratory rodents induced biochemical changes in the brain, but rodents did not exhibit the neurological signs exhibited by humans. Occupational exposure to high concentrations in air induced a generally typical spectrum of neurological effects and an increased incidence of pneumonia (ACGIH, 1986).

The USEPA (July 1997) presented a verified chronic inhalation RfC of 0.00005 mg/m³ based on a LOAEL for respiratory symptoms and psychomotor disturbances in occupationally exposed humans. The inhalation RfC is equivalent to 0.000014 mg/kg/day, assuming humans inhale 20 m³ of air/day and weigh 70 kg. The CNS and respiratory tract are target organs of inhalation exposure to manganese.

The USEPA (Region I, November 1996) presented an oral RfD of 0.14 mg/kg/day for the total oral intake of manganese based on several dietary studies. An oral RfD of 0.024 mg/kg/day was recommended for exposure to drinking water (USEPA, November 1996).

13.2 CARCINOGENICITY

The USEPA (October 1998) classifies manganese in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans). Quantitative cancer risk estimates are not derived from Group D chemicals.

14.0 MERCURY

Mercury occurs in three forms: elemental, organic, and inorganic. Although the toxicity of all forms is mediated by the mercury cation, the extent of absorption and pattern of distribution within the body, which determines the effects observed, depends on the form to which the organism is exposed (Goyer, 1991). Bacterial activity in the environment converts inorganic mercury to methyl mercury (Berlin, 1986). It is likely that either inorganic mercury or methyl mercury may be taken up by plants and enter the food chain, and this discussion will focus on inorganic and methyl mercury. Exposure to elemental mercury, which is more likely to occur in an occupational setting, is not discussed herein.

14.1 PHARMACOKINETICS

The GI absorption of inorganic mercury salts is about 2 to 10 percent in humans, and slightly higher in experimental animals (Berlin, 1986; Goyer, 1991). Inorganic mercury in the blood is roughly equally divided between the plasma and erythrocytes. Distribution is preferentially to the kidney, with somewhat lower concentrations found in the liver, and even lower levels found in the skin, spleen, testes, and brain (Berlin, 1986). Inorganic mercury is excreted principally through the feces and urine, with minor pathways including the secretions of exocrine glands and exhalation of elemental mercury vapor.

Methyl mercury is nearly completely (90 to 95 percent) absorbed from the GI tract (Berlin, 1986). The concentration of methyl mercury in the erythrocytes is about 10 times that in the plasma. Methyl mercury leaves the blood slowly, showing particular affinity for the brain, particularly in primates. In rats, 1 percent of the body burden of methyl mercury is found in the brain, but in humans, 10 percent of the body burden is found in the brain. Somewhat lower levels are found in the liver and kidney. During pregnancy, methyl mercury accumulates in the fetal brain, often at levels higher than in the maternal brain. Most tissues except the brain transform methyl mercury to inorganic mercury. Excretion of methyl mercury is principally via the bile, with a half-life of 70 days in humans not suffering from toxicity. Following exposure to methyl mercury, some of the mercury in the bile exists as methyl mercury and some as the inorganic

form. The inorganic form is largely passed in the feces, but the methyl mercury is subject to enterohepatic recirculation. Another important excretory pathway for methyl mercury is lactation.

14.2 NONCANCER TOXICITY

Target organs for inorganic or methyl mercury include the kidney and nervous system. Acute oral exposure to high doses of inorganic mercury causes severe damage to the GI mucosa because of the corrosive nature of mercury salts, which may lead to bloody diarrhea, shock, circulatory collapse, and death (Berlin, 1986; Goyer, 1991). Acute sublethal poisoning induces severe kidney damage. Chronic exposure induces an autoimmune glomerular disease and renal tubular injury. The USEPA (July 1997) presented a withdrawn verified RfD of 0.3 $\mu\text{g}/\text{mg}\text{-day}$ for chronic oral exposure to inorganic mercury, based on kidney effects in rats.

Acute or chronic exposure to methyl mercury leads to neurologic dysfunction (Berlin, 1986; Goyer, 1991). The region of the nervous system affected is species-dependent. Methyl mercury poisoning in rats induces peripheral nerve damage and kidney effects. In humans, the sensory cortex appears to be the most sensitive. The brain of the fetus and the neonate may be unusually sensitive to methyl mercury; retarded neurologic development was observed in prenatally exposed children whose mothers showed no clinical signs of poisoning. The USEPA (July 1997) derived an RfD of 0.3 $\text{mg}/\text{kg}/\text{day}$ for chronic oral exposure to methyl mercury based on neurological effects in environmentally exposed humans. In this derivation, an intake of 3 $\text{mg}/\text{kg}/\text{day}$ was an LOAEL corresponding to a blood level of 200 ng/mL , which was associated with CNS effects. An uncertainty factor of 10 was used to estimate an NOAEL from an LOAEL. An inhalation RfC of 0.0003 mg/m^3 (uncertainty factor of 30) has been established for inorganic mercury based on neurotoxic effects in humans. This translates into a chronic RfD of 0.000086 $\text{mg}/\text{kg}/\text{day}$ (USEPA, July 1997).

14.3 CARCINOGENICITY

The USEPA (October 1998) classifies inorganic mercury in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans), based on no data regarding cancer in humans, and inadequate animal and supporting data. In an intraperitoneal injection study with metallic mercury in rats, sarcomas developed only in those tissues in direct contact with the test material (ATSDR, 1992). A two-year dietary study in rats with mercuric acetate (inorganic mercury) yielded no evidence of carcinogenicity (ATSDR, 1992). In mice, however, dietary exposure to high doses of mercury chloride for up to 78 weeks induced renal adenomas and adenocarcinomas (ATSDR, 1992). The USEPA has not yet evaluated the carcinogenicity of organic mercury. No carcinogenic effect, however, was observed in a two-year feeding study with phenylmercuric acetate in rats (ATSDR, 1992).

15.0 METHYLENE CHLORIDE

15.1 NONCANCER TOXICITY

Occupational exposure to high concentrations of methylene chloride may induce liver damage (ACGIH, 1986). Liver effects were induced in animals by inhalation or oral exposure (USEPA, October 1998). The USEPA (USEPA, July 1997) presented a verified chronic oral RfD for methylene chloride of 0.06 mg/kg/day based on an NOAEL for liver toxicity in male and female rats in chronic drinking water studies and an uncertainty factor of 100. The USEPA presented the same value as a provisional subchronic oral RfD. The USEPA (July 1997) also presented a provisional subchronic and chronic inhalation RfC of 3 mg/m³, derived from an NOAEL for liver toxicity in a two-year intermittent exposure inhalation study in rats and an uncertainty factor of 100. The inhalation RfC is equivalent to 0.86 mg/kg/day, assuming humans inhale 20 m³ of air/day and weigh 70 kg. The principal target organ for methylene chloride is the liver.

15.2 CARCINOGENICITY

Methylene chloride is classified in USEPA cancer weight-of-evidence Group B2 (probable human carcinogen), based on inadequate human data and sufficient evidence of carcinogenicity in animals (USEPA, October 1998). Animal inhalation studies showed increased incidence of hepatocellular neoplasms and alveolar/bronchiolar neoplasms in male and female mice, mammary tumors in rats of either sex, salivary gland sarcomas in male rats, and leukemia in female rats. Oral studies were inconclusive. An oral slope factor of 0.0075 per mg/kg/day was based on the incidence of liver tumors in two inhalation studies in mice (USEPA, July 1997). An inhalation unit risk of 4.7E-07 per mg/m³ was based on the incidence of liver and lung tumors in one inhalation study. The inhalation unit risk is equivalent to 0.00165 per mg/kg/day, based on inhaled dose, assuming humans inhale 20 m³ of air/day and weigh 70 kg.

16.0 NICKEL

16.1 NONCANCER TOXICITY

In a subchronic gavage study with nickel chloride in water, clinical signs of toxicity in rats included lethargy, ataxia, irregular breathing, reduced body temperature, salivation, and discolored extremities (USEPA, October 1998). Inhalation exposure was associated with asthma and pulmonary fibrosis in welders using nickel alloys (ACGIH, 1986). Lung effects were observed in laboratory animals exposed by inhalation. The USEPA (July 1997) presented a verified RfD of 0.02 for chronic oral exposure to nickel,

based on an NOAEL for decreased organ and body weights in a two-year dietary study with nickel sulfate in rats and an uncertainty factor of 300. The USEPA presented the same value as a provisional subchronic oral RfD. The CNS appears to be the target organ for the oral toxicity of nickel. The lung is clearly the target organ for inhalation exposure.

16.2 CARCINOGENICITY

Occupational exposure to nickel was associated with increased risk of nasal, laryngeal and lung cancer (ATSDR, 1995b). Inhalation exposure of rats to nickel subsulfide increased the incidence of lung tumors. The USEPA (October 1998) presents a cancer weight-of-evidence Group A classification (human carcinogen) for nickel, and presents an inhalation unit risk of 0.00024 per mg/m³ for nickel refinery dust. The unit risk is equivalent to 0.84 per mg/kg/day, assuming humans inhale 20 m³ of air/day and weigh 70 kg. The quantitative estimate was derived from the human occupational studies.

17.0 POLYCYCLIC AROMATIC HYDROCARBONS (PAHS)

PAHs are a large class of ubiquitous natural and anthropogenic chemicals, all with similar chemical structures (ATSDR, 1989a).

17.1 PHARMACOKINETICS

Although quantitative absorption data for the PAHs were not located, benzo(a)pyrene was readily absorbed across the GI (Rees et al. 1971) and respiratory epithelia (Kotin et al. 1969; Vainich et al. 1976). The high lipophilicity of other compounds in this class suggests that other PAHs also would be readily absorbed across GI and respiratory epithelia.

Benzo(a)pyrene was distributed widely in the tissues of treated rats and mice, but primarily to tissues high in fat, such as adipose tissue and mammary gland (Kotin et al. 1969; Schlede et al. 1970a). Patterns of tissue distribution of other PAHs would be expected to be similar because of the high lipophilicity of the members of this class.

Studies of the metabolism of benzo(a)pyrene provide information relevant to other PAHs because of the structural similarities of all members of the class. Metabolism involves microsomal mixed function oxidase hydroxylation of one or more of the phenyl rings with the formation of phenols and dihydrodiols, probably via formation of arene oxide intermediates (USEPA 1979a). The dihydrodiols may be further oxidized to

diol epoxides, which, for certain members of the class, are known to be the ultimate carcinogens (LaVoie et al. 1982). Conjugation with glutathione or glucuronic acid, and reduction to tetrahydrotetraols are important detoxification pathways. Metabolism of naphthalene resulted in the formation of 1,2-naphthoquinone, which induced cataract formation and retinal damage in rats and rabbits.

Excretion of benzo(a)pyrene or dibenzo(a,h)anthracene residues was reported to be rapid, although quantitative data were not located (USEPA 1979b). Excretion occurred mainly via the feces, probably largely due to biliary secretion (Schlede et al. 1970a, 1970b). The USEPA (1990) concluded that accumulation in the body tissues of PAHs from chronic low level exposure would be unlikely.

17.2 NONCANCER TOXICITY

For the PAHs considered COPCs at this site, no oral noncancer toxicity information was available.

17.3 CARCINOGENICITY

The PAHs are ubiquitous, being released to the environment from anthropogenic as well as from natural sources (ATSDR, 1989a). Benzo(a)pyrene is the most extensively studied member of the class, inducing tumors in multiple tissues of virtually all laboratory species tested by all routes of exposure. Although epidemiology studies suggested that complex mixtures that contain PAHs (coal tar, soots, coke oven emissions, cigarette smoke) are carcinogenic to humans (USEPA, February 1998), the carcinogenicity cannot be attributed to PAHs alone because of the presence of other potentially carcinogenic substances in these mixtures (ATSDR, 1989a). In addition, recent investigations showed that the PAH fraction of roofing tar, cigarette smoke, and coke oven emissions accounted for only 0.1 to 8 percent of the total mutagenic activity of the unfractionated complex mixture in Salmonella (Lewtas, 1988). Aromatic amines, nitrogen heterocyclic compounds, highly oxygenated quinones, diones, and nitrooxygenated compounds, none of which would be expected to arise from in vivo metabolism of PAHs, probably accounted for the majority of the mutagenicity of coke oven emissions and cigarette smoke. Furthermore, coal tar, which contains a mixture of many PAHs, has a long history of use in the clinical treatment of a variety of skin disorders in humans (ATSDR, 1989).

Because of the lack of human cancer data, assignment of individual PAHs to USEPA cancer weight-of-evidence groups was based largely on the results of animal studies with large doses of purified compound (USEPA, October 1998). Frequently, unnatural routes of exposure, including implants of the test chemical in beeswax and trioctanoin in the lungs of female Osborne-Mendel rats, intratracheal instillation, and subcutaneous or intraperitoneal injection, were used. Of the PAHs of concern, benzo(a)anthracene,

benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were classified in Group B2 (probable human carcinogens).

The USEPA (1993) verified a slope factor for oral exposure to benzo(a)pyrene of 7.3 per mg/kg/day, based on several dietary studies in mice and rats. Neither verified nor provisional quantitative risk estimates were available for the other PAHs in Group B2. The USEPA (1980a) promulgated an ambient water quality criterion for "total carcinogenic PAHs," based on an oral slope factor derived from a study with benzo(a)pyrene, as being sufficiently protective for the class. Largely because of this precedent, the quantitative risk estimates for benzo(a)pyrene were adopted for the other carcinogenic PAHs when quantitative estimates were needed.

Recent reevaluations of the carcinogenicity and mutagenicity of the Group B2 PAHs suggest that there are large differences between individual PAHs in cancer potency (Krewski et al., 1989). A Relative Potency Factor (RPF) scheme was derived for the Group B2 PAHs based only on the induction of lung epidermoid carcinomas in female Osborne-Mendel rats in lung-implantation experiments (Clement International, 1990) (USEPA, July 1993).

18.0 SELENIUM

18.1 NONCANCER TOXICITY

Selenium is a nutritionally essential trace element that is an integral part of the enzyme glutathione peroxidase and other proteins (Högberg and Alexander, 1986). Chronic ingestion of 5 mg/day (0.071 mg/kg/day, assuming humans weigh 70 kg) induced selenosis in humans, characterized by abnormal hair and nail formation (Högberg and Alexander, 1986). Effects in domestic grazing animals exposed to high levels of selenium included emaciation, lameness, and loss of hair and hooves. Occupational exposure to selenium fume or various selenium compounds was associated with intense ocular and respiratory tract irritation, chemical pneumonia, skin rashes, garlic odor to the breath, metallic taste in the mouth, and various socio-psychological effects (ACGIH, 1986). The USEPA (October 1998) presented a verified RfD of 0.005 mg/kg/day for chronic oral exposure to selenourea, based on effects in humans exposed to selenium in high selenium areas. An uncertainty factor of 3 was used. The USEPA (July 1997) presented the same value as a provisional subchronic oral RfD. The principal target organs for oral exposure to selenium are the skin, including the nails and hair, and, in animals, the hooves and joints. Targets for inhalation or dermal exposure include the skin and mucous membranes of the eyes and respiratory tract, and possibly the CNS.

18.2 CARCINOGENICITY

An impressive body of data indicates that selenium exerts an anticarcinogenic effect (Högberg and Alexander, 1986). In laboratory animals, selenium supplementation decreased the incidence of chemical-induced cancers. In humans, the incidence of lymphomas and cancers of the breast, digestive tract, and lung were lower in geographic areas with high soil selenium levels. Occupational data suggest that selenium may protect against lung cancer. Several animal tests with various deficiencies in design and conduct equivocally associated exposure to selenium with cancer induction. In a well controlled oral experiment, selenium sulfide was associated with an increase in the incidence of liver tumors in rats, and with liver and lung tumors in mice. On the basis of this study, USEPA (October 1998) classified selenium sulfide a cancer weight-of-evidence Group B2 compound (probable human carcinogen), but declined to derive quantitative risk estimates. Selenium and other selenium compounds were classified in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans) (USEPA, October 1998). Quantitative risk estimates are not derived for Group D substances.

19.0 TETRACHLOROETHENE (PCE; TETRACHLOROETHYLENE)

19.1 NONCANCER TOXICITY

Occupational (inhalation and dermal) exposure to tetrachloroethene was associated with neurologic effects, beginning with incoordination and progressing to dizziness, headache, vertigo, and unconsciousness (ACGIH, 1986). The USEPA (July 1997) presented a verified chronic oral RfD for tetrachloroethene of 0.01 mg/kg/day based on an NOAEL for liver toxicity in mice in a subchronic gavage study, and on an NOEL for depressed body weight gain in rats in a subchronic drinking water study. An uncertainty factor of 1000 was used. The USEPA (July 1997) presented a provisional subchronic oral RfD of 0.1 mg/kg/day based on the same NOAEL for liver toxicity in mice and an uncertainty factor of 100. The CNS is the principal target organ for inhalation exposure and the liver is the principal target organ for oral exposure to tetrachloroethene.

19.2 CARCINOGENICITY

The USEPA (September 21, 1994) lists tetrachloroethene as on a cancer weight-of-evidence continuum of C-B2. The USEPA (September 21, 1994) presented an oral slope factor of 0.052 per mg/kg/day and an inhalation slope factor of 0.002 per mg/kg/day. Inhalation exposure to tetrachloroethene induced mononuclear cell leukemia in rats, and inhalation or oral exposure induced hepatocellular carcinomas in mice (ATSDR, 1995c). Occupational exposure data do not suggest a carcinogenic role for tetrachloroethene in humans (ACGIH, 1986). Interpretation of the data regarding the carcinogenicity of

tetrachloroethene is controversial, and the USEPA has not adopted a final position on the cancer weight-of-evidence classification.

20.0 THALLIUM

20.1 NONCANCER TOXICITY

Thallium is highly toxic; acute ingestion by humans or laboratory animals induced gastroenteritis, neurological dysfunction, and renal and liver damage (Kazantzis, 1986). Chronic ingestion of more moderate doses characteristically caused alopecia. Thallium was used medicinally to induce alopecia in cases of ringworm of the scalp, sometimes with disastrous results. In industrial (inhalation, oral, dermal) exposure, neurologic signs preceded alopecia, suggesting that the nervous system is more sensitive than the hair follicle. The USEPA (October 1998) presented verified chronic oral RfD values for several thallium compounds (thallium acetate, thallium acetate, thallium carbonate, thallium chloride, thallium nitrate, thallium sulfate, and thallic oxide) based on increased incidence of alopecia and increased serum levels of liver enzymes indicative of hepatocellular damage in rats treated with thallium sulfate for 90 days. An oral RfD for thallium alone was not located.

20.2 CARCINOGENICITY

Several thallium compounds (thallic oxide, thallium acetate, thallium carbonate, thallium chloride, thallium nitrate, thallium sulfate) were classified as cancer weight-of-evidence Group D substances (not classifiable as to carcinogenicity to humans) (USEPA, October 1998). No weight-of-evidence classification was located for thallium alone.

21.0 VANADIUM

21.1 NONCANCER TOXICITY

The oral toxicity of vanadium compounds to humans is very low (Lagerkvist et al. 1986), probably because little vanadium is absorbed from the GI tract. Effects in humans exposed by inhalation include upper and lower respiratory tract irritation. A provisional subchronic and chronic oral RfD of 0.007 mg/kg/day was derived from an NOEL in rats in a lifetime drinking water study with vanadyl sulfate and an uncertainty factor of 100 (USEPA, July 1997). A target organ could not be identified for oral exposure. The respiratory tract is the target organ for inhalation exposure.

21.2 CARCINOGENICITY

No information was located regarding the carcinogenicity of vanadium.

22.0 VINYL CHLORIDE

22.1 NONCANCER TOXICITY

Data were not located regarding oral exposure of humans to vinyl chloride (ATSDR, 1995d). In rats, lifetime dietary ingestion of vinyl chloride slightly but significantly increased mortality and induced mild histopathologic effects in the liver. Several early occupational studies associated vinyl chloride exposure with a syndrome known as vinyl chloride disease, which includes acroosteolysis (dissolution of the ends of the distal phalanges of the hands), circulatory disturbances in the extremities, Raynaud syndrome (sudden, recurrent bilateral cyanosis of the digits), scleroderma, hematologic effects, effects on the lungs, and impaired liver function and liver damage. Mild neurologic effects were also associated with occupational exposure. Long-term inhalation studies in rats and mice identified elevated relative liver weight as a sensitive indicator of liver effects. Neither inhalation RfC values nor oral RfD values for vinyl chloride were located. The principal target organs for vinyl chloride appear to be the CNS and the liver.

22.2 CARCINOGENICITY

The USEPA (July 1997) lists vinyl chloride as a USEPA cancer weight-of-evidence Group A compound (human carcinogen) and presents a verified oral slope factor of 1.9 per mg/kg/day, based on the increased incidence of liver and lung tumors in a lifetime dietary study in rats. An inhalation unit risk of 0.000084 per mg/m³, equivalent to 0.3 per mg/kg/day, assuming humans inhale 20 m³ of air/day and weigh 70 kg, is based on liver tumors in rats intermittently exposed by inhalation for 12 months.

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APPENDIX I.5

ZONE 1

**COC SCREENING FOR LOWER SUBBASE
ZONE 1-SHALLOW SOIL (0-5 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2**

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COPC? (4)	Rationale
Semivolatile Organic Compounds (mg/kg)													
2,4-DIMETHYLPHENOL	1/8	0.037	0.33-0.43	0.165	LS1SB0020101	160	-	0.4	1000(5)	2500(5)	28(5)	N	2
2-METHYLNAPHTHALENE	4/9	0.032-0.87	0.33-0.43	0.224	LS1SB0020101	310	-	-	1000(5)	2500(5)	56(5)	N	2
ACENAPHTHENE	3/9	0.036-3.8	0.33-0.43	0.555	LS1SB0020101	470	-	29	1000(5)	2500(5)	84(5)	N	2
ACENAPHTHYLENE	3/9	0.021-0.95	0.33-0.43	0.334	LS1SB0020101, LS1SB0040101	-	-	-	1000	2500	84	N	2
ANTHRACENE	3/9	0.041-12	0.33-0.43	1.545	LS1SB0020101	2300	-	590	1000	2500	400	N	2
BENZO(A)ANTHRACENE	9/9	0.02-21	-	2.865	LS1SB0020101	0.88	-	0.08	1	7.8	1	Y	3
BENZO(A)PYRENE	9/9	0.018-17	-	2.719	LS1SB0020101	0.088	-	0.4	1	1	1	Y	3
BENZO(B)FLUORANTHENE	8/9	0.031-17	0.36	2.789	LS1SB0020101	0.88	-	0.2	1	7.8	1	Y	3
BENZO(G,H,I)PERYLENE	8/9	0.02-9	0.36	1.847	LS1SB0020101	-	-	-	1000(5)	2500(5)	40(5)	N	2
BENZO(K)FLUORANTHENE	6/9	0.05-5.1	0.36	0.689	LS1SB0040101	8.8	-	2	8.4	78	1	Y	3, 5
CARBAZOLE	2/9	0.13-4.3	0.33-0.43	0.633	LS1SB0020101	32	-	0.03	31(5)	290(5)	0.36(5)	Y	3, 5
CHRYSENE	9/9	0.028-19	-	2.718	LS1SB0020101	88	-	8	84(5)	780(5)	0.96(5)	Y	3, 5
DI-N-BUTYL PHTHALATE	1/9	0.13	0.33-0.43	0.175	LS1SB0080101	780	2300	270	1000	2500	140	N	2
DIBENZO(A,H)ANTHRACENE	3/9	0.04-5.2	0.33-0.36	0.705	LS1SB0020101	0.088	-	0.08	0.084(5)	0.78(5)	0.000096(5)	Y	3
DIBENZOFURAN	2/9	0.05-4	0.33-0.43	0.591	LS1SB0020101	31	-	-	270(5)	2500(5)	5.6(5)	N	2
FLUORANTHENE	9/9	0.023-44	-	5.441	LS1SB0020101	310	-	210	1000	2500	56	N	2
FLUORENE	3/9	0.061-4.8	0.33-0.43	0.683	LS1SB0020101	310	-	28	1000	2500	56	N	2
INDENO(1,2,3-CD)PYRENE	8/9	0.025-12	0.36	2.071	LS1SB0020101	0.88	-	0.7	0.84(5)	7.8(5)	0.0096(5)	Y	3
NAPHTHALENE	4/9	0.019-1.3	0.33-0.43	0.266	LS1SB0020101	310	-	4	1000	2500	56	N	2
PHENANTHRENE	8/9	0.02-41	0.36	4.726	LS1SB0020101	-	-	-	1000	2500	40	Y	3, 5
PHENOL	1/8	0.029	0.33-0.43	0.164	LS1SB0020101	4700	-	5	1000	2500	800	N	2
PYRENE	9/9	0.024-45	-	5.947	LS1SB0020101	230	-	210	1000	2500	40	Y	3, 5
Metals (mg/kg)													
ALUMINUM	3/3	4670-5750	-	5350	LS1SB0010101	7800	-	-	-	-	-	N	2
ARSENIC	3/3	1.3-12.3	-	5.2	LS1SB0020101	0.43	750	1	10	10	-	Y	3
BARIUM	3/3	36.8-45.7	-	143.485714	LS1SB0020101	550	690000	82	4700	140000	-	N	2
BERYLLIUM	1/3	0.2	0.18-0.22	0.133333	LS1SB0060101	0.15	1300	3	2	2	-	Y	3
CHROMIUM (TOTAL)	3/3	10.5-13.7	-	11.966667	LS1SB0060101	39(6)	270	2	100(6)	100(6)	-	Y	3, 5
COBALT	3/3	3-3.1	-	3.066667	LS1SB0010101, LS1SB0060101	470	-	-	1000(5)	2500(5)	-	N	2
COPPER	3/3	13-64.5	-	31.866667	LS1SB0010101	310	-	-	-	-	-	N	2
IRON	3/3	7830-11600	-	9360	LS1SB0020101	2300	-	-	-	-	-	Y	3, 4
LEAD	7/7	24.2-112	-	59.571429	13TB15-0305	400(7)	-	-	500	1000	-	N	2
MANGANESE	3/3	118-228	-	159.666667	LS1SB0060101	180	-	-	1600(5)	47000(5)	-	Y	3
MERCURY	1/3	83.4	0.01-0.2	27.803333	LS1SB0020101	2.3	-	-	20	610	-	Y	3
NICKEL	3/3	7-8.1	-	7.633333	LS1SB0010101	160	13000	7	1400	7500	-	Y	3, 5
VANADIUM	3/3	14-15.3	-	14.533333	LS1SB0020101	55	-	300	470	14000	-	N	2
ZINC	3/3	28.3-54.8	-	39.633333	LS1SB0010101	2300	-	620	20000	610000	-	N	2
Miscellaneous (mg/kg)													
TPH	10/11	23.8-2300	25	408	LS1SB0060101	-	-	-	500	2500	2500	Y	1, 3

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**COC SCREENING FOR LOWER SUBBASE
ZONE 1-SHALLOW SOIL (0-5 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2**

Notes:

- Not available or Not applicable.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Residential Soil Ingestion is used for soil and sediment. Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of $1E-6$.
- (2) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with dilution and attenuation factor (DAF) of 1.0 are used.
- (3) CTDEP, January 1996. State Pollutant Mobility criteria for metals are not included since a direct comparison of the aqueous SPLP criteria (in ug/L) and the soil analytical results (in mg/kg) cannot be made. TCLP and SPLP results for soil samples are addressed in The Nature and Extent Section of the RI Report.
- (4) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (5) No value promulgated by CTDEP, calculated or surrogate value is used. Ceiling limit is used if calculated or surrogate value exceeds the ceiling limit.
- (6) Hexavalent chromium.
- (7) Value is based on OSWER soil screening level for residential land use (USEPA, July 14, 1994).

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Maximum exceeds migration to groundwater criteria only; chemical will not be quantitatively evaluated in the risk assessment.

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COC SCREENING FOR LOWER SUBBASE
 ZONE 1-ALL SOIL (0-10 FEET)
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COPC? (4)	Rationale
Volatile Organic Compounds (mg/kg)													
CARBON DISULFIDE	1/4	0.005	0.005-0.006	0.003375	13MW7(8-10)	20000	720	2	500(5)	1000(5)	140(5)	N	2
Semivolatile Organic Compounds (mg/kg)													
2,4-DIMETHYLPHENOL	1/13	0.037	0.33-0.46	0.173	LS1SB0020101	160	-	0.4	1000(5)	2500(5)	28(5)	N	2
2-METHYLNAPHTHALENE	8/15	0.032-1.5	0.33-0.43	0.313	LS1SB0020201	310	-	-	1000(5)	2500(5)	56(5)	N	2
ACENAPHTHENE	6/15	0.036-4.3	0.33-0.43	0.667	LS1SB0020201	470	-	29	1000(5)	2500(5)	84(5)	N	2
ACENAPHTHYLENE	7/15	0.018-0.95	0.33-0.43	0.267	LS1SB0020101, LS1SB0040101	-	-	-	1000	2500	84	N	2
ANTHRACENE	8/15	0.033-12	0.33-0.43	1.713	LS1SB0020101	2300	-	590	1000	2500	400	N	2
BENZO(A)ANTHRACENE	14/15	0.02-21	0.33-0.36	3.003	LS1SB0020101	0.88	-	0.08	1	7.8	1	Y	3
BENZO(A)PYRENE	14/15	0.018-17	0.33-0.36	2.690	LS1SB0020101	0.088	-	0.4	1	1	1	Y	3
BENZO(B)FLUORANTHENE	12/15	0.031-17	0.33-0.4	2.660	LS1SB0020101	0.88	-	0.2	1	7.8	1	Y	3
BENZO(G,H,I)PERYLENE	13/15	0.02-9	0.33-0.36	1.807	LS1SB0020101	-	-	-	1000(5)	2500(5)	40(5)	N	2
BENZO(K)FLUORANTHENE	10/15	0.035-11	0.33-0.36	1.201	LS1SB0020201	8.8	-	2	8.4	78	1	Y	3
BUTYLBENZYL PHTHALATE	1/15	0.022	0.33-0.46	0.173	LS1SB0040301	1600	930	810	1000	2500	200	N	2
CARBAZOLE	4/15	0.064-5.2	0.33-0.46	0.782	LS1SB0020201	32	-	0.03	31(5)	290(5)	0.36(5)	Y	3, 5
CHRYSENE	14/15	0.028-19	0.33-0.36	2.926	LS1SB0020101	88	-	8	84(5)	780(5)	0.96(5)	Y	3, 5
DI-N-BUTYL PHTHALATE	1/15	0.13	0.33-0.46	0.180	LS1SB0080101	780	2300	270	1000	2500	140	N	2
DIBENZO(A,H)ANTHRACENE	8/15	0.04-5.2	0.33-0.36	0.728	LS1SB0020101	0.088	-	0.08	0.084(5)	0.78(5)	0.000096(5)	Y	3
DIBENZOFURAN	5/15	0.041-4.7	0.33-0.43	0.710	LS1SB0020201	31	-	-	270(5)	2500(5)	5.6(5)	N	2
FLUORANTHENE	14/15	0.023-44	0.33-0.36	6.027	LS1SB0020101	310	-	210	1000	2500	56	N	2
FLUORENE	6/15	0.061-5.2	0.33-0.43	0.809	LS1SB0020201	310	-	28	1000	2500	56	N	2
INDENO(1,2,3-CD)PYRENE	13/15	0.025-12	0.33-0.36	2.049	LS1SB0020101	0.88	-	0.7	0.84(5)	7.8(5)	0.0096(5)	Y	3
NAPHTHALENE	8/15	0.019-1.7	0.33-0.43	0.311	LS1SB0020201	310	-	4	1000	2500	56	N	2
PHENANTHRENE	13/15	0.02-42	0.33-0.36	5.784	LS1SB0020201	-	-	-	1000	2500	40	Y	3
PHENOL	1/13	0.029	0.33-0.46	0.173	LS1SB0020101	4700	-	5	1000	2500	800	N	2
PYRENE	14/15	0.024-45	0.33-0.36	6.595	LS1SB0020101	230	-	210	1000	2500	40	Y	3, 5
Metals (mg/kg)													
ALUMINUM	7/7	3250-6490	-	4664.28571	13MW4(6-8)	7800	-	-	-	-	-	N	2
ARSENIC	6/7	0.53-12.3	0.235	2.716429	LS1SB0020101	0.43	750	1	10	10	-	Y	3
BARIUM	7/7	14.7-45.7	-	31.3	LS1SB0020101	550	690000	82	4700	140000	-	N	2
BERYLLIUM	2/7	0.2-0.4	0.00018-0.00024	0.165714	13MW4(6-8)	0.15	1300	3	2	2	-	Y	3
CADMIUM	4/7	0.57-1.4	0.00003-0.002	0.532143	13MW8(8-10)	3.9	1800	0.4	34	1000	-	Y	3, 5
CHROMIUM (total)	7/7	4.6-13.8	0.003	9.828571	13MW4(6-8)	39(6)	270	2	100(6)	100(6)	-	Y	3, 5
COBALT	7/7	1.8-5.5	-	3.242857	13MW4(6-8)	470	-	-	1000(5)	2500(5)	-	N	2
COPPER	7/7	7.7-64.5	-	26.8	LS1SB0010101	310	-	-	-	-	-	N	2
IRON	7/7	3770-11600	-	7505.71429	LS1SB0020101	2300	-	-	-	-	-	Y	3, 4
LEAD	16/16	2.6-383	0.02-0.1	59.0875	13MW4(6-8)	400(7)	-	-	500	1000	-	N	2
MANGANESE	7/7	56.1-228	-	129.614286	LS1SB0060101	180	-	-	1600(5)	47000(5)	-	Y	3
MERCURY	3/7	0.12-83.4	0.00001-0.002	12.017143	LS1SB0020101	2.3	-	-	20	610	-	Y	3
NICKEL	7/7	2.4-12	-	6.628571	13MW4(6-8)	160	13000	7	1400	7500	-	Y	3, 5
SILVER	1/7	2.2	0.00017-0.007	0.716429	13MW4(6-8)	39	-	2	340	10000	-	Y	3, 5
VANADIUM	7/7	5.7-27.1	-	14.985714	13MW4(6-8)	55	-	300	470	14000	-	N	2
ZINC	7/7	20.3-70.4	-	38.685714	13MW4(6-8)	2300	-	620	20000	610000	-	N	2
Miscellaneous (mg/kg)													
TPH	25/27	20.7-51600	0.025-0.07	3204.01111	13MW18-0911	-	-	-	500	2500	2500	Y	1, 3

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COC SCREENING FOR LOWER SUBBASE
ZONE 1-ALL SOIL (0-10 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Notes:

- Not available or Not applicable.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Residential Soil Ingestion is used for soil and sediment. Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with dilution and attenuation factor (DAF) of 1.0 are used.
- (3) CTDEP, January 1996. State Pollutant Mobility criteria for metals are not included since a direct comparison of the aqueous SPLP criteria (in ug/L) and the soil analytical results (in mg/kg) cannot be made. TCLP and SPLP results for soil samples are addressed in The Nature and Extent Section of the RI Report.
- (4) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (5) No value promulgated by CTDEP, calculated or surrogate value is used. Ceiling limit is used if calculated or surrogate value exceeds the ceiling limit.
- (6) Hexavalent chromium.
- (7) Value is based on OSWER soil screening level for residential land use (USEPA, July 14, 1994).

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Maximum exceeds migration to groundwater criteria only; chemical will not be quantitatively evaluated in the risk assessment.

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COC SCREENING FOR LOWER SUBBASE
 ZONE 1 - GROUNDWATER
 NSB-NLON, GROTON, CONNECTICUT
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Parameter	Frequency	Range of Detection	Range of Nondetects	Location of Maximum	COC Screening Level (1)	EPA MCL (2)	State MCL (3)	State RSR Groundwater (4)	State AWQC		Selected as COC (6)	Rationale
									Saltwater (5)	Human Health (5)		
Volatile Organic Compounds (ug/L)												
1,1-Dichloroethane	1/31	3	5 - 10	13MW19	81	-	-	70	-	-	N	2
Benzene	2/31	3	5 - 10	13MW2	0.36	5	5	1	-	1.2	Y	3
Carbon disulfide	3/31	1 - 3	5 - 10	13MW9	100	-	-	700 (7)	-	-	N	2
Ethylbenzene	3/31	2 - 11	5 - 10	13MW19	130	700	700	700	-	3100	N	2
Styrene	1/31	2	5 - 10	13MW8	160	100	100	100	-	-	N	2
Xylenes, total	2/31	8 - 44	5 - 10	13MW19	1200	10000	10000	530	-	-	N	2
Semivolatile Organic Compounds (ug/L)												
1,2,4-Trichlorobenzene	1/35	0.7	10 - 12	NESO4	19	70	70	70 (7)	-	-	N	2
1,3-Dichlorobenzene	2/35	0.5	10 - 12	13MW3	54	600	-	600	-	400	N	2
1,3-Dichlorobenzene	2/35	0.5	10 - 12	NESO4	54	600	-	600	-	400	N	2
2-Methylnaphthalene	7/35	1 - 47	10 - 12	13MW2	150	-	-	280 (7)	-	-	N	2
4-Methylphenol	5/35	1 - 6	10 - 12	13MW3	18	-	-	35 (7)	-	-	N	2
Acenaphthene	14/35	0.6 - 10	10 - 12	13MW2	220	-	-	420 (7)	-	1200	N	2
Acenaphthylene	1/35	1	10 - 12	13MW2	-	-	-	420	-	0.0028	Y	3, 6
Anthracene	3/35	1 - 2	10 - 12	13MW2	1100	-	-	2000	-	9600	N	2
Benzoic acid	1/21	0.6	50	13MW1	15000	-	-	28000 (7)	-	-	N	2
Bis(2-Ethylhexyl)phthalate	3/35	0.8 - 3	10 - 12	13MW1	4.8	6	6	2	-	1.8	Y	3, 6
Butylbenzyl phthalate	1/35	2	10 - 12	13MW2	730	-	-	1000	-	3000	N	2
Carbazole	5/35	0.6 - 1	10 - 12	13MW2, 13MW20	3.4	-	-	1.8 (7)	-	-	N	2
Di-N-butyl phthalate	2/35	0.6 - 1	10 - 12	13MW21	370	-	-	700	-	2700	N	2
Di-N-octyl phthalate	1/35	1	10 - 12	13MW2	73	-	-	100	-	-	N	2
Dibenzofuran	7/35	1 - 11	10 - 12	13MW2	15	-	-	28 (7)	-	-	N	2
Diethyl phthalate	10/35	0.6 - 3	10 - 12	13MW1	2900	-	-	5600 (7)	-	23000	N	2
Fluoranthene	6/35	0.7 - 2	10 - 12	13MW2	150	-	-	280	-	300	N	2
Fluorene	7/35	1 - 15	10 - 12	13MW2	150	-	-	280	-	1300	N	2
Naphthalene	6/35	1 - 28	10 - 12	13MW2	150	-	-	280	-	-	N	2
Phenanthrene	6/35	1 - 9	10 - 12	13MW2	-	-	-	200	-	0.0028	Y	3, 6
Phenol	2/35	5 - 28	10 - 12	13MW3	2200	-	-	4000	-	21000	N	2
Pyrene	9/35	0.5 - 2	10 - 12	13MW2	110	-	-	200	-	960	N	2
Metals (ug/L)												
Aluminum	20/45	23.5 - 26100	10 - 342	13MW19	3700	50 - 200 (8)	-	-	-	-	Y	3, 4
Aluminum, filtered	10/35	20 - 18700	10 - 88.7	13MW19	3700	50 - 200 (8)	-	-	-	-	Y	3, 4
Antimony	1/45	6.6	2.5 - 25	13MW20	1.5	6	6	6	-	14	Y	3
Antimony, filtered	3/35	2.6 - 8	2.5 - 15.6	13MW20	1.5	6	6	6	-	14	Y	3, 5
Arsenic	21/45	1.5 - 16.8	2 - 3	13MW21	0.045	50	50	50	36	0.018	Y	3
Arsenic, filtered	15/35	1.2 - 24.8	2 - 2.5	13MW19	0.045	50	50	50	36	0.018	Y	3, 5
Barium	32/45	3.5 - 210	2.9 - 40.6	13MW5	260	2000	2000	1000	-	-	N	2
Barium, filtered	23/35	9.4 - 138	1.4 - 40.3	13MW20	260	2000	2000	1000	-	-	N	2
Beryllium	1/45	1.3	0.11 - 1	13MW19	0.016	4	4	4	-	0.0077	Y	3
Beryllium, filtered	1/35	1	0.11 - 1	13MW19	0.016	4	4	4	-	0.0077	Y	3, 5
Boron	18/21	52 - 1430	50	13MW9	330	-	-	630 (7)	-	-	Y	3
Boron, filtered	18/21	50 - 1410	50	13MW9	330	-	-	630 (7)	-	-	Y	3, 5
Cadmium	4/45	1.4 - 20.9	0.22 - 5	NESO4	1.8	5	5	5	9.3	16	Y	3
Chromium (total)	10/45	1.1 - 11.6	0.68 - 14	13MW7	18 (10)	100	100	50	50 (10)	170 (10)	N	2
Chromium (total), filtered	9/35	0.76 - 9.3	0.68 - 4	13MW19	18 (10)	100	100	50	50 (10)	170 (10)	N	2
Cobalt	6/45	1.9 - 8.2	0.8 - 5	13MW3	220	-	-	420 (7)	-	-	N	2
Cobalt, filtered	3/35	1.4 - 3.1	0.8 - 5	FOMW14	220	-	-	420 (7)	-	-	N	2

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COC SCREENING FOR LOWER SUBASE
 ZONE 1 - GROUNDWATER
 NSB-NLON, GROTON, CONNECTICUT
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Parameter	Frequency	Range of Detection	Range of Nondetects	Location of Maximum	COC Screening Level (1)	EPA MCL (2)	State MCL (3)	State RSR Groundwater (4)	State AWQC		Selected as COC (6)	Rationale
									Saltwater (5)	Human Health (5)		
Metals (ug/L)												
Copper	17/45	1.6 - 156	1.5 - 5	13MW20	150	1300 (9)	-	1300	2.4	1300	Y	3, 4
Copper, filtered	13/35	2.3 - 120	1.3 - 5	13MW20	150	1300 (9)	-	1300	2.4	1300	Y	3, 6
Iron	41/45	43.1 - 11600	17 - 214	13MW2	1100	300 (8)	-	-	-	-	Y	3, 4
Iron, filtered	28/35	127 - 8490	17 - 239	13MW2	1100	300 (8)	-	-	-	-	Y	3, 4
Lead	20/44	2 - 55.7	1 - 10	13MW20	-	15 (9)	-	15	8.1	50	Y	3
Lead, filtered	7/33	2.1 - 36.3	1 - 2	13MW20	-	15 (9)	-	15	8.1	50	Y	3, 5
Manganese	45/45	9.6 - 3540	0	13MW8	84	50 (8)	5000 (11)	160 (7)	-	-	Y	3
Manganese, filtered	33/35	8.3 - 3810	8.3 - 10.6	13MW8	84	50 (8)	5000 (11)	160 (7)	-	-	Y	3, 5
Mercury	4/45	0.24 - 0.97	0.01 - 0.2	13MW19	1.1	2	2	2	0.025	0.14	Y	3, 6
Mercury, filtered	3/35	0.2 - 0.35	0.01 - 0.2	13MW21	1.1	2	2	2	0.025	0.14	Y	3, 6
Nickel	22/45	1 - 27.2	3 - 11	13MW1	73	100	100	100	8.2	610	Y	3, 6
Nickel, filtered	8/35	1 - 9.8	0.75 - 11	FOMW14	73	100	100	100	8.2	610	Y	3, 6
Selenium	4/45	1 - 22	1 - 30	13MW9	18	50	50	50	71	100	Y	3
Selenium, filtered	1/33	3.1	1.9 - 4.4	FOMW16	18	50	50	50	71	100	N	2
Silver	4/45	1.6 - 7.4	1.1 - 7	13MW8	18	100 (8)	50	36	-	105	N	2
Silver, filtered	2/35	1.2 - 2.6	1.1 - 3	13MW9	18	100 (8)	50	36	-	105	N	2
Sodium	45/45	14800 - 4950000	-	13MW9	-	-	28000 (12)	-	-	-	Y	3, 1
Sodium, filtered	35/35	30100 - 4860000	-	13MW9	-	-	28000 (12)	-	-	-	Y	3, 1
Thallium	2/45	5.4	1 - 20	13MW3 FOMW16	0.26 (13)	2	2	5	-	1.7	Y	3
Vanadium	16/45	0.72 - 689	0.55 - 20	13MW19	26	-	-	50	-	-	Y	3
Vanadium, filtered	14/35	0.67 - 593	0.55 - 5	13MW19	26	-	-	50	-	-	Y	3, 5
Zinc	23/45	4 - 121	2 - 26.5	13MW19	1100	5000 (8)	-	5000	81	-	Y	3, 6
Zinc, filtered	8/35	3.4 - 60.5	2 - 23.9	13MW18	1100	5000 (8)	-	5000	81	-	N	2
Miscellaneous (ug/L)												
TPH	9/45	600 - 16000	500 - 3000	FOMW14	-	-	-	500	-	-	Y	3, 1

Notes:

- Not available or Not applicable.
- Bolded cell indicates that the maximum detected site concentration exceeds this criteria.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Tap Water Ingestion Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) Maximum Contaminant Level. (USEPA, October 1996).
- (3) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter II Environmental Health.
- (4) CDTEP, January 1996.
- (5) Connecticut Water Quality Standards, 1992. Chronic values for saltwater bodies and protection of human health values for water and organisms are presented.
- (6) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (7) No value promulgated by CTDEP, calculated value used.
- (8) Secondary MCL (SMCL) based on aesthetic water qualities.
- (9) Action Level.
- (10) Hexavalent chromium.
- (11) Current Connecticut Department of Public Health and Addiction Services Action Level.
- (12) Notification Level.
- (13) Thallic oxide.

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Unfiltered data, rather than filtered data, will be used in quantitative risk assessment.
- (6) Maximum is greater than State AWQC only; chemicals will not be quantitatively evaluated in the risk assessment.

90000

**95% UPPER CONFIDENCE LIMITS
ZONE 1 - SHALLOW SOILS (0-5 FT)
NSB - NLON, GROTON, CONNECTICUT**

PARAMETER	UNITS	DETECTS	COUNT	AVERAGE	W NORMAL	W LOGNORMAL	W TEST	DISTRIBUTION	UCL - NORMAL	UCL - LOGNORMAL	DETECTS - MAX	95% UCL ⁽¹⁾
ALUMINUM	mg/kg	3	3	5350.00	0.8322	0.8252	0.767	NORMAL	6347.94	6742.65	5750	5750
ARSENIC	mg/kg	3	3	5.20	0.7975	0.8875	0.767	LOGNORMAL	15.58	3283269.78	12.3	12.3
BARIIUM	mg/kg	3	3	41.80	0.9562	0.9454	0.767	NORMAL	49.47	52.27	45.7	45.7
BERYLLIUM	mg/kg	1	3	0.13	0.8811	0.9238	0.767	LOGNORMAL	0.23	0.67	0.2	0.2
CALCIUM	mg/kg	3	3	7518.67	0.7878	0.9178	0.767	LOGNORMAL	25613.67	967587510000000	19900	19900
CHROMIUM	mg/kg	3	3	11.97	0.9796	0.9885	0.767	LOGNORMAL	14.89	15.84	13.7	13.7
COBALT	mg/kg	3	3	3.07	0.75	0.75	0.767	NOT DEFINED	3.16	3.19	3.1	3.1
COPPER	mg/kg	3	3	31.87	0.8235	0.897	0.767	LOGNORMAL	79.70	25839.04	64.5	64.5
IRON	mg/kg	3	3	9360.00	0.9038	0.925	0.767	LOGNORMAL	12702.65	15244.63	11600	11600
LEAD	mg/kg	7	7	59.57	0.8923	0.9168	0.803	LOGNORMAL	85.13	120.79	112	112
MAGNESIUM	mg/kg	3	3	2313.33	0.9841	0.9956	0.767	LOGNORMAL	3163.04	3941.54	2850	2850
MANGANESE	mg/kg	3	3	159.67	0.8501	0.881	0.767	LOGNORMAL	260.23	518.72	228	228
MERCURY	mg/kg	1	3	27.80	0.75	0.75	0.767	NOT DEFINED	108.97	3.E+132	83.4	83.4
NICKEL	mg/kg	3	3	7.63	0.9355	0.9279	0.767	NORMAL	8.59	8.88	8.1	8.1
POTASSIUM	mg/kg	3	3	1473.33	0.9845	0.9789	0.767	NORMAL	1668.73	1726.46	1580	1580
SODIUM	mg/kg	3	3	143.10	0.8774	0.9174	0.767	LOGNORMAL	243.62	613.51	211	211
VANADIUM	mg/kg	3	3	14.53	0.9119	0.9166	0.767	LOGNORMAL	15.88	15.98	15.3	15.3
ZINC	mg/kg	3	3	39.63	0.9409	0.973	0.767	LOGNORMAL	62.66	117.08	54.8	54.8
2,4-DIMETHYLPHENOL	µg/kg	1	8	164.63	0.6322	0.5272	0.818	NOT DEFINED	200.44	301.36	37	37
2-METHYLNAPHTHALENE	µg/kg	4	9	223.78	0.613	0.9055	0.829	LOGNORMAL	378.27	583.48	870	583.4786
ACENAPHTHENE	µg/kg	3	9	555.22	0.4325	0.7631	0.829	NOT DEFINED	1310.46	2416.30	3800	3800
ACENAPHTHYLENE	µg/kg	3	9	334.00	0.659	0.8172	0.829	NOT DEFINED	553.13	1594.04	950	950
ANTHRACENE	µg/kg	3	9	1545.11	0.4263	0.7578	0.829	NOT DEFINED	3979.37	14383.66	12000	12000
BENZO(A)ANTHRACENE	µg/kg	9	9	2865.33	0.4912	0.8061	0.829	NOT DEFINED	7170.01	1005496.48	21000	21000
BENZO(A)PYRENE	µg/kg	9	9	2719.00	0.5565	0.827	0.829	NOT DEFINED	6321.81	1347125.12	17000	17000
BENZO(B)FLUORANTHENE	µg/kg	8	9	2789.11	0.5625	0.7947	0.829	NOT DEFINED	6416.52	612815.94	17000	17000
BENZO(G,H,I)PERYLENE	µg/kg	8	9	1847.11	0.5833	0.8417	0.829	LOGNORMAL	4002.23	194777.39	9000	9000
BENZO(K)FLUORANTHENE	µg/kg	6	9	689.00	0.4165	0.6924	0.829	NOT DEFINED	1714.97	2896.53	5100	5100
CARBAZOLE	µg/kg	2	9	632.78	0.4046	0.5021	0.829	NOT DEFINED	1485.52	1676.94	4300	4300
CHRYSENE	µg/kg	9	9	2718.33	0.5116	0.8134	0.829	NOT DEFINED	6624.95	486668.33	19000	19000
DI-N-BUTYL PHTHALATE	µg/kg	1	9	175.00	0.8481	0.8272	0.829	NORMAL	188.78	191.20	130	130
DIBENZO(A,H)ANTHRACENE	µg/kg	3	9	704.67	0.4179	0.7182	0.829	NOT DEFINED	1750.41	3770.06	5200	5200
DIBENZOFURAN	µg/kg	2	9	590.56	0.4199	0.6584	0.829	NOT DEFINED	1383.76	2021.07	4000	4000
FLUORANTHENE	µg/kg	9	9	5440.67	0.4418	0.8117	0.829	NOT DEFINED	14447.15	2518931.35	44000	44000
FLUORENE	µg/kg	3	9	682.89	0.4148	0.6359	0.829	NOT DEFINED	1640.50	2332.67	4800	4800
INDENO(1,2,3-CD)PYRENE	µg/kg	8	9	2070.67	0.5748	0.807	0.829	NOT DEFINED	4678.09	332536.39	12000	12000
NAPHTHALENE	µg/kg	4	9	266.11	0.5508	0.8642	0.829	LOGNORMAL	510.33	1588.01	1300	1300
PHENANTHRENE	µg/kg	8	9	4725.89	0.4038	0.8327	0.829	LOGNORMAL	13161.15	843292.98	41000	41000
PHENOL	µg/kg	1	8	163.63	0.6226	0.5132	0.818	NOT DEFINED	201.28	348.57	29	29
PYRENE	µg/kg	9	9	5947.00	0.4753	0.854	0.829	LOGNORMAL	15151.34	3974975.42	45000	45000
TPH	mg/kg	10	11	407.66	0.6293	0.9604	0.85	LOGNORMAL	774.60	5133.97	2300	2300

(1) The UCL Normal and UCL Lognormal values are the 95% UCL for normal and lognormal distributions, respectively; if these values exceeded the maximum concentration, then the maximum concentration was used as the 95% UCL. For undefined distributions, the maximum concentration was used as the 95% UCL.

00007

00008

**95% UPPER CONFIDENCE LIMITS
ZONE 1- SOILS (0-10 FT)
NSB - NLON, GROTON, CONNECTICUT**

PARAMETER	UNITS	DETECTS	COUNT	AVERAGE	W NORMAL	W LOGNORMAL	W TEST	DISTRIBUTION	UCL - NORMAL	UCL - LOGNORMAL	DETECTS - MAX	95% UCL ⁽¹⁾
ALUMINUM	mg/kg	7	7	4664.29	0.8806	0.8715	0.803	NORMAL	5635.74	6018.71	6490	5635.74
ARSENIC	mg/kg	6	7	2.72	0.6013	0.956	0.803	LOGNORMAL	5.86	27.09	12.3	12.30
BARIUM	mg/kg	7	7	31.30	0.8937	0.8808	0.803	NORMAL	40.27	48.62	45.7	40.27
BERYLLIUM	mg/kg	2	7	0.17	0.6832	0.7992	0.803	NOT DEFINED	0.25	0.28	0.4	0.40
CADMIUM	mg/kg	4	7	0.53	0.8789	0.7797	0.803	NORMAL	0.93	573.19	1.4	0.93
CALCIUM	mg/kg	7	7	3788.00	0.5182	0.782	0.803	NOT DEFINED	9020.27	28780.89	19900	19900.00
CHROMIUM	mg/kg	7	7	9.83	0.9219	0.9052	0.803	NORMAL	12.43	14.64	13.8	12.43
COBALT	mg/kg	7	7	3.24	0.8058	0.8641	0.803	LOGNORMAL	4.06	4.35	5.5	4.35
COPPER	mg/kg	7	7	26.80	0.7307	0.8556	0.803	LOGNORMAL	44.67	83.26	64.5	64.50
IRON	mg/kg	7	7	7505.71	0.9864	0.9692	0.803	NORMAL	9413.18	10714.47	11600	9413.18
LEAD	mg/kg	16	16	59.09	0.6026	0.945	0.887	LOGNORMAL	100.10	277.03	383	277.03
MAGNESIUM	mg/kg	7	7	2060.00	0.9039	0.9332	0.803	LOGNORMAL	2548.65	2742.78	3020	2742.78
MANGANESE	mg/kg	7	7	129.61	0.9457	0.9569	0.803	LOGNORMAL	169.42	202.76	228	202.76
MERCURY	mg/kg	3	7	12.02	0.4572	0.8648	0.803	LOGNORMAL	35.13	87698127.18	83.4	83.40
NICKEL	mg/kg	7	7	6.63	0.9648	0.9594	0.803	NORMAL	8.93	11.74	12	8.93
POTASSIUM	mg/kg	7	7	1521.43	0.9449	0.957	0.803	LOGNORMAL	1697.70	1726.61	1950	1726.61
SILVER	mg/kg	1	7	0.72	0.7968	0.8007	0.803	NOT DEFINED	1.27	14.39	2.2	2.20
SODIUM	mg/kg	7	7	320.47	0.8485	0.9616	0.803	LOGNORMAL	507.20	847.28	821	821.00
VANADIUM	mg/kg	7	7	14.99	0.8266	0.8225	0.803	NORMAL	19.60	23.95	27.1	19.60
ZINC	mg/kg	7	7	38.69	0.8727	0.9432	0.803	LOGNORMAL	51.61	58.37	70.4	58.37
CARBON DISULFIDE	µg/kg	1	4	3.38	0.8004	0.8491	0.748	LOGNORMAL	4.68	5.96	5	5.00
2,4-DIMETHYLPHENOL	µg/kg	1	13	173.62	0.6948	0.5103	0.866	NOT DEFINED	196.05	237.00	37	37.00
2-METHYLNAPHTHALENE	µg/kg	8	15	313.27	0.6501	0.9259	0.881	LOGNORMAL	497.99	678.09	1500	678.09
ACENAPHTHENE	µg/kg	6	15	666.80	0.4578	0.7446	0.881	NOT DEFINED	1293.29	1514.62	4300	4300.00
ACENAPHTHYLENE	µg/kg	7	15	266.60	0.6423	0.848	0.881	NOT DEFINED	397.09	683.06	950	950.00
ANTHRACENE	µg/kg	8	15	1712.73	0.4515	0.7996	0.881	NOT DEFINED	3523.32	7621.74	12000	12000.00
BENZO(A)ANTHRACENE	µg/kg	14	15	3002.93	0.5309	0.87	0.881	NOT DEFINED	5946.37	72273.42	21000	21000.00
BENZO(A)PYRENE	µg/kg	14	15	2689.67	0.5728	0.8811	0.881	LOGNORMAL	5125.38	64046.38	17000	17000.00
BENZO(B)FLUORANTHENE	µg/kg	12	15	2659.80	0.5777	0.8248	0.881	NOT DEFINED	5049.39	43454.01	17000	17000.00
BENZO(G,H,I)PERYLENE	µg/kg	13	15	1807.27	0.5997	0.8531	0.881	NOT DEFINED	3248.71	18121.98	9000	9000.00
BENZO(K)FLUORANTHENE	µg/kg	10	15	1201.07	0.4334	0.7361	0.881	NOT DEFINED	2563.51	3216.77	11000	11000.00
BUTYLBENZYL PHTHALATE	µg/kg	1	15	173.47	0.6276	0.4286	0.881	NOT DEFINED	194.21	254.98	22	22.00
CARBAZOLE	µg/kg	4	15	782.27	0.4471	0.6189	0.881	NOT DEFINED	1518.99	1488.00	5200	5200.00
CHRYSENE	µg/kg	14	15	2926.00	0.5403	0.8766	0.881	NOT DEFINED	5691.19	47464.46	19000	19000.00
DI-N-BUTYL PHTHALATE	µg/kg	1	15	179.67	0.8852	0.881	0.881	NORMAL	190.21	191.19	130	130.00
DIBENZO(A,H)ANTHRACENE	µg/kg	8	15	728.40	0.5346	0.8242	0.881	NOT DEFINED	1381.16	2349.52	5200	5200.00
DIBENZOFURAN	µg/kg	5	15	709.87	0.4574	0.7323	0.881	NOT DEFINED	1385.02	1754.04	4700	4700.00
FLUORANTHENE	µg/kg	14	15	6026.80	0.4802	0.8795	0.881	NOT DEFINED	12442.48	219169.04	44000	44000.00
FLUORENE	µg/kg	6	15	808.73	0.4405	0.6304	0.881	NOT DEFINED	1583.42	1593.35	5200	5200.00
INDENO(1,2,3-CD)PYRENE	µg/kg	13	15	2048.73	0.5898	0.855	0.881	NOT DEFINED	3814.45	28262.29	12000	12000.00
NAPHTHALENE	µg/kg	8	15	311.40	0.5487	0.8912	0.881	LOGNORMAL	535.35	851.82	1700	851.82
PHENANTHRENE	µg/kg	13	15	5783.87	0.4309	0.8631	0.881	NOT DEFINED	12379.08	107825.51	42000	42000.00
PHENOL	µg/kg	1	13	173.00	0.6793	0.4845	0.866	NOT DEFINED	196.43	252.80	29	29.00
PYRENE	µg/kg	14	15	6594.53	0.4904	0.916	0.881	LOGNORMAL	13378.78	191750.03	45000	45000.00
TPH	mg/kg	24	26	3324.36	0.3551	0.9484	0.92	LOGNORMAL	6788.96	20743.73	51600	20743.73

(1) The UCL Normal and UCL Lognormal values are the 95% UCL for normal and lognormal distributions, respectively; if these values exceeded the maximum concentration, then the maximum concentration was used as the 95% UCL. For undefined distributions, the maximum concentration was used as the 95% UCL.

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**SUMMARY OF MAXIMUM AND AVERAGE CONCENTRATIONS
 ZONE 1 - GROUNDWATER
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2**

Parameter	Maximum Detected Concentration	Average Concentration
Volatile Organic Compounds (ug/L)		
1,1-DICHLOROETHANE	3.00	4.27
BENZENE	3.00	4.27
CARBON DISULFIDE	3.00	3.85
ETHYLBENZENE	8.00	4.65
STYRENE	2.00	4.19
XYLENES, TOTAL	24.50	6.15
Semivolatile Organic Compounds (ug/L)		
1,2,4-TRICHLOROBENZENE	0.70	5.35
1,3-DICHLOROBENZENE	0.50	4.98
2-METHYLNAPHTHALENE	25.00	6.41
4-METHYLPHENOL	6.00	4.91
ACENAPHTHENE	6.67	4.77
ACENAPHTHYLENE	1.00	5.34
ANTHRACENE	1.67	5.39
BENZOIC ACID	0.60	22.56
BIS(2-ETHYLHEXYL)PHTHALATE	3.00	4.80
BUTYLBENZYL PHTHALATE	2.00	5.41
CARBAZOLE	1.00	5.01
DI-N-BUTYL PHTHALATE	1.00	4.95
DI-N-OCTYL PHTHALATE	1.00	5.34
DIBENZOFURAN	7.67	5.57
DIETHYL PHTHALATE	2.00	3.34
FLUORANTHENE	1.63	4.72
FLUORENE	11.00	5.83
NAPHTHALENE	21.30	6.15
PHENANTHRENE	7.33	5.51
PHENOL	28.00	7.23
PYRENE	1.23	4.32
Metals (ug/L)		
ALUMINUM	10,600.00	2,001.22
ALUMINUM, FILTERED	6,874.47	1,064.33
ANTIMONY	6.87	6.11
ANTIMONY, FILTERED	7.33	4.24
ARSENIC	9.23	3.39
ARSENIC, FILTERED	10.77	2.98
BARIUM	210.00	53.29
BARIUM, FILTERED	84.20	46.45
BERYLLIUM	0.62	0.37
BERYLLIUM, FILTERED	0.52	0.31
BORON	1,220.00	207.89

00011

SUMMARY OF MAXIMUM AND AVERAGE CONCENTRATIONS
ZONE 1 - GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Maximum Detected Concentration	Average Concentration
Metals (ug/L)		
BORON, FILTERED	1,196.00	206.74
CADMIUM	9.93	1.37
CALCIUM	140,775.00	47,334.07
CALCIUM, FILTERED	155,000.00	55,179.05
CHROMIUM	10.50	3.34
CHROMIUM, FILTERED	3.92	1.62
COBALT	4.20	2.06
COBALT, FILTERED	3.10	1.56
COPPER	77.90	14.39
COPPER, FILTERED	42.15	7.87
IRON	7,760.00	2,314.25
IRON, FILTERED	6,390.00	1,652.48
LEAD	36.80	7.18
LEAD, FILTERED	12.77	2.97
MAGNESIUM	399,500.00	30,283.13
MAGNESIUM, FILTERED	442,666.67	38,981.11
MANGANESE	1,573.93	278.74
MANGANESE, FILTERED	2,490.00	340.05
MERCURY	0.44	0.10
MERCURY, FILTERED	0.20	0.08
NICKEL	23.50	9.39
NICKEL, FILTERED	9.80	4.31
POTASSIUM	131,300.00	15,639.85
POTASSIUM, FILTERED	145,000.00	18,800.83
SELENIUM	8.61	2.20
SELENIUM, FILTERED	3.10	1.41
SILVER	2.49	1.71
SILVER, FILTERED	1.55	1.00
SODIUM	3,050,000.00	350,502.94
SODIUM, FILTERED	3,650,000.00	416,100.00
THALLIUM	5.40	2.82
VANADIUM	252.20	26.25
VANADIUM, FILTERED	218.13	25.00
ZINC	48.70	16.29
ZINC, FILTERED	23.52	6.95
Miscellaneous (ug/L)		
TPH	16,000.00	1,725.25

00012

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 1
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker (All Soil), RME

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	480	IR:	0
EF:	120	EF:	120
Fi:	1	Fi:	1
ED:	1	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	365	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:	YOUTH:	ADULT/YOUTH (CANCER RISK):
CF: 2.25E-06 (AVG ANNUAL DOSE)	CF: 0.00E+00 (AVG ANNUAL DOSE)	CF: 3.22E-08

00013

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 1
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Construction Worker (All Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
SA _c = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
SA _a = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	1
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	120
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	1
BW _c = BODY WEIGHT CHILD (KG):	1
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	2.55E-07
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	1.78E-05			

00017

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER

SITE NAME: ZONE 1
 LOCATION: NSB-NLON, Groton, CT
 DATE: 2/2/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker, RME

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

$$DAD = (DAevent \times EV \times ED \times EF \times A) / (BW \times AT)$$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DAevent = ABSORBED DOSE PER EVENT (MG/CM**2/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS:
 FOR ORGANICS:

$$DAevent = Kp \times C \times tevent \times CF$$

IF $tevent < t^*$, $DAevent = 2Kp \times C \times CF \times (6T \times tevent / 3.141592654)^{0.5}$
 IF $tevent > t^*$, $DAevent = Kp \times C \times CF \times ((tevent / (1 + B)) + (2T \times ((1 + 3B) / (1 + B))))$

WHERE: Kp = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MGL)
 tevent = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1 L/1000 CM**3)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERIVED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

EV:	1	CONVERSION	
ED:	1	FACTOR (NONCAR) =	1.78E+01
EF:	120		
A:	3800	CONVERSION	
tevent:	8	FACTOR (CARCIN) =	2.55E-01
BW:	70		
AT(NON):	365		
AT(CAR):	25550		

00021

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

ZONE 1

EXPOSURE SCENARIO: Construction Worker, RME

CHEMICAL	CONC. (MG/L)	ORGANIC OR INORGANIC?	t* (HR)	T (HR)	Kp (CM/HR)	B	DAevent
Benzene	0.003	O	6.30E-01	2.60E-01	2.10E-02	1.30E-02	5.31E-07
Bis(2-ethylhexyl)phthalate	0.003	O	1.00E+02	2.10E+01	3.30E-02	1.30E+01	3.55E-06
Antimony	0.0066	I			1.00E-03		5.28E-08
Arsenic	0.0092	I			1.00E-03		7.36E-08
Beryllium	0.00062	I			1.00E-03		4.96E-09
Boron	1.22	I			1.00E-03		9.76E-06
Cadmium	0.0099	I			1.00E-03		7.92E-08
Manganese	1.57	I			1.00E-03		1.26E-05
Selenium	0.0086	I			1.00E-03		6.88E-08
Thallium	0.0054	I			1.00E-03		4.32E-08
Vanadium	0.252	I			1.00E-03		2.02E-06

00022

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER WATER (PAGE THREE)

ZONE 1

EXPOSURE SCENARIO: Construction Worker, RME

CALCULATE DOSES:

CHEMICAL	ANNUAL DERMAL DOSE (MG/KG/DAY)	DERMAL RfD (MG/KG/DAY)	HAZARD INDEX DERMAL
Benzene	9.48E-06	3.00E-03	3.16E-03
Bis(2-ethylhexyl)phthalate	6.33E-05	1.10E-02	5.75E-03
Antimony	9.42E-07	4.00E-04	2.36E-03
Arsenic	1.31E-06	2.80E-04	4.69E-03
Beryllium	8.85E-08	1.00E-04	8.85E-04
Boron	1.74E-04	4.50E-03	3.87E-02
Cadmium	1.41E-06	2.50E-05	5.65E-02
Manganese	2.24E-04	7.20E-04	3.11E-01
Selenium	1.23E-06	1.00E-03	1.23E-03
Thallium	7.71E-07	3.50E-06	2.20E-01
Vanadium	3.60E-05	3.50E-04	1.03E-01

TOTAL RISK

7.48E-01

00023

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)

ZONE 1

EXPOSURE SCENARIO: Construction Worker, RME

CALCULATE INCREMENTAL CANCER RISKS:

CHEMICAL	LIFETIME AVERAGE DERMAL DOSE (MG/KG/DAY)	CSF DERMAL (KG/DAY/MG)	CANCER RISK DERMAL CONTACT
Benzene	1.35E-07	2.90E-02	3.93E-09
Bis(2-ethylhexyl)phthalate	9.04E-07	2.50E-02	2.26E-08
Antimony	1.35E-08	0.00E+00	0.00E+00
Arsenic	1.88E-08	1.60E+00	3.00E-08
Beryllium	1.26E-09	0.00E+00	0.00E+00
Boron	2.49E-06	0.00E+00	0.00E+00
Cadmium	2.02E-08	0.00E+00	0.00E+00
Manganese	3.20E-06	0.00E+00	0.00E+00
Selenium	1.75E-08	0.00E+00	0.00E+00
Thallium	1.10E-08	0.00E+00	0.00E+00
Vanadium	5.14E-07	0.00E+00	0.00E+00

TOTAL RISK

5.66E-08

00024

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 1
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

**HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.**

EXPOSURE SCENARIO: Construction Worker (All Soil), CTE

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	240	IR:	0
EF:	80	EF:	120
Fi:	0.5	Fi:	1
ED:	1	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	365	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:	YOUTH:	ADULT/YOUTH (CANCER RISK):
CF: 3.76E-07 (AVG ANNUAL DOSE)	CF: 0.00E+00 (AVG ANNUAL DOSE)	CF: 5.37E-09

00025

00028

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 1
LOCATION: NSB - NILON, Groton, CT
DATE: 09/23/98

EXPOSURE SCENARIO: Construction Worker (All Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
Sa _c = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
Sa _a = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	0.2
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	80
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	1
BW _c = BODY WEIGHT CHILD (KG):	15
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	3.40E-08
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	2.38E-06			

00029

00032

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER

SITE NAME: ZONE 1
 LOCATION: NSB-NLON, Groton, CT
 DATE: 2/2/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker, CTE

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

$$DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DA_{event} = ABSORBED DOSE PER EVENT (MG/CM²/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM²)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS:
 FOR ORGANICS:

$$DA_{event} = K_p \times C \times t_{event} \times CF$$

$$\text{IF } t_{event} < t^*, DA_{event} = 2K_p \times C \times CF \times (6T \times t_{event} / 3.141592654)^{0.5}$$

$$\text{IF } t_{event} > t^*, DA_{event} = K_p \times C \times CF \times ((t_{event} / (1 + B)) + (2T \times ((1 + 3B) / (1 + B))))$$

WHERE: K_p = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MGL)
 t_{event} = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1 L/1000 CM³)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERIVED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

EV:	1	CONVERSION	
ED:	1	FACTOR (NONCAR) =	1.19E+01
EF:	80		
A:	3800	CONVERSION	
t _{event} :	8	FACTOR (CARCIN) =	1.70E-01
BW:	70		
AT(NON):	365		
AT(CAR):	25550		

00033

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

ZONE 1

EXPOSURE SCENARIO: Construction Worker, CTE

CHEMICAL	CONC. (MG/L)	ORGANIC OR INORGANIC?	t* (HR)	T (HR)	Kp (CM/HR)	B	DAevent
Benzene	0.003	O	6.30E-01	2.60E-01	2.10E-02	1.30E-02	5.31E-07
Bis(2-ethylhexyl)phthalate	0.003	O	1.00E+02	2.10E+01	3.30E-02	1.30E+01	3.55E-06
Antimony	0.0061	I			1.00E-03		4.88E-08
Arsenic	0.0034	I			1.00E-03		2.72E-08
Beryllium	0.00037	I			1.00E-03		2.96E-09
Boron	0.208	I			1.00E-03		1.66E-06
Cadmium	0.0014	I			1.00E-03		1.12E-08
Manganese	0.279	I			1.00E-03		2.23E-06
Selenium	0.0022	I			1.00E-03		1.76E-08
Thallium	0.0028	I			1.00E-03		2.24E-08
Vanadium	0.0263	I			1.00E-03		2.10E-07

00034

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER WATER (PAGE THREE)

ZONE 1

EXPOSURE SCENARIO: Construction Worker, CTE

CALCULATE DOSES:

CHEMICAL	ANNUAL DERMAL DOSE (MG/KG/DAY)	DERMAL RfD (MG/KG/DAY)	HAZARD INDEX DERMAL
Benzene	6.32E-06	3.00E-03	2.11E-03
Bis(2-ethylhexyl)phthalate	4.22E-05	1.10E-02	3.84E-03
Antimony	5.81E-07	4.00E-04	1.45E-03
Arsenic	3.24E-07	2.80E-04	1.16E-03
Beryllium	3.52E-08	1.00E-04	3.52E-04
Boron	1.98E-05	4.50E-03	4.40E-03
Cadmium	1.33E-07	2.50E-05	5.33E-03
Manganese	2.66E-05	7.20E-04	3.69E-02
Selenium	2.09E-07	1.00E-03	2.09E-04
Thallium	2.67E-07	3.50E-06	7.61E-02
Vanadium	2.50E-06	3.50E-04	7.15E-03

TOTAL RISK

1.39E-01

00035

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)

ZONE 1

EXPOSURE SCENARIO: Construction Worker, CTE

CALCULATE INCREMENTAL CANCER RISKS:

CHEMICAL	LIFETIME AVERAGE DERMAL DOSE (MG/KG/DAY)	CSF DERMAL (KG/DAY/MG)	CANCER RISK DERMAL CONTACT
Benzene	9.03E-08	2.90E-02	2.62E-09
Bis(2-ethylhexyl)phthalate	6.03E-07	2.50E-02	1.51E-08
Antimony	8.29E-09	0.00E+00	0.00E+00
Arsenic	4.62E-09	1.60E+00	7.40E-09
Beryllium	5.03E-10	0.00E+00	0.00E+00
Boron	2.83E-07	0.00E+00	0.00E+00
Cadmium	1.90E-09	0.00E+00	0.00E+00
Manganese	3.79E-07	0.00E+00	0.00E+00
Selenium	2.99E-09	0.00E+00	0.00E+00
Thallium	3.81E-09	0.00E+00	0.00E+00
Vanadium	3.58E-08	0.00E+00	0.00E+00

TOTAL RISK

2.51E-08

00036

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 1
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), RME

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
 C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
 IR = SOIL INGESTION RATE (MG/EVENT)
 EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
 Fi = FRACTION FROM CONTAMINATED SOURCE
 ED = EXPOSURE DURATION (YEARS)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)
 BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	100	IR:	0
EF:	150	EF:	120
Fi:	1	Fi:	1
ED:	25	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	9125	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:		YOUTH:		ADULT/YOUTH (CANCER RISK):	
CF:	5.87E-07 (AVG ANNUAL DOSE)	CF:	0.00E+00 (AVG ANNUAL DOSE)	CF:	2.10E-07

00037

00040

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 1
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Full-Time Employees (Surface Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
SA _c = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
SA _a = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	1
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	25
BW _c = BODY WEIGHT CHILD (KG):	1
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	9125
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG/1E6 MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	7.97E-06
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	2.23E-05			

00041

00044

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 1
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), CTE

RELEVANT EQUATION:
$$IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	50	IR:	0
EF:	150	EF:	52
Fi:	0.5	Fi:	0.5
ED:	6	ED:	3
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	2190	AT(NON):	1095

DETERMINE CONVERSION FACTORS:

ADULT:	YOUTH:	ADULT/YOUTH (CANCER RISK):
CF: 1.47E-07 (AVG ANNUAL DOSE)	CF: 0.00E+00 (AVG ANNUAL DOSE)	CF: 1.26E-08

00045

00048

67000

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 1
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
S _{Ac} = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
S _{Aa} = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	0.2
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	25
BW _c = BODY WEIGHT CHILD (KG):	1
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	9125
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

 $DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE_{child} = (CF1)*(C)*(ABS)
 DOSE_{adult} = (CF2)*(C)*(ABS)

CF1 = 0.00E+00
 CF2 = 4.46E-06

CANCER RISK = (CF3)*(C)*(ABS)

CF3 = 1.59E-06

00052

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 1
 LOCATION: NSB-NLON, GROTON, CT
 DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), RME

RELEVANT EQUATIONS: $IEX = (C \times IFadj \times Fi \times EF) / (AT \times CF)$ $IFadj = (IRc \times EDc) / BWc + (IRa \times EDa) / BWa$

WHERE:

- C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
- IFadj = AGE-ADJUSTED SOIL INGESTION FACTOR (MG YEAR/KG DAY)
- Fi = FRACTION FROM CONTAMINATED SOURCE (UNITLESS)
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- AT = AVERAGING TIME (DAYS)
- CF = CONVERSION FACTOR (1E+6 MG/KG)
- IRc = CHILD INGESTION RATE (MG/DAY)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- BWc = CHILD BODY WEIGHT (KG)
- IRa = ADULT INGESTION RATE (MG/DAY)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWa = ADULT BODY WEIGHT (KG)

ENTER INPUT PARAMETERS:

IRc: 200
 EDc: 6
 BWc: 15
 IRa: 100
 EDa: 24
 BWa: 70
 IFadj: 114.28571
 Fi: 1
 EF: 150
 AT(NONC): 10950
 AT(CARC): 25550

DETERMINE CONVERSION FACTORS:

NONCARC = 1.57E-06 CARCIN = 6.71E-07

00053

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 1
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA_{adj} \times AF \times ABS \times EF) / (AT \times 1E6)$ $SA_{adj} = (SA_a \times ED_a) / BW_a + (SA_c \times ED_c) / BW_c$

WHERE:

- C = CONCENTRATION IN SOIL (MG/KG)
- SA_c = CHILD SKIN SURFACE AREA (SQ CM/DAY)
- SA_a = ADULT SKIN SURFACE AREA (SQ CM/DAY)
- AF = ADHERENCE FACTOR (MG/SQ CM)
- ABS = ABSORPTION FRACTION
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- ED_c = CHILD EXPOSURE DURATION (YEARS)
- ED_a = ADULT EXPOSURE DURATION (YEARS)
- BW_c = BODY WEIGHT CHILD (KG)
- BW_a = BODY WEIGHT ADULT (KG)
- AT_n = AVERAGING TIME (DAYS), NONCARCINOGENS
- AT_c = AVERAGING TIME (DAYS), CARCINOGENS
- SA_{adj} = AGE-ADJUSTED SKIN SURFACE AREA (SQ CM-YR/DAY-KG)

ENTER INPUT PARAMETERS

SA _c :	2094
SA _a :	3800
AF:	1
EF:	150
ED _c :	6
ED _a :	24
BW _c :	15
BW _a :	70
AT _n :	10950
AT _c :	25550
SA _{adj} :	2140

DETERMINE CONVERSION FACTORS:

NONCARC = 2.93E-05 CARCIN = 1.26E-05

00055

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 1
LOCATION: NSB-NLON, GROTON, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), CTE

RELEVANT EQUATIONS: $IEX = (C \times IFadj \times Fi \times EF) / (AT \times CF)$ $IFadj = (IRc \times EDc) / BWc + (IRa \times EDa) / BWa$

WHERE:

- C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
- IFadj = AGE-ADJUSTED SOIL INGESTION FACTOR (MG YEAR/KG DAY)
- Fi = FRACTION FROM CONTAMINATED SOURCE (UNITLESS)
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- AT = AVERAGING TIME (DAYS)
- CF = CONVERSION FACTOR (1E+6 MG/KG)
- IRc = CHILD INGESTION RATE (MG/DAY)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- BWc = CHILD BODY WEIGHT (KG)
- IRa = ADULT INGESTION RATE (MG/DAY)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWa = ADULT BODY WEIGHT (KG)

ENTER INPUT PARAMETERS:

IRc:	100
EDc:	2
BWc:	15
IRa:	50
EDa:	7
BWa:	70
IFadj:	18.333333
Fi:	0.5
EF:	150
AT(NONC):	3285
AT(CARC):	25550

DETERMINE CONVERSION FACTORS:

NONCARC = 4.19E-07 CARCIN = 5.38E-08

00057

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 1
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA_{adj} \times AF \times ABS \times EF) / (AT \times 1E6)$ $SA_{adj} = (SAa \times EDa) / BWa + (SAc \times EDc) / BWc$

WHERE:

- C = CONCENTRATION IN SOIL (MG/KG)
- SAc = CHILD SKIN SURFACE AREA (SQ CM/DAY)
- SAa = ADULT SKIN SURFACE AREA (SQ CM/DAY)
- AF = ADHERENCE FACTOR (MG/SQ CM)
- ABS = ABSORPTION FRACTION
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWc = BODY WEIGHT CHILD (KG)
- BWa = BODY WEIGHT ADULT (KG)
- ATn = AVERAGING TIME (DAYS), NONCARCINOGENS
- ATc = AVERAGING TIME (DAYS), CARCINOGENS
- SAadj = AGE-ADJUSTED SKIN SURFACE AREA (SQ CM-YR/DAY-KG)

ENTER INPUT PARAMETERS

SAc:	2094
SAa:	3800
AF:	0.2
EF:	150
EDc:	2
EDa:	7
BWc:	15
BWa:	70
ATn:	3285
ATc:	25550
SAadj:	659.2

DETERMINE CONVERSION FACTORS:

NONCARC = 6.02E-06 CARCIN = 7.74E-07

00059

APPENDIX I.6

ZONE 2

**COC SCREENING FOR LOWER SUBBASE
ZONE 2- SHALLOW SOIL (0-4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2**

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COPC? (4)	Rationale
Semivolatile Organic Compounds (mg/kg)													
2-METHYLNAPHTHALENE	1/7	0.02	0.33-0.36	0.146	LS2SB0010101	310	-	-	1000(5)	2500(5)	56(5)	N	2
ACENAPHTHENE	2/7	0.026-0.029	0.33-0.36	0.128	LS2SB0050101	470	-	29	1000(5)	2500(5)	84(5)	N	2
ACENAPHTHYLENE	3/7	0.018-0.057	0.33-0.36	0.112	LS2SB0030101	-	-	-	1000	2500	84	N	2
ANTHRACENE	5/7	0.02-0.085	0.33-0.36	0.089	LS2SB0050101	2300	-	590	1000	2500	400	N	2
BENZO(A)ANTHRACENE	7/7	0.053-0.41	-	0.198	LS2SB0020101	0.88	-	0.08	1	7.8	1	Y	3, 5
BENZO(A)PYRENE	7/7	0.06-0.39	-	0.194	LS2SB0020101	0.088	-	0.4	1	1	1	Y	3
BENZO(B)FLUORANTHENE	7/7	0.059-0.39	-	0.191	LS2SB0020101	0.88	-	0.2	1	7.8	1	Y	3, 5
BENZO(G,H,I)PERYLENE	7/7	0.058-0.28	-	0.151	LS2SB0020101	-	-	-	1000(5)	2500(5)	40(5)	N	2
BENZO(K)FLUORANTHENE	7/7	0.049-0.3	-	0.155	LS2SB0020101	8.8	-	2	8.4	78	1	N	2
CARBAZOLE	3/7	0.022-0.036	0.33-0.36	0.108	LS2SB0020101	32	-	0.03	31(5)	290(5)	0.36(5)	Y	3, 5
CHRYSENE	7/7	0.062-0.45	-	0.226	LS2SB0020101	88	-	8	84(5)	780(5)	0.96(5)	N	2
DIBENZO(A,H)ANTHRACENE	7/7	0.031-0.17	-	0.067	LS2SB0020101	0.088	-	0.08	0.084(5)	0.78(5)	0.00096(5)	Y	3
DIETHYL PHTHALATE	2/7	0.022-0.024	0.33-0.36	0.127	LS2SB0010101	6300	2000	23	1000(5)	2500(5)	1100(5)	N	2
FLUORANTHENE	7/7	0.094-0.79	-	0.383	LS2SB0020101	310	-	210	1000	2500	56	N	2
FLUORENE	2/7	0.021-0.022	0.33-0.36	0.126	LS2SB0020101	310	-	28	1000	2500	56	N	2
INDENO(1,2,3-CD)PYRENE	7/7	0.043-0.32	-	0.148	LS2SB0020101	0.88	-	0.7	0.84(5)	7.8(5)	0.0096(5)	Y	3, 5
NAPHTHALENE	1/7	0.02	0.33	0.144	LS2SB0070101	310	-	4	1000	2500	56	N	2
PHENANTHRENE	7/7	0.042-0.39	-	0.190	LS2SB0020101	-	-	-	1000	2500	40	N	2
PYRENE	7/7	0.088-0.63	-	0.340	LS2SB0020101	230	-	210	1000	2500	40	N	2
Metals (mg/kg)													
ALUMINUM	1/1	7210	-	7210	13MW11(2-4)	7800	-	-	-	-	-	N	2
ARSENIC	1/1	1.8	-	1.8	13MW11(2-4)	0.43	750	1	10	10	-	Y	3
BARIUM	1/1	30.1	-	30.1	13MW11(2-4)	550	690000	82	4700	140000	-	N	2
BERYLLIUM	1/1	0.29	-	0.29	13MW11(2-4)	0.15	1300	3	2	2	-	Y	3
CADMIUM	1/1	1.3	-	1.3	13MW11(2-4)	3.9	1800	0.4	34	1000	-	Y	3, 5
CHROMIUM (TOTAL)	1/1	12.4	-	12.4	13MW11(2-4)	39(6)	270	2	100(6)	100(6)	-	Y	3, 5
COBALT	1/1	4.1	-	4.1	13MW11(2-4)	470	-	-	-	-	-	N	2
COPPER	1/1	17.8	-	17.8	13MW11(2-4)	310	-	-	1000(5)	2500(5)	-	N	2
IRON	1/1	9560	-	9560	13MW11(2-4)	2300	-	-	-	-	-	Y	3, 4
LEAD	3/3	149-178	-	159	13MW11(2-4)	400(7)	-	-	500	1000	-	N	2
MANGANESE	1/1	153	-	153	13MW11(2-4)	180	-	-	1600	47000	-	N	2
MERCURY	1/1	0.11	-	0.11	13MW11(2-4)	2.3	-	-	20	610	-	N	2
NICKEL	1/1	8.2	-	8.2	13MW11(2-4)	160	13000	7	1400	7500	-	Y	3, 5
VANADIUM	1/1	16.8	-	16.8	13MW11(2-4)	55	-	300	470	14000	-	N	2
ZINC	1/1	54.3	-	54.3	13MW11(2-4)	2300	-	620	20000	610000	-	N	2
Miscellaneous (mg/kg)													
TPH	8/9	26.8-856	25	250.58889	13TB8-0103	-	-	-	500	2500	2500	Y	1, 3

Notes:

- Not available or Not applicable.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Residential Soil Ingestion is used for soil and sediment. Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with dilution and attenuation factor (DAF) of 1.0 are used.

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.

00001

**COC SCREENING FOR LOWER SUBBASE
ZONE 2- SHALLOW SOIL (0-4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2**

Notes (continued):

- (3) CTDEP, January 1996. State Pollutant Mobility criteria for metals are not included since a direct comparison of the aqueous SPLP criteria (in ug/L) and the soil analytical results (in mg/kg) cannot be made. TCLP and SPLP results for soil samples are addressed in The Nature and Extent Section of the RI Report.
- (4) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (5) No value promulgated by CTDEP, calculated or surrogate value is used. Ceiling limit is used if calculated or surrogate value exceeds the ceiling limit.
- (6) Hexavalent chromium.
- (7) Value is based on OSWER soil screening level for residential land use (USEPA, July 14, 1994).

Rational Designations (continued):

- (5) Maximum exceeds migration to groundwater criteria only; chemical will not be quantitatively evaluated in the risk assessment.

00002

**COC SCREENING FOR LOWER SUBASE
ZONE 2- ALL SOIL (0-10 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2**

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COCP? (4)	Rationale
Volatile Organic Compounds (mg/kg)													
METHYLENE CHLORIDE	1/3	0.002	0.005	0.00233333	13MW17(8-10)	85	13	0.001	82	760	1	Y	3, 5
TRICHLOROETHENE	1/3	0.001	0.005	0.002	13MW17(8-10)	58	5	0.003	56	520	1	N	2
Semivolatile Organic Compounds (mg/kg)													
2-METHYLNAPHTHALENE	2/14	0.02	0.33-0.4	0.150	LS2SB0010101, LS2SB0030201	310	-	-	1000(5)	2500(5)	56(5)	N	2
ACENAPHTHENE	5/14	0.026-0.46	0.33-0.4	0.152	LS2SB0020201	470	-	29	1000(5)	2500(5)	84(5)	N	2
ACENAPHTHYLENE	4/14	0.018-0.063	0.33-0.4	0.136	LS2SB0030201	-	-	-	1000	2500	84	N	2
ANTHRACENE	8/14	0.02-0.18	0.33-0.4	0.127	LS2SB0020201, LS2SB0030201	2300	-	590	1000	2500	400	N	2
BENZO(A)ANTHRACENE	12/14	0.018-0.65	0.33-0.4	0.192	LS2SB0030201	0.88	-	0.08	1	7.8	1	Y	3, 5
BENZO(A)PYRENE	12/14	0.019-0.57	0.33-0.4	0.180	LS2SB0030201	0.088	-	0.4	1	1	1	Y	3
BENZO(B)FLUORANTHENE	12/14	0.019-0.68	0.33-0.4	0.189	LS2SB0030201	0.88	-	0.2	1	7.8	1	Y	3, 5
BENZO(G,H,I)PERYLENE	11/14	0.02-0.4	0.33-0.4	0.160	LS2SB0030201	-	-	-	1000(5)	2500(5)	40(5)	N	2
BENZO(K)FLUORANTHENE	11/14	0.023-0.43	0.33-0.4	0.156	LS2SB0030201	8.8	-	2	8.4	78	1	N	2
CARBAZOLE	5/14	0.022-0.065	0.33-0.4	0.124	LS2SB0030201	32	-	0.03	31(5)	290(5)	0.36(5)	Y	3, 5
CHRYSENE	12/14	0.023-0.68	0.33-0.4	0.207	LS2SB0030201	88	-	8	84(5)	780(5)	0.96(5)	N	2
DI-N-BUTYL PHTHALATE	2/14	0.017-0.018	0.33-0.4	0.150	LS2SB0030201	7800	2300	270	1000	2500	140	N	2
DIBENZO(A,H)ANTHRACENE	9/14	0.031-0.18	0.33-0.4	0.112	LS2SB0030201	0.088	-	0.08	0.084(5)	0.78(5)	0.000096(5)	Y	3
DIBENZOFURAN	3/14	0.026-0.32	0.33-0.4	0.161	LS2SB0020201	310	-	-	270(5)	2500(5)	5.6(5)	N	2
DIETHYL PHTHALATE	5/14	0.018-0.047	0.33-0.36	0.119	LS2SB0010201	6300	2000	23	1000(5)	2500(5)	1100(5)	N	2
FLUORANTHENE	12/14	0.034-1.3	0.33-0.4	0.382	LS2SB0030201	310	-	210	1000	2500	56	N	2
FLUORENE	4/14	0.021-0.064	0.33-0.4	0.132	LS2SB0030201	310	-	28	1000	2500	56	N	2
INDENO(1,2,3-CD)PYRENE	11/14	0.02-0.4	0.33-0.4	0.149	LS2SB0030201	0.88	-	0.7	0.84(5)	7.8(5)	0.0096(5)	Y	3, 5
NAPHTHALENE	2/14	0.018-0.02	0.33-0.4	0.149	LS2SB0070101	310	-	4	1000	2500	56	N	2
PHENANTHRENE	11/14	0.018-0.75	0.33-0.4	0.212	LS2SB0030201	-	-	-	1000	2500	40	N	2
PYRENE	12/14	0.03-1.2	0.33-0.4	0.329	LS2SB0030201	230	-	210	1000	2500	40	N	2
Metals (mg/kg)													
ALUMINUM	6/6	2670-7210	-	4168.33333	13MW11(2-4)	7800	-	-	-	-	-	N	2
ARSENIC	5/6	0.82-1.9	0.355	1.1775	13MW10(6-8)	0.43	750	1	10	10	-	Y	3
BARIUM	3/6	15.3-30.1	26.3-32.6	18.875	13MW11(2-4)	550	690000	82	4700	140000	-	N	2
BERYLLIUM	1/6	0.29	0.1-0.24	0.113333	13MW11(2-4)	0.15	1300	3	2	2	-	Y	3
CADMIUM	3/6	0.6-1.3	0.04-5	0.441667	13MW11(2-4)	3.9	1800	0.4	34	1000	-	Y	3, 5
CHROMIUM (total)	6/6	3.9-12.4	-	7.8	13MW11(2-4)	39(6)	270	2	100(6)	100(6)	-	Y	3, 5
COBALT	6/6	2.2-4.1	-	2.766667	13MW11(2-4)	470	-	-	1000(5)	2500(5)	-	N	2
COPPER	6/6	6.6-17.8	-	9.566667	13MW11(2-4)	310	-	-	-	-	-	N	2
IRON	6/6	4310-9560	-	6121.66667	13MW11(2-4)	2300	-	-	-	-	-	Y	3, 4
LEAD	9/9	2.1-404	-	102.74444	13TB11-0406	400(7)	-	-	500	1000	-	Y	3
MANGANESE	6/6	94.5-208	-	134.116667	13MW17(8-10)	180	-	-	1600(5)	47000(5)	-	Y	3
MERCURY	1/6	0.11	0.002-0.01	0.0355	13MW11(2-4)	2.3	-	-	20	610	-	N	2
NICKEL	6/6	3.8-8.2	-	5.55	13MW11(2-4)	160	13000	7	1400	7500	-	Y	3, 5
VANADIUM	6/6	6-16.8	-	10.666667	13MW11(2-4)	55	-	300	470	14000	-	N	2
ZINC	6/6	14-54.3	-	23.166667	13MW11(2-4)	2300	-	620	20000	610000	-	N	2
Miscellaneous (mg/kg)													
TPH	14/18	26.8-8210	10.2-80	612.019444	FPTB22L-07	-	-	-	500	2500	2500	Y	1, 3

30000

**COC SCREENING FOR LOWER SUBBASE
ZONE 2- ALL SOIL (0-10 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2**

Notes:

- Not available or Not applicable.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Residential Soil Ingestion is used for soil and sediment. Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with dilution and attenuation factor (DAF) of 1.0 are used.
- (3) CTDEP, January 1996. State Pollutant Mobility criteria for metals are not included since a direct comparison of the aqueous SPLP criteria (in ug/L) and the soil analytical results (in mg/kg) cannot be made. TCLP and SPLP results for soil samples are addressed in The Nature and Extent Section of the RI Report.
- (4) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (5) No value promulgated by CTDEP, calculated or surrogate value is used. Ceiling limit is used if calculated or surrogate value exceeds the ceiling limit.
- (6) Hexavalent chromium.
- (7) Value is based on OSWER soil screening level for residential land use (USEPA, July 14, 1994).

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Maximum exceeds migration to groundwater criteria only; chemical will not be quantitatively evaluated in the risk assessment.

40000

COC SCREENING FOR LOWER SUBBASE
 ZONE 2 - GROUNDWATER
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2

Parameter	Frequency	Range of Detection	Range of Nondetects	Location of Maximum	COC Screening Level (1)	EPA MCL (2)	State MCL (3)	State RSR Groundwater (4)	State AWQC		Selected as COC (6)	Rationale
									Saltwater (5)	Human Health (5)		
Volatile Organic Compounds (ug/L)												
1,1,1-Trichloroethane	1/18	3	5 - 10	13MW6	54	200	200	200	-	-	N	2
Carbon disulfide	1/18	2	5 - 10	NESO6	100	-	-	700 (7)	-	-	N	2
Chloroform	1/18	1	5 - 10	13MW10	0.15	100/80	100	6	-	5.7	Y	3
Tetrachloroethene	1/18	2	5 - 10	13MW6	1.1	5	5	5	-	0.8	Y	3
Benzoic acid	1/12	1	50	NESO6	15000	-	-	28000 (7)	-	-	N	2
Semivolatile Organic Compounds (ug/L)												
Bis(2-Ethylhexyl)phthalate	1/17	0.8	10 - 12	13MW10	4.8	6	6	2	-	1.8	N	2
Butylbenzyl phthalate	1/17	1	10 - 12	13MW10	730	-	-	1000	-	3000	N	2
Di-N-butyl phthalate	1/17	0.9	10 - 12	13MW10	370	-	-	700	-	2700	N	2
Di-N-octyl phthalate	1/17	3	10 - 12	13MW11	73	-	-	100	-	-	N	2
Metals (ug/L)												
Aluminum	2/23	17.3 - 23.8	10 - 501	13MW6	3700	50 TO 200 (8)	-	-	-	-	N	2
Aluminum, filtered	1/17	33.9	10 - 39.3	13MW11	3700	50 TO 200 (8)	-	-	-	-	N	2
Antimony	1/23	4.1	2.5 - 25	13MW11	1.5	6	6	6	-	14	Y	3
Antimony, filtered	6/17	2.6 - 15.1	2.5 - 15	13MW11	1.5	6	6	6	-	14	Y	3, 5
Arsenic	3/23	1.3 - 4.7	2 - 10	13MW11	0.045	50	50	50	36	0.018	Y	3
Arsenic, filtered	3/17	3.1 - 10	2 - 2.5	13MW10	0.045	50	50	50	36	0.018	Y	3, 5
Barium	12/23	18.4 - 46.5	5.6 - 26	NESO6	260	2000	2000	1000	-	-	N	2
Barium, filtered	11/17	6.3 - 259	5 - 23.6	13MW17	260	2000	2000	1000	-	-	N	2
Boron	10/12	60.8 - 630	50 - 72.9	13MW10	330	-	-	630 (7)	-	-	Y	3
Boron, filtered	10/12	57 - 627	50 - 78.4	13MW10	330	-	-	630 (7)	-	-	Y	3, 5
Cadmium	1/23	3.3	0.22 - 3.1	13MW10	1.8	5	5	5	9.3	16	Y	3
Chromium (total)	3/23	0.77 - 1.2	1 - 5	13MW11	18 (10)	100	100	50	50 (10)	170 (10)	N	2
Chromium, (total) filtered	3/17	1 - 3.5	0.86 - 4	13MW11	18(10)	100	100	50	50 (10)	170 (10)	N	2
Cobalt	1/23	2.1	0.8 - 5	13MW10	220	-	-	420 (7)	-	-	N	2
Cobalt, filtered	1/17	1	0.8 - 5	13MW10	220	-	-	420 (7)	-	-	N	2
Copper	6/23	3.2 - 34.7	1.8 - 5	13MW11	150	1300	-	1300	2.4	1300	Y	3, 6
Copper, filtered	5/17	2.2 - 5.3	0.74 - 5	NESO6	150	1300	-	1300	2.4	1300	Y	3, 6
Iron	12/23	29.2 - 9930	4 - 145	13MW10	1100	300 (8)	-	-	-	-	Y	3, 4
Iron, filtered	3/17	900 - 5070	8.1 - 37.8	13MW11	1100	300 (8)	-	-	-	-	Y	3, 4
Lead	13/22	1.3 - 27.7	1 - 10	13MW10	-	15 (9)	-	15	8.1	50	Y	3
Lead, filtered	2/13	1.6 - 6.1	1 - 20	13MW10	-	15 (9)	-	15	8.1	50	N	2
Manganese	12/23	0.95 - 356	1 - 7.3	13MW11	84	50 (8)	5000 (11)	160 (7)	-	-	Y	3
Manganese, filtered	9/17	1.1 - 387	0.9 - 4.9	13MW11	84	50 (8)	5000 (11)	160 (7)	-	-	Y	3, 5
Nickel	8/23	5.2 - 23.9	0.75 - 12	NESO6	73	100	100	100	8.2	610	Y	3, 6
Nickel, filtered	2/17	0.77 - 0.97	0.75 - 11	13MW10	73	100	100	100	8.2	610	N	2
Selenium	4/22	1.2 - 11	1 - 3	13MW17	18	50	50	50	71	100	N	2
Selenium, filtered	2/15	2.2 - 2.7	1.9 - 3	13MW17	18	50	50	50	71	100	N	2
Silver, filtered	1/17	1.3	1.1 - 3	13MW10	18	100 (8)	50	36	-	105	N	2
Sodium	23/23	15500 - 1850000	-	13MW10	-	-	28000 (12)	-	-	-	Y	1, 3
Sodium, filtered	17/17	55300 - 1880000	-	13MW10	-	-	28000 (12)	-	-	-	Y	1, 3
Vanadium	1/23	3.1	0.55 - 20	13MW10	26	-	-	50	-	-	N	2

00005

COC SCREENING FOR LOWER SUBBASE
 ZONE 2 - GROUNDWATER
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 2 OF 2

Parameter	Frequency	Range of Detection	Range of Nondetects	Location of Maximum	COC Screening Level (1)	EPA MCL (2)	State MCL (3)	State RSR Groundwater (4)	State AWQC		Selected as COC (6)	Rationale
									Saltwater (5)	Human Health (5)		
Metals (ug/L)												
Vanadium, filtered	1/17	0.63	0.55 - 5	13MW10	26	-	-	50	-	-	N	2
Zinc	13/23	5 - 58.2	2.9 - 15.8	13MW10	1100	5000 (8)	-	5000	81	-	N	2
Zinc, filtered	6/17	4.5 - 132	3.2 - 15	13MW17	1100	5000 (8)	-	5000	81	-	Y	3, 6
Miscellaneous (ug/L)												
TPH	2/23	600	500 - 3000	13MW11,13MW6	-	-	-	500	-	-	Y	1, 3

Notes:

- Not available or Not applicable.
- Bolded cell indicates that the maximum detected site concentration exceeds this criteria.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Tap Water Ingestion Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) Maximum Contaminant Level. (USEPA, October 1996).
- (3) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter II Environmental Health.
- (4) CDTEP, January 1996.
- (5) Connecticut Water Quality Standards, 1992. Chronic values for saltwater bodies and protection of human health values for water and organisms are presented.
- (6) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (7) No value promulgated by CTDEP, calculated value used.
- (8) Secondary MCL (SMCL) based on aesthetic water qualities.
- (9) Action Level.
- (10) Hexavalent chromium.
- (11) Current Connecticut Department of Public Health and Addiction Services Action Level.
- (12) Notification Level.

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Unfiltered data, rather than filtered data, will be in quantitative risk assessment.
- (6) Maximum is greater than State AWQC only; chemical will not be quantitatively evaluated in the risk assessment.

90000

95% UPPER CONFIDENCE LIMITS
 ZONE 2 - SHALLOW SOILS (0-4 FT)
 NSB - NLON, GROTON, CONNECTICUT

PARAMETER	UNITS	DETECTS	COUNT	AVERAGE	W NORMAL	W LOGNORMAL	W TEST	DISTRIBUTION	UCL - NORMAL	UCL - LOGNORMAL	DETECTS - MAX	95% UCL ⁽¹⁾
ALUMINUM	mg/kg	1	1	7210	*****	*****	0	NOT DEFINED	*****	0	7210	7210
ARSENIC	mg/kg	1	1	1.8	*****	*****	0	NOT DEFINED	*****	0	1.8	1.8
BARIUM	mg/kg	1	1	30.1	*****	*****	0	NOT DEFINED	*****	0	30.1	30.1
BERYLLIUM	mg/kg	1	1	0.29	*****	*****	0	NOT DEFINED	*****	0	0.29	0.29
CADMIUM	mg/kg	1	1	1.3	*****	*****	0	NOT DEFINED	*****	0	1.3	1.3
CALCIUM	mg/kg	1	1	1540	*****	*****	0	NOT DEFINED	*****	0	1540	1540
CHROMIUM	mg/kg	1	1	12.4	*****	*****	0	NOT DEFINED	*****	0	12.4	12.4
COBALT	mg/kg	1	1	4.1	*****	*****	0	NOT DEFINED	*****	0	4.1	4.1
COPPER	mg/kg	1	1	17.8	*****	*****	0	NOT DEFINED	*****	0	17.8	17.8
IRON	mg/kg	1	1	9560	*****	*****	0	NOT DEFINED	*****	0	9560	9560
LEAD	mg/kg	3	3	159	0.7758	0.7782	0.767	LOGNORMAL	186.7528	193.8052	178	178
MAGNESIUM	mg/kg	1	1	2330	*****	*****	0	NOT DEFINED	*****	0	2330	2330
MANGANESE	mg/kg	1	1	153	*****	*****	0	NOT DEFINED	*****	0	153	153
MERCURY	mg/kg	1	1	0.11	*****	*****	0	NOT DEFINED	*****	0	0.11	0.11
NICKEL	mg/kg	1	1	8.2	*****	*****	0	NOT DEFINED	*****	0	8.2	8.2
POTASSIUM	mg/kg	1	1	1590	*****	*****	0	NOT DEFINED	*****	0	1590	1590
SODIUM	mg/kg	1	1	184	*****	*****	0	NOT DEFINED	*****	0	184	184
VANADIUM	mg/kg	1	1	16.8	*****	*****	0	NOT DEFINED	*****	0	16.8	16.8
ZINC	mg/kg	1	1	54.3	*****	*****	0	NOT DEFINED	*****	0	54.3	54.3
2-METHYLNAPHTHALENE	µg/kg	1	7	146.4286	0.528	0.4839	0.803	NOT DEFINED	187.5757	482.1947	20	20
ACENAPHTHENE	µg/kg	2	7	127.8571	0.6633	0.6396	0.803	NOT DEFINED	178.3688	501.5765	29	29
ACENAPHTHYLENE	µg/kg	3	7	112.4286	0.7858	0.8069	0.803	LOGNORMAL	164.819	485.4203	57	57
ANTHRACENE	µg/kg	5	7	89.4286	0.8905	0.9509	0.803	LOGNORMAL	134.1374	250.3034	85	85
BENZO(A)ANTHRACENE	µg/kg	7	7	198	0.8654	0.8415	0.803	NORMAL	297.4027	664.0992	410	297.4027
BENZO(A)PYRENE	µg/kg	7	7	194.4286	0.8839	0.8662	0.803	NORMAL	285.2807	516.8179	390	285.2807
BENZO(B)FLUORANTHENE	µg/kg	7	7	191.2857	0.8993	0.8739	0.803	NORMAL	283.9568	541.5122	390	283.9568
BENZO(G,H,I)PERYLENE	µg/kg	7	7	150.8571	0.8725	0.8329	0.803	NORMAL	216.7944	350.7826	280	216.7944
BENZO(K)FLUORANTHENE	µg/kg	7	7	155.2857	0.9419	0.9398	0.803	NORMAL	222.6796	355.5519	300	222.6796
CARBAZOLE	µg/kg	3	7	108	0.7333	0.7409	0.803	NOT DEFINED	163.8776	579.8882	36	36
CHRYSENE	µg/kg	7	7	226	0.8759	0.8595	0.803	NORMAL	333.8121	666.6136	450	333.8121
DIBENZO(A,H)ANTHRACENE	µg/kg	7	7	67.1429	0.7714	0.8641	0.803	LOGNORMAL	103.7332	141.1988	170	141.1988
DIETHYL PHTHALATE	µg/kg	2	7	126.5714	0.66	0.6341	0.803	NOT DEFINED	178.6884	640.0171	24	24
FLUORANTHENE	µg/kg	7	7	383.4286	0.9158	0.885	0.803	NORMAL	582.3944	1407.1704	790	582.3944
FLUORENE	µg/kg	2	7	126.1429	0.6579	0.6291	0.803	NOT DEFINED	178.7944	705.6397	22	22
INDENO(1,2,3-CD)PYRENE	µg/kg	7	7	148.4286	0.9019	0.8939	0.803	NORMAL	223.236	433.4421	320	223.236
NAPHTHALENE	µg/kg	1	7	144.2857	0.4533	0.4533	0.803	NOT DEFINED	184.5336	467.7311	20	20
PHENANTHRENE	µg/kg	7	7	189.8571	0.8254	0.8725	0.803	LOGNORMAL	304.0978	870.027	390	390
PYRENE	µg/kg	7	7	339.7143	0.9012	0.8836	0.803	NORMAL	501.5023	1044.1655	630	501.5023
TPH	mg/kg	8	9	250.5889	0.8344	0.935	0.829	LOGNORMAL	423.5232	3592.4304	856	856

(1) The UCL Normal and UCL Lognormal values are the 95% UCL for normal and lognormal distributions, respectively; if these values exceeded the maximum concentration, then the maximum concentration was used as the 95% UCL. For undefined distributions, the maximum concentration was used as the 95% UCL. Asterisks indicate insufficient number of samples to calculate statistics.

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00008

**95% UPPER CONFIDENCE LIMITS
ZONE 2- SOILS (0-10 FT)
NSB - NLON, GROTON, CONNECTICUT**

PARAMETER	UNITS	DETECTS	COUNT	AVERAGE	W NORMAL	W LOGNORMAL	W TEST	DISTRIBUTION	UCL - NORMAL	UCL - LOGNORMAL	DETECTS - MAX	95% UCL ⁽¹⁾
ALUMINUM	mg/kg	4	4	4427.50	0.9128	0.9623	0.748	LOGNORMAL	6806.60	13091.35	7210	7210
ARSENIC	mg/kg	3	4	1.31	0.8934	0.8153	0.748	NORMAL	2.15	36.21	1.9	1.9
BARIUM	mg/kg	3	4	20.81	0.9182	0.9205	0.748	LOGNORMAL	30.19	50.86	30.1	30.1
BERYLLIUM	mg/kg	1	4	0.14	0.8708	0.9637	0.748	LOGNORMAL	0.26	2.31	0.29	0.29
CADMIUM	mg/kg	3	4	0.65	0.9721	0.7863	0.748	NORMAL	1.27	150812937.66	1.3	1.2689
CALCIUM	mg/kg	4	4	1206.00	0.9215	0.8981	0.748	NORMAL	1775.14	4055.09	1650	1650
CHROMIUM	mg/kg	4	4	7.75	0.9593	0.972	0.748	LOGNORMAL	11.88	27.64	12.4	12.4
COBALT	mg/kg	4	4	2.73	0.704	0.7269	0.748	NOT DEFINED	3.81	4.82	4.1	4.1
COPPER	mg/kg	4	4	10.43	0.7898	0.8607	0.748	LOGNORMAL	16.32	29.28	17.8	17.8
IRON	mg/kg	4	4	5990.00	0.7601	0.812	0.748	LOGNORMAL	8820.50	12700.57	9560	9560
LEAD	mg/kg	7	7	128.01	0.8336	0.8534	0.803	LOGNORMAL	234.00	153260.24	404	404
MAGNESIUM	mg/kg	4	4	1752.50	0.9906	0.969	0.748	NORMAL	2325.36	3067.17	2330	2325.3621
MANGANESE	mg/kg	4	4	145.13	0.9792	1	0.748	LOGNORMAL	201.89	286.91	208	208
MERCURY	mg/kg	1	4	0.05	0.9397	0.7737	0.748	NORMAL	0.11	2210834583.86	0.11	0.1052
NICKEL	mg/kg	4	4	5.73	0.9256	0.9531	0.748	LOGNORMAL	7.87	10.65	8.2	8.2
POTASSIUM	mg/kg	4	4	1380.00	0.9488	0.9293	0.748	NORMAL	1608.74	1717.74	1590	1590
SODIUM	mg/kg	4	4	196.50	0.9101	0.8764	0.748	NORMAL	269.49	428.47	250	250
VANADIUM	mg/kg	4	4	10.20	0.8865	0.9557	0.748	LOGNORMAL	15.65	28.89	16.8	16.8
ZINC	mg/kg	4	4	25.90	0.7428	0.8217	0.748	LOGNORMAL	48.40	212.10	54.3	54.3
METHYLENE CHLORIDE	µg/kg	1	3	2.33	0.75	0.75	0.767	NOT DEFINED	2.82	3.05	2	2
TRICHLOROETHENE	µg/kg	1	3	2.00	0.75	0.75	0.767	NOT DEFINED	3.46	27.74	1	1
2-METHYLNAPHTHALENE	µg/kg	2	12	147.50	0.6171	0.5271	0.859	NOT DEFINED	178.87	335.34	20	20
ACENAPHTHENE	µg/kg	5	12	149.58	0.778	0.8266	0.859	NOT DEFINED	211.32	364.52	460	460
ACENAPHTHYLENE	µg/kg	4	12	131.25	0.7843	0.7501	0.859	NOT DEFINED	165.60	268.79	63	63
ANTHRACENE	µg/kg	8	12	120.92	0.8827	0.8562	0.859	NORMAL	154.00	221.65	180	154.0019
BENZO(A)ANTHRACENE	µg/kg	10	12	220.92	0.8479	0.9651	0.859	LOGNORMAL	309.47	408.92	650	408.9247
BENZO(A)PYRENE	µg/kg	10	12	206.42	0.8603	0.9461	0.859	LOGNORMAL	285.27	361.89	570	361.8862
BENZO(B)FLUORANTHENE	µg/kg	10	12	217.25	0.8147	0.9615	0.859	LOGNORMAL	308.59	388.83	680	388.8255
BENZO(G,H,I)PERYLENE	µg/kg	10	12	171.75	0.9168	0.939	0.859	LOGNORMAL	223.72	270.91	400	270.9144
BENZO(K)FLUORANTHENE	µg/kg	10	12	166.58	0.8979	0.9499	0.859	LOGNORMAL	226.27	298.68	430	298.6817
CARBAZOLE	µg/kg	5	12	116.58	0.7854	0.7743	0.859	NOT DEFINED	154.30	272.43	65	65
CHRYSENE	µg/kg	10	12	237.25	0.8483	0.9614	0.859	LOGNORMAL	331.75	421.47	680	421.47
DI-N-BUTYL PHTHALATE	µg/kg	1	12	159.42	0.5281	0.4052	0.859	NOT DEFINED	183.19	280.49	18	18
DIBENZO(A,H)ANTHRACENE	µg/kg	9	12	102.92	0.817	0.8396	0.859	NOT DEFINED	138.90	194.77	180	180
DIBENZOFURAN	µg/kg	3	12	160.25	0.7895	0.6859	0.859	NOT DEFINED	198.43	288.64	320	320
DIETHYL PHTHALATE	µg/kg	5	12	110.83	0.7212	0.7287	0.859	NOT DEFINED	149.96	326.83	47	47
FLUORANTHENE	µg/kg	10	12	439.08	0.8695	0.9594	0.859	LOGNORMAL	622.07	893.65	1300	893.6549
FLUORENE	µg/kg	4	12	126.92	0.7575	0.7147	0.859	NOT DEFINED	163.11	300.40	64	64
INDENO(1,2,3-CD)PYRENE	µg/kg	10	12	158.75	0.889	0.9158	0.859	LOGNORMAL	218.66	320.25	400	320.2495
NAPHTHALENE	µg/kg	2	12	146.08	0.611	0.5282	0.859	NOT DEFINED	177.35	342.14	20	20
PHENANTHRENE	µg/kg	9	12	244.50	0.8634	0.9593	0.859	LOGNORMAL	348.00	540.60	750	540.5994
PYRENE	µg/kg	10	12	378.58	0.8194	0.9805	0.859	LOGNORMAL	540.39	692.87	1200	692.8729
TPH	mg/kg	14	18	612.02	0.3324	0.9652	0.897	LOGNORMAL	1394.68	2876.34	8210	2876.3446

(1) The UCL Normal and UCL Lognormal values are the 95% UCL for normal and lognormal distributions, respectively; if these values exceeded the maximum concentration, then the maximum concentration was used as the 95% UCL. For undefined distributions, the maximum concentration was used as the 95% UCL.

6000

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**SUMMARY OF MAXIMUM AND AVERAGE CONCENTRATIONS
 ZONE 2 - GROUNDWATER
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2**

Parameter	Maximum Detected Concentration	Average Concentration
Volatile Organic Compounds (ug/L)		
1,1,1-TRICHLOROETHANE	3.00	4.10
CARBON DISULFIDE	2.00	3.90
CHLOROFORM	1.00	4.20
TETRACHLOROETHENE	2.00	3.90
Semivolatile Organic Compounds (ug/L)		
BENZOIC ACID	1.00	20.20
BIS(2-ETHYLHEXYL)PHTHALATE	0.80	4.76
BUTYLBENZYL PHTHALATE	1.00	4.80
DI-N-BUTYL PHTHALATE	0.90	4.78
DI-N-OCTYL PHTHALATE	3.00	5.20
Metals (ug/L)		
ALUMINUM	23.41	36.51
ALUMINUM, FILTERED	18.95	11.22
ANTIMONY	6.40	6.41
ANTIMONY, FILTERED	10.15	6.05
ARSENIC	3.01	1.77
ARSENIC, FILTERED	4.08	2.01
BARIUM	23.48	19.09
BARIUM, FILTERED	99.64	36.13
BORON	463.50	176.61
BORON, FILTERED	459.00	175.83
CADMIUM	1.50	0.88
CALCIUM	66,087.50	43,845.00
CALCIUM, FILTERED	72,266.67	48,543.33
CHROMIUM	1.69	1.59
CHROMIUM, FILTERED	2.18	1.33
COBALT	2.28	1.69
COBALT, FILTERED	1.83	1.35
COPPER	10.35	5.17
COPPER, FILTERED	2.70	1.93
IRON	4,237.50	1,383.92
IRON, FILTERED	3,096.67	626.49
LEAD	8.55	5.54
LEAD, FILTERED	5.53	1.70
MAGNESIUM	135,700.00	45,630.00
MAGNESIUM, FILTERED	145,400.00	51,057.33
MANGANESE	250.05	56.93
MANGANESE, FILTERED	238.50	50.51
NICKEL	11.38	8.47

SUMMARY OF MAXIMUM AND AVERAGE CONCENTRATIONS
ZONE 2 - GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Maximum Detected Concentration	Average Concentration
Metals (ug/L)		
NICKEL, FILTERED	3.82	3.31
POTASSIUM	46,012.50	18,170.00
POTASSIUM, FILTERED	49,400.00	20,258.00
SELENIUM	3.50	1.64
SELENIUM, FILTERED	1.72	1.41
SILVER, FILTERED	1.27	1.09
SODIUM	1,106,062.50	392,022.50
SODIUM, FILTERED	1,267,333.33	463,040.00
VANADIUM	4.40	3.72
VANADIUM, FILTERED	1.71	1.46
ZINC	35.26	15.05
ZINC, FILTERED	49.66	17.14
Miscellaneous (ug/L)		
TPH	600.00	617.50

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 2
 LOCATION: NSB-NLON, Groton, CT
 DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker (All Soil), RME

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
 C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
 IR = SOIL INGESTION RATE (MG/EVENT)
 EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
 Fi = FRACTION FROM CONTAMINATED SOURCE
 ED = EXPOSURE DURATION (YEARS)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)
 BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	480	IR:	0
EF:	120	EF:	120
Fi:	1	Fi:	1
ED:	1	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	365	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:		YOUTH:		ADULT/YOUTH (CANCER RISK):	
CF:	2.25E-06 (AVG ANNUAL DOSE)	CF:	0.00E+00 (AVG ANNUAL DOSE)	CF:	3.22E-08

00013

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 2
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Construction Worker (All Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:	C = CONCENTRATION IN SOIL (MG/KG)	
	S _c = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
	S _a = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
	AF = ADHERENCE FACTOR (MG/SQ CM):	1
	ABS = ABSORPTION FRACTION:	
		Chemical Specific
	E _f = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
	E _f = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	120
	E _d = CHILD EXPOSURE DURATION (YEARS):	1
	E _d = ADULT EXPOSURE DURATION (YEARS):	1
	B _w = BODY WEIGHT CHILD (KG):	1
	B _w = BODY WEIGHT ADULT (KG):	70
	A _t = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
	A _t = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
	A _t = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	2.55E-07
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	1.78E-05			

00017

00020

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER

SITE NAME: ZONE 2
 LOCATION: NSB-NLON, Groton, CT
 DATE: 2/2/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker, RME

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

$$DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DA_{event} = ABSORBED DOSE PER EVENT (MG/CM**2/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS:
 FOR ORGANICS:

$$DA_{event} = K_p \times C \times t_{event} \times CF$$

$$\text{IF } t_{event} < t^*, DA_{event} = 2K_p \times C \times CF \times (6T \times t_{event}/3.141592654)^{0.5}$$

$$\text{IF } t_{event} > t^*, DA_{event} = K_p \times C \times CF \times ((t_{event}/(1+B)) + (2T \times ((1+3B)/(1+B))))$$

WHERE: K_p = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MG/L)
 t_{event} = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1 L/1000 CM**3)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERIVED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

EV: 1
 ED: 1
 EF: 120
 A: 3800
 t_{event}: 8
 BW: 70
 AT(NON): 365
 AT(CAR): 25550

CONVERSION
 FACTOR (NONCAR) = 1.78E+01
 CONVERSION
 FACTOR (CARCIN) = 2.55E-01

00021

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

ZONE 2

EXPOSURE SCENARIO: Construction Worker, RME

CHEMICAL	CONC. (MG/L)	ORGANIC OR INORGANIC?	t* (HR)	T (HR)	Kp (CM/HR)	B	DAevent
Chloroform	0.001	O	1.10E+00	4.70E-01	8.90E-03	9.30E-03	7.91E-08
Tetrachloroethene	0.002	O	4.30E+00	9.00E-01	4.80E-02	2.50E-01	8.56E-07
Antimony	0.0064	I			1.00E-03		5.12E-08
Arsenic	0.003	I			1.00E-03		2.40E-08
Boron	0.464	I			1.00E-03		3.71E-06
Cadmium	0.0015	I			1.00E-03		1.20E-08
Manganese	0.25	I			1.00E-03		2.00E-06

00022

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER WATER (PAGE THREE)

ZONE 2

EXPOSURE SCENARIO: Construction Worker, RME

CALCULATE DOSES:

CHEMICAL	ANNUAL DERMAL DOSE (MG/KG/DAY)	DERMAL RfD (MG/KG/DAY)	HAZARD INDEX DERMAL
Chloroform	1.41E-06	1.00E-02	1.41E-04
Tetrachloroethene	1.53E-05	1.00E-02	1.53E-03
Antimony	9.14E-07	4.00E-04	2.28E-03
Arsenic	4.28E-07	2.80E-04	1.53E-03
Boron	6.62E-05	4.50E-03	1.47E-02
Cadmium	2.14E-07	2.50E-05	8.57E-03
Manganese	3.57E-05	7.20E-04	4.96E-02
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00

TOTAL RISK

7.83E-02

00023

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)

ZONE 2

EXPOSURE SCENARIO: Construction Worker, RME

CALCULATE INCREMENTAL CANCER RISKS:

CHEMICAL	LIFETIME AVERAGE DERMAL DOSE (MG/KG/DAY)	CSF DERMAL (KG/DAY/MG)	CANCER RISK DERMAL CONTACT
Chloroform	2.02E-08	6.10E-03	1.23E-10
Tetrachloroethene	2.18E-07	5.20E-02	1.14E-08
Antimony	1.31E-08	0.00E+00	0.00E+00
Arsenic	6.12E-09	1.60E+00	9.79E-09
Boron	9.46E-07	0.00E+00	0.00E+00
Cadmium	3.06E-09	0.00E+00	0.00E+00
Manganese	5.10E-07	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00

TOTAL RISK

2.13E-08

00024

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 2
 LOCATION: NSB-NLON, Groton, CT
 DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker (All Soil), CTE

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
 C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
 IR = SOIL INGESTION RATE (MG/EVENT)
 EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
 Fi = FRACTION FROM CONTAMINATED SOURCE
 ED = EXPOSURE DURATION (YEARS)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)
 BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	240	IR:	0
EF:	80	EF:	120
Fi:	1	Fi:	1
ED:	1	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	365	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:		YOUTH:		ADULT/YOUTH (CANCER RISK):	
CF:	7.51E-07 (AVG ANNUAL DOSE)	CF:	0.00E+00 (AVG ANNUAL DOSE)	CF:	1.07E-08

00025

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 2
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Construction Worker (All Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
S _{ac} = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
S _{aa} = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	0.2
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	80
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	1
BW _c = BODY WEIGHT CHILD (KG):	15
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	3.40E-08
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	2.38E-06			

00029

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER

SITE NAME: ZONE 2
 LOCATION: NSB-NLON, Groton, CT
 DATE: 2/2/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker, CTE

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

$$DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DA_{event} = ABSORBED DOSE PER EVENT (MG/CM**2/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS:
 FOR ORGANICS:

$$DA_{event} = K_p \times C \times t_{event} \times CF$$

IF $t_{event} < t^*$, $DA_{event} = 2K_p \times C \times CF \times (6T \times t_{event}/3.141592654)^{0.5}$
 IF $t_{event} > t^*$, $DA_{event} = K_p \times C \times CF \times ((t_{event}/(1 + B)) + (2T \times ((1+3B)/(1 + B))))$

WHERE: K_p = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MGL)
 t_{event} = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1 L/1000 CM**3)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERIVED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

EV:	1	CONVERSION	
ED:	1	FACTOR (NONCAR) =	1.19E+01
EF:	80		
A:	3800	CONVERSION	
t _{event} :	8	FACTOR (CARCIN) =	1.70E-01
BW:	70		
AT(NON):	365		
AT(CAR):	25550		

00033

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

ZONE 2

EXPOSURE SCENARIO: Construction Worker, CTE

CHEMICAL	CONC. (MG/L)	ORGANIC OR INORGANIC?	I* (HR)	T (HR)	Kp (CM/HR)	B	DAevent
Chloroform	0.001	O	1.10E+00	4.70E-01	8.90E-03	9.30E-03	7.91E-08
Tetrachloroethene	0.002	O	4.30E+00	9.00E-01	4.80E-02	2.50E-01	8.56E-07
Antimony	0.0064	I			1.00E-03		5.12E-08
Arsenic	0.0018	I			1.00E-03		1.44E-08
Boron	0.177	I			1.00E-03		1.42E-06
Cadmium	0.00088	I			1.00E-03		7.04E-09
Manganese	0.0569	I			1.00E-03		4.55E-07

00034

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER WATER (PAGE THREE)

ZONE 2

EXPOSURE SCENARIO: Construction Worker, CTE

CALCULATE DOSES:

CHEMICAL	ANNUAL DERMAL DOSE (MG/KG/DAY)	DERMAL RID (MG/KG/DAY)	HAZARD INDEX DERMAL
Chloroform	9.41E-07	1.00E-02	9.41E-05
Tetrachloroethene	1.02E-05	1.00E-02	1.02E-03
Antimony	6.09E-07	4.00E-04	1.52E-03
Arsenic	1.71E-07	2.80E-04	6.12E-04
Boron	1.68E-05	4.50E-03	3.74E-03
Cadmium	8.38E-08	2.50E-05	3.35E-03
Manganese	5.42E-06	7.20E-04	7.52E-03
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00

TOTAL RISK

1.79E-02

00035

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)

ZONE 2

EXPOSURE SCENARIO: Construction Worker, CTE

CALCULATE INCREMENTAL CANCER RISKS:

CHEMICAL	LIFETIME AVERAGE DERMAL DOSE (MG/KG/DAY)	CSF DERMAL (KG/DAY/MG)	CANCER RISK DERMAL CONTACT
Chloroform	1.34E-08	6.10E-03	8.20E-11
Tetrachloroethene	1.46E-07	5.20E-02	7.57E-09
Antimony	8.70E-09	0.00E+00	0.00E+00
Arsenic	2.45E-09	1.80E+00	3.92E-09
Boron	2.41E-07	0.00E+00	0.00E+00
Cadmium	1.20E-09	0.00E+00	0.00E+00
Manganese	7.74E-08	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00

TOTAL RISK

1.16E-08

00036

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 2
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Full-Time Employees (Surface Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E8)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
SAC = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
SAa = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	1
ABS = ABSORPTION FRACTION:	Chemical Specific
EFc = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EFa = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
EDc = CHILD EXPOSURE DURATION (YEARS):	1
EDa = ADULT EXPOSURE DURATION (YEARS):	25
BWc = BODY WEIGHT CHILD (KG):	1
BWa = BODY WEIGHT ADULT (KG):	70
ATc = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
ATa = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	9125
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSEchild = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	7.97E-06
DOSEadult = (CF2)*(C)*(ABS)	CF2 =	2.23E-05			

00037

00040

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 2
 LOCATION: NSB - NILON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Full-Time Employees (Surface Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E8)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
S _{ac} = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
S _{aa} = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	1
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	1
BW _c = BODY WEIGHT CHILD (KG):	1
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E8 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	3.19E-07
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	2.23E-05			

00041

00044

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 2
 LOCATION: NSB-NLON, Groton, CT
 DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), CTE

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
 C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
 IR = SOIL INGESTION RATE (MG/EVENT)
 EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
 Fi = FRACTION FROM CONTAMINATED SOURCE
 ED = EXPOSURE DURATION (YEARS)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)
 BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	50	IR:	0
EF:	150	EF:	120
Fi:	1	Fi:	1
ED:	6	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	2190	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:		YOUTH:		ADULT/YOUTH (CANCER RISK):	
CF:	2.94E-07 (AVG ANNUAL DOSE)	CF:	0.00E+00 (AVG ANNUAL DOSE)	CF:	2.52E-08

06045

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 2
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/88

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
S _{Ac} = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
S _{Aa} = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	0.2
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	25
BW _c = BODY WEIGHT CHILD (KG):	1
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	9125
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	1.59E-06
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	4.46E-06			

67000

00052

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 2
 LOCATION: NSB-NLON, GROTON, CT
 DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), RME

RELEVANT EQUATIONS: $IEX = (C \times IF_{adj} \times F_i \times EF) / (AT \times CF)$ $IF_{adj} = (IR_c \times ED_c) / BW_c + (IR_a \times ED_a) / BW_a$

WHERE:

- C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
- IF_{adj} = AGE-ADJUSTED SOIL INGESTION FACTOR (MG YEAR/KG DAY)
- F_i = FRACTION FROM CONTAMINATED SOURCE (UNITLESS)
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- AT = AVERAGING TIME (DAYS)
- CF = CONVERSION FACTOR (1E+6 MG/KG)
- IR_c = CHILD INGESTION RATE (MG/DAY)
- ED_c = CHILD EXPOSURE DURATION (YEARS)
- BW_c = CHILD BODY WEIGHT (KG)
- IR_a = ADULT INGESTION RATE (MG/DAY)
- ED_a = ADULT EXPOSURE DURATION (YEARS)
- BW_a = ADULT BODY WEIGHT (KG)

ENTER INPUT PARAMETERS:

IR _c :	200
ED _c :	6
BW _c :	15
IR _a :	100
ED _a :	24
BW _a :	70
IF _{adj} :	114.28571
F _i :	1
EF:	150
AT(NONC):	10950
AT(CARC):	25550

DETERMINE CONVERSION FACTORS:

NONCARC = 1.57E-06 CARCIN = 6.71E-07

00053

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 2
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA_{adj} \times AF \times ABS \times EF) / (AT \times 1E6)$ $SA_{adj} = (SA_a \times ED_a) / BW_a + (SA_c \times ED_c) / BW_c$

WHERE:

- C = CONCENTRATION IN SOIL (MG/KG)
- SA_c = CHILD SKIN SURFACE AREA (SQ CM/DAY)
- SA_a = ADULT SKIN SURFACE AREA (SQ CM/DAY)
- AF = ADHERENCE FACTOR (MG/SQ CM)
- ABS = ABSORPTION FRACTION
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- ED_c = CHILD EXPOSURE DURATION (YEARS)
- ED_a = ADULT EXPOSURE DURATION (YEARS)
- BW_c = BODY WEIGHT CHILD (KG)
- BW_a = BODY WEIGHT ADULT (KG)
- AT_n = AVERAGING TIME (DAYS), NONCARCINOGENS
- AT_c = AVERAGING TIME (DAYS), CARCINOGENS
- SA_{adj} = AGE-ADJUSTED SKIN SURFACE AREA (SQ CM-YR/DAY-KG)

ENTER INPUT PARAMETERS

SA _c :	2094
SA _a :	3800
AF:	1
EF:	150
ED _c :	6
ED _a :	24
BW _c :	15
BW _a :	70
AT _n :	10950
AT _c :	25550
SA _{adj} :	2140

DETERMINE CONVERSION FACTORS:

NONCARC = 2.93E-05 CARCIN = 1.26E-05

00055

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 2
 LOCATION: NSB-NLON, GROTON, CT
 DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), CTE

RELEVANT EQUATIONS: $IEX = (C \times IFadj \times Fi \times EF) / (AT \times CF)$ $IFadj = (IRc \times EDc) / BWc + (IRa \times EDa) / BWa$

WHERE:

- C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
- IFadj = AGE-ADJUSTED SOIL INGESTION FACTOR (MG YEAR/KG DAY)
- Fi = FRACTION FROM CONTAMINATED SOURCE (UNITLESS)
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- AT = AVERAGING TIME (DAYS)
- CF = CONVERSION FACTOR (1E+6 MG/KG)
- IRc = CHILD INGESTION RATE (MG/DAY)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- BWc = CHILD BODY WEIGHT (KG)
- IRa = ADULT INGESTION RATE (MG/DAY)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWa = ADULT BODY WEIGHT (KG)

ENTER INPUT PARAMETERS:

IRc: 100
 EDc: 2
 BWc: 15
 IRa: 50
 EDa: 7
 BWa: 70
 IFadj: 18.333333
 Fi: 0.5
 EF: 150
 AT(NONC): 3285
 AT(CARC): 25550

DETERMINE CONVERSION FACTORS:

NONCARC = 4.19E-07 CARCIN = 5.38E-08

00057

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 2
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA_{adj} \times AF \times ABS \times EF) / (AT \times 1E6)$ $SA_{adj} = (SAa \times EDa) / BWa + (SAc \times EDc) / BWc$

WHERE:

- C = CONCENTRATION IN SOIL (MG/KG)
- SAc = CHILD SKIN SURFACE AREA (SQ CM/DAY)
- SAa = ADULT SKIN SURFACE AREA (SQ CM/DAY)
- AF = ADHERENCE FACTOR (MG/SQ CM)
- ABS = ABSORPTION FRACTION
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWc = BODY WEIGHT CHILD (KG)
- BWa = BODY WEIGHT ADULT (KG)
- ATn = AVERAGING TIME (DAYS), NONCARCINOGENS
- ATc = AVERAGING TIME (DAYS), CARCINOGENS
- SAadj = AGE-ADJUSTED SKIN SURFACE AREA (SQ CM-YR/DAY-KG)

ENTER INPUT PARAMETERS

SAc:	2094
SAa:	3800
AF:	0.2
EF:	150
EDc:	2
EDa:	7
BWc:	15
BWa:	70
ATn:	3285
ATc:	25550
SAadj:	659.2

DETERMINE CONVERSION FACTORS:

NONCARC = 6.02E-06 CARCIN = 7.74E-07

65000

IEUBK MODEL - EXPOSURE TO LEAD (PAGE 1 of 2)

SITE NAME: Zone 2
 LOCATION: NSB-NLON, Groton, Connecticut
 DATE: 2/12/98

EXPOSURE SCENARIO: RME

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
 Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
 WATER Consumption: DEFAULT

SOIL & DUST:

Soil: constant conc.
 Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	404.0	404.0
1-2	404.0	404.0
2-3	404.0	404.0
3-4	404.0	404.0
4-5	404.0	404.0
5-6	404.0	404.0
6-7	404.0	404.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
 Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

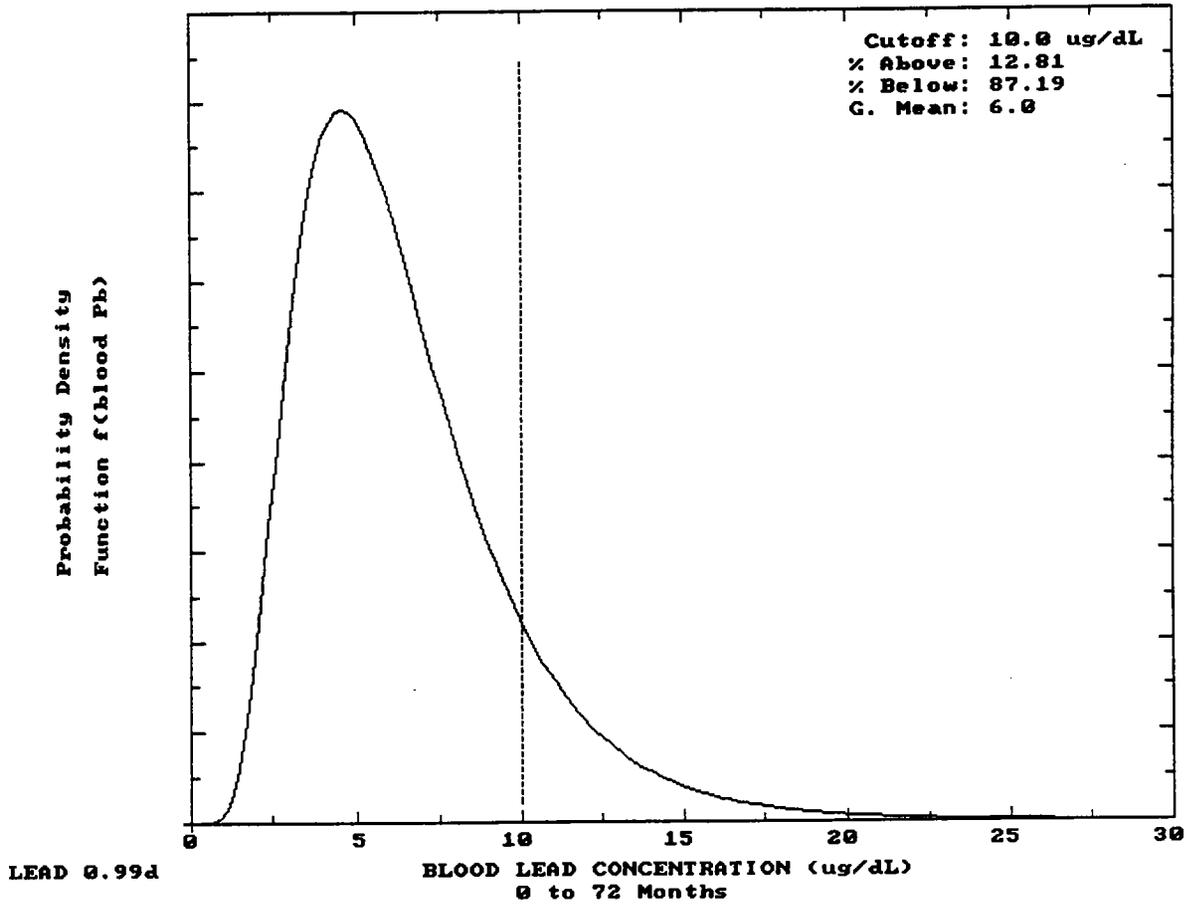
YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	6.3	11.78	8.99	0.00	0.02
1-2:	7.1	17.38	14.01	0.00	0.03
2-3:	6.7	18.08	14.28	0.00	0.06
3-4:	6.4	18.33	14.55	0.00	0.07
4-5:	5.3	15.01	11.16	0.00	0.07
5-6:	4.5	14.31	10.18	0.00	0.09
6-7:	4.1	14.16	9.67	0.00	0.09

00061

IEUBK MODEL - EXPOSURE TO LEAD (PAGE 2 of 2)

SITE NAME: Zone 2
LOCATION: NSB-NLON, Groton, Connecticut
DATE: 2/12/98

EXPOSURE SCENARIO: RME



IEUBK MODEL - EXPOSURE TO LEAD (PAGE 1 of 2)

SITE NAME: Zone 2
 LOCATION: NSB-NLON, Groton, Connecticut
 DATE: 2/12/98

EXPOSURE SCENARIO: CTE

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
 Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
 WATER Consumption: DEFAULT

SOIL & DUST:

Soil: constant conc.
 Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	128.0	128.0
1-2	128.0	128.0
2-3	128.0	128.0
3-4	128.0	128.0
4-5	128.0	128.0
5-6	128.0	128.0
6-7	128.0	128.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
 Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

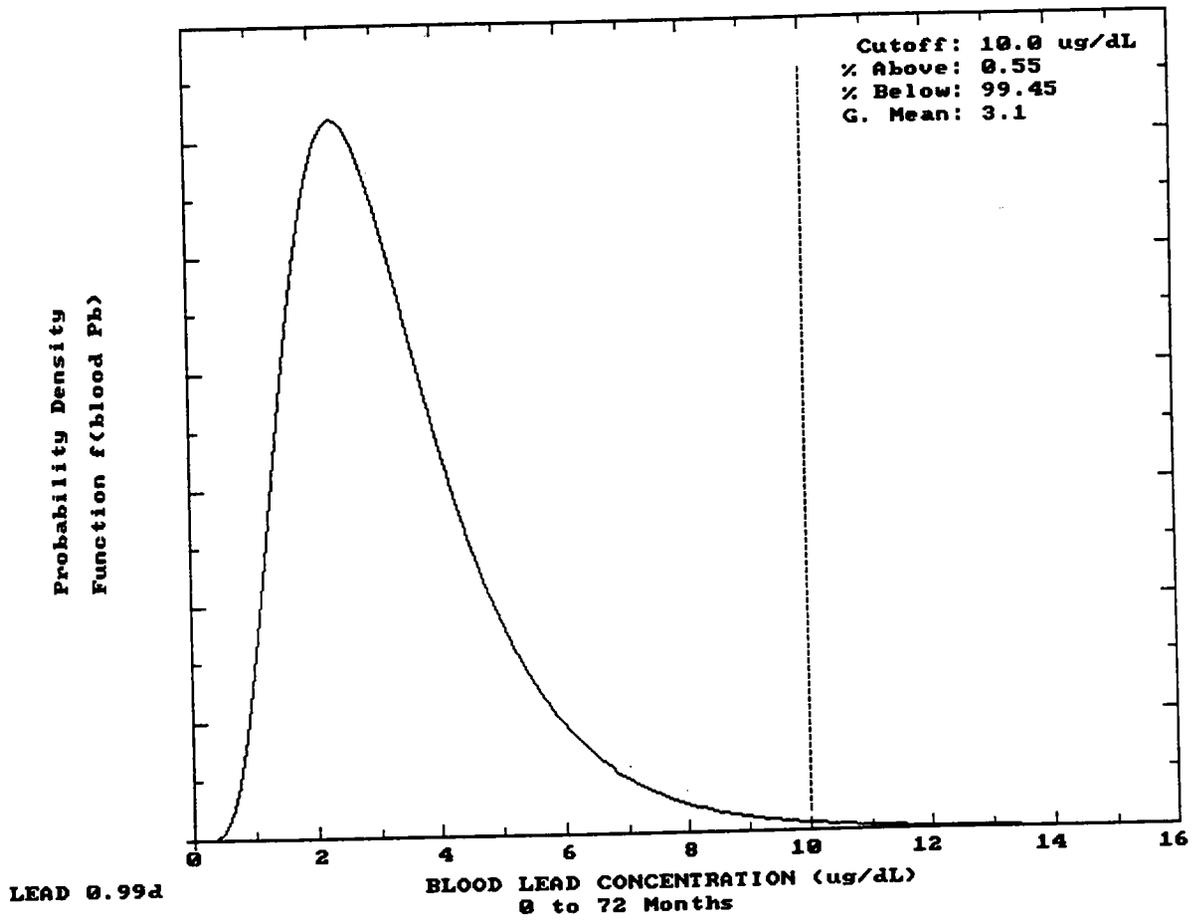
YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	3.3	6.02	3.05	2.58	0.37	0.00	0.02
1-2:	3.5	8.46	4.81	2.68	0.93	0.00	0.03
2-3:	3.3	8.93	4.85	3.04	0.97	0.00	0.06
3-4:	3.1	8.92	4.90	2.95	1.00	0.00	0.07
4-5:	2.7	7.69	3.68	2.88	1.06	0.00	0.07
5-6:	2.4	7.60	3.33	3.06	1.12	0.00	0.09
6-7:	2.2	7.77	3.15	3.38	1.14	0.00	0.09

00063

IEUBK MODEL - EXPOSURE TO LEAD (PAGE 2 of 2)

SITE NAME: Zone 2
LOCATION: NSB-NLON, Groton, Connecticut
DATE: 2/12/98

EXPOSURE SCENARIO: CTE



Calculations of 95th Percentile Fetal Blood Lead Concentrations for Adult Exposure to Soil

SITE NAME: Zone 2

LOCATION: NSB-NLON, Groton, Connecticut

DATE: February 11, 1998

OBJECTIVE: Adult exposure to lead in soil is addressed by an evaluation of the relationship between the site soil lead concentration and the blood lead concentration in the developing fetuses of adult women. This spreadsheet calculates a range of 95th percentile fetal blood lead concentrations from central estimates of blood lead concentrations in pregnant adult women using the exposure parameters identified below (U.S. EPA, Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil, December 1996).

RELEVANT EQUATIONS: $PbB_{adult, central} = PbB_{adult, 0} + [(PbS \times BKSF \times IR_s \times AF_s \times EF_s)/AT]$

and

$PbB_{fetal, 0.95} = PbB_{adult, central} \times GSD_{i, adult}^{1.645} \times R_{fetal/maternal}$

00065

Exposure Parameter	Description (units)	Future Employee		Construction Worker	
		RME	CTE	RME	CTE
$PbB_{adult, 0}$	Typical blood lead concentration in adult women of child-bearing age in absence of site exposures (ug/dL)	2.0	2.0	2.0	2.0
PbS	Site-specific soil lead concentration (mg/kg)	178	159	404	128
BKSF	Biokinetic slope factor (ug/dl)/(ug/day)	0.4	0.4	0.4	0.4
IR_s	Intake rate of soil, includes outdoor soil and indoor soil-derived dust (g/day)	0.100	0.050	0.480	0.240
AF_s	Absolute gastrointestinal absorption fraction (unitless)	0.12	0.12	0.12	0.12
EF_s	Exposure frequency (days/year)	150	150	120	80
AT	Averaging time (days/year)	365	365	365	365
$GSD_{i, adult}$	Estimate of individual geometric standard deviation among adults (unitless)	2.1	2.1	2.1	2.1
$R_{fetal/maternal}$	Constant of proportionality between fetal blood lead concentration at birth and maternal blood lead concentration (unitless)	0.9	0.9	0.9	0.9
$PbB_{adult, central}$	Calculated central estimate of blood lead concentrations in adult women of child-bearing age from site exposures (ug/dL)	2.35	2.16	5.06	(1)
$PbB_{fetal, 0.95}$	Calculated 95th percentile blood lead concentrations among fetuses born to women having site exposures (ug/dL)	7.17	6.58	15.43	(1)

Notes:

- (1) According to the cited guidance document, this adult exposure model is not applicable for infrequent site exposures, where the EF_s is less than 1 day/week or 90 days/year.

APPENDIX I.7

ZONE 3

COC SCREENING FOR LOWER SUBBASE
 ZONE 3-SHALLOW SOIL (0-4 FEET)
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2

00001

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COCP? (4)	Rationale
Volatile Organic Compounds (mg/kg)													
ACETONE	1/1	0.13	-	0.13	SB14-2.0	780	100000	0.8	500	1000	140	N	2
CHLOROFORM	1/1	0.001	-	0.001	SB14-2.0	100	0.3	0.03	100	940	1.2	N	2
METHYLENE CHLORIDE	1/1	0.004	-	0.004	SB14-2.0	85	13	0.001	82	760	1	Y	3, 5
Semivolatile Organic Compounds (mg/kg)													
2-METHYLNAPHTHALENE	3/8	0.028-0.037	0.36-0.43	0.129	LS3SB0040101	310	-	-	1000(5)	2500(5)	56(5)	N	2
ACENAPHTHENE	2/8	0.017-0.033	0.33-0.43	0.144	LS3SB0040101	470	-	29	1000(5)	2500(5)	84(5)	N	2
ACENAPHTHYLENE	4/8	0.026-0.34	0.36-0.43	0.151	LS3SB0040101	-	-	-	1000	2500	84	N	2
ANTHRACENE	6/8	0.023-0.13	0.36-0.43	0.089	LS3SB0040101	2300	-	590	1000	2500	400	N	2
BENZO(A)ANTHRACENE	6/8	0.041-1.5	0.36-0.43	0.362	LS3SB0040101	0.88	-	0.08	1	7.8	1	Y	3
BENZO(A)PYRENE	7/8	0.023-1	0.36	0.290	LS3SB0040101	0.088	-	0.4	1	1	1	Y	3
BENZO(B)FLUORANTHENE	7/8	0.025-1.3	0.36	0.352	LS3SB0040101	0.88	-	0.2	1	7.8	1	Y	3
BENZO(G,H,I)PERYLENE	6/8	0.027-0.85	0.33-0.36	0.230	LS3SB0040101	-	-	-	1000(5)	2500(5)	40(5)	N	2
BENZO(K)FLUORANTHENE	5/8	0.098-0.74	0.36-0.43	0.279	LS3SB0040101	8.8	-	2	8.4	78	1	N	2
BIS(2-ETHYLHEXYL)PHTHALATE	2/8	0.16-0.36	0.33-0.43	0.201	LS3SB0040101	46	31000	180	44	410	11	N	2
CARBAZOLE	3/8	0.022-0.034	0.33-0.43	0.126	LS3SB0040101	32	-	0.03	31(5)	290(5)	0.36(5)	Y	3, 5
CHRYSENE	7/8	0.024-1.4	0.36	0.332	LS3SB0040101	88	-	8	84(5)	780(5)	0.96(5)	Y	3, 5
DIBENZO(A,H)ANTHRACENE	5/8	0.079-0.4	0.36-0.43	0.181	LS3SB0040101	0.088	-	0.08	0.084(5)	0.78(5)	0.000096(5)	Y	3
DIETHYL PHTHALATE	1/8	0.02	0.33-0.43	0.161	LS3SB0040101	6300	2000	23	1000(5)	2500(5)	1100(5)	N	2
FLUORANTHENE	7/8	0.033-2.2	0.36	0.464	LS3SB0040101	310	-	210	1000	2500	56	N	2
FLUORENE	3/8	0.025-0.064	0.33-0.43	0.129	LS3SB0040101	310	-	28	1000	2500	56	N	2
INDENO(1,2,3-CD)PYRENE	7/8	0.023-0.87	0.36	0.222	LS3SB0040101	0.88	-	0.7	0.84(5)	7.8(5)	0.0096(5)	Y	3
NAPHTHALENE	2/8	0.022-0.041	0.33-0.43	0.145	LS3SB0050101	310	-	4	1000	2500	56	N	2
PHENANTHRENE	6/8	0.036-0.91	0.36-0.43	0.260	LS3SB0040101	-	-	-	1000	2500	40	N	2
PYRENE	7/8	0.033-2.5	0.36	0.571	LS3SB0040101	230	-	210	1000	2500	40	N	2
Metals (mg/kg)													
ALUMINUM	5/5	4610-8790	-	6036	SB14-2.0	7800	-	-	-	-	-	Y	3, 4
ANTIMONY	2/5	0.64-1.1	0.42-5.2	0.961	LS3SB0010201	3.1	-	0.3	27	8200	-	Y	3, 5
ARSENIC	5/5	0.93-2.6	-	1.766	LS3SB0010201	0.43	750	1	10	10	-	Y	3
BARIUM	5/5	25.8-43.8	-	36.6	SB14-2.0	550	690000	82	4700	140000	-	N	2
BERYLLIUM	2/5	0.23-0.38	0.15-0.2	0.173	SB14-2.0	0.15	1300	3	2	2	-	Y	3
CADMIUM	1/5	0.46	0.04-0.05	0.117	SB14-2.0	3.9	1800	0.4	34	1000	-	Y	3, 5
CHROMIUM (TOTAL)	5/5	7.6-16.9	-	12.84	SB14-2.0	39(6)	270	2	100(6)	100(6)	-	Y	3, 5
COBALT	5/5	2.4-5	-	4.04	LS3SB0020201, SB14-2.0	470	-	-	1000(5)	2500(5)	-	N	2
COPPER	3/5	6.4-15.9	25.4-28.4	12.24	LS3SB0010201	310	-	-	-	-	-	N	2
IRON	5/5	7520-9440	-	8420	SB14-2.0	2300	-	-	-	-	-	Y	3, 4
LEAD	10/12	3.1-1390	4.8-50	385.3188	LS3SB0010201	400(7)	-	-	500	1000	-	Y	3
MANGANESE	5/5	114-160	-	139.2	LS3SB0020201	180	-	-	1600(5)	47000(5)	-	N	2
MERCURY	3/5	0.02-0.23	0.005-0.1	0.0715	LS3SB0010201	2.3	-	-	20	610	-	N	2
NICKEL	5/5	5.4-13.4	-	9.48	SB14-2.0	160	13000	7	1400	7500	-	Y	3, 5
VANADIUM	5/5	10-24.8	-	18.56	LS3SB0020201	55	-	300	470	14000	-	N	2
ZINC	5/5	18-68.6	-	36.8	LS3SB0010201	2300	-	620	20000	610000	-	N	2
Miscellaneous (mg/kg)													
TPH	7/7	65.2-1600	-	743.885714	LS3SB0020201	-	-	-	500	2500	2500	Y	1, 3

**COC SCREENING FOR LOWER SUBBASE
ZONE 3-SHALLOW SOIL (0-4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2**

Notes:

- Not available or Not applicable.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Residential Soil Ingestion is used for soil and sediment. Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with dilution and attenuation factor (DAF) of 1.0 are used.
- (3) CTDEP, January 1996. State Pollutant Mobility criteria for metals are not included since a direct comparison of the aqueous SPLP criteria (in ug/L) and the soil analytical results (in mg/kg) cannot be made. TCLP and SPLP results for soil samples are addressed in The Nature and Extent Section of the RI Report.
- (4) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (5) No value promulgated by CTDEP, calculated or surrogate value is used. Ceiling limit is used if calculated or surrogate value exceeds the ceiling limit.
- (6) Hexavalent chromium.
- (7) Value is based on OSWER soil screening level for residential land use (USEPA, July 14, 1994).

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Maximum exceeds migration to groundwater criteria only; chemical will not be quantitatively evaluated in the risk assessment.

00002

**COC SCREENING FOR LOWER SUBBASE
ZONE 3- ALL SOIL (0-10 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2**

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COPC? (4)	Rationale
Volatile Organic Compounds (mg/kg)													
1,1,1-TRICHLOROETHANE	1/3	0.006	0.006-0.011	0.004833333	SB22-6.0	1600	1200	0.1	500	1000	40	N	2
ACETONE	2/3	0.084-0.13	0.013	0.0735	SB14-2.0	780	100000	0.8	500	1000	140	N	2
CHLOROFORM	1/3	0.001	0.006-0.012	0.003333333	SB14-2.0	100	0.3	0.03	100	940	1.2	N	2
METHYLENE CHLORIDE	2/3	0.003-0.004	0.006	0.003333333	SB14-2.0	85	13	0.001	82	760	1	Y	3, 5
TETRACHLOROETHENE	1/3	0.001	0.006-0.011	0.003166667	SB22-6.0	12	11	0.003	12	110	1	N	2
TOLUENE	1/3	0.0008	0.006-0.011	0.0031	SB22-6.0	16000	650	0.6	500	1000	67	N	2
XYLENES, TOTAL	1/3	0.001	0.006-0.011	0.003166667	SB22-6.0	160000	410(8)	9(8)	500	1000	19.5	N	2
Semivolatile Organic Compounds (mg/kg)													
2-METHYLNAPHTHALENE	5/14	0.025-0.3	0.33-0.43	0.150	LS3SB0050201	310	-	-	1000(5)	2500(5)	56(5)	N	2
ACENAPHTHENE	5/14	0.017-0.2	0.33-0.43	0.141	LS3SB0050201	470	-	29	1000(5)	2500(5)	84(5)	N	2
ACENAPHTHYLENE	4/14	0.026-0.34	0.33-0.43	0.164	LS3SB0040101	-	-	-	1000	2500	84	N	2
ANTHRACENE	9/14	0.023-0.35	0.33-0.43	0.120	LS3SB0040201	2300	-	590	1000	2500	400	N	2
BENZO(A)ANTHRACENE	11/14	0.021-2.1	0.33-0.43	0.424	LS3SB0040201	0.88	-	0.08	1	7.8	1	Y	3
BENZO(A)PYRENE	11/14	0.023-1	0.33-0.38	0.348	LS3SB0040101	0.088	-	0.4	1	1	1	Y	3
BENZO(B)FLUORANTHENE	11/14	0.025-1.5	0.33-0.38	0.378	LS3SB0040201	0.88	-	0.2	1	7.8	1	Y	3
BENZO(G,H,I)PERYLENE	10/14	0.027-0.85	0.33-0.38	0.247	LS3SB0040101	-	-	-	1000(5)	2500(5)	40(5)	N	2
BENZO(K)FLUORANTHENE	9/14	0.081-0.87	0.33-0.43	0.278	LS3SB0040201	8.8	-	2	8.4	78	1	N	2
BIS(2-ETHYLHEXYL)PHTHALATE	3/14	0.16-0.36	0.33-0.43	0.197	LS3SB0040101	46	31000	180	44	410	11	N	2
CARBAZOLE	5/14	0.022-0.27	0.33-0.43	0.146	LS3SB0040201	32	-	0.03	31(5)	290(5)	0.36(5)	Y	3, 5
CHRYSENE	12/14	0.024-1.5	0.33-0.36	0.440	LS3SB0040201, LS3SB0050201	88	-	8	84(5)	780(5)	0.96(5)	Y	3, 5
DI-N-BUTYL PHTHALATE	1/14	0.02	0.33-0.43	0.168	SB22-6.0	7800	2300	270	1000	2500	140	N	2
DIBENZO(A,H)ANTHRACENE	8/14	0.051-0.4	0.33-0.43	0.174	LS3SB0040101	0.088	-	0.08	0.084(5)	0.78(5)	0.00096(5)	Y	3
DIBENZOFURAN	3/14	0.035-0.081	0.33-0.43	0.153	LS3SB0050201	310	-	-	270(5)	2500(5)	5.6(5)	N	2
DIETHYL PHTHALATE	1/14	0.02	0.33-0.43	0.169	LS3SB0040101	6300	2000	23	1000(5)	2500(5)	1100(5)	N	2
FLUORANTHENE	12/14	0.033-4.2	0.33-0.36	0.636	LS3SB0040201	310	-	210	1000	2500	56	N	2
FLUORENE	6/14	0.025-0.37	0.33-0.43	0.147	LS3SB0050201	310	-	28	1000	2500	56	N	2
INDENO(1,2,3-CD)PYRENE	11/14	0.023-0.87	0.33-0.38	0.224	LS3SB0040101	0.88	-	0.7	0.84(5)	7.8(5)	0.0096(5)	Y	3
NAPHTHALENE	4/14	0.018-0.042	0.33-0.43	0.140	LS3SB0050201	310	-	4	1000	2500	56	N	2
PHENANTHRENE	10/14	0.036-1.7	0.33-0.43	0.421	LS3SB0040201	-	-	-	1000	2500	40	N	2
PYRENE	13/14	0.02-4.4	0.36	0.808	LS3SB0040201	230	-	210	1000	2500	40	N	2
Metals (mg/kg)													
ALUMINUM	9/9	3510-8790	-	5910	SB14-2.0	7800	-	-	-	-	-	Y	3, 4
ANTIMONY	2/9	0.64-1.1	0.42-6.2	0.956667	LS3SB0010201	3.1	-	0.3	27	8200	-	Y	3, 5
ARSENIC	9/9	0.93-4.9	-	2.125556	LS3SB0010301	0.43	750	1	10	10	-	Y	3
BARIUM	9/9	22.5-43.8	-	32.23333	SB14-2.0	550	690000	82	4700	140000	-	N	2
BERYLLIUM	5/9	0.21-0.38	0.15-0.21	0.193333	SB14-2.0	0.15	1300	3	2	2	-	Y	3
CADMIUM	2/9	0.46-0.83	0.04-3	0.166667	13MW12(8-10)	3.9	1800	0.4	34	1000	-	Y	3, 5
CHROMIUM (total)	9/9	6.1-19.3	-	12.388889	LS3SB0050201	39(6)	270	2	100(6)	100(6)	-	Y	3, 5
COBALT	9/9	2.4-5.1	-	3.988889	LS3SB0050201	470	-	-	1000(5)	2500(5)	-	N	2
COPPER	7/9	6.4-73.6	25.4-28.4	18.688889	LS3SB0050201	310	-	-	-	-	-	N	2
IRON	9/9	5100-9440	-	8008.888889	SB14-2.0	2300	-	-	-	-	-	Y	3, 4
LEAD	16/18	2.6-1390	4.8-100	305.2125	LS3SB0010201	400(7)	-	-	500	1000	-	Y	3
MANGANESE	9/9	88.1-290	-	147.455556	LS3SB0010301	180	-	-	1600(5)	47000(5)	-	Y	3

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**COC SCREENING FOR LOWER SUBASE
ZONE 3- ALL SOIL (0-10 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2**

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COPC? (4)	Rationale
Metals (mg/kg)													
MERCURY	4/9	0.02-0.23	0.005-0.1	0.052778	LS3SB0010201	2.3	-	-	20	610	-	N	2
NICKEL	9/9	5.4-13.4	-	9	SB14-2.0	160	13000	7	1400	7500	-	Y	3, 5
SELENIUM	2/9	0.42-0.6	0.22-0.5	0.274444	LS3SB0010301	390	-	0.3	340	10000	-	Y	3, 5
SILVER	1/9	0.35	0.19-0.5	0.357222	LS3SB0050201	390	-	2	340	10000	-	N	2
VANADIUM	9/9	9.7-24.8	-	17.188889	LS3SB0020201	55	-	300	470	14000	-	N	2
ZINC	9/9	17-74.1	-	36.8	LS3SB0010301	2300	-	620	20000	610000	-	N	2
Miscellaneous (mg/kg)													
TPH	10/11	20.7-3400	11.1	797.404545	110890-13MW12(8-10)	-	-	-	500	2500	2500	Y	1, 3

Notes:

- Not available or Not applicable.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Residential Soil Ingestion is used for soil and sediment. Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with dilution and attenuation factor (DAF) of 1.0 are used.
- (3) CTDEP, January 1996. State Pollutant Mobility criteria for metals are not included since a direct comparison of the aqueous SPLP criteria (in ug/L) and the soil analytical results (in mg/kg) cannot be made. TCLP and SPLP results for soil samples are addressed in The Nature and Extent Section of the RI Report.
- (4) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (5) No value promulgated by CTDEP, calculated or surrogate value is used. Ceiling limit is used if calculated or surrogate value exceeds the ceiling limit.
- (6) Hexavalent chromium.
- (7) Value is based on OSWER soil screening level for residential land use (USEPA, July 14, 1994).
- (8) O-xylene.

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Maximum exceeds migration to groundwater criteria only; chemical will not be quantitatively evaluated in the risk assessment.

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COC SCREENING FOR LOWER SUBBASE
ZONE 3 - GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency	Range of Detection	Range of Nondetects	Location of Maximum	COC Screening Level (1)	EPA MCL (2)	State MCL (3)	State RSR Groundwater (4)	State AWQC		Selected as COC (6)	Rationale
									Saltwater (5)	Human Health (5)		
Semivolatiles (ug/L)												
Bis(2-Ethylhexyl)phthalate	2/6	0.6 - 1	10 - 26	13MW12	4.8	6	6	2	-	1.8	N	2
Fluorene	3/6	0.9 - 1	10 - 12	13MW12	150	-	-	280	-	1300	N	2
Metals (ug/L)												
Antimony, filtered	1/6	2.8	2.5 - 20.2	MW1-3RI	1.5	6	6	6	-	14	Y	3
Arsenic	2/7	2.6 - 2.8	2 - 3	13MW12	0.045	50	50	50	36	0.018	Y	3
Arsenic, filtered	2/6	2.6 - 3.2	2 - 2.5	13MW12	0.045	50	50	50	36	0.018	Y	3, 5
Barium	7/7	22.4 - 135	-	MW2-3RI	260	2000	2000	1000	-	-	N	2
Barium, filtered	6/6	24.2 - 446	-	MW2-3RI	260	2000	2000	1000	-	-	Y	3, 5
Chromium (total), filtered	1/6	3.6	0.68 - 4	MW2-3RI	18 (10)	100	100	50	50 (10)	170 (10)	N	2
Iron	5/7	3160 - 6040	13 - 30.5	13MW12	1100	300 (8)	-	-	-	-	Y	3, 4
Iron, filtered	5/6	106 - 5900	13	13MW12	1100	300 (8)	-	-	-	-	Y	3, 4
Lead	3/7	2.2 - 9.7	1.3 - 4.4	MW2-3RI	15	15 (9)	-	15	8.1	50	Y	3, 6
Lead, filtered	1/6	10.5	1.3 - 3.2	MW2-3RI	15	15 (9)	-	15	8.1	50	Y	3, 6
Manganese	7/7	43.8 - 329	-	13MW12	84	50 (8)	5000 (11)	160 (7)	-	-	Y	3
Manganese, filtered	6/6	48 - 321	-	13MW12	84	50 (8)	5000 (11)	160 (7)	-	-	Y	3, 5
Nickel	3/7	1.3 - 19.1	0.75 - 11	13MW12	73	100	100	100	8.2	610	Y	3, 6
Selenium, filtered	1/6	3.2	1.9 - 2	13MW12	18	50	50	50	71	100	N	2
Silver	1/7	1.4	1.1 - 7	MW2-3RI	18	100	50	36	-	105	N	2
Silver, filtered	1/6	1.6	1.1 - 2	MW2-3RI	18	100	50	36	-	105	N	2
Sodium	7/7	39200 - 1930000	-	MW2-3RI	-	-	28000 (12)	-	-	-	Y	1, 3
Sodium, filtered	6/6	58100 - 2080000	-	MW2-3RI	-	-	28000 (12)	-	-	-	Y	1, 3
Zinc	2/7	13.2 - 27.8	3 - 10.8	13MW12	1100	5000 (8)	-	5000	81	-	N	2
Zinc, filtered	3/6	5.1 - 119	3 - 9.6	MW2-3RI	1100	5000 (8)	-	5000	81	-	Y	3, 6

Notes:

- Not available or Not applicable.
- Bolded cell indicates that the maximum detected site concentration exceeds this criteria.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Tap Water Ingestion Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) Maximum Contaminant Level. (USEPA, October 1996).
- (3) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter II Environmental Health.
- (4) CDTEP, January 1996.
- (5) Connecticut Water Quality Standards, 1992. Chronic values for saltwater bodies and protection of human health values for water and organisms are presented.
- (6) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (7) No value promulgated by CTDEP, calculated value used.
- (8) Secondary MCL (SMCL) based on aesthetic water qualities.
- (9) Action Level.
- (10) Hexavalent chromium.
- (11) Current Connecticut Department of Public Health and Addiction Services Action Level.
- (12) Notification Level.

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Unfiltered data, rather than filtered data, will be in quantitative risk assessment.
- (6) Maximum is greater than State AWQC only; chemical will not be quantitatively evaluated in the risk assessment.

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**95% UPPER CONFIDENCE LIMITS
ZONE 3 - SHALLOW SOILS (0-4 FT)
NSB - NLON, GROTON, CONNECTICUT**

PARAMETER	UNITS	DETECTS	COUNT	AVERAGE	W NORMAL	W LOGNORMAL	W TEST	DISTRIBUTION	UCL - NORMAL	UCL - LOGNORMAL	DETECTS - MAX	95% UCL ⁽¹⁾
ALUMINUM	mg/kg	3	3	6276.6667	0.8904	0.9251	0.767	LOGNORMAL	10010.6656	18588.2944	8790	8790
ANTIMONY	mg/kg	1	3	1.3183	0.9746	0.9781	0.767	LOGNORMAL	3.3205	603523.0062	1.1	1.1
ARSENIC	mg/kg	3	3	1.91	0.917	0.8681	0.767	NORMAL	3.38	33.3711	2.6	2.6
BARIUM	mg/kg	4	4	43.8	36.675	0.9201	0.8811	NORMAL	45.8262	54.6553	43.8	43.8
BERYLLIUM	mg/kg	2	4	0.1913	0.8745	0.8688	0.748	NORMAL	0.3618	5.9434	0.38	0.38
CADMIUM	mg/kg	1	4	0.1388	0.6804	0.8383	0.748	LOGNORMAL	0.3912	6212.134	0.46	0.46
CALCIUM	mg/kg	4	4	1442	0.9124	0.918	0.748	LOGNORMAL	2495.2104	16994.749	2500	2500
CHROMIUM	mg/kg	4	4	13.025	0.884	0.8828	0.748	LOGNORMAL	18.2964	30.4297	16.9	16.9
COBALT	mg/kg	4	4	3.975	0.8642	0.8637	0.748	LOGNORMAL	5.4643	8.3853	5	5
COPPER	mg/kg	3	4	11.75	0.9435	0.883	0.748	NORMAL	16.3973	28.7732	15.9	15.9
IRON	mg/kg	4	4	8392.5	0.83	0.8252	0.748	LOGNORMAL	9559.9997	9942.3519	9440	9440
LEAD	mg/kg	9	10	411.545	0.7594	0.9288	0.842	LOGNORMAL	723.2528	73274.915	1390	1390
MAGNESIUM	mg/kg	4	4	2442.5	0.9316	0.9338	0.748	LOGNORMAL	3285.2319	4313.0854	3260	3260
MANGANESE	mg/kg	4	4	139.25	0.9052	0.906	0.748	LOGNORMAL	165.0504	177.9781	155	155
MERCURY	mg/kg	2	4	0.0844	0.8247	0.8999	0.748	LOGNORMAL	0.2019	24244159.1713	0.23	0.23
NICKEL	mg/kg	4	4	9.55	0.9786	0.9403	0.748	NORMAL	13.417	22.4715	13.4	13.4
POTASSIUM	mg/kg	4	4	1530	0.9147	0.9273	0.748	LOGNORMAL	2076.5346	2692.1306	2130	2130
SODIUM	mg/kg	4	4	226.925	0.8107	0.9258	0.748	LOGNORMAL	425.4882	2679.3395	474	474
VANADIUM	mg/kg	4	4	17.075	0.9953	0.993	0.748	NORMAL	24.4906	41.1271	18.9	18.9
ZINC	mg/kg	4	4	36.625	0.8789	0.9159	0.748	LOGNORMAL	64.1394	299.2894	68.6	68.6
ACETONE	µg/kg	1	1	130	*****	*****	0	NOT DEFINED	*****	0	130	130
CHLOROFORM	µg/kg	1	1	1	*****	*****	0	NOT DEFINED	*****	0	1	1
METHYLENE CHLORIDE	µg/kg	1	1	4	*****	*****	0	NOT DEFINED	*****	0	4	4
2-METHYLNAPHTHALENE	µg/kg		4	188.75	0.6297	0.6297	0.748	NOT DEFINED	209.3388	215.5604	NA	0
ACENAPHTHENE	µg/kg		4	188.75	0.6297	0.6297	0.748	NOT DEFINED	209.3388	215.5604	NA	0
ACENAPHTHYLENE	µg/kg	1	4	158.25	0.8188	0.7463	0.748	NORMAL	239.24	1173.1278	58	58
ANTHRACENE	µg/kg	2	4	117.25	0.8812	0.9011	0.748	LOGNORMAL	228.3753	49951.7882	51	51
BENZO(A)ANTHRACENE	µg/kg	2	4	219	0.9558	0.9262	0.748	NORMAL	413.5819	45802.5683	440	413.5819
BENZO(A)PYRENE	µg/kg	3	4	179.25	0.8429	0.9201	0.748	LOGNORMAL	429.7117	8636585.743	480	480
BENZO(B)FLUORANTHENE	µg/kg	3	4	196.75	0.8607	0.9976	0.748	LOGNORMAL	454.0305	1318561.644	510	510
BENZO(G,H,I)PERYLENE	µg/kg	3	4	120.75	0.9023	0.9074	0.748	LOGNORMAL	224.3505	16506.6852	210	210
BENZO(K)FLUORANTHENE	µg/kg	1	4	253.75	0.7235	0.7632	0.748	LOGNORMAL	401.1161	711.8953	440	440
BIS(2-ETHYLHEXYL)PHTHALATE	µg/kg	1	4	183.75	0.9106	0.9255	0.748	LOGNORMAL	210.6535	219.0105	160	160
CARBAZOLE	µg/kg		4	188.75	0.6297	0.6297	0.748	NOT DEFINED	209.3388	215.5604	NA	0
CHRYSENE	µg/kg	3	4	159.75	0.9007	0.973	0.748	LOGNORMAL	349.8446	491088.8564	380	380
DIBENZO(A,H)ANTHRACENE	µg/kg	1	4	181.25	0.9417	0.9444	0.748	LOGNORMAL	212.5159	225.8181	150	150
DIETHYL PHTHALATE	µg/kg		4	188.75	0.6297	0.6297	0.748	NOT DEFINED	209.3388	215.5604	NA	0
FLUORANTHENE	µg/kg	3	4	180.75	0.8636	0.9696	0.748	LOGNORMAL	404.9103	232384.1562	450	450
FLUORENE	µg/kg		4	188.75	0.6297	0.6297	0.748	NOT DEFINED	209.3388	215.5604	NA	0
INDENO(1,2,3-CD)PYRENE	µg/kg	3	4	116.75	0.8706	0.89	0.748	LOGNORMAL	231.9084	70822.1511	220	220
NAPHTHALENE	µg/kg	1	4	154	0.8013	0.7218	0.748	NORMAL	244.7305	4041.8813	41	41
PHENANTHRENE	µg/kg	2	4	157.75	0.7835	0.7076	0.748	NORMAL	254.7209	8418.2072	200	200
PYRENE	µg/kg	3	4	249	0.7916	0.9825	0.748	LOGNORMAL	617.8748	2381524.497	710	710
PH		1	1	10.4	*****	*****	0	NOT DEFINED	*****	0	10.4	10.4
TPH	mg/kg	4	4	499.3	0.9859	0.8549	0.748	NORMAL	917.5526	733935.3856	930	917.5526

(1) The UCL Normal and UCL Lognormal values are the 95% UCL for normal and lognormal distributions, respectively; if these values exceeded the maximum concentration, then the maximum concentration was used as the 95% UCL. For undefined distributions, the maximum concentration was used as the 95% UCL. Asterisks indicate insufficient number of samples to calculate statistics.

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**95% UPPER CONFIDENCE LIMITS
ZONE 3 - SOILS (0-10 FT)
NSB - NLON, GROTON, CONNECTICUT**

PARAMETER	UNITS	DETECTS	COUNT	AVERAGE	W NORMAL	W LOGNORMAL	W TEST	DISTRIBUTION	UCL - NORMAL	UCL - LOGNORMAL	DETECTS - MAX	95% UCL ⁽¹⁾
XYLENES, TOTAL	µg/kg	1	3	3.1667	0.9959	0.9729	0.767	NORMAL	6.9677	3621.055	1	1
ALUMINUM	mg/kg	8	8	5957.5	0.9291	0.9525	0.818	LOGNORMAL	7121.0899	7532.5227	8790	7532.5227
ANTIMONY	mg/kg	2	8	1.05	0.7528	0.8273	0.818	LOGNORMAL	1.8264	5.5005	1.1	1.1
ARSENIC	mg/kg	8	8	2.2163	0.8783	0.9765	0.818	LOGNORMAL	3.0702	3.7162	4.9	3.7162
BARIIUM	mg/kg	8	8	32.85	0.8807	0.8757	0.818	NORMAL	38.7444	40.9326	43.8	38.7444
BERYLLIUM	mg/kg	5	9	0.1944	0.8979	0.9058	0.829	NORMAL	0.2631	0.3418	0.38	0.2631
CADMIUM	mg/kg	2	9	0.2006	0.7076	0.793	0.829	NOT DEFINED	0.3782	2.2784	0.83	0.83
CALCIUM	mg/kg	9	9	3139.778	0.6513	0.8794	0.829	LOGNORMAL	5830.0447	11216.4838	13800	11216.4838
CHROMIUM	mg/kg	9	9	12.2111	0.9264	0.9404	0.829	LOGNORMAL	14.9576	16.3721	19.3	16.3721
COBALT	mg/kg	9	9	3.9222	0.8926	0.8738	0.829	NORMAL	4.5634	4.8372	5.1	4.5634
COPPER	mg/kg	8	9	18.4889	0.6526	0.8191	0.829	LOGNORMAL	31.4894	34.4165	73.6	34.4165
IRON	mg/kg	9	9	7901.111	0.895	0.8461	0.829	NORMAL	8732.012	8994.3563	9440	8732.012
LEAD	mg/kg	16	17	295.1794	0.6826	0.9529	0.892	LOGNORMAL	478.4541	4272.9513	1390	1390
MAGNESIUM	mg/kg	9	9	2288.889	0.9059	0.918	0.829	LOGNORMAL	2654.9967	2748.8134	3260	2748.8134
MANGANESE	mg/kg	9	9	149.5667	0.7983	0.9188	0.829	LOGNORMAL	185.8697	192.3156	290	192.3156
MERCURY	mg/kg	3	9	0.0567	0.6864	0.8271	0.829	LOGNORMAL	0.0998	1.4888	0.23	0.23
NICKEL	mg/kg	9	9	8.5556	0.8856	0.9096	0.829	LOGNORMAL	10.5274	11.3348	13.4	11.3348
POTASSIUM	mg/kg	9	9	1327.778	0.877	0.9425	0.829	LOGNORMAL	1556.9426	1588.9982	2130	1588.9982
SELENIUM	mg/kg	2	9	0.2517	0.8114	0.9257	0.829	LOGNORMAL	0.3508	0.4076	0.6	0.4076
SILVER	mg/kg	2	9	0.5194	0.7833	0.9292	0.829	LOGNORMAL	0.851	1.7119	1.7	1.7
SODIUM	mg/kg	9	9	253.8556	0.8536	0.9331	0.829	LOGNORMAL	352.8222	442.7407	530	442.7407
VANADIUM	mg/kg	9	9	16.1	0.9331	0.9347	0.829	NORMAL	19.1932	20.3449	24.8	19.1932
ZINC	mg/kg	9	9	38.1778	0.8606	0.8728	0.829	LOGNORMAL	51.8988	65.0908	74.1	65.0908
1,1,1-TRICHLOROETHANE	µg/kg	1	3	4.8333	0.871	0.8425	0.767	NORMAL	7.543	18.7315	6	6
ACETONE	µg/kg	2	3	73.5	0.9788	0.8567	0.767	NORMAL	178.7247	4.96042E+12	130	130
CHLOROFORM	µg/kg	1	3	3.3333	0.9868	0.9832	0.767	NORMAL	7.576	7340.3218	1	1
METHYLENE CHLORIDE	µg/kg	2	3	3.3333	0.75	0.75	0.767	NOT DEFINED	4.3067	4.8239	4	4
TETRACHLOROETHENE	µg/kg	1	3	3.1667	0.9959	0.9729	0.767	NORMAL	6.9677	3621.055	1	1
TOLUENE	µg/kg	1	3	3.1	0.9986	0.9561	0.767	NORMAL	7.0645	30141.4551	0.8	0.8
2-METHYLNAPHTHALENE	µg/kg	4	12	157.0833	0.8428	0.7294	0.859	NOT DEFINED	200.2154	349.3176	300	300
ACENAPHTHENE	µg/kg	5	12	135.8333	0.7784	0.7304	0.859	NOT DEFINED	175.4792	361.9208	200	200
ACENAPHTHYLENE	µg/kg	3	12	173.6667	0.8473	0.7353	0.859	NOT DEFINED	213.3301	289.8491	340	340
ANTHRACENE	µg/kg	7	12	134.25	0.8961	0.9067	0.859	LOGNORMAL	184.6565	301.0059	350	301.0059
BENZO(A)ANTHRACENE	µg/kg	9	12	468.5	0.6596	0.9481	0.859	LOGNORMAL	804.1758	2043.3445	2100	2043.3445
BENZO(A)PYRENE	µg/kg	9	12	373.5	0.7628	0.8991	0.859	LOGNORMAL	567.0161	1499.9919	1000	1000
BENZO(B)FLUORANTHENE	µg/kg	9	12	401.8333	0.6836	0.9365	0.859	LOGNORMAL	652.2895	1251.7511	1500	1251.7511
BENZO(G,H,I)PERYLENE	µg/kg	9	12	260.6667	0.7617	0.9397	0.859	LOGNORMAL	386.4687	598.2313	850	598.2313
BENZO(K)FLUORANTHENE	µg/kg	7	12	303.4167	0.7189	0.8788	0.859	LOGNORMAL	433.2363	491.8195	870	491.8195
BIS(2-ETHYLHEXYL)PHTHALATE	µg/kg	3	12	200.8333	0.6911	0.7664	0.859	NOT DEFINED	230.6132	229.3603	360	360
CARBAZOLE	µg/kg	4	12	153.5	0.8232	0.7242	0.859	NOT DEFINED	193.4948	331.6482	270	270
CHRYSENE	µg/kg	10	12	480.8333	0.6892	0.9136	0.859	LOGNORMAL	793.3241	3046.6451	1500	1500
DI-N-BUTYL PHTHALATE	µg/kg	1	12	167.5	0.5937	0.4347	0.859	NOT DEFINED	192.7182	288.5831	20	20
DIBENZO(A,H)ANTHRACENE	µg/kg	6	12	188.0833	0.8837	0.8895	0.859	LOGNORMAL	238.2777	285.3316	400	285.3316
DIBENZOFURAN	µg/kg	3	12	149.9167	0.7627	0.6786	0.859	NOT DEFINED	182.0311	251.5049	81	81
DIETHYL PHTHALATE	µg/kg	1	12	168.3333	0.6083	0.4404	0.859	NOT DEFINED	193.7166	290.6294	20	20
FLUORANTHENE	µg/kg	10	12	696.4167	0.5686	0.9271	0.859	LOGNORMAL	1345.1383	3039.2477	4200	3039.2477
FLUORENE	µg/kg	5	12	155	0.8832	0.8388	0.859	NORMAL	204.4689	332.6896	370	204.4689
INDENO(1,2,3-CD)PYRENE	µg/kg	9	12	238.5	0.7052	0.9335	0.859	LOGNORMAL	369.5684	595.3501	870	595.3501
NAPHTHALENE	µg/kg	4	12	134.4167	0.7622	0.7319	0.859	NOT DEFINED	174.7552	350.408	42	42
PHENANTHRENE	µg/kg	8	12	460.5	0.7038	0.8917	0.859	LOGNORMAL	740.1509	1292.2734	1700	1292.2734
PYRENE	µg/kg	11	12	884.75	0.7006	0.9695	0.859	LOGNORMAL	1579.4704	12173.2816	4400	4400
PH		3	3	9.58	0.927	0.8979	0.767	NORMAL	14.0101	23.1687	11.7	11.7
TPH	mg/kg	9	10	777.145	0.7484	0.9421	0.842	LOGNORMAL	1383.4964	72610.4467	3400	3400

(1) The UCL Normal and UCL Lognormal values are the 95% UCL for normal and lognormal distributions, respectively; if these values exceeded the maximum concentration, then the maximum concentration was used as the 95% UCL. For undefined distributions, the maximum concentration was used as the 95% UCL.

6000

00010

**SUMMARY OF MAXIMUM AND AVERAGE CONCENTRATIONS
 ZONE 3 - GROUNDWATER
 NSB-NLON, GROTON, CONNECTICUT**

Parameter	Maximum Detected Concentration	Average Concentration
Semivolatile Organic Compounds (ug/L)		
BIS(2-ETHYLHEXYL)PHTHALATE	0.80	6.60
FLUORENE	0.95	4.15
Metals (ug/L)		
ANTIMONY, FILTERED	2.80	3.33
ARSENIC	1.61	1.37
ARSENIC, FILTERED	1.72	1.41
BARIUM	135.00	66.30
BARIUM, FILTERED	446.00	260.51
CALCIUM	129,000.00	61,933.33
CALCIUM, FILTERED	136,000.00	65,105.56
CHROMIUM, FILTERED	3.60	1.74
IRON	4,636.25	1,552.67
IRON, FILTERED	4,973.33	1,695.28
LEAD	9.70	4.55
LEAD, FILTERED	10.50	4.33
MAGNESIUM	237,000.00	98,087.08
MAGNESIUM, FILTERED	254,000.00	105,625.56
MANGANESE	261.13	124.44
MANGANESE, FILTERED	263.00	136.70
NICKEL	7.49	3.46
POTASSIUM	77,700.00	35,886.25
POTASSIUM, FILTERED	83,000.00	38,301.67
SELENIUM, FILTERED	1.72	1.21
SILVER	1.40	1.15
SILVER, FILTERED	1.60	1.00
SODIUM	1,930,000.00	842,783.33
SODIUM, FILTERED	2,080,000.00	910,966.67
ZINC	13.20	8.99
ZINC, FILTERED	119.00	80.16

00012

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 3
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker (All Soil), RME

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		CHILD:	
IR:	480	IR:	0
EF:	120	EF:	120
Fi:	1	Fi:	1
ED:	1	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	365	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:	CHILD:	ADULT/CHILD (CANCER RISK):
CF: 2.25E-06 (AVG ANNUAL DOSE)	CF: 0.00E+00 (AVG ANNUAL DOSE)	CF: 3.22E-08

00013

00016

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 3
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Construction Worker (All Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
S _{ac} = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
S _{aa} = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	1
ABS = ABSORPTION FRACTION:	
	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	120
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	1
BW _c = BODY WEIGHT CHILD (KG):	1
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	2.55E-07
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	1.78E-05			

00017

00020

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER

SITE NAME: ZONE 3
 LOCATION: NSB-NLON, Groton, CT
 DATE: 2/2/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker, RME

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

$$DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DA_{event} = ABSORBED DOSE PER EVENT (MG/CM**2/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS: $DA_{event} = K_p \times C \times t_{event} \times CF$
 IF $t_{event} < t^*$, $DA_{event} = 2K_p \times C \times CF \times (6T \times t_{event} / 3.141592654)^{0.5}$
 FOR ORGANICS: IF $t_{event} > t^*$, $DA_{event} = K_p \times C \times CF \times ((t_{event} / (1 + B)) + (2T \times ((1 + 3B) / (1 + B))))$

WHERE: K_p = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MG/L)
 t_{event} = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1 L/1000 CM**3)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERIVED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

EV:	1	CONVERSION	
ED:	1	FACTOR (NONCAR) =	1.78E+01
EF:	120		
A:	3800	CONVERSION	
t _{event} :	8	FACTOR (CARCIN) =	2.55E-01
BW:	70		
AT(NON):	365		
AT(CAR):	25550		

00021

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

ZONE 3

EXPOSURE SCENARIO: Construction Worker, RME

CHEMICAL	CONC. (MG/L)	ORGANIC OR INORGANIC?	I* (HR)	T (HR)	Kp (CM/HR)	B	DAevent
Antimony, filtered	0.0028	I			1.00E-03		2.24E-08
Arsenic	0.0016	I			1.00E-03		1.28E-08
Barium, filtered	0.446	I			1.00E-03		3.57E-06
Manganese	0.261	I			1.00E-03		2.09E-06
							0.00E+00
							0.00E+00
							0.00E+00

00022

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER WATER (PAGE THREE)

ZONE 3

EXPOSURE SCENARIO: Construction Worker, RME

CALCULATE DOSES:

CHEMICAL	ANNUAL DERMAL DOSE (MG/KG/DAY)	DERMAL RfD (MG/KG/DAY)	HAZARD INDEX DERMAL
Antimony, filtered	4.00E-07	4.00E-04	9.99E-04
Arsenic	2.28E-07	2.80E-04	8.16E-04
Barium, filtered	6.37E-05	3.50E-03	1.82E-02
Manganese	3.73E-05	7.20E-04	5.18E-02
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00

TOTAL RISK

7.18E-02

00023

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)

ZONE 3

EXPOSURE SCENARIO: Construction Worker, RME

CALCULATE INCREMENTAL CANCER RISKS:

CHEMICAL	LIFETIME AVERAGE DERMAL DOSE (MG/KG/DAY)	CSF DERMAL (KG/DAY/MG)	CANCER RISK DERMAL CONTACT
Antimony, filtered	5.71E-09	0.00E+00	0.00E+00
Arsenic	3.26E-09	1.60E+00	5.22E-09
Barium, filtered	9.10E-07	0.00E+00	0.00E+00
Manganese	5.32E-07	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00

TOTAL RISK

5.22E-09

00024

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 3
 LOCATION: NSB-NLON, Groton, CT
 DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker (All Soil), CTE

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
 C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
 IR = SOIL INGESTION RATE (MG/EVENT)
 EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
 Fi = FRACTION FROM CONTAMINATED SOURCE
 ED = EXPOSURE DURATION (YEARS)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)
 BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		CHILD:	
IR:	240	IR:	0
EF:	80	EF:	120
Fi:	1	Fi:	1
ED:	1	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	365	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:		CHILD:		ADULT/CHILD (CANCER RISK):	
CF:	7.51E-07 (AVG ANNUAL DOSE)	CF:	0.00E+00 (AVG ANNUAL DOSE)	CF:	1.07E-08

00025

00028

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 3
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Construction Worker (All Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
S _{Ac} = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
S _{Aa} = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	0.2
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	80
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	1
BW _c = BODY WEIGHT CHILD (KG):	15
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	3.40E-08
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	2.38E-06			

00029

00032

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER

SITE NAME: ZONE 3
 LOCATION: NSB-NLON, Groton, CT
 DATE: 2/2/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker, CTE

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

$$DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DA_{event} = ABSORBED DOSE PER EVENT (MG/CM**2/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS:
 FOR ORGANICS:

$$DA_{event} = K_p \times C \times te_{event} \times CF$$

$$\text{IF } te_{event} < t^*, DA_{event} = 2K_p \times C \times CF \times (6T \times te_{event}/3.141592654)^{0.5}$$

$$\text{IF } te_{event} > t^*, DA_{event} = K_p \times C \times CF \times ((te_{event}/(1 + B)) + (2T \times ((1+3B)/(1 + B))))$$

WHERE: K_p = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MG/L)
 te_{event} = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1 L/1000 CM**3)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERIVED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

EV: 1
 ED: 1
 EF: 80
 A: 3800
 tevent: 8
 BW: 70
 AT(NON): 365
 AT(CAR): 25550

CONVERSION
 FACTOR (NONCAR) = 1.19E+01
 CONVERSION
 FACTOR (CARCIN) = 1.70E-01

00033

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

ZONE 3

EXPOSURE SCENARIO: Construction Worker, CTE

CHEMICAL	CONC. (MG/L)	ORGANIC OR INORGANIC?	t* (HR)	T (HR)	Kp (CM/HR)	B	DAevent
Antimony, filtered	0.0028	I			1.00E-03		2.24E-08
Arsenic	0.0014	I			1.00E-03		1.12E-08
Barium, filtered	0.261	I			1.00E-03		2.09E-06
Manganese	0.124	I			1.00E-03		9.92E-07
							0.00E+00
							0.00E+00
							0.00E+00

00034

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER WATER (PAGE THREE)

ZONE 3

EXPOSURE SCENARIO: Construction Worker, CTE

CALCULATE DOSES:

CHEMICAL	ANNUAL DERMAL DOSE (MG/KG/DAY)	DERMAL RfD (MG/KG/DAY)	HAZARD INDEX DERMAL
Antimony, filtered	2.67E-07	4.00E-04	6.66E-04
Arsenic	1.33E-07	2.80E-04	4.76E-04
Barium, filtered	2.48E-05	3.50E-03	7.10E-03
Manganese	1.18E-05	7.20E-04	1.64E-02
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00

TOTAL RISK

2.46E-02

00035

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)

ZONE 3

EXPOSURE SCENARIO: Construction Worker, CTE

CALCULATE INCREMENTAL CANCER RISKS:

CHEMICAL	LIFETIME AVERAGE DERMAL DOSE (MG/KG/DAY)	CSF DERMAL (KG/DAY/MG)	CANCER RISK DERMAL CONTACT
Antimony, filtered	3.81E-09	0.00E+00	0.00E+00
Arsenic	1.90E-09	1.60E+00	3.05E-09
Barium, filtered	3.55E-07	0.00E+00	0.00E+00
Manganese	1.69E-07	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00
0	0.00E+00	0.00E+00	0.00E+00

TOTAL RISK

3.05E-09

00036

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 3
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

**HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.**

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), RME

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		CHILD:	
IR:	100	IR:	0
EF:	150	EF:	120
Fi:	1	Fi:	1
ED:	25	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	9125	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:	CHILD:	ADULT/CHILD (CANCER RISK):
CF: 5.87E-07 (AVG ANNUAL DOSE)	CF: 0.00E+00 (AVG ANNUAL DOSE)	CF: 2.10E-07

00037

00040

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 3
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

EXPOSURE SCENARIO: Full-Time Employees (Surface Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E8)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
S _{ac} = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
S _{aa} = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	1
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	25
BW _c = BODY WEIGHT CHILD (KG):	1
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	9125
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E8 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	7.97E-08
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	2.23E-05			

00041

00044

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 3
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), CTE

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
 C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
 IR = SOIL INGESTION RATE (MG/EVENT)
 EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
 Fi = FRACTION FROM CONTAMINATED SOURCE
 ED = EXPOSURE DURATION (YEARS)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)
 BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		CHILD:	
IR:	50	IR:	0
EF:	150	EF:	120
Fi:	1	Fi:	1
ED:	6	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	2190	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:		CHILD:		ADULT/CHILD (CANCER RISK):	
CF:	2.94E-07 (AVG ANNUAL DOSE)	CF:	0.00E+00 (AVG ANNUAL DOSE)	CF:	2.52E-08

00045

00048

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 3
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
SAC = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
SAa = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	0.2
ABS = ABSORPTION FRACTION:	Chemical Specific
EFc = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EFa = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
EDc = CHILD EXPOSURE DURATION (YEARS):	1
EDa = ADULT EXPOSURE DURATION (YEARS):	25
BWc = BODY WEIGHT CHILD (KG):	1
BWa = BODY WEIGHT ADULT (KG):	70
ATc = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
ATa = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	9125
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSEchild = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	1.59E-06
DOSEadult = (CF2)*(C)*(ABS)	CF2 =	4.46E-06			

64000

00052

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 3
 LOCATION: NSB-NLON, GROTON, CT
 DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), RME

RELEVANT EQUATIONS: $IEX = (C \times IFadj \times Fi \times EF) / (AT \times CF)$ $IFadj = (IRc \times EDc) / BWc + (IRa \times EDa) / BWa$

WHERE:

- C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
- IFadj = AGE-ADJUSTED SOIL INGESTION FACTOR (MG YEAR/KG DAY)
- Fi = FRACTION FROM CONTAMINATED SOURCE (UNITLESS)
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- AT = AVERAGING TIME (DAYS)
- CF = CONVERSION FACTOR (1E+6 MG/KG)
- IRc = CHILD INGESTION RATE (MG/DAY)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- BWc = CHILD BODY WEIGHT (KG)
- IRa = ADULT INGESTION RATE (MG/DAY)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWa = ADULT BODY WEIGHT (KG)

ENTER INPUT PARAMETERS:

IRc: 200
 EDc: 6
 BWc: 15
 IRa: 100
 EDa: 24
 BWa: 70
 IFadj: 114.28571
 Fi: 1
 EF: 150
 AT(NONC): 10950
 AT(CARC): 25550

DETERMINE CONVERSION FACTORS:

NONCARC = 1.57E-06 CARCIN = 6.71E-07

00053

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 3
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA_{adj} \times AF \times ABS \times EF) / (AT \times 1E6)$ $SA_{adj} = (SAa \times EDa) / BWa + (SAC \times EDc) / BWc$

WHERE:

- C = CONCENTRATION IN SOIL (MG/KG)
- Sac = CHILD SKIN SURFACE AREA (SQ CM/DAY)
- SAa = ADULT SKIN SURFACE AREA (SQ CM/DAY)
- AF = ADHERENCE FACTOR (MG/SQ CM)
- ABS = ABSORPTION FRACTION
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWc = BODY WEIGHT CHILD (KG)
- BWa = BODY WEIGHT ADULT (KG)
- ATn = AVERAGING TIME (DAYS), NONCARCINOGENS
- ATc = AVERAGING TIME (DAYS), CARCINOGENS
- SAadj = AGE-ADJUSTED SKIN SURFACE AREA (SQ CM-YR/DAY-KG)

ENTER INPUT PARAMETERS

SAc:	2094
SAa:	3800
AF:	1
EF:	150
EDc:	6
EDa:	24
BWc:	15
BWa:	70
ATn:	10950
ATc:	25550
SAadj:	2140

DETERMINE CONVERSION FACTORS:

NONCARC = 2.93E-05 CARCIN = 1.26E-05

00055

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 3
 LOCATION: NSB-NLON, GROTON, CT
 DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), CTE

RELEVANT EQUATIONS: $IEX = (C \times IF_{adj} \times F_i \times EF) / (AT \times CF)$ $IF_{adj} = (IR_c \times ED_c) / BW_c + (IR_a \times ED_a) / BW_a$

WHERE:

- C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
- IF_{adj} = AGE-ADJUSTED SOIL INGESTION FACTOR (MG YEAR/KG DAY)
- F_i = FRACTION FROM CONTAMINATED SOURCE (UNITLESS)
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- AT = AVERAGING TIME (DAYS)
- CF = CONVERSION FACTOR (1E+6 MG/KG)
- IR_c = CHILD INGESTION RATE (MG/DAY)
- ED_c = CHILD EXPOSURE DURATION (YEARS)
- BW_c = CHILD BODY WEIGHT (KG)
- IR_a = ADULT INGESTION RATE (MG/DAY)
- ED_a = ADULT EXPOSURE DURATION (YEARS)
- BW_a = ADULT BODY WEIGHT (KG)

ENTER INPUT PARAMETERS:

IR_c: 100
 ED_c: 2
 BW_c: 15
 IR_a: 50
 ED_a: 7
 BW_a: 70
 IF_{adj}: 18.333333
 F_i: 0.5
 EF: 150
 AT(NONC): 3285
 AT(CARC): 25550

DETERMINE CONVERSION FACTORS:

NONCARC = 4.19E-07 CARCIN = 5.38E-08

00057

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 3
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA_{adj} \times AF \times ABS \times EF) / (AT \times 1E6)$ $SA_{adj} = (SA_a \times ED_a) / BW_a + (SA_c \times ED_c) / BW_c$

WHERE:

- C = CONCENTRATION IN SOIL (MG/KG)
- SA_c = CHILD SKIN SURFACE AREA (SQ CM/DAY)
- SA_a = ADULT SKIN SURFACE AREA (SQ CM/DAY)
- AF = ADHERENCE FACTOR (MG/SQ CM)
- ABS = ABSORPTION FRACTION
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- ED_c = CHILD EXPOSURE DURATION (YEARS)
- ED_a = ADULT EXPOSURE DURATION (YEARS)
- BW_c = BODY WEIGHT CHILD (KG)
- BW_a = BODY WEIGHT ADULT (KG)
- AT_n = AVERAGING TIME (DAYS), NONCARCINOGENS
- AT_c = AVERAGING TIME (DAYS), CARCINOGENS
- SA_{adj} = AGE-ADJUSTED SKIN SURFACE AREA (SQ CM-YR/DAY-KG)

ENTER INPUT PARAMETERS

SA _c :	2094
SA _a :	3800
AF:	0.2
EF:	150
ED _c :	2
ED _a :	7
BW _c :	15
BW _a :	70
AT _n :	3285
AT _c :	25550
SA _{adj} :	659.2

DETERMINE CONVERSION FACTORS:

NONCARC = 6.02E-06 CARCIN = 7.74E-07

6500

IEUBK MODEL - EXPOSURE TO LEAD (PAGE 1 OF 2)

SITE NAME: Zone 3
 LOCATION: NSB-NLON, Groton, Connecticut
 DATE: 2/12/98

EXPOSURE SCENARIO: RME/CTE

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
 Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
 WATER Consumption: DEFAULT

SOIL & DUST:

Soil: constant conc.
 Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	1390.0	1390.0
1-2	1390.0	1390.0
2-3	1390.0	1390.0
3-4	1390.0	1390.0
4-5	1390.0	1390.0
5-6	1390.0	1390.0
6-7	1390.0	1390.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
 Maternal Blood Conc: 2.50 ug Pb/dL

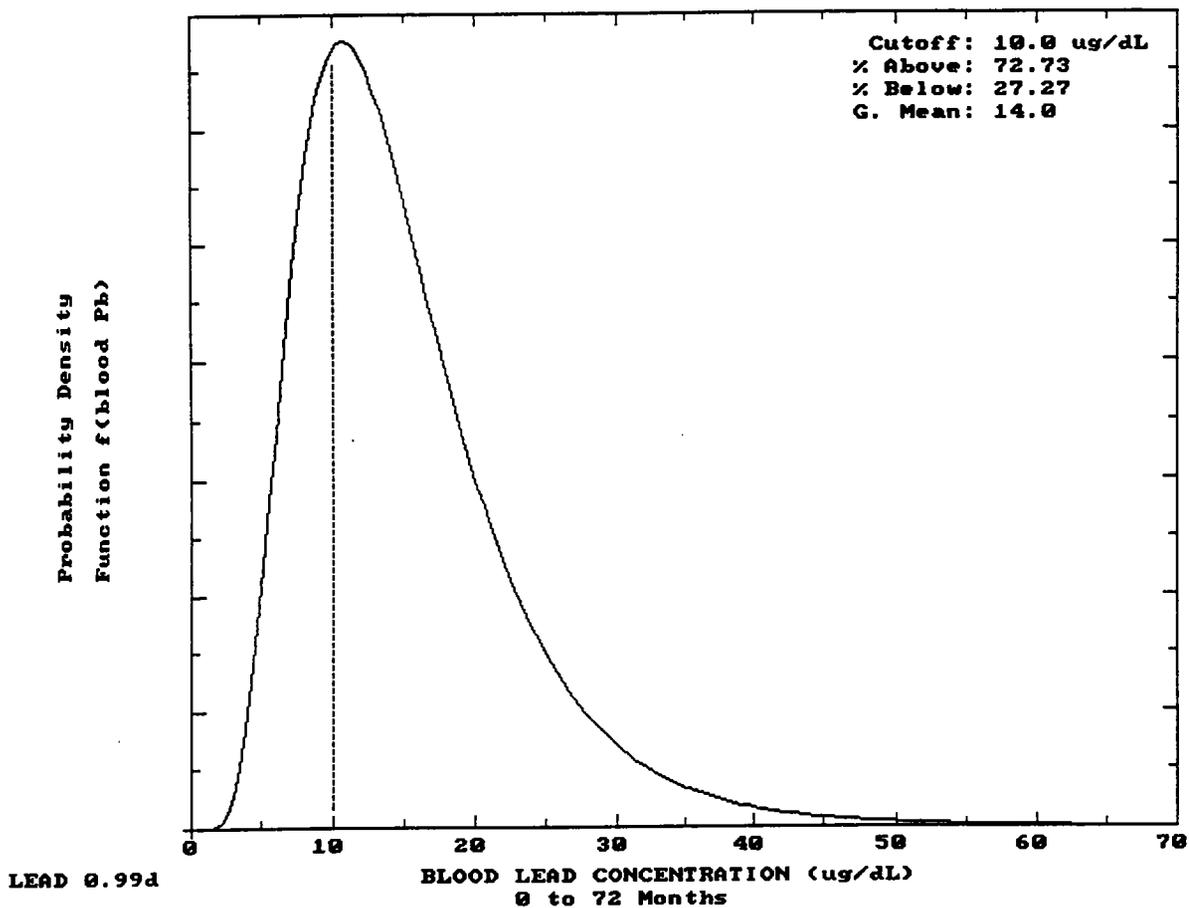
CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	14.3	27.80	25.50	1.99	0.29	0.00	0.02
1-2:	16.5	41.27	38.57	1.98	0.69	0.00	0.03
2-3:	15.7	43.33	40.21	2.32	0.74	0.00	0.06
3-4:	15.2	44.98	41.81	2.32	0.79	0.00	0.07
4-5:	12.9	37.20	33.80	2.44	0.89	0.00	0.07
5-6:	11.0	35.22	31.50	2.66	0.97	0.00	0.09
6-7:	9.8	34.40	30.31	2.99	1.01	0.00	0.09

IEUBK MODEL - EXPOSURE TO LEAD (PAGE 2 OF 2)

SITE NAME: Zone 3
LOCATION: NSB-NLON, Groton, Connecticut
DATE: 2/12/98

EXPOSURE SCENARIO: RME/CTE



Calculations of 95th Percentile Fetal Blood Lead Concentrations for Adult Exposure to Soil

SITE NAME: Zone 3

LOCATION: NSB-NLON, Groton, Connecticut

DATE: February 11, 1998

OBJECTIVE: Adult exposure to lead in soil is addressed by an evaluation of the relationship between the site soil lead concentration and the blood lead concentration in the developing fetuses of adult women. This spreadsheet calculates a range of 95th percentile fetal blood lead concentrations from central estimates of blood lead concentrations in pregnant adult women using the exposure parameters identified below (U.S. EPA, Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil, December 1996).

RELEVANT EQUATIONS: $PbB_{adult, central} = PbB_{adult, 0} + [(PbS \times BKSF \times IR_s \times AF_s \times EF_s)/AT]$

and

$$PbB_{fetal, 0.95} = PbB_{adult, central} \times GSD_{i, adult}^{1.645} \times R_{fetal/maternal}$$

Exposure Parameter	Description (units)	Future Employee		Construction Worker	
		RME	CTE	RME	CTE
$PbB_{adult, 0}$	Typical blood lead concentration in adult women of child-bearing age in absence of site exposures (ug/dL)	2.0	2.0	2.0	2.0
PbS	Site-specific soil lead concentration (mg/kg)	1390	412	1390	1390
BKSF	Biokinetic slope factor (ug/dl)/(ug/day)	0.4	0.4	0.4	0.4
IR_s	Intake rate of soil, includes outdoor soil and indoor soil-derived dust (g/day)	0.100	0.050	0.480	0.240
AF_s	Absolute gastrointestinal absorption fraction (unitless)	0.12	0.12	0.12	0.12
EF_s	Exposure frequency (days/year)	150	150	120	80
AT	Averaging time (days/year)	365	365	365	365
$GSD_{i, adult}$	Estimate of individual geometric standard deviation among adults (unitless)	2.1	2.1	2.1	2.1
$R_{fetal/maternal}$	Constant of proportionality between fetal blood lead concentration at birth and maternal blood lead concentration (unitless)	0.9	0.9	0.9	0.9
$PbB_{adult, central}$	Calculated central estimate of blood lead concentrations in adult women of child-bearing age from site exposures (ug/dL)	4.74	2.41	12.53	(1)
$PbB_{fetal, 0.95}$	Calculated 95th percentile blood lead concentrations among fetuses born to women having site exposures (ug/dL)	14.46	7.34	38.21	(1)

Notes:

- (1) According to the cited guidance document, this adult exposure model is not applicable for infrequent site exposures, where the EF_s is less than 1 day/week or 90 days/year.

00063

APPENDIX I.8

ZONE 4

COC SCREENING FOR LOWER SUBBASE
 ZONE 4-SHALLOW SOIL (0-5 FEET)
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COPC? (4)	Rationale
Semivolatile Organic Compounds (mg/kg)													
2-METHYLNAPHTHALENE	2/5	0.024-2	0.36	0.513	LS4SB0010101	310	-	-	1000(5)	2500(5)	56(5)	N	2
ACENAPHTHENE	1/5	0.9	0.36	0.324	LS4SB0010101	470	-	29	1000(5)	2500(5)	84(5)	N	2
ACENAPHTHYLENE	3/5	0.019-1.2	0.36	0.330	LS4SB0010101	-	-	-	1000	2500	84	N	2
ANTHRACENE	2/5	0.066-2.7	0.36	0.661	LS4SB0010101	2300	-	590	1000	2500	400	N	2
BENZO(A)ANTHRACENE	5/5	0.044-5.3	-	1.224	LS4SB0010101	0.88	-	0.08	1	7.8	1	Y	3
BENZO(A)PYRENE	5/5	0.059-4.3	-	1.032	LS4SB0010101	0.088	-	0.4	1	1	1	Y	3
BENZO(B)FLUORANTHENE	5/5	0.057-4.3	-	1.036	LS4SB0010101	0.88	-	0.2	1	7.8	1	Y	3
BENZO(G,H,I)PERYLENE	5/5	0.055-3.1	-	0.790	LS4SB0010101	-	-	-	1000(5)	2500(5)	40(5)	N	2
BENZO(K)FLUORANTHENE	5/5	0.056-1.4	-	0.436	LS4SB0010101	8.8	-	2	8.4	78	1	Y	3, 5
CARBAZOLE	2/5	0.025-1.1	0.36	0.333	LS4SB0010101	32	-	0.03	31(5)	290(5)	0.36(5)	Y	3, 5
CHRYSENE	5/5	0.055-5.5	-	1.282	LS4SB0010101	88	-	8	84(5)	780(5)	0.96(5)	Y	3, 5
DIBENZO(A,H)ANTHRACENE	2/5	0.034-1.5	0.36	0.415	LS4SB0010101	0.088	-	0.08	0.084(5)	0.78(5)	0.000096(5)	Y	3
DIBENZOFURAN	1/5	1.3	0.36	0.404	LS4SB0010101	310	-	-	270(5)	2500(5)	5.6(5)	N	2
FLUORANTHENE	5/5	0.045-11	-	2.425	LS4SB0010101	310	-	210	1000	2500	56	N	2
FLUORENE	1/5	2.9	0.36	0.724	LS4SB0010101	310	-	28	1000	2500	56	N	2
INDENO(1,2,3-CD)PYRENE	5/5	0.046-3.4	-	0.827	LS4SB0010101	0.88	-	0.7	0.84(5)	7.8(5)	0.0096(5)	Y	3
NAPHTHALENE	2/5	0.034-1.7	0.36	0.455	LS4SB0010101	310	-	4	1000	2500	56	N	2
PHENANTHRENE	5/5	0.024-14	-	2.870	LS4SB0010101	-	-	-	1000	2500	40	N	2
PHENOL	1/5	0.024	0.36	0.149	LS4SB00050101	4700	-	5	1000	2500	800	N	2
PYRENE	5/5	0.061-15	-	3.226	LS4SB0010101	230	-	210	1000	2500	40	N	2
Metals (mg/kg)													
				0									
ALUMINUM	3/3	3300-5450	-	4480	LS4SB0030101	7800	-	-	-	-	-	N	2
ANTIMONY	2/3	0.49-3.3	0.45	1.338333	LS4SB0010101	3.1	-	0.3	27	8200	-	Y	3
ARSENIC	3/3	1.9-4.5	-	3.53333	LS4SB0030101	0.43	750	1	10	10	-	Y	3
BARIUM	2/3	19.5-46.8	34.5	27.85	13TB4A-0002	550	690000	82	4700	140000	-	N	2
BERYLLIUM	1/3	0.28	0.13-0.19	0.146667	LS4SB0010101	0.15	1300	3	2	2	-	Y	3
CADMIUM	2/3	0.07-0.53	0.1	0.216667	LS4SB0010101	3.9	1800	0.4	34	1000	-	Y	3, 5
CHROMIUM (TOTAL)	3/3	5.9-11.4	-	9.266667	LS4SB0030101	39(6)	270	2	100(6)	100(6)	-	Y	3, 5
COBALT	3/3	2.1-2.9	-	2.6	LS4SB0030101	470	-	-	1000(5)	2500(5)	-	N	2
COPPER	3/3	7.3-147	-	56.1	LS4SB0010101	310	-	-	-	-	-	N	2
IRON	3/3	5200-7860	-	6650	LS4SB0010101	2300	-	-	-	-	-	N	2
LEAD	8/8	57.1-10600	-	2173.5125	13WE4A-0002	400(7)	-	-	500	1000	-	Y	3
MANGANESE	3/3	75.1-130	-	109.033333	LS4SB0010101	180	-	-	1600(5)	47000(5)	-	N	2
MERCURY	2/3	0.31-0.5	0.01	0.271667	LS4SB0030101	2.3	-	-	20	610	-	N	2
NICKEL	3/3	4.6-8.7	-	6.933333	LS4SB0010101	160	13000	7	1400	7500	-	Y	3, 5
VANADIUM	3/3	8.7-14.1	-	11.833333	LS4SB0010101	55	-	300	470	14000	-	N	2
ZINC	3/3	29.2-128	-	72.366667	LS4SB0010101	2300	-	620	20000	610000	-	N	2
Miscellaneous (mg/kg)													
TPH	7/7	31.8-3440	-	805.685714	13TB4A-0002	-	-	-	500	2500	2500	Y	1, 3

00001

**COC SCREENING FOR LOWER SUBBASE
ZONE 4-SHALLOW SOIL (0-5 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2**

Notes:

- Not available or Not applicable.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Residential Soil Ingestion is used for soil and sediment. Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with dilution and attenuation factor (DAF) of 1.0 are used.
- (3) CTDEP, January 1996. State Pollutant Mobility criteria for metals are not included since a direct comparison of the aqueous SPLP criteria (in ug/L) and the soil analytical results (in mg/kg) cannot be made. TCLP and SPLP results for soil samples are addressed in The Nature and Extent Section of the RI Report.
- (4) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (5) No value promulgated by CTDEP, calculated or surrogate value is used. Ceiling limit is used if calculated or surrogate value exceeds the ceiling limit.
- (6) Hexavalent chromium.
- (7) Value is based on OSWER soil screening level for residential land use (USEPA, July 14, 1994).

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Maximum exceeds migration to groundwater criteria only; chemical will not be quantitatively evaluated in the risk assessment.

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COC SCREENING FOR LOWER SUBBASE
 ZONE 4-ALL SOIL (0-10 FEET)
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COPC? (4)	Rationale
Volatile Organic Compounds (mg/kg)													
BENZENE	1/5	0.0014	0.00115-0.013	0.001935	QW-3 (94)	22	0.8	0.002	21	200	0.2	N	2
ETHYLBENZENE	2/5	0.0007-0.018	0.00117-0.013	0.00528	QW-2 (94)	780	400	0.7	500	1000	10.1	N	2
TOLUENE	2/5	0.003-0.0032	0.00115-0.00123	0.001595	QW-3 (94)	1600	650	0.6	500	1000	67	N	2
XYLENES, TOTAL	3/5	0.000616-0.0203	0.00117-0.013	0.0066802	QW-2 (94)	16000	410(8)	9(8)	500	1000	19.5	N	2
Semivolatile Organic Compounds (mg/kg)													
2-METHYLNAPHTHALENE	3/11	0.023-2	0.36-0.43	0.325	LS4SB0010101	310	-	-	1000(5)	2500(5)	56	N	2
ACENAPHTHENE	1/11	0.9	0.36-0.43	0.253	LS4SB0010101	470	-	29	1000(5)	2500(5)	84	N	2
ACENAPHTHYLENE	3/11	0.019-1.2	0.36-0.43	0.256	LS4SB0010101	-	-	-	1000	2500	84	N	2
ANTHRACENE	5/11	0.028-2.7	0.36-0.43	0.367	LS4SB0010101	2300	-	590	1000	2500	400	N	2
BENZO(A)ANTHRACENE	9/11	0.044-5.3	0.36-0.43	0.660	LS4SB0010101	0.88	-	0.08	1	7.8	1	Y	3
BENZO(A)PYRENE	10/11	0.041-4.3	0.36	0.554	LS4SB0010101	0.88	-	0.4	1	1	1	Y	3
BENZO(B)FLUORANTHENE	10/11	0.022-4.3	0.36	0.547	LS4SB0010101	0.88	-	0.2	1	7.8	1	Y	3
BENZO(G,H,I)PERYLENE	10/11	0.054-3.1	0.36	0.429	LS4SB0010101	-	-	-	1000(5)	2500(5)	40(5)	N	2
BENZO(K)FLUORANTHENE	8/11	0.056-1.4	0.36-0.43	0.308	LS4SB0010101	8.8	-	2	8.4	78	1	Y	3, 5
BUTYLBENZYL PHTHALATE	1/11	0.023	0.36-0.43	0.173	LS4SB0020201	1600	930	810	1000	2500	200	N	2
CARBAZOLE	2/11	0.025-1.1	0.36-0.43	0.257	LS4SB0010101	32	-	0.03	31(5)	290(5)	0.36(5)	Y	3, 5
CHRYSENE	9/11	0.055-5.5	0.36-0.43	0.693	LS4SB0010101	88	-	8	84(5)	780(5)	0.96(5)	Y	3, 5
DIBENZO(A,H)ANTHRACENE	5/11	0.034-1.5	0.36-0.42	0.258	LS4SB0010101	0.888	-	0.08	0.084(5)	0.78(5)	0.000096(5)	Y	3
DIBENZOFURAN	1/11	1.3	0.36-0.43	0.290	LS4SB0010101	310	-	-	270(5)	2500(5)	5.6(5)	N	2
FLUORANTHENE	9/11	0.045-11	0.36-0.43	1.256	LS4SB0010101	310	-	210	1000	2500	56	N	2
FLUORENE	2/11	0.028-2.9	0.36-0.43	0.419	LS4SB0010101	310	-	28	1000	2500	56	N	2
INDENO(1,2,3-CD)PYRENE	10/11	0.046-3.4	0.36	0.447	LS4SB0010101	0.88	-	0.7	0.84(5)	7.8(5)	0.0096(5)	Y	3
NAPHTHALENE	3/11	0.034-1.7	0.36-0.43	0.297	LS4SB0010101	310	-	4	1000	2500	56	N	2
PHENANTHRENE	9/11	0.024-14	0.36-0.43	1.385	LS4SB0010101	-	-	-	1000	2500	40	N	2
PHENOL	1/9	0.024	0.36-0.43	0.166	LS4SB0050101	4700	-	5	1000	2500	800	N	2
PYRENE	10/11	0.019-15	0.43	1.610	LS4SB0010101	230	-	210	1000	2500	40	N	2
Pesticides (mg/kg)													
ENDRIN	1/1	0.0067	-	0.007	QW-1 (94)	2.3	-	0.05	20	610	-	N	2
Metals (mg/kg)													
ALUMINUM	7/7	2670-5520	-	4208.571429	LS4SB0030201	7800	-	-	-	-	-	N	2
ANTIMONY	3/7	0.49-3.3	0.44-0.56	0.865714	LS4SB0010101	3.1	-	0.3	27	8200	-	Y	3
ARSENIC	7/7	1.2-4.5	-	2.942857	LS4SB0030101	0.43	750	1	10	10	-	Y	3
BARIUM	5/7	17.8-46.8	34.5-38.6	23.907143	LS4SB0010101	550	690000	82	4700	140000	-	N	2
BERYLLIUM	3/7	0.15-0.28	0.11-0.19	0.13	LS4SB0010101	0.15	1300	3	2	2	-	Y	3
CADMIUM	3/7	0.07-0.53	0.04-0.15	0.125714	LS4SB0010101	3.9	1800	0.4	34	1000	-	Y	3, 5
CHROMIUM (total)	7/7	5.6-11.4	-	8.457143	LS4SB0030101	39(6)	270	2	100(6)	100(6)	-	Y	3, 5
COBALT	7/7	1.8-3.3	-	2.542857	LS4SB0030201	470	-	-	1000(5)	2500(5)	-	N	2
COPPER	7/7	4.5-147	-	30.4	LS4SB0010101	310	-	-	-	-	-	N	2
IRON	7/7	4720-7860	-	6174.285714	LS4SB0010101	2300	-	-	-	-	-	Y	3, 4
LEAD	12/14	57.1-10600	2.2-2.7	1511.675	13WE4A-0002	400(7)	-	-	500	1000	-	Y	3
MANGANESE	7/7	75.1-130	-	103.571429	LS4SB0010101	180	-	-	1600(5)	47000(5)	-	N	2
MERCURY	2/7	0.31-0.5	0.01-0.13	0.128571	LS4SB0030101	2.3	-	-	20	610	-	N	2
NICKEL	7/7	4.6-8.7	-	6.371429	LS4SB0010101	160	13000	7	1400	7500	-	Y	3, 5
VANADIUM	7/7	7.3-14.1	-	10.5	LS4SB0010101	55	-	300	470	14000	-	N	2
ZINC	7/7	12.3-128	-	49.557143	LS4SB0010101	2300	-	620	20000	610000	-	N	2
Miscellaneous (mg/kg)													
TPH	17/19	15.3-11800	10.4-13.1	1495.044737	13TB2A-0608	-	-	-	500	2500	2500	Y	1, 3

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COC SCREENING FOR LOWER SUBBASE
ZONE 4-ALL SOIL (0-10 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Notes:

- Not available or Not applicable.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Residential Soil Ingestion is used for soil and sediment. Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of $1E-6$.
- (2) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with dilution and attenuation factor (DAF) of 1.0 are used.
- (3) CTDEP, January 1996. State Pollutant Mobility criteria for metals are not included since a direct comparison of the aqueous SPLP criteria (in ug/L) and the soil analytical results (in mg/kg) cannot be made. TCLP and SPLP results for soil samples are addressed in The Nature and Extent Section of the RI Report.
- (4) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (5) No value promulgated by CTDEP, calculated or surrogate value is used. Ceiling limit is used if calculated or surrogate value exceeds the ceiling limit.
- (6) Hexavalent chromium.
- (7) Value is based on OSWER soil screening level for residential land use (USEPA, July 14, 1994).
- (8) O-xylene.

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Maximum exceeds migration to groundwater criteria only; chemical will not be quantitatively evaluated in the risk assessment.

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COC SCREENING FOR LOWER SUBBASE
 ZONE 4 - GROUNDWATER
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2

Parameter	Frequency	Range of Detection	Range of Nondetects	Location of Maximum	COC Screening Level (1)	EPA MCL (2)	State MCL (3)	State RSR Groundwater (4)	State AWQC		Selected as COC (6)	Rationale
									Saltwater (5)	Human Health (5)		
Volatiles (ug/L)												
1,1,1-Trichloroethane	1/26	1	5 - 10	NESO11	54	200	200	200	-	-	N	2
1,1-Dichloroethane	7/26	1 - 15	5 - 10	13MW13	81	-	-	70	-	-	N	2
1,1-Dichloroethene	4/26	4 - 57	5 - 10	13MW13	0.044	7	7	7	-	0.057	Y	3
Ethylbenzene	2/26	2 - 8	5 - 10	WE1	130	700	700	700	-	3100	N	2
Methylene chloride	1/26	9	5 - 11	WE5	4.1	5	5	5	-	4.7	Y	3
Toluene	1/26	36	5 - 10	NESO10	75	1000	1000	1000	-	6800	N	2
Vinyl chloride	2/26	5 - 12	10	13MW13	0.019	2	2	2	-	2	Y	3
Xylenes, total	3/26	5 - 27	5 - 10	WE1	1200	10000	10000	530	-	-	N	2
Semivolatiles (ug/L)												
2,4-Dimethylphenol	1/26	1	10 - 12	13MW16	73	-	-	140 (7)	-	-	N	2
Acenaphthene	4/26	0.8 - 2	10 - 12	13MW16	220	-	-	420 (7)	-	1200	N	2
Benzo(a)anthracene	1/26	1	10 - 12	NESO11	0.092	-	-	0.06	-	0.0028	Y	3
Benzo(a)pyrene	1/26	0.8	10 - 12	NESO11	0.0092	2	0.2	0.2	-	0.0028	Y	3
Benzo(b)fluoranthene	1/26	0.6	10 - 12	NESO11	0.092	-	-	0.08	-	0.0028	Y	3
Benzo(g,h,i)perylene	1/26	1	10 - 12	NESO11	-	-	-	100 (7)	-	0.0028	Y	3,6
Benzo(k)fluoranthene	1/26	1	10 - 12	NESO11	0.92	-	-	0.5	-	0.0028	Y	3
Bis(2-Ethylhexyl)phthalate	2/26	1 - 10	10 - 15	NESO11	4.8	6	6	2	-	1.8	Y	3
Carbazole	1/26	0.7	10 - 12	13MW16	3.4	-	-	1.8 (7)	-	-	N	2
Chrysene	1/26	0.9	10 - 12	NESO11	9.2	-	-	4.8 (7)	-	0.0028	Y	3,6
Di-N-butyl phthalate	1/26	0.6	10 - 12	13MW16	370	-	-	700	-	2700	N	2
Dibenzofuran	1/26	1	10 - 12	13MW16	15	-	-	28 (7)	-	-	N	2
Fluoranthene	1/26	2	10 - 12	NESO11	150	-	-	280	-	300	N	2
Fluorene	1/26	0.8	10 - 12	13MW16	150	-	-	280	-	1300	N	2
Indeno(1,2,3-Cd)pyrene	1/26	0.7	10 - 12	NESO11	0.092	-	-	0.045 (7)	-	0.0028	Y	3
Naphthalene	3/26	0.6 - 4	10 - 12	13MW16	150	-	-	280	-	-	N	2
Phenanthrene	2/26	0.6 - 1	10 - 12	NESO11	-	-	-	200	-	0.0028	Y	3,6
Pyrene	4/26	1 - 2	10 - 12	NESO11	110	-	-	200	-	960	N	2
Metals (ug/L)												
Aluminum	5/36	18.2 - 40800	10 - 178	NESO11	3700	50 TO 200 (8)	-	-	-	-	Y	3,4
Aluminum, filtered	1/26	11	10 - 85.7	13MW16	3700	50 TO 200 (8)	-	-	-	-	N	2
Antimony	3/33	5.6 - 9	2.5 - 57.9	MW2-4RI	1.5	6	6	6	-	14	Y	3
Antimony, filtered	5/26	4.6 - 14.8	2.5 - 22.3	13MW14	1.5	6	6	6	-	14	Y	3,5
Arsenic	18/36	1.3 - 29.6	2 - 20	WE5	0.045	50	50	50	36	0.018	Y	3
Arsenic, filtered	8/26	2.3 - 14.7	1 - 20	13MW13	0.045	50	50	50	36	0.018	Y	3,5
Barium	31/36	3.6 - 283	10.9 - 37.6	NESO11	260	2000	2000	1000	-	-	Y	3
Barium, filtered	23/26	6 - 452	9.6 - 39.1	NESO10	260	2000	2000	1000	-	-	Y	3,5
Beryllium	2/36	1.1 - 2.6	0.11 - 1	NESO11	0.016	4	4	4	-	0.0077	Y	3
Boron	16/16	80.8 - 2070	-	13MW15	330	-	-	630 (7)	-	-	Y	3
Boron, filtered	16/16	78.8 - 2370	-	13MW15	330	-	-	630 (7)	-	-	Y	3,5
Cadmium	4/35	1.5 - 25.5	0.22 - 3	NESO10	1.8	5	5	5	9.3	16	Y	3
Chromium (total)	3/36	1.4 - 116	0.68 - 5	NESO11	18 (10)	100	100	50	50 (10)	170 (10)	Y	3
Cobalt	2/36	1.4 - 25.6	0.8 - 5	NESO11	220	-	-	420 (7)	-	-	N	2
Cobalt, filtered	1/26	1.1	0.8 - 5	13MW15	220	-	-	420 (7)	-	-	N	2
Copper	10/35	1.7 - 649	1 - 17.2	NESO11	150	1300 (9)	-	1300	2.4	1300	Y	3,4
Copper, filtered	8/25	1.6 - 20.4	1 - 7.5	13MW16	150	1300 (9)	-	1300	2.4	1300	Y	3,6
Iron	30/36	95.2 - 36700	13 - 150	NESO11	1100	300 (8)	-	-	-	-	Y	3,4
Iron, filtered	19/26	56.2 - 9280	13 - 97	13MW13	1100	300 (8)	-	-	-	-	Y	3,4
Lead	18/32	1.3 - 2760	1.3 - 20	NESO11	-	15 (9)	-	15	8.1	50	Y	3

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COC SCREENING FOR LOWER SUBBASE
 ZONE 4 - GROUNDWATER
 NSB-NLON, GROTON, CONNECTICUT
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Parameter	Frequency	Range of Detection	Range of Nondetects	Location of Maximum	COC Screening Level (1)	EPA MCL (2)	State MCL (3)	State RSR Groundwater (4)	State AWQC		Selected as COC (6)	Rationale
									Saltwater (5)	Human Health (5)		
Metals (ug/L)												
Lead, filtered	6/25	1.4 - 14.1	1 - 20	NESO11	-	15 (9)	-	15	8.1	50	Y	3, 6
Manganese	33/36	3.4 - 1980	11.9 - 99.9	NESO11	84	50 (8)	5000 (11)	160 (7)	-	-	Y	3
Manganese, filtered	23/26	6.1 - 611	10.9 - 89.4	WE5	84	50 (8)	5000 (11)	160 (7)	-	-	Y	3, 5
Mercury	1/36	0.47	0.01 - 0.2	NESO11	1.1	2	2	2	0.025	0.14	Y	3, 6
Nickel	16/36	0.83 - 80	0.75 - 12	NESO11	73	100	100	100	8.2	610	Y	3
Nickel, filtered	1/26	1.2	2.6 - 11	NESO10	73	100	100	100	8.2	610	N	2
Selenium	1/33	7.7	1 - 30	13MW14	18	50	50	50	71	100	N	2
Selenium, filtered	1/25	2.1	1.9 - 30	NESO10	18	50	50	50	71	100	N	2
Silver	3/36	1.5 - 4.1	1 - 7	13MW15	18	100 (8)	50	36	-	105	N	2
Silver, filtered	1/26	3.4	1.1 - 5.3	QW-4	18	100 (8)	50	36	-	105	N	2
Sodium	36/36	40800 - 7120000	-	13MW15	-	-	28000 (12)	-	-	-	Y	1, 3
Sodium, filtered	24/26	56200 - 7260000	142	13MW15	-	-	28000 (12)	-	-	-	Y	1, 3
Thallium	4/27	3.6 - 11.5	1 - 10	13MW15	0.26 (13)	2	2	5	-	1.7	Y	3
Thallium, filtered	1/25	6.8	1 - 20	WE5	0.26 (13)	2	2	5	-	1.7	Y	3, 5
Vanadium	4/36	0.63 - 105	0.55 - 20	NESO11	26	-	-	50	-	-	Y	3
Vanadium, filtered	1/26	5.7	0.55 - 5	13MW16	26	-	-	50	-	-	N	2
Zinc	20/36	4.9 - 924	1.2 - 14.5	NESO11	1100	5000	-	5000	81	-	Y	3, 6
Zinc, filtered	14/26	8.5 - 126	1.2 - 17.1	NESO11	1100	5000	-	5000	81	-	Y	3, 6
Miscellaneous (ug/L)												
TPH	4/36	500 - 5400	500 - 3000	13MW16	-	-	-	500	-	-	Y	1, 3

Notes:

- Not available or Not applicable.
- Bolded cell indicates that the maximum detected site concentration exceeds this criteria.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Tap Water Ingestion Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) Maximum Contaminant Level. (USEPA, October 1996).
- (3) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter II Environmental Health.
- (4) CDTEP, January 1996.
- (5) Connecticut Water Quality Standards, 1992. Chronic values for saltwater bodies and protection of human health values for water and organisms are presented.
- (6) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (7) No value promulgated by CTDEP, calculated value used.
- (8) Secondary MCL (SMCL) based on aesthetic water qualities.
- (9) Action Level.
- (10) Hexavalent chromium.
- (11) Current Connecticut Department of Public Health and Addiction Services Action Level.
- (12) Notification Level.
- (13) Thallic oxide.

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Unfiltered data, rather than filtered data, will be in quantitative risk assessment.
- (6) Maximum is greater than State AWQC only; chemical will not be quantitatively evaluated in the risk assessment.

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**95% UPPER CONFIDENCE LIMITS
ZONE 4 - SHALLOW SOILS (0-5 FT)
NSB - NLON, GROTON, CONNECTICUT**

PARAMETER	UNITS	DETECTS	COUNT	AVERAGE	W NORMAL	W LOGNORMAL	W TEST	DISTRIBUTION	UCL - NORMAL	UCL - LOGNORMAL	DETECTS - MAX	95% UCL ⁽¹⁾
ALUMINUM	mg/kg	3	3	4480	0.9722	0.949	0.767	NORMAL	6318.05	8994.51	5450	5450
ANTIMONY	mg/kg	2	3	1.3383	0.8141	0.9444	0.767	LOGNORMAL	4.21	84907175.50	3.3	3.3
ARSENIC	mg/kg	3	3	3.5333	0.8352	0.8096	0.767	NORMAL	5.93	30.53	4.5	4.5
BARIUM	mg/kg	2	3	27.85	0.8067	0.8406	0.767	LOGNORMAL	55.58	442.77	46.8	46.8
BERYLLIUM	mg/kg	1	3	0.1467	0.8523	0.9286	0.767	LOGNORMAL	0.34	31.79	0.28	0.28
CADMIUM	mg/kg	2	3	0.2167	0.7812	0.8544	0.767	LOGNORMAL	0.67	969160.85	0.53	0.53
CALCIUM	mg/kg	3	3	1077.3333	0.8198	0.8024	0.767	NORMAL	1671.28	4040.63	1310	1310
CHROMIUM	mg/kg	3	3	9.2667	0.8689	0.842	0.767	NORMAL	14.24	31.81	11.4	11.4
COBALT	mg/kg	3	3	2.6	0.8421	0.8305	0.767	NORMAL	3.33	3.89	2.9	2.9
COPPER	mg/kg	3	3	56.1	0.7859	0.9034	0.767	LOGNORMAL	188.93	881097946838.00	147	147
IRON	mg/kg	3	3	6650	0.9761	0.9581	0.767	NORMAL	8919.41	11106.62	7860	7860
LEAD	mg/kg	8	8	2173.5125	0.6226	0.9613	0.818	LOGNORMAL	4522.40	77958.81	10600	10600
MAGNESIUM	mg/kg	3	3	1520	0.9337	0.9054	0.767	NORMAL	2200.43	3488.58	1850	1850
MANGANESE	mg/kg	3	3	109.0333	0.8566	0.8355	0.767	NORMAL	159.03	265.32	130	130
MERCURY	mg/kg	2	3	0.2717	0.9823	0.8269	0.767	NORMAL	0.69	1.26E+26	0.5	0.5
NICKEL	mg/kg	3	3	6.9333	0.9458	0.9131	0.767	NORMAL	10.49	20.36	8.7	8.7
POTASSIUM	mg/kg	3	3	835	0.9777	0.9499	0.767	NORMAL	1255.28	2279.46	1060	1060
SODIUM	mg/kg	3	3	107.8	0.989	0.9995	0.767	LOGNORMAL	160.86	253.84	141	141
VANADIUM	mg/kg	3	3	11.8333	0.9283	0.9032	0.767	NORMAL	16.56	23.42	14.1	14.1
ZINC	mg/kg	3	3	72.3667	0.9544	0.9997	0.767	LOGNORMAL	157.61	12238.66	128	128
2-METHYLNAPHTHALENE	µg/kg	2	5	512.8	0.6197	0.8792	0.762	LOGNORMAL	1308.09	223854.61	2000	2000
ACENAPHTHENE	µg/kg	1	5	324	0.5521	0.5521	0.762	NOT DEFINED	631.01	1236.71	900	900
ACENAPHTHYLENE	µg/kg	3	5	330.2	0.6814	0.9657	0.762	LOGNORMAL	798.56	101344.78	1200	1200
ANTHRACENE	µg/kg	2	5	661.2	0.5887	0.7841	0.762	LOGNORMAL	1748.90	68023.76	2700	2700
BENZO(A)ANTHRACENE	µg/kg	5	5	1224.2	0.628	0.8718	0.762	LOGNORMAL	3408.71	32397363.03	5300	5300
BENZO(A)PYRENE	µg/kg	5	5	1032.4	0.6463	0.7844	0.762	LOGNORMAL	2792.70	10712301.74	4300	4300
BENZO(B)FLUORANTHENE	µg/kg	5	5	1035.8	0.6485	0.8236	0.762	LOGNORMAL	2794.00	7929025.95	4300	4300
BENZO(G,H,I)PERYLENE	µg/kg	5	5	790.4	0.6784	0.8398	0.762	LOGNORMAL	2044.78	2042812.76	3100	3100
BENZO(K)FLUORANTHENE	µg/kg	5	5	435.8	0.7621	0.8242	0.762	LOGNORMAL	991.83	97726.60	1400	1400
CARBAZOLE	µg/kg	2	5	333	0.6775	0.8824	0.762	LOGNORMAL	746.79	30899.15	1100	1100
CHRYSENE	µg/kg	5	5	1281.6	0.6278	0.8684	0.762	LOGNORMAL	3542.68	9345030.50	5500	5500
DIBENZO(A,H)ANTHRACENE	µg/kg	2	5	414.8	0.6379	0.8758	0.762	LOGNORMAL	996.34	36566.22	1500	1500
DIBENZOFURAN	µg/kg	1	5	404	0.5521	0.5521	0.762	NOT DEFINED	881.57	2779.51	1300	1300
FLUORANTHENE	µg/kg	5	5	2425	0.6004	0.9291	0.762	LOGNORMAL	7003.74	196558901.94	11000	11000
FLUORENE	µg/kg	1	5	724	0.5521	0.5521	0.762	NOT DEFINED	1883.81	27782.75	2900	2900
INDENO(1,2,3-CD)PYRENE	µg/kg	5	5	827	0.6517	0.8291	0.762	LOGNORMAL	2213.98	3869255.73	3400	3400
NAPHTHALENE	µg/kg	2	5	454.8	0.6274	0.8719	0.762	LOGNORMAL	1121.22	54062.79	1700	1700
PHENANTHRENE	µg/kg	5	5	2869.8	0.5617	0.8132	0.762	LOGNORMAL	8802.60	14905910029.03	14000	14000
PHENOL	µg/kg	1	5	148.8	0.5521	0.5521	0.762	NOT DEFINED	215.32	1360.50	24	24
PYRENE	µg/kg	5	5	3226.2	0.5873	0.8465	0.762	LOGNORMAL	9508.90	641374060.75	15000	15000
TPH	mg/kg	7	7	805.6857	0.6689	0.9901	0.803	LOGNORMAL	1685.40	22204.54	3440	3440

(1) The UCL Normal and UCL Lognormal values are the 95% UCL for normal and lognormal distributions, respectively; if these values exceeded the maximum concentration, then the maximum concentration was used as the 95% UCL. For undefined distributions, the maximum concentration was used as the 95% UCL.

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**95% UPPER CONFIDENCE LIMITS
ZONE 4 - SOILS (0-10 FT)
NSB - NLON, GROTON, CONNECTICUT**

PARAMETER	UNITS	DETECTS	COUNT	AVERAGE	W NORMAL	W LOGNORMAL	W TEST	DISTRIBUTION	UCL - NORMAL	UCL - LOGNORMAL	DETECTS - MAX	95% UCL ⁽¹⁾
XYLENES, TOTAL	µg/kg	3	5	6.6802	0.8077	0.8755	0.762	LOGNORMAL	14.3834	3366.6451	20.3	20.3
ALUMINUM	mg/kg	7	7	4208.5714	0.9476	0.9483	0.803	LOGNORMAL	4996.1051	5308.6968	5520	5308.6968
ANTIMONY	mg/kg	3	7	0.8657	0.6654	0.8095	0.803	LOGNORMAL	1.7036	4.47	3.3	3.3
ARSENIC	mg/kg	7	7	2.9429	0.9349	0.9258	0.803	NORMAL	3.8707	4.9039	4.5	3.8707
BARIUM	mg/kg	5	7	23.9071	0.6696	0.7647	0.803	NOT DEFINED	31.5486	32.5591	46.8	46.8
BERYLLIUM	mg/kg	3	7	0.13	0.862	0.8948	0.803	LOGNORMAL	0.1943	0.2873	0.28	0.28
CADMIUM	mg/kg	3	7	0.1257	0.6135	0.9214	0.803	LOGNORMAL	0.2586	0.7133	0.53	0.53
CALCIUM	mg/kg	7	7	1089.1429	0.8508	0.8412	0.803	NORMAL	1334.4067	1472.0026	1460	1334.4067
CHROMIUM	mg/kg	7	7	8.4571	0.9041	0.8904	0.803	NORMAL	10.1736	10.9373	11.4	10.1736
COBALT	mg/kg	7	7	2.5429	0.9155	0.9072	0.803	NORMAL	2.9425	3.0637	3.3	2.9425
COPPER	mg/kg	7	7	30.4	0.5544	0.8593	0.803	LOGNORMAL	68.3917	210.8314	147	147
IRON	mg/kg	7	7	6174.2857	0.9171	0.9127	0.803	NORMAL	7012.2986	7201.2321	7860	7012.2986
LEAD	mg/kg	12	14	1511.675	0.5501	0.8743	0.874	LOGNORMAL	2811.341	96888.8536	10600	10600
MAGNESIUM	mg/kg	7	7	1580	0.8394	0.8185	0.803	NORMAL	1828.6086	1929.8704	1890	1828.6086
MANGANESE	mg/kg	7	7	103.5714	0.8945	0.8777	0.803	NORMAL	119.7555	125.0101	130	119.7555
MERCURY	mg/kg	2	7	0.1286	0.7138	0.8108	0.803	LOGNORMAL	0.2738	63.8713	0.5	0.5
NICKEL	mg/kg	7	7	6.3714	0.8889	0.8768	0.803	NORMAL	7.5942	8.0292	8.7	7.5942
POTASSIUM	mg/kg	7	7	959	0.931	0.91	0.803	NORMAL	1177.422	1304.1072	1330	1177.422
SODIUM	mg/kg	7	7	158.9143	0.6779	0.8519	0.803	LOGNORMAL	240.1728	270.7777	403	270.7777
VANADIUM	mg/kg	7	7	10.5	0.915	0.9246	0.803	LOGNORMAL	12.3709	12.9352	14.1	12.9352
ZINC	mg/kg	7	7	49.5571	0.8679	0.9647	0.803	LOGNORMAL	78.8614	157.2919	128	128
BENZENE	µg/kg	1	5	1.935	0.6441	0.7605	0.762	NOT DEFINED	4.391	28.1509	1.4	1.4
ETHYLBENZENE	µg/kg	2	5	5.28	0.7403	0.7927	0.762	LOGNORMAL	12.4795	2980.7475	18	18
TOLUENE	µg/kg	2	5	1.595	0.7154	0.7152	0.762	NOT DEFINED	2.9067	13.4164	3.2	3.2
2-METHYLNAPHTHALENE	µg/kg	3	11	324.7273	0.4446	0.7663	0.85	NOT DEFINED	630.5551	1150.9744	2000	2000
ACENAPHTHENE	µg/kg	1	11	253.1818	0.3901	0.4484	0.85	NOT DEFINED	370.6146	336.134	900	900
ACENAPHTHYLENE	µg/kg	3	11	256	0.5077	0.7873	0.85	NOT DEFINED	430.2275	668.4189	1200	1200
ANTHRACENE	µg/kg	5	11	367.4545	0.419	0.8264	0.85	NOT DEFINED	791.6002	1007.1308	2700	2700
BENZO(A)ANTHRACENE	µg/kg	9	11	659.9091	0.4355	0.8786	0.85	LOGNORMAL	1506.0515	2697.6385	5300	2697.6385
BENZO(A)PYRENE	µg/kg	10	11	554.1818	0.4576	0.8423	0.85	NOT DEFINED	1241.3353	2272.0962	4300	4300
BENZO(B)FLUORANTHENE	µg/kg	10	11	546.6364	0.4497	0.905	0.85	LOGNORMAL	1234.0356	2447.643	4300	2447.643
BENZO(G,H,I)PERYLENE	µg/kg	10	11	429.1818	0.4783	0.8051	0.85	NOT DEFINED	922.7496	1451.8973	3100	3100
BENZO(K)FLUORANTHENE	µg/kg	8	11	307.8182	0.6611	0.9395	0.85	LOGNORMAL	523.8644	776.6584	1400	776.6584
BUTYLBENZYL PHTHALATE	µg/kg	1	11	173.4545	0.5574	0.4335	0.85	NOT DEFINED	201.6864	307.2461	23	23
CARBAZOLE	µg/kg	2	11	257.2727	0.4813	0.6865	0.85	NOT DEFINED	412.501	552.196	1100	1100
CHRYSENE	µg/kg	9	11	692.7273	0.4346	0.8577	0.85	LOGNORMAL	1569.4508	2319.44	5500	2319.44
DIBENZO(A,H)ANTHRACENE	µg/kg	5	11	258.1818	0.4803	0.8562	0.85	LOGNORMAL	485.891	611.4723	1500	611.4723
DIBENZOFURAN	µg/kg	1	11	289.5455	0.3739	0.4293	0.85	NOT DEFINED	472.7867	408.2715	1300	1300
FLUORANTHENE	µg/kg	9	11	1256.3636	0.4035	0.8683	0.85	LOGNORMAL	3026.2738	5139.6194	11000	5139.6194
FLUORENE	µg/kg	2	11	419.3636	0.3897	0.6532	0.85	NOT DEFINED	869.6668	992.6241	2900	2900
INDENO(1,2,3-CD)PYRENE	µg/kg	10	11	447	0.4559	0.8045	0.85	NOT DEFINED	988.6589	1518.9367	3400	3400
NAPHTHALENE	µg/kg	3	11	297.0909	0.4504	0.7611	0.85	NOT DEFINED	553.4867	738.4882	1700	1700
PHENANTHRENE	µg/kg	9	11	1385	0.3605	0.7661	0.85	NOT DEFINED	3671.1699	6504.6305	14000	14000
PHENOL	µg/kg	1	9	166	0.511	0.441	0.829	NOT DEFINED	199.5832	346.1712	24	24
PYRENE	µg/kg	10	11	1610.4545	0.3936	0.8901	0.85	LOGNORMAL	4041.6544	13395.6324	15000	13395.6324
ENDRIN	µg/kg	1	1	6.7	*****	*****	0	NOT DEFINED	*****	0	6.7	6.7
TPH	mg/kg	17	19	1495.0447	0.5724	0.9482	0.901	LOGNORMAL	2588.3691	53750.9542	11800	11800

(1) The UCL Normal and UCL Lognormal values are the 95% UCL for normal and lognormal distributions, respectively; if these values exceeded the maximum concentration, then the maximum concentration was used as the 95% UCL. For undefined distributions, the maximum concentration was used as the 95% UCL. Asterisks indicate insufficient number of samples to calculate statistics.

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**SUMMARY OF MAXIMUM AND AVERAGE CONCENTRATIONS
 ZONE 4 - GROUNDWATER
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2**

Parameter	Maximum Detected Concentration	Average Concentration
Volatile Organic Compounds (ug/L)		
1,1,1-TRICHLOROETHANE	1.00	4.00
1,1-DICHLOROETHANE	8.33	4.31
1,1-DICHLOROETHENE	27.30	6.81
ETHYLBENZENE	8.00	4.44
METHYLENE CHLORIDE	5.50	4.50
TOLUENE	15.30	5.59
VINYL CHLORIDE	7.33	5.26
XYLENES, TOTAL	11.50	5.55
Semivolatile Organic Compounds (ug/L)		
2,4-DIMETHYLPHENOL	1.00	5.23
ACENAPHTHENE	1.27	4.83
BENZO(A)ANTHRACENE	1.00	5.23
BENZO(A)PYRENE	0.80	5.21
BENZO(B)FLUORANTHENE	0.60	5.19
BENZO(G,H,I)PERYLENE	1.00	5.23
BENZO(K)FLUORANTHENE	1.00	5.23
BIS(2-ETHYLHEXYL)PHTHALATE	10.00	5.82
CARBAZOLE	0.70	5.20
CHRYSENE	0.90	5.22
DI-N-BUTYL PHTHALATE	0.60	5.19
DIBENZOFURAN	1.00	5.23
FLUORANTHENE	2.00	5.32
FLUORENE	0.80	5.21
INDENO(1,2,3-CD)PYRENE	0.70	5.20
NAPHTHALENE	2.30	4.92
PHENANTHRENE	1.00	4.78
PYRENE	2.00	4.91
Metals (ug/L)		
ALUMINUM	10,207.25	879.73
ALUMINUM, FILTERED	8.35	8.53
ANTIMONY	13.46	7.63
ANTIMONY, FILTERED	11.40	6.00
ARSENIC	15.53	5.40
ARSENIC, FILTERED	7.17	4.03
BARIUM	111.00	50.78
BARIUM, FILTERED	344.00	154.97
BERYLLIUM	0.91	0.39
BORON	1,980.00	786.88
BORON, FILTERED	2,135.00	830.44
CADMIUM	7.08	1.58
CALCIUM	208,000.00	89,425.00
CALCIUM, FILTERED	223,000.00	105,965.15

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**SUMMARY OF MAXIMUM AND AVERAGE CONCENTRATIONS
 ZONE 4 - GROUNDWATER
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 2 OF 2**

Parameter	Maximum Detected Concentration	Average Concentration
Metals (ug/L)		
CHROMIUM	30.21	4.05
COBALT	7.75	2.12
COBALT, FILTERED	1.53	1.37
COPPER	166.68	16.56
COPPER, FILTERED	9.90	3.25
IRON	17,166.67	4,154.14
IRON, FILTERED	6,144.67	1,958.27
LEAD	700.95	67.59
LEAD, FILTERED	8.83	3.26
MAGNESIUM	700,375.00	205,656.74
MAGNESIUM, FILTERED	712,666.67	236,975.45
MANGANESE	651.33	188.24
MANGANESE, FILTERED	573.50	133.56
MERCURY	0.17	0.08
NICKEL	26.85	8.81
NICKEL, FILTERED	3.90	4.30
POTASSIUM	243,125.00	75,197.29
POTASSIUM, FILTERED	268,666.67	89,314.39
SELENIUM	7.88	1.97
SELENIUM, FILTERED	1.52	2.06
SILVER	3.00	1.85
SILVER, FILTERED	3.40	1.26
SODIUM	5,960,000.00	1,751,562.50
SODIUM, FILTERED	5,810,000.00	1,617,046.73
THALLIUM	5.68	3.41
THALLIUM, FILTERED	3.65	3.55
VANADIUM	29.50	5.88
VANADIUM, FILTERED	3.22	1.54
ZINC	250.13	45.92
ZINC, FILTERED	118.00	48.46
Miscellaneous (ug/L)		
TPH	1,862.50	710.76

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 4
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

**HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.**

EXPOSURE SCENARIO: Construction Worker (All Soil), RME

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	480	IR:	0
EF:	120	EF:	120
Fi:	1	Fi:	1
ED:	1	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	365	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:	YOUTH:	ADULT/YOUTH (CANCER RISK):
CF: 2.25E-06 (AVG ANNUAL DOSE)	CF: 0.00E+00 (AVG ANNUAL DOSE)	CF: 3.22E-08

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RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 4
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Construction Worker (All Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
S _{Ac} = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
S _{Aa} = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	1
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	120
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	1
BW _c = BODY WEIGHT CHILD (KG):	1
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	2.55E-07
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	1.78E-05			

00017

00020

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER

SITE NAME: ZONE 4
LOCATION: NSB-NLON, Groton, CT
DATE: 2/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker, RME

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

$$DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DA_{event} = ABSORBED DOSE PER EVENT (MG/CM²/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM²)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS: DA_{event} = K_p x C x tevent x CF
FOR ORGANICS: IF tevent < t*, DA_{event} = 2K_p x C x CF x (6T x tevent/3.141592654)^{0.5}
 IF tevent > t*, DA_{event} = K_p x C x CF x ((tevent/(1 + B)) + (2T x ((1+3B)/(1 + B))))

WHERE: K_p = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MG/L)
 tevent = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1 L/1000 CM³)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERVIDED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

EV:	1	CONVERSION	
ED:	1	FACTOR (NONCAR) =	1.78E+01
EF:	120		
A:	3800	CONVERSION	
tevent:	8	FACTOR (CARCIN) =	2.55E-01
BW:	70		
AT(NON):	365		
AT(CAR):	25550		

00021

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

ZONE 4

EXPOSURE SCENARIO: Construction Worker, RME

CHEMICAL	CONC. (MG/L)	ORGANIC OR INORGANIC?	t* (HR)	T (HR)	Kp (CM/HR)	B	DAevent
1,1-Dichloroethene	0.027	O	8.20E-01	3.40E-01	1.60E-02	1.30E-02	3.71E-06
Methylene chloride	0.0055	O	6.90E-01	2.90E-01	4.50E-03	1.80E-03	2.12E-07
Vinyl chloride	0.0073	O	5.10E-01	2.10E-01	7.30E-03	2.30E-03	4.48E-07
Benzo(a)anthracene	0.001	O	1.00E+01	2.20E+00	8.10E-01	4.60E+01	9.39E-06
Benzo(a) pyrene	0.0008	O	1.40E+01	2.90E+00	1.20E+00	1.30E+02	1.28E-05
Benzo(b)fluoranthene	0.0006	O	1.40E+01	3.00E+00	1.20E+00	1.30E+02	9.75E-06
Benzo(k)fluoranthene	0.001	O	1.43E+01	3.04E+00	3.96E+00	6.92E+02	5.40E-05
Bis(2-ethylhexyl)phthalate	0.01	O	1.00E+02	2.10E+01	3.30E-02	1.30E+01	1.18E-05
Indeno(1,2,3-cd)pyrene	0.0007	O	2.00E+01	4.20E+00	1.90E+00	3.80E+02	2.13E-05
Antimony	0.009	I			1.00E-03		7.20E-08
Arsenic	0.0155	I			1.00E-03		1.24E-07
Barium	0.111	I			1.00E-03		8.88E-07
Beryllium	0.00091	I			1.00E-03		7.28E-09
Boron	1.98	I			1.00E-03		1.58E-05
Cadmium	0.0071	I			1.00E-03		5.88E-08
Chromium	0.0302	I			2.00E-03		4.83E-07
Manganese	0.651	I			1.00E-03		5.21E-06
Nickel	0.0269	I			1.00E-04		2.15E-08
Thallium	0.0057	I			1.00E-03		4.56E-08
Vanadium	0.0295	I			1.00E-03		2.36E-07

00022

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER WATER (PAGE THREE)

ZONE 4

EXPOSURE SCENARIO: Construction Worker, RME

CALCULATE DOSES:

CHEMICAL	ANNUAL DERMAL DOSE (MG/KG/DAY)	DERMAL RID (MG/KG/DAY)	HAZARD INDEX DERMAL
1,1-Dichloroethene	6.63E-05	9.00E-03	7.36E-03
Methylene chloride	3.78E-06	6.00E-02	6.31E-05
Vinyl chloride	7.99E-06	0.00E+00	0.00E+00
Benzo(a)anthracene	1.68E-04	0.00E+00	0.00E+00
Benzo(a) pyrene	2.28E-04	0.00E+00	0.00E+00
Benzo(b)fluoranthene	1.74E-04	0.00E+00	0.00E+00
Benzo(k)fluoranthene	9.63E-04	0.00E+00	0.00E+00
Bis(2-ethylhexyl)phthalate	2.11E-04	1.10E-02	1.92E-02
Indeno(1,2,3-cd)pyrene	3.80E-04	0.00E+00	0.00E+00
Antimony	1.29E-06	4.00E-04	3.21E-03
Arsenic	2.21E-06	2.80E-04	7.90E-03
Barium	1.58E-05	3.50E-03	4.53E-03
Beryllium	1.30E-07	1.00E-04	1.30E-03
Boron	2.83E-04	4.50E-03	6.28E-02
Cadmium	1.01E-06	2.50E-05	4.05E-02
Chromium	8.62E-06	6.00E-05	1.44E-01
Manganese	9.29E-05	7.20E-04	1.29E-01
Nickel	3.84E-07	2.00E-03	1.92E-04
Thallium	8.14E-07	3.50E-06	2.33E-01
Vanadium	4.21E-06	3.50E-04	1.20E-02

TOTAL RISK

6.65E-01

00023

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)

ZONE 4

EXPOSURE SCENARIO: Construction Worker, RME

CALCULATE INCREMENTAL CANCER RISKS:

CHEMICAL	LIFETIME AVERAGE DERMAL DOSE (MG/KG/DAY)	CSF DERMAL (KG/DAY/MG)	CANCER RISK DERMAL CONTACT
1,1-Dichloroethene	9.47E-07	6.00E-01	5.68E-07
Methylene chloride	5.41E-08	7.50E-03	4.05E-10
Vinyl chloride	1.14E-07	1.90E+00	2.17E-07
Benzo(a)anthracene	2.39E-06	0.00E+00	0.00E+00
Benzo(a) pyrene	3.26E-06	0.00E+00	0.00E+00
Benzo(b)fluoranthene	2.49E-06	0.00E+00	0.00E+00
Benzo(k)fluoranthene	1.38E-05	0.00E+00	0.00E+00
Bis(2-ethylhexyl)phthalate	3.01E-06	2.50E-02	7.54E-08
Indeno(1,2,3-cd)pyrene	5.43E-06	0.00E+00	0.00E+00
Antimony	1.84E-08	0.00E+00	0.00E+00
Arsenic	3.16E-08	1.60E+00	5.06E-08
Barium	2.26E-07	0.00E+00	0.00E+00
Beryllium	1.86E-09	0.00E+00	0.00E+00
Boron	4.04E-06	0.00E+00	0.00E+00
Cadmium	1.45E-08	0.00E+00	0.00E+00
Chromium	1.23E-07	0.00E+00	0.00E+00
Manganese	1.33E-06	0.00E+00	0.00E+00
Nickel	5.49E-09	0.00E+00	0.00E+00
Thallium	1.16E-08	0.00E+00	0.00E+00
Vanadium	6.02E-08	0.00E+00	0.00E+00

TOTAL RISK

9.11E-07

00024

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 4
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker (All Soil), CTE

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
 C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
 IR = SOIL INGESTION RATE (MG/EVENT)
 EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
 Fi = FRACTION FROM CONTAMINATED SOURCE
 ED = EXPOSURE DURATION (YEARS)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)
 BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	240	IR:	0
EF:	80	EF:	120
Fi:	1	Fi:	1
ED:	1	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	365	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:		YOUTH:		ADULT/YOUTH (CANCER RISK):	
CF:	7.51E-07 (AVG ANNUAL DOSE)	CF:	0.00E+00 (AVG ANNUAL DOSE)	CF:	1.07E-08

00025

00028

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 4
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Construction Worker (All Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
S _{Ac} = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
S _{Aa} = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	0.2
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	80
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	1
BW _c = BODY WEIGHT CHILD (KG):	15
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (BW \text{ KG}) / (1 \text{ KG/1E6 MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	3.40E-08
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	2.38E-06			

00029

00032

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER

SITE NAME: ZONE 4
 LOCATION: NSB-NLON, Groton, CT
 DATE: 2/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker, CTE

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

$$DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DA_{event} = ABSORBED DOSE PER EVENT (MG/CM²/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM²)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS:
 FOR ORGANICS:

$$DA_{event} = K_p \times C \times t_{event} \times CF$$

IF $t_{event} < t^*$, $DA_{event} = 2K_p \times C \times CF \times (6T \times t_{event}/3.141592654)^{0.5}$
 IF $t_{event} > t^*$, $DA_{event} = K_p \times C \times CF \times ((t_{event}/(1 + B)) + (2T \times ((1+3B)/(1 + B))))$

WHERE: K_p = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MG/L)
 t_{event} = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1 L/1000 CM³)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERIVED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

EV:	1	CONVERSION	
ED:	1	FACTOR (NONCAR) =	1.19E+01
EF:	80		
A:	3800	CONVERSION	
t _{event} :	8	FACTOR (CARCIN) =	1.70E-01
BW:	70		
AT(NON):	365		
AT(CAR):	25550		

00033

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

ZONE 4

EXPOSURE SCENARIO: Construction Worker, CTE

CHEMICAL	CONC. (MG/L)	ORGANIC OR INORGANIC?	t* (HR)	T (HR)	Kp (CM/HR)	B	DAevent
1,1-Dichloroethene	0.0068	O	8.20E-01	3.40E-01	1.60E-02	1.30E-02	9.35E-07
Methylene chloride	0.0045	O	6.90E-01	2.90E-01	4.50E-03	1.80E-03	1.73E-07
Vinyl chloride	0.0053	O	5.10E-01	2.10E-01	7.30E-03	2.30E-03	3.25E-07
Benzo(a)anthracene	0.001	O	1.00E+01	2.20E+00	8.10E-01	4.60E+01	9.39E-06
Benzo(a) pyrene	0.0008	O	1.40E+01	2.90E+00	1.20E+00	1.30E+02	1.28E-05
Benzo(b)fluoranthene	0.0006	O	1.40E+01	3.00E+00	1.20E+00	1.30E+02	9.75E-06
Benzo(k)fluoranthene	0.001	O	1.43E+01	3.04E+00	3.96E+00	6.92E+02	5.40E-05
Bis(2-ethylhexyl)phthalate	0.0058	O	1.00E+02	2.10E+01	3.30E-02	1.30E+01	6.86E-06
Indeno(1,2,3-cd)pyrene	0.0007	O	2.00E+01	4.20E+00	1.90E+00	3.80E+02	2.13E-05
Antimony	0.0076	I			1.00E-03		6.08E-08
Arsenic	0.0054	I			1.00E-03		4.32E-08
Barium	0.0508	I			1.00E-03		4.06E-07
Beryllium	0.00039	I			1.00E-03		3.12E-09
Boron	0.787	I			1.00E-03		6.30E-06
Cadmium	0.0016	I			1.00E-03		1.28E-08
Chromium	0.0041	I			2.00E-03		6.56E-08
Manganese	0.188	I			1.00E-03		1.50E-06
Nickel	0.0088	I			1.00E-04		7.04E-09
Thallium	0.0034	I			1.00E-03		2.72E-08
Vanadium	0.0059	I			1.00E-03		4.72E-08

00034

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER WATER (PAGE THREE)

ZONE 4

EXPOSURE SCENARIO: Construction Worker, CTE

CALCULATE DOSES:

CHEMICAL	ANNUAL DERMAL DOSE (MG/KG/DAY)	DERMAL RID (MG/KG/DAY)	HAZARD INDEX DERMAL
1,1-Dichloroethene	1.11E-05	9.00E-03	1.24E-03
Methylene chloride	2.06E-06	6.00E-02	3.44E-05
Vinyl chloride	3.87E-06	0.00E+00	0.00E+00
Benzo(a)anthracene	1.12E-04	0.00E+00	0.00E+00
Benzo(a) pyrene	1.52E-04	0.00E+00	0.00E+00
Benzo(b)fluoranthene	1.16E-04	0.00E+00	0.00E+00
Benzo(k)fluoranthene	6.42E-04	0.00E+00	0.00E+00
Bis(2-ethylhexyl)phthalate	8.16E-05	1.10E-02	7.42E-03
Indeno(1,2,3-cd)pyrene	2.54E-04	0.00E+00	0.00E+00
Antimony	7.23E-07	4.00E-04	1.81E-03
Arsenic	5.14E-07	2.80E-04	1.84E-03
Barium	4.84E-06	3.50E-03	1.38E-03
Beryllium	3.71E-08	1.00E-04	3.71E-04
Boron	7.49E-05	4.50E-03	1.66E-02
Cadmium	1.52E-07	2.50E-05	6.09E-03
Chromium	7.81E-07	6.00E-05	1.30E-02
Manganese	1.79E-05	7.20E-04	2.49E-02
Nickel	8.38E-08	2.00E-03	4.19E-05
Thallium	3.24E-07	3.50E-06	9.25E-02
Vanadium	5.62E-07	3.50E-04	1.60E-03

TOTAL RISK

1.69E-01

00035

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)

ZONE 4

EXPOSURE SCENARIO: Construction Worker, CTE

CALCULATE INCREMENTAL CANCER RISKS:

CHEMICAL	LIFETIME AVERAGE DERMAL DOSE (MG/KG/DAY)	CSF DERMAL (KG/DAY/MG)	CANCER RISK DERMAL CONTACT
1,1-Dichloroethene	1.59E-07	6.00E-01	9.54E-08
Methylene chloride	2.95E-08	7.50E-03	2.21E-10
Vinyl chloride	5.53E-08	1.90E+00	1.05E-07
Benzo(a)anthracene	1.60E-06	0.00E+00	0.00E+00
Benzo(a) pyrene	2.17E-06	0.00E+00	0.00E+00
Benzo(b)fluoranthene	1.86E-06	0.00E+00	0.00E+00
Benzo(k)fluoranthene	9.17E-06	0.00E+00	0.00E+00
Bis(2-ethylhexyl)phthalate	1.17E-06	2.50E-02	2.91E-08
Indeno(1,2,3-cd)pyrene	3.62E-06	0.00E+00	0.00E+00
Antimony	1.03E-08	0.00E+00	0.00E+00
Arsenic	7.34E-09	1.60E+00	1.17E-08
Barium	6.91E-08	0.00E+00	0.00E+00
Beryllium	5.30E-10	0.00E+00	0.00E+00
Boron	1.07E-06	0.00E+00	0.00E+00
Cadmium	2.18E-09	0.00E+00	0.00E+00
Chromium	1.12E-08	0.00E+00	0.00E+00
Manganese	2.56E-07	0.00E+00	0.00E+00
Nickel	1.20E-09	0.00E+00	0.00E+00
Thallium	4.62E-09	0.00E+00	0.00E+00
Vanadium	8.02E-09	0.00E+00	0.00E+00

TOTAL RISK

2.41E-07

00036

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 4
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), RME

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
 C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
 IR = SOIL INGESTION RATE (MG/EVENT)
 EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
 Fi = FRACTION FROM CONTAMINATED SOURCE
 ED = EXPOSURE DURATION (YEARS)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)
 BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	100	IR:	0
EF:	150	EF:	120
Fi:	1	Fi:	1
ED:	25	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	9125	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:		YOUTH:		ADULT/YOUTH (CANCER RISK):
CF:	5.87E-07 (AVG ANNUAL DOSE)	CF:	0.00E+00 (AVG ANNUAL DOSE)	CF: 2.10E-07

00037

00040

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 4
 LOCATION: NSB - NILON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Full-Time Employees (Surface Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
S _{ac} = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
S _{aa} = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	1
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	25
BW _c = BODY WEIGHT CHILD (KG):	1
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	9125
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	7.97E-06
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	2.23E-05			

06041

00044

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 4
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), CTE

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	50	IR:	0
EF:	150	EF:	120
Fi:	1	Fi:	1
ED:	6	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	2190	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:	YOUTH:	ADULT/YOUTH (CANCER RISK):
CF: 2.94E-07 (AVG ANNUAL DOSE)	CF: 0.00E+00 (AVG ANNUAL DOSE)	CF: 2.52E-08

54005

00048

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 4
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
SAC = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
SAA = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	0.2
ABS = ABSORPTION FRACTION:	Chemical Specific
EFc = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EFa = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
EDc = CHILD EXPOSURE DURATION (YEARS):	1
EDA = ADULT EXPOSURE DURATION (YEARS):	25
BWc = BODY WEIGHT CHILD (KG):	1
BWa = BODY WEIGHT ADULT (KG):	70
ATc = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
ATA = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	9125
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSEchild = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	1.59E-06
DOSEadult = (CF2)*(C)*(ABS)	CF2 =	4.46E-06			

67000

00052

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 4
LOCATION: NSB-NLON, GROTON, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), RME

RELEVANT EQUATIONS: $IEX = (C \times IFadj \times Fi \times EF) / (AT \times CF)$ $IFadj = (IRc \times EDc) / BWc + (IRa \times EDa) / BWa$

WHERE:

- C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
- IFadj = AGE-ADJUSTED SOIL INGESTION FACTOR (MG YEAR/KG DAY)
- Fi = FRACTION FROM CONTAMINATED SOURCE (UNITLESS)
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- AT = AVERAGING TIME (DAYS)
- CF = CONVERSION FACTOR (1E+6 MG/KG)
- IRc = CHILD INGESTION RATE (MG/DAY)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- BWc = CHILD BODY WEIGHT (KG)
- IRa = ADULT INGESTION RATE (MG/DAY)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWa = ADULT BODY WEIGHT (KG)

ENTER INPUT PARAMETERS:

IRc: 200
EDc: 6
BWc: 15
IRa: 100
EDa: 24
BWa: 70
IFadj: 114.28571
Fi: 1
EF: 150
AT(NONC): 10950
AT(CARC): 25550

DETERMINE CONVERSION FACTORS:

NONCARC = 1.57E-06 CARCIN = 6.71E-07

00053

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 4
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA_{adj} \times AF \times ABS \times EF) / (AT \times 1E6)$ $SA_{adj} = (SA_a \times ED_a) / BW_a + (SA_c \times ED_c) / BW_c$

WHERE:

- C = CONCENTRATION IN SOIL (MG/KG)
- SA_c = CHILD SKIN SURFACE AREA (SQ CM/DAY)
- SA_a = ADULT SKIN SURFACE AREA (SQ CM/DAY)
- AF = ADHERENCE FACTOR (MG/SQ CM)
- ABS = ABSORPTION FRACTION
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- ED_c = CHILD EXPOSURE DURATION (YEARS)
- ED_a = ADULT EXPOSURE DURATION (YEARS)
- BW_c = BODY WEIGHT CHILD (KG)
- BW_a = BODY WEIGHT ADULT (KG)
- AT_n = AVERAGING TIME (DAYS), NONCARCINOGENS
- AT_c = AVERAGING TIME (DAYS), CARCINOGENS
- SA_{adj} = AGE-ADJUSTED SKIN SURFACE AREA (SQ CM-YR/DAY-KG)

ENTER INPUT PARAMETERS

SA _c :	2094
SA _a :	3800
AF:	1
EF:	150
ED _c :	6
ED _a :	24
BW _c :	15
BW _a :	70
AT _n :	10950
AT _c :	25550
SA _{adj} :	2140

DETERMINE CONVERSION FACTORS:

NONCARC = 2.93E-05 CARCIN = 1.26E-05

00055

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 4
LOCATION: NSB-NLON, GROTON, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), CTE

RELEVANT EQUATIONS: $IEX = (C \times IFadj \times Fi \times EF) / (AT \times CF)$ $IFadj = (IRc \times EDc) / BWc + (IRa \times EDa) / BWa$

WHERE:

- C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
- IFadj = AGE-ADJUSTED SOIL INGESTION FACTOR (MG YEAR/KG DAY)
- Fi = FRACTION FROM CONTAMINATED SOURCE (UNITLESS)
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- AT = AVERAGING TIME (DAYS)
- CF = CONVERSION FACTOR (1E+6 MG/KG)
- IRc = CHILD INGESTION RATE (MG/DAY)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- BWc = CHILD BODY WEIGHT (KG)
- IRa = ADULT INGESTION RATE (MG/DAY)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWa = ADULT BODY WEIGHT (KG)

ENTER INPUT PARAMETERS:

IRc: 100
EDc: 2
BWc: 15
IRa: 50
EDa: 7
BWa: 70
IFadj: 18.333333
Fi: 0.5
EF: 150
AT(NONC): 3285
AT(CARC): 25550

DETERMINE CONVERSION FACTORS:

NONCARC = 4.19E-07 CARCIN = 5.38E-08

00057

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 4
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA_{adj} \times AF \times ABS \times EF) / (AT \times 1E6)$ $SA_{adj} = (SA_a \times ED_a) / BW_a + (SA_c \times ED_c) / BW_c$

WHERE:

- C = CONCENTRATION IN SOIL (MG/KG)
- SA_c = CHILD SKIN SURFACE AREA (SQ CM/DAY)
- SA_a = ADULT SKIN SURFACE AREA (SQ CM/DAY)
- AF = ADHERENCE FACTOR (MG/SQ CM)
- ABS = ABSORPTION FRACTION
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- ED_c = CHILD EXPOSURE DURATION (YEARS)
- ED_a = ADULT EXPOSURE DURATION (YEARS)
- BW_c = BODY WEIGHT CHILD (KG)
- BW_a = BODY WEIGHT ADULT (KG)
- AT_n = AVERAGING TIME (DAYS), NONCARCINOGENS
- AT_c = AVERAGING TIME (DAYS), CARCINOGENS
- SA_{adj} = AGE-ADJUSTED SKIN SURFACE AREA (SQ CM-YR/DAY-KG)

ENTER INPUT PARAMETERS

SA _c :	2094
SA _a :	3800
AF:	0.2
EF:	150
ED _c :	2
ED _a :	7
BW _c :	15
BW _a :	70
AT _n :	3285
AT _c :	25550
SA _{adj} :	659.2

DETERMINE CONVERSION FACTORS:

NONCARC = 6.02E-06 CARCIN = 7.74E-07

00059

IEUBK MODEL - EXPOSURE TO LEAD (PAGE 1 OF 2)

SITE NAME: Zone 4
 LOCATION: NSB-NLON, Groton, Connecticut

EXPOSURE SCENARIO: RME

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
 Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
 WATER Consumption: DEFAULT

SOIL & DUST:

Soil: constant conc.
 Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	10600.0	10600.0
1-2	10600.0	10600.0
2-3	10600.0	10600.0
3-4	10600.0	10600.0
4-5	10600.0	10600.0
5-6	10600.0	10600.0
6-7	10600.0	10600.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
 Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

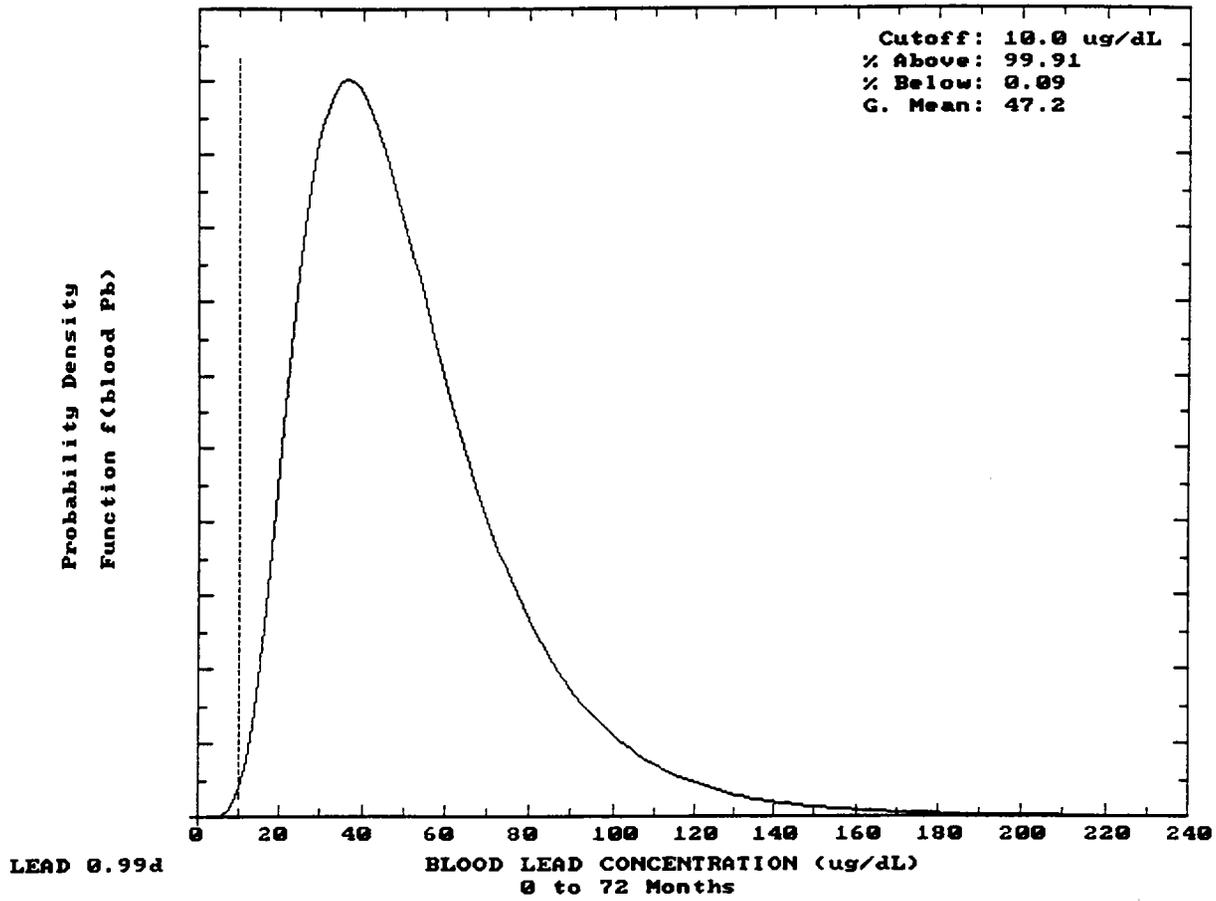
YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	47.3	100.24	99.05	1.01	0.15	0.00	0.02
1-2:	53.9	147.84	146.48	0.99	0.34	0.00	0.03
2-3:	51.5	156.54	154.93	1.17	0.38	0.00	0.06
3-4:	51.0	165.68	164.01	1.19	0.40	0.00	0.07
4-5:	45.6	145.54	143.62	1.36	0.50	0.00	0.07
5-6:	41.0	142.87	140.64	1.56	0.57	0.00	0.09
6-7:	37.7	142.52	140.00	1.81	0.61	0.00	0.09

IEUBK MODEL - EXPOSURE TO LEAD (PAGE 2 OF 2)

SITE NAME: Zone 4

LOCATION: NSB-NLON, Groton, Connecticut

EXPOSURE SCENARIO: RME



00062

IEUBK MODEL - EXPOSURE TO LEAD (PAGE 1 OF 2)

SITE NAME: Zone 4
 LOCATION: NSB-NLON, Groton, Connecticut
 DATE: 2/12/98

EXPOSURE SCENARIO: CTE

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
 Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
 WATER Consumption: DEFAULT

SOIL & DUST:

Soil: constant conc.
 Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	1152.0	1152.0
1-2	1152.0	1152.0
2-3	1152.0	1152.0
3-4	1152.0	1152.0
4-5	1152.0	1152.0
5-6	1152.0	1152.0
6-7	1152.0	1152.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
 Maternal Blood Conc: 2.50 ug Pb/dL

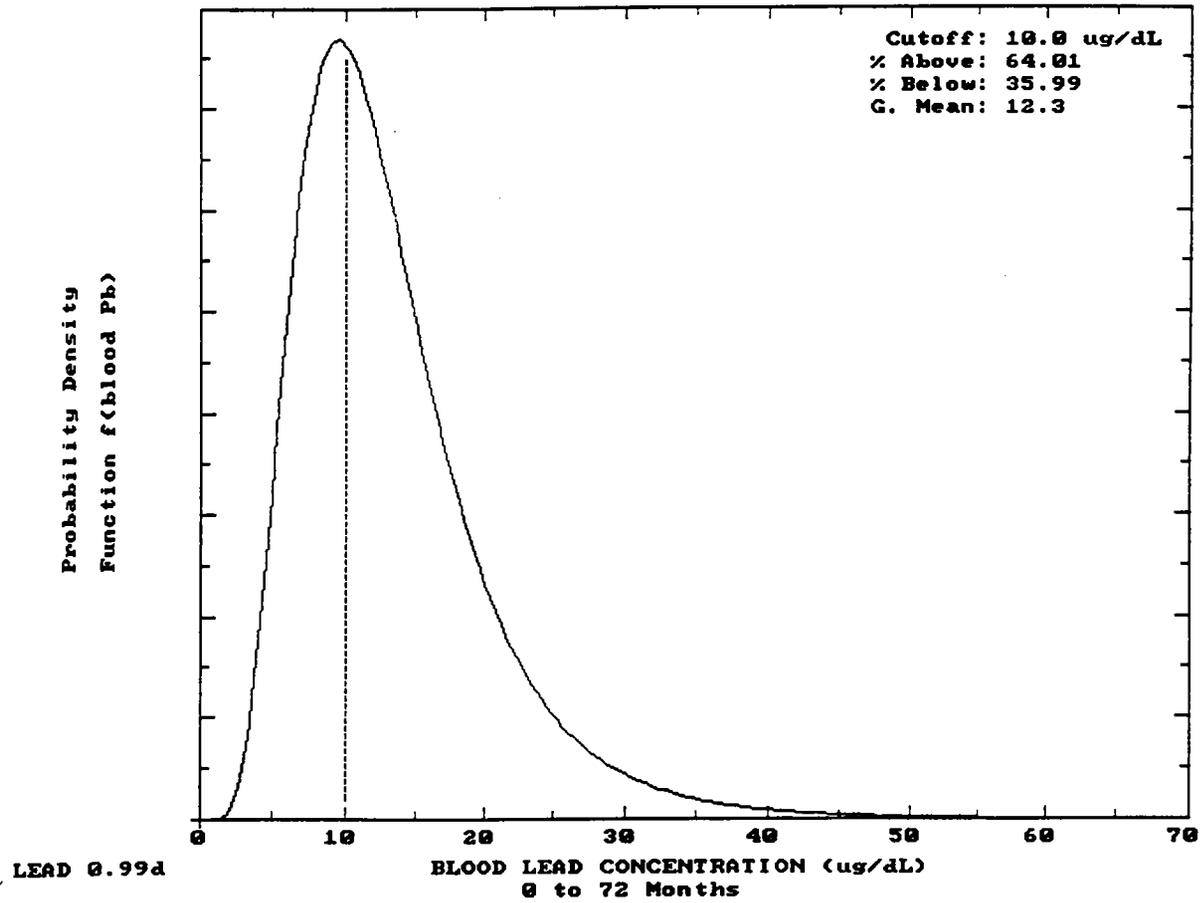
CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)		
0.5-1:	12.7	24.42		22.02	
1-2:	14.6	36.31		33.49	
2-3:	13.8	38.03		34.77	
3-4:	13.4	39.31		36.02	
4-5:	11.3	32.31		28.82	
5-6:	9.6	30.55		26.74	
6-7:	8.5	29.84		25.66	
YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)	
0.5-1:	2.07	0.30	0.00	0.02	0.02
1-2:	2.07	0.72	0.00	0.03	0.03
2-3:	2.42	0.78	0.00	0.06	0.06
3-4:	2.41	0.82	0.00	0.07	0.07
4-5:	2.51	0.92	0.00	0.07	0.07
5-6:	2.72	1.00	0.00	0.09	0.09
6-7:	3.06	1.03	0.00	0.09	0.09

IEUBK MODEL - EXPOSURE TO LEAD (PAGE 2 OF 2)

SITE NAME: Zone 4
LOCATION: NSB-NLON, Groton, Connecticut
DATE: 2/12/98

EXPOSURE SCENARIO: CTE



Calculations of 95th Percentile Fetal Blood Lead Concentrations for Adult Exposure to Soil

SITE NAME: Zone 4

LOCATION: NSB-NLON, Groton, Connecticut

DATE: February 11, 1998

OBJECTIVE: Adult exposure to lead in soil is addressed by an evaluation of the relationship between the site soil lead concentration and the blood lead concentration in the developing fetuses of adult women. This spreadsheet calculates a range of 95th percentile fetal blood lead concentrations from central estimates of blood lead concentrations in pregnant adult women using the exposure parameters identified below (U.S. EPA, Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil, December 1996).

RELEVANT EQUATIONS: $PbB_{adult, central} = PbB_{adult, 0} + [(PbS \times BKSF \times IR_s \times AF_s \times EF_s)/AT]$

and

$PbB_{fetal, 0.95} = PbB_{adult, central} \times GSD_{i, adult}^{1.845} \times R_{fetal/maternal}$

Exposure Parameter	Description (units)	Future Employee		Construction Worker	
		RME	CTE	RME	CTE
$PbB_{adult, 0}$	Typical blood lead concentration in adult women of child-bearing age in absence of site exposures (ug/dL)	2.0	2.0	2.0	2.0
PbS	Site-specific soil lead concentration (mg/kg)	10900	2174	10900	1510
BKSF	Biokinetic slope factor (ug/dl)/(ug/day)	0.4	0.4	0.4	0.4
IR_s	Intake rate of soil, includes outdoor soil and indoor soil-derived dust (g/day)	0.100	0.050	0.480	0.240
AF_s	Absolute gastrointestinal absorption fraction (unitless)	0.12	0.12	0.12	0.12
EF_s	Exposure frequency (days/year)	150	150	120	80
AT	Averaging time (days/year)	365	365	365	365
$GSD_{i, adult}$	Estimate of individual geometric standard deviation among adults (unitless)	2.1	2.1	2.1	2.1
$R_{fetal/maternal}$	Constant of proportionality between fetal blood lead concentration at birth and maternal blood lead concentration (unitless)	0.9	0.9	0.9	0.9
$PbB_{adult, central}$	Calculated central estimate of blood lead concentrations in adult women of child-bearing age from site exposures (ug/dL)	23.50	4.14	84.57	(1)
$PbB_{fetal, 0.95}$	Calculated 95th percentile blood lead concentrations among fetuses born to women having site exposures (ug/dL)	71.68	12.64	257.92	(1)

Notes:

- (1) According to the cited guidance document, this adult exposure model is not applicable for infrequent site exposures, where the EF_s is less than 1 day/week or 90 days/year.

00065

APPENDIX I.9

ZONE 5

COC SCREENING FOR LOWER SUBBASE
 ZONE 5- SHALLOW SOIL (0-4 FEET)
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COPC? (4)	Rationale
Volatile Organic Compounds (mg/kg)													
ACETONE	1/1	0.028	-	0.028	19TB4-0002 (93)	780	100000	0.8	500	1000	140	N	2
METHYLENE CHLORIDE	1/1	0.009	-	0.009	19TB4-0002 (93)	85	13	0.001	82	760	1	Y	3, 5
Semivolatile Organic Compounds (mg/kg)													
2-METHYLNAPHTHALENE	1/9	0.027	330-530	0.079	LS5SB0010101	310	-	-	1000(5)	2500(5)	56(5)	N	2
ACENAPHTHENE	1/9	0.02	330-530	0.078	LS5SB0010101	470	-	29	1000(5)	2500(5)	84(5)	N	2
ACENAPHTHYLENE	3/9	0.02-0.03	330-530	0.066	LS5SB0040101	-	-	-	1000	2500	84	N	2
ANTHRACENE	7/9	0.022-0.045	330-530	0.047	LS5SB0030101	2300	-	590	1000	2500	400	N	2
BENZO(A)ANTHRACENE	8/9	0.037-0.22	360-530	0.139	LS5SB0040101	0.88	-	0.08	1	7.8	1	Y	3, 5
BENZO(A)PYRENE	9/10	0.029-0.23	360	0.141	LS5SB0040101	0.088	-	0.4	1	1	1	Y	3
BENZO(B)FLUORANTHENE	9/10	0.032-0.33	360	0.147	LS5SB0040101	0.88	-	0.2	1	7.8	1	Y	3, 5
BENZO(G,H,I)PERYLENE	8/10	0.045-0.21	330-360	0.103	LS5SB0040101	-	-	-	1000(5)	2500(5)	40(5)	N	2
BENZO(K)FLUORANTHENE	7/9	0.049-0.29	330-530	0.128	LS5SB0040101	8.8	-	2	8.4	78	1	N	2
CARBAZOLE	6/9	0.021-0.026	330-530	0.044	LS5SB0040101	32	-	0.03	31(5)	290(5)	0.36(5)	N	2
CHRYSENE	9/10	0.028-0.26	360	0.150	LS5SB0040101	88	-	8	84(5)	780(5)	0.96(5)	N	2
DI-N-BUTYL PHTHALATE	1/9	0.019	330-530	0.078	LS5SB0040101	7800	2300	270	1000	2500	140	N	2
DIBENZO(A,H)ANTHRACENE	5/9	0.032-0.12	330-530	0.071	LS5SB0040101	0.088	-	0.08	0.084(5)	0.78(5)	0.000096(5)	Y	3
FLUORANTHENE	9/10	0.039-0.52	360	0.229	LS5SB0040101	310	-	210	1000	2500	56	N	2
FLUORENE	3/9	0.018-0.021	330-530	0.064	LS5SB0040101	310	-	28	1000	2500	56	N	2
INDENO(1,2,3-CD)PYRENE	7/9	0.034-0.18	330-530	0.101	LS5SB0040101	0.88	-	0.7	0.84	7.8	0.0096	Y	3, 5
PHENANTHRENE	8/9	0.032-0.21	360-530	0.144	LS5SB0040101	-	-	-	1000	2500	40	N	2
PYRENE	9/10	0.047-0.41	360	0.235	LS5SB0040101	230	-	210	1000	2500	40	N	2
Pesticides (mg/kg)													
AROCLOR-1260	1/1	0.055	-	0.055	19TB4-0002 (93)	0.16	-	-	1	10	-	N	2
Metals (mg/kg)													
ALUMINUM	4/4	3470-4460	-	3990	LS5SB0010101	7800	-	-	-	-	-	N	2
ARSENIC	4/4	0.52-1.6	-	1.105	LS5SB0010101	0.43	750	1	10	10	-	Y	3
BARIUM	4/4	27.2-34.4	-	30.975	LS5SB0010101	550	690000	82	4700	140000	-	N	2
CHROMIUM (TOTAL)	4/4	7.1-8.7	-	7.75	LS5SB0010101	39(6)	270	2	100(6)	100(6)	-	Y	3, 5
COBALT	4/4	2.4-3.4	-	2.75	19TB4-0002 (93)	470	-	-	1000(5)	2500(5)	-	N	2
COPPER	4/4	11.2-19.7	-	15.55	LS5SB0010101	310	-	-	-	-	-	N	2
IRON	4/4	5510-6800	-	6057.5	LS5SB0010101	2300	-	-	-	-	-	N	2
LEAD	3/5	9.6-91.2	10.4-31.5	36.955	LS5SB0010101	400(7)	-	-	500	1000	-	N	2
MANGANESE	4/4	97.5-150	-	122.325	19TB4-0002 (93)	180	-	-	1600(5)	47000(5)	-	N	2
MERCURY	2/4	0.01-0.02	0.01-0.12	0.015625	LS5SB0010101	2.3	-	-	20	610	-	N	2
NICKEL	4/4	5.5-7	-	6.05	LS5SB0010101	160	13000	7	1400	7500	-	N	2
VANADIUM	4/4	9.2-11.6	-	10.175	LS5SB0010101	55	-	300	470	14000	-	N	2
ZINC	4/4	23.8-73.5	-	46.925	LS5SB0010101	2300	-	620	20000	610000	-	N	2
Miscellaneous (mg/kg)													
TPH	9/9	53-1900	-	812.44444	LS5SB0030101	-	-	-	500	2500	2500	Y	1, 3

00001

COC SCREENING FOR LOWER SUBBASE
ZONE 5- SHALLOW SOIL (0-4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Notes:

- Not available or Not applicable.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Residential Soil Ingestion is used for soil and sediment. Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with dilution and attenuation factor (DAF) of 1.0 are used.
- (3) CTDEP, January 1996. State Pollutant Mobility criteria for metals are not included since a direct comparison of the aqueous SPLP criteria (in ug/L) and the soil analytical results (in mg/kg) cannot be made. TCLP and SPLP results for soil samples are addressed in The Nature and Extent Section of the RI Report.
- (4) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (5) No value promulgated by CTDEP, calculated or surrogate value is used. Ceiling limit is used if calculated or surrogate value exceeds the ceiling limit.
- (6) Hexavalent chromium.
- (7) Value is based on OSWER soil screening level for residential land use (USEPA, July 14, 1994).

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Maximum exceeds migration to groundwater criteria only; chemical will not be quantitatively evaluated in the risk assessment.

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COC SCREENING FOR LOWER SUBBASE
 ZONE 5- ALL SOIL (0-10 FEET)
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COPC? (4)	Rationale
Volatile Organic Compounds (mg/kg)													
ACETONE	2/2	0.028-0.12	-	0.074	19TB4-0406 (93)	780	100000	0.8	500	1000	140	N	2
METHYLENE CHLORIDE	2/2	0.008-0.009	-	0.0085	19TB4-0002 (93)	85	13	0.001	82	760	1	Y	3, 5
Semivolatile Organic Compounds (mg/kg)													
2-METHYLNAPHTHALENE	3/16	0.027-21	330-530	1.460	LS5SB0010201	310	-	-	1000(5)	2500(5)	56(5)	N	2
ACENAPHTHENE	2/16	0.02-0.048	330-7300	0.376	LS5SB0060201	470	-	29	1000(5)	2500(5)	84(5)	N	2
ACENAPHTHYLENE	4/16	0.02-0.049	330-7300	0.358	LS5SB0060201	-	-	-	1000	2500	84	N	2
ANTHRACENE	10/16	0.021-0.64	330-7300	0.350	LS5SB0030201	2300	-	590	1000	2500	400	N	2
BENZO(A)ANTHRACENE	13/16	0.031-0.7	360-7300	0.409	LS5SB0040201	0.88	-	0.08	1	7.8	1	Y	3, 5
BENZO(A)PYRENE	14/17	0.029-1.1	360-7300	0.417	LS5SB0040201	0.088	-	0.4	1	1	1	Y	3
BENZO(B)FLUORANTHENE	14/17	0.032-1.2	360-7300	0.422	LS5SB0040201	0.88	-	0.2	1	7.8	1	Y	3
BENZO(G,H,I)PERYLENE	13/17	0.035-0.6	330-7300	0.357	LS5SB0040201	-	-	-	1000(5)	2500(5)	40(5)	N	2
BENZO(K)FLUORANTHENE	11/16	0.018-0.29	330-7300	0.366	LS5SB0040101-D	8.8	-	2	8.4	78	1	N	2
CARBAZOLE	7/16	0.021-0.061	330-7300	0.331	LS5SB0060201	32	-	0.03	31(5)	290(5)	0.36(5)	Y	3, 5
CHRYSENE	14/17	0.028-0.85	360-7300	0.412	LS5SB0040201	88	-	8	84(5)	780(5)	0.96(5)	N	2
DI-N-BUTYL PHTHALATE	1/16	0.019	330-7300	0.384	LS5SB0040101-D	7800	2300	270	1000	2500	140	N	2
DIBENZO(A,H)ANTHRACENE	6/16	0.032-0.12	330-7300	0.352	LS5SB0040101-D	0.088	-	0.08	0.084(5)	0.78(5)	0.00096(5)	Y	3
DIBENZOFURAN	1/16	0.057	330-7300	0.386	LS5SB0060201	310	-	-	270(5)	2500(5)	5.6(5)	N	2
FLUORANTHENE	14/17	0.039-1.9	360-7300	0.567	LS5SB0040201	310	-	210	1000	2500	56	N	2
FLUORENE	5/16	0.018-4.1	330-530	0.389	LS5SB0010201	310	-	28	1000	2500	56	N	2
INDENO(1,2,3-CD)PYRENE	12/16	0.024-0.53	330-7300	0.366	LS5SB0040201	0.88	-	0.7	0.84(5)	7.8(5)	0.0096(5)	Y	3, 5
NAPHTHALENE	2/16	0.025-4.5	330-530	0.437	LS5SB0010201	310	-	4	1000	2500	56	Y	3, 5
PHENANTHRENE	13/16	0.031-5.8	360-530	0.597	LS5SB0010201	-	-	-	1000	2500	40	N	2
PYRENE	15/17	0.047-1.6	360-370	0.426	LS5SB0040201	230	-	210	1000	2500	40	N	2
Pesticides (mg/kg)													
AROCLOR-1260	2/2	0.055-0.12	-	0.088	19TB4-0406 (93)	0.32	-	-	1	10	-	N	2
Metals (mg/kg)													
ALUMINUM	7/7	2890-4610	-	3892.857143	19TB4-0406 (93)	7800	-	-	-	-	-	N	2
ARSENIC	7/7	0.52-2.2	-	1.222857	LS5SB0010201	0.43	750	1	10	10	-	Y	3
BARIUM	7/7	15.1-36	-	30.114286	19TB4-0406 (93)	550	690000	82	4700	140000	-	N	2
BERYLLIUM	1/7	0.2	0.08-0.29	0.097143	19TB4-0406 (93)	0.15	1300	3	2	2	-	Y	3
CHROMIUM	7/7	5.4-14	-	8.742857	LS5SB0060201	39(6)	270	2	100(6)	100(6)	-	Y	3, 5
COBALT	7/7	2.2-4.9	-	3.214286	19TB4-0406 (93)	470	-	-	1000(5)	2500(5)	-	N	2
COPPER	7/7	6.4-19.7	-	13.8	LS5SB0010101	310	-	-	-	-	-	N	2
IRON	7/7	3500-6800	-	5892.857143	9TB4-0406 (93), LS5SB001010	2300	-	-	-	-	-	Y	3, 4
LEAD	6/8	3.6-91.2	10.4-31.5	27.34375	LS5SB0010101	400(7)	-	-	500	1000	-	N	2
MANGANESE	7/7	43.1-209	-	122.914286	19TB4-0406 (93)	180	-	-	1600(5)	47000(5)	-	Y	3
MERCURY	2/7	0.01-0.02	-	0.019286	LS5SB0010101-D	2.3	-	-	20	610	-	N	2
NICKEL	7/7	5.4-7.4	-	6.128571	LS5SB0060201	160	13000	7	1400	7500	-	Y	3, 5
VANADIUM	7/7	6.6-11.9	-	10.042857	19TB4-0406 (93)	55	-	300	470	14000	-	N	2
ZINC	7/7	12.2-116	-	49.314286	LS5SB0060201	2300	-	620	20000	610000	-	N	2
Miscellaneous (mg/kg)													
TPH	10/10	53-1900	-	739	LS5SB0030101-D	-	-	-	500	2500	2500	Y	1, 3

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COC SCREENING FOR LOWER SUBBASE
ZONE 5- ALL SOIL (0-10 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Notes:

- Not available or Not applicable.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Residential Soil Ingestion is used for soil and sediment. Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of $1E-6$.
- (2) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with dilution and attenuation factor (DAF) of 1.0 are used.
- (3) CTDEP, January 1996. State Pollutant Mobility criteria for metals are not included since a direct comparison of the aqueous SPLP criteria (in ug/L) and the soil analytical results (in mg/kg) cannot be made. TCLP and SPLP results for soil samples are addressed in The Nature and Extent Section of the RI Report.
- (4) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (5) No value promulgated by CTDEP, calculated or surrogate value is used. Ceiling limit is used if calculated or surrogate value exceeds the ceiling limit.
- (6) Hexavalent chromium.
- (7) Value is based on OSWER soil screening level for residential land use (USEPA, July 14, 1994).

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Maximum exceeds migration to groundwater criteria only; chemical will not be quantitatively evaluated in the risk assessment.

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COC SCREENING FOR LOWER SUBBASE
 ZONE 5 - GROUNDWATER
 NSB-NLON, GORTON, CONNECTICUT
 PAGE 1 OF 2

Parameter	Frequency	Range of Detection	Range of Nondetects	Location of Maximum	COC Screening Level (1)	EPA MCL (2)	State MCL (3)	State RSR Groundwater (4)	State AWQC		Selected as COC (6)	Rationale
									Saltwater (5)	Human Health (5)		
Volatiles (ug/L)												
Ethylbenzene	1/3	4	1	19MW4	130	700	700	700	-	3100	N	2
Toluene	1/3	0.8	1	19MW4	75	1000	1000	1000	-	6800	N	2
Xylenes, total	1/3	13	1 - 5	19MW4	1200	10000	10000	530	-	-	N	2
Semivolatiles (ug/L)												
2-Methylnaphthalene	2/5	37 - 75	10 - 12	19MW4	150	-	-	280 (7)	-	-	N	2
Acenaphthene	2/5	2 - 3	10 - 12	19MW3	220	-	-	420 (7)	-	1200	N	2
Acenaphthylene	1/5	2	10 - 12	19MW3	-	-	-	420	-	0.0028	Y	3, 6
Di-N-butyl phthalate	1/5	0.6	10 - 12	19MW3	370	-	-	700	-	2700	N	2
Dibenzofuran	3/5	1 - 2	10 - 12	19MW3, 19MW4	15	-	-	28 (7)	-	-	N	2
Fluorene	3/5	2 - 4	10 - 12	19MW3	150	-	-	280	-	1300	N	2
Naphthalene	3/5	0.6 - 73	10 - 12	19MW4	150	-	-	280	-	-	N	2
Phenanthrene	2/5	1 - 2	10 - 12	19MW4	-	-	-	200	-	0.0028	Y	3, 6
Metals (ug/L)												
Aluminum, filtered	3/5	136 - 172	12.5 - 26.8	19MW3	3700	50 TO 200 (8)	-	-	-	-	Y	3, 4
Arsenic, filtered	1/5	34.3	2 - 2.5	19MW4	0.045	50	50	50	36	0.018	Y	3
Barium	2/5	177 - 324	43.7 - 72.8	19MW2	260	2000	2000	1000	-	-	Y	3
Barium, filtered	5/5	43.7 - 370	-	19MW3	260	2000	2000	1000	-	-	Y	3, 5
Boron, filtered	3/3	162 - 206	-	19MW4	330	-	-	630 (7)	-	-	N	2
Cobalt	1/5	11.5	2.9 - 3	19MW4	220	-	-	420 (7)	-	-	N	2
Cobalt, filtered	1/5	10.5	2.9 - 3	19MW4	220	-	-	420 (7)	-	-	N	2
Copper	2/5	2.4 - 4.2	3	19MW2	150	1300 (9)	-	1300	2.4	1300	Y	3, 6
Copper, filtered	2/5	3.2 - 11.4	3	19MW3	150	1300 (9)	-	1300	2.4	1300	Y	3, 6
Iron	3/5	10700 - 31900	30.9 - 220	19MW4	1100	300 (8)	-	-	-	-	Y	3, 4
Iron, filtered	4/5	42.5 - 31100	22.2	19MW4	1100	300(8)	-	-	-	-	Y	3, 4
Lead	1/5	1.3	1.3 - 4.4	19MW2	-	15 (9)	-	15	8.1	50	N	2
Lead, filtered	2/5	1.4 - 2.2	1 - 1.3	19MW3	-	15 (9)	-	15	8.1	50	N	2
Manganese	4/5	4.6 - 4140	6.2	19MW4	84	50 (8)	5000(10)	160 (7)	-	-	Y	3
Manganese, filtered	4/5	7.6 - 4090	1.6	19MW4	84	50 (8)	5000 (10)	160 (7)	-	-	Y	3, 5
Mercury	1/5	0.41	0.04 - 0.18	19MW3	1.1	2	2	2	0.025	0.14	Y	3, 6
Sodium	5/5	21900 - 3090000	-	19MW2	-	-	28000 (11)	-	-	-	Y	3, 1
Sodium, filtered	5/5	21600 - 2770000	-	19MW2	-	-	28000 (11)	-	-	-	Y	3, 1
Vanadium, filtered	1/5	3	2.9 - 5	19MW3	26	-	-	50	-	-	N	2
Zinc	1/5	21.3	3 - 15.7	19MW2	1100	5000 (8)	-	5000	81	-	N	2
Zinc, filtered	4/5	3.3 - 185	11	19MW2	1100	5000 (8)	-	5000	81	-	Y	3, 6

Notes:

- Not available or Not applicable.
- Bolded cell indicates that the maximum detected site concentration exceeds this criteria.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Tap Water Ingestion Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) Maximum Contaminant Level. (USEPA, October 1996).
- (3) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter II Environmental Health.
- (4) CDTEP, January 1996.

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Unfiltered data, rather than filtered data, will be in quantitative risk assessment.
- (6) Maximum is greater than State AWQC only; chemical will not be quantitatively evaluate in the risk assessment.

00005

COC SCREENING FOR LOWER SUBBASE
ZONE 5 - GROUNDWATER
NSB-NLON, GORTON, CONNECTICUT
PAGE 2 OF 2

- (5) Connecticut Water Quality Standards, 1992. Chronic values for saltwater bodies and protection of human health values for water and organisms are presented.
- (6) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (7) No value promulgated by CTDEP, calculated value used.
- (8) Secondary MCL (SMCL) based on aesthetic water qualities.
- (9) Action Level.
- (10) Hexavalent chromium.
- (11) Current Connecticut Department of Public Health and Addiction Services Action Level.
- (12) Notification Level.

90000

**95% UPPER CONFIDENCE LIMITS
ZONE 5 - SHALLOW SOILS (0-4 FT)
NSB - NLON, GROTON, CONNECTICUT**

PARAMETER	UNITS	DETECTS	COUNT	AVERAGE	W NORMAL	W LOGNORMAL	W TEST	DISTRIBUTION	UCL - NORMAL	UCL - LOGNORMAL	DETECTS - MAX	95% UCL ⁽¹⁾
ALUMINUM	mg/kg	3	3	4076.6667	0.8675	0.8565	0.767	NORMAL	4972.6093	5423.7447	4460	4460
ARSENIC	mg/kg	3	3	1.04	0.9959	0.9911	0.767	NORMAL	1.9522	20.6561	1.6	1.6
BARIUM	mg/kg	3	3	31.5667	0.8802	0.8692	0.767	NORMAL	38.0355	40.9506	34.4	34.4
CALCIUM	mg/kg	3	3	1466.3333	0.7802	0.8091	0.767	LOGNORMAL	3429.3338	220367.3164	2810	2810
CHROMIUM	mg/kg	3	3	7.6667	0.7967	0.8013	0.767	LOGNORMAL	9.1777	9.6367	8.7	8.7
COBALT	mg/kg	3	3	2.8667	0.9868	0.9956	0.767	LOGNORMAL	3.7152	4.2534	3.4	3.4
COPPER	mg/kg	3	3	16.3333	0.8853	0.8596	0.767	NORMAL	23.9484	40.6997	19.7	19.7
IRON	mg/kg	3	3	6240	0.8622	0.8688	0.767	LOGNORMAL	7066.0728	7278.5051	6800	6800
LEAD	mg/kg	2	4	30.4375	0.7262	0.9246	0.748	LOGNORMAL	78.3666	87590.2929	91.2	91.2
MAGNESIUM	mg/kg	3	3	1793.3333	0.9845	0.9799	0.767	NORMAL	1988.7286	2045.2794	1900	1900
MANGANESE	mg/kg	3	3	130.6	0.866	0.8488	0.767	NORMAL	176.0708	226.5844	150	150
MERCURY	mg/kg	1	3	0.0283	0.9355	0.9955	0.767	LOGNORMAL	0.0763	65572.41	0.02	0.02
NICKEL	mg/kg	3	3	6.0667	0.848	0.8583	0.767	LOGNORMAL	7.4397	7.9544	7	7
POTASSIUM	mg/kg	3	3	1121	0.9533	0.9429	0.767	NORMAL	1316.9738	1383.6607	1220	1220
SODIUM	mg/kg	2	3	117.0667	0.8202	0.8002	0.767	NORMAL	190.8733	710.8508	146	146
VANADIUM	mg/kg	3	3	10.2333	0.9453	0.9569	0.767	LOGNORMAL	12.3141	13.0235	11.6	11.6
ZINC	mg/kg	3	3	44.5333	0.9239	0.9794	0.767	LOGNORMAL	88.1175	928.3253	73.5	73.5
ACETONE	µg/kg	1	1	28	*****	*****	0	NOT DEFINED	*****	0	28	28
METHYLENE CHLORIDE	µg/kg	1	1	9	*****	*****	0	NOT DEFINED	*****	0	9	9
2-METHYLNAPHTHALENE	µg/kg	1	6	144.5	0.5781	0.5337	0.788	NOT DEFINED	192.109	515.5578	27	27
ACENAPHTHENE	µg/kg	1	6	143.3333	0.5744	0.5285	0.788	NOT DEFINED	193.2811	765.9694	20	20
ACENAPHTHYLENE	µg/kg	2	6	123.3333	0.7178	0.7106	0.788	NOT DEFINED	186.2875	1094.319	30	30
ANTHRACENE	µg/kg	4	6	83	0.7433	0.8279	0.788	LOGNORMAL	140.421	326.3884	45	45
BENZO(A)ANTHRACENE	µg/kg	5	6	152.8333	0.9006	0.7445	0.788	NORMAL	205.6617	417.099	220	205.6617
BENZO(A)PYRENE	µg/kg	6	7	145.4286	0.8318	0.7446	0.803	NORMAL	203.5763	522.1353	230	203.5763
BENZO(B)FLUORANTHENE	µg/kg	6	7	156.8571	0.9147	0.8303	0.803	NORMAL	231.9842	621.459	330	231.9842
BENZO(G,H,I)PERYLENE	µg/kg	6	7	114.2857	0.9291	0.9414	0.803	LOGNORMAL	160.0042	222.1932	210	210
BENZO(K)FLUORANTHENE	µg/kg	5	6	158.1667	0.9305	0.8913	0.788	NORMAL	222.6265	357.9308	290	222.6265
CARBAZOLE	µg/kg	3	6	97.3333	0.7296	0.7239	0.788	NOT DEFINED	162.9755	961.2619	26	26
CHRYSENE	µg/kg	6	7	148.7143	0.8704	0.7784	0.803	NORMAL	209.9532	535.6824	260	209.9532
DI-N-BUTYL PHTHALATE	µg/kg	1	6	145.6667	0.5947	0.5367	0.788	NOT DEFINED	197.07	862.3636	19	19
DIBENZO(A,H)ANTHRACENE	µg/kg	4	6	101.8333	0.8289	0.8193	0.788	NORMAL	152.4801	260.5062	120	120
FLUORANTHENE	µg/kg	6	7	221	0.9131	0.9385	0.803	LOGNORMAL	337.2781	790.5156	520	520
FLUORENE	µg/kg	2	6	121.5	0.7042	0.6818	0.788	NOT DEFINED	186.7328	1748.2493	21	21
INDENO(1,2,3-CD)PYRENE	µg/kg	5	6	114.5	0.9015	0.8727	0.788	NORMAL	161.2426	276.936	180	161.2426
PHENANTHRENE	µg/kg	5	6	160.3333	0.7737	0.6546	0.788	NOT DEFINED	215.9845	539.899	210	210
PYRENE	µg/kg	6	7	227.4286	0.9065	0.8328	0.803	NORMAL	326.3971	787.3822	410	326.3971
AROCLOR-1260	µg/kg	1	1	55	*****	*****	0	NOT DEFINED	*****	0	55	55
TPH	mg/kg	6	6	866.5	0.9463	0.8676	0.788	NORMAL	1419.0103	20312.1402	1900	1419.0103

(1) The UCL Normal and UCL Lognormal values are the 95% UCL for normal and lognormal distributions, respectively; if these values exceeded the maximum concentration, then the maximum concentration was used as the 95% UCL. For undefined distributions, the maximum concentration was used as the 95% UCL. Asterisks indicate insufficient number of samples to calculate statistics.

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00008

**95% UPPER CONFIDENCE LIMITS
ZONE 5- SOILS (0-10 FT)
NSB - NLON, GROTON, CONNECTICUT**

PARAMETER	UNITS	DETECTS	COUNT	AVERAGE	W NORMAL	W LOGNORMAL	W TEST	DISTRIBUTION	UCL - NORMAL	UCL - LOGNORMAL	DETECTS - MAX	95% UCL ⁽¹⁾
ALUMINUM	mg/kg	6	6	3920	0.9308	0.9141	0.788	NORMAL	4464.7213	4637.8554	4610	4464.7213
ARSENIC	mg/kg	6	6	1.21	0.9574	0.9931	0.788	LOGNORMAL	1.7135	2.3619	2.2	2.2
BARIIUM	mg/kg	6	6	30.2667	0.7773	0.7197	0.788	NOT DEFINED	36.9297	43.7582	36	36
BERYLLIUM	mg/kg	1	6	0.1	0.8937	0.9689	0.788	LOGNORMAL	0.1498	0.2242	0.2	0.2
CALCIUM	mg/kg	6	6	1254.5	0.8144	0.901	0.788	LOGNORMAL	1997.1551	3279.96	2810	2810
CHROMIUM	mg/kg	6	6	8.8667	0.9346	0.9746	0.788	LOGNORMAL	11.4163	12.7467	14	12.7467
COBALT	mg/kg	6	6	3.35	0.9151	0.9342	0.788	LOGNORMAL	4.2538	4.7285	4.9	4.7285
COPPER	mg/kg	6	6	13.9	0.9723	0.9132	0.788	NORMAL	17.8592	22.256	19.7	17.8592
IRON	mg/kg	6	6	5956.6667	0.7383	0.6911	0.788	NOT DEFINED	7000.4635	7725.324	6800	6800
LEAD	mg/kg	5	7	20.75	0.5799	0.8895	0.803	LOGNORMAL	43.7648	100.9226	91.2	91.2
MAGNESIUM	mg/kg	6	6	1768.3333	0.896	0.832	0.788	NORMAL	2065.4538	2229.748	2160	2065.4538
MANGANESE	mg/kg	6	6	127.15	0.9841	0.9004	0.788	NORMAL	172.6862	261.7633	209	172.6862
MERCURY	mg/kg	1	6	0.0208	0.8054	0.8282	0.788	LOGNORMAL	0.0387	0.2245	0.02	0.02
NICKEL	mg/kg	6	6	6.15	0.8414	0.8533	0.788	LOGNORMAL	6.8417	6.9333	7.4	6.9333
POTASSIUM	mg/kg	6	6	1114	0.9728	0.9421	0.788	NORMAL	1308.4776	1390.466	1450	1308.4776
SODIUM	mg/kg	5	6	153.2	0.9373	0.9355	0.788	NORMAL	229.8015	458.2588	286	229.8015
VANADIUM	mg/kg	6	6	10.05	0.8955	0.8531	0.788	NORMAL	11.6777	12.4581	11.9	11.6777
ZINC	mg/kg	6	6	48.5167	0.8669	0.9766	0.788	LOGNORMAL	80.6442	190.9813	116	116
ACETONE	µg/kg	2	2	74	1	1	0	LOGNORMAL	*****	1406169.571	120	120
METHYLENE CHLORIDE	µg/kg	2	2	8.5	1	1	0	LOGNORMAL	*****	9.9654	9	9
2-METHYLNAPHTHALENE	µg/kg	3	13	1756.5385	0.3183	0.6057	0.866	NOT DEFINED	4614.3161	3554.5774	21000	21000
ACENAPHTHENE	µg/kg	2	13	421.7692	0.3552	0.7057	0.866	NOT DEFINED	901.9133	911.6388	48	48
ACENAPHTHYLENE	µg/kg	3	13	412.6154	0.3645	0.7708	0.866	NOT DEFINED	894.4151	1051.4785	49	49
ANTHRACENE	µg/kg	7	13	423.3846	0.4288	0.8999	0.866	LOGNORMAL	909.1363	1526.6657	640	640
BENZO(A)ANTHRACENE	µg/kg	10	13	470.5385	0.4521	0.9072	0.866	LOGNORMAL	950.5816	1398.231	700	700
BENZO(A)PYRENE	µg/kg	11	14	471.8571	0.4744	0.9057	0.874	LOGNORMAL	922.7554	1440.3163	1100	1100
BENZO(B)FLUORANTHENE	µg/kg	11	14	479.3571	0.4855	0.9124	0.874	LOGNORMAL	932.9663	1384.2743	1200	1200
BENZO(G,H,I)PERYLENE	µg/kg	11	14	404.2857	0.4	0.8549	0.874	NOT DEFINED	851.3483	806.421	600	600
BENZO(K)FLUORANTHENE	µg/kg	9	13	420.9231	0.3895	0.8611	0.866	NOT DEFINED	902.1955	1334.2417	290	290
CARBAZOLE	µg/kg	4	13	401.5385	0.3704	0.7981	0.866	NOT DEFINED	885.166	1163.4703	61	61
CHRYSENE	µg/kg	11	14	461.4286	0.4604	0.9188	0.874	LOGNORMAL	906.7474	1335.6598	850	850
DI-N-BUTYL PHTHALATE	µg/kg	1	13	433	0.3436	0.6057	0.866	NOT DEFINED	911.2417	873.905	19	19
DIBENZO(A,H)ANTHRACENE	µg/kg	5	13	404.8462	0.3632	0.7472	0.866	NOT DEFINED	887.6317	753.7039	120	120
DIBENZOFURAN	µg/kg	1	13	434.7692	0.3378	0.5384	0.866	NOT DEFINED	912.5373	646.246	57	57
FLUORANTHENE	µg/kg	11	14	629.5	0.6222	0.9578	0.874	LOGNORMAL	1101.5221	2348.2088	1900	1900
FLUORENE	µg/kg	4	13	451.0769	0.3559	0.7365	0.866	NOT DEFINED	993.7722	1234.2353	4100	4100
INDENO(1,2,3-CD)PYRENE	µg/kg	10	13	419.6923	0.4075	0.8821	0.866	LOGNORMAL	903.4686	1049.1075	530	530
NAPHTHALENE	µg/kg	2	13	497.6923	0.3367	0.591	0.866	NOT DEFINED	1092.4175	909.9378	4500	4500
PHENANTHRENE	µg/kg	10	13	702.1538	0.4515	0.8933	0.866	LOGNORMAL	1474.7625	2842.9997	5800	2842.9997
PYRENE	µg/kg	12	14	456	0.8147	0.9253	0.874	LOGNORMAL	683.608	1500.2998	1600	1500.2998
AROCLOR-1260	µg/kg	2	2	87.5	1	1	0	LOGNORMAL	*****	1464.0009	120	120
TPH	mg/kg	7	7	753.8571	0.9085	0.8834	0.803	NORMAL	1254.5028	14391.5233	1900	1254.5028

(1) The UCL Normal and UCL Lognormal values are the 95% UCL for normal and lognormal distributions, respectively; if these values exceeded the maximum concentration, then the maximum concentration was used as the 95% UCL. For undefined distributions, the maximum concentration was used as the 95% UCL. Asterisks indicate insufficient number of samples to calculate statistics.

6000

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**SUMMARY OF MAXIMUM AND AVERAGE CONCENTRATIONS
ZONE 5 - GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT**

Parameter	Maximum Detected Concentration	Average Concentration
Volatile Organic Compounds (ug/L)		
ETHYLBENZENE	4.00	1.67
TOLUENE	0.80	0.60
XYLENES, TOTAL	13.00	5.33
Semivolatile Organic Compounds (ug/L)		
2-METHYLNAPHTHALENE	75.00	34.08
ACENAPHTHENE	3.00	3.67
ACENAPHTHYLENE	2.00	4.33
DI-N-BUTYL PHTHALATE	0.60	3.87
DIBENZOFURAN	2.00	3.17
FLUORENE	3.00	4.00
NAPHTHALENE	73.00	28.93
PHENANTHRENE	2.00	3.00
Metals (ug/L)		
ALUMINUM, FILTERED	153.00	105.61
ARSENIC, FILTERED	34.30	12.18
BARIUM	172.93	104.23
BARIUM, FILTERED	221.40	149.65
BORON, FILTERED	206.00	184.00
CALCIUM	102,350.00	72,783.33
CALCIUM, FILTERED	94,450.00	68,750.00
COBALT	11.50	4.82
COBALT, FILTERED	10.50	4.48
COPPER	2.85	2.10
COPPER, FILTERED	6.45	3.43
IRON	31,900.00	15,687.58
IRON, FILTERED	31,100.00	15,375.60
LEAD	0.98	1.08
LEAD, FILTERED	1.43	0.98
MAGNESIUM	197,180.00	68,808.33
MAGNESIUM, FILTERED	177,205.00	62,158.33
MANGANESE	4,140.00	1,656.78
MANGANESE, FILTERED	4,090.00	1,648.57
MERCURY	0.25	0.13
POTASSIUM	58,420.00	23,671.67
POTASSIUM, FILTERED	52,015.00	21,516.67
SODIUM	1,576,700.00	555,066.67
SODIUM, FILTERED	1,418,350.00	502,966.67
VANADIUM, FILTERED	2.75	2.41
ZINC	11.40	7.08
ZINC, FILTERED	94.15	48.65

00011

00012

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 5
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker (All Soil), RME

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
 C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
 IR = SOIL INGESTION RATE (MG/EVENT)
 EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
 Fi = FRACTION FROM CONTAMINATED SOURCE
 ED = EXPOSURE DURATION (YEARS)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)
 BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		CHILD:	
IR:	480	IR:	0
EF:	120	EF:	120
Fi:	1	Fi:	1
ED:	1	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	365	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:		CHILD:		ADULT/CHILD (CANCER RISK):
CF:	2.25E-06 (AVG ANNUAL DOSE)	CF:	0.00E+00 (AVG ANNUAL DOSE)	CF: 3.22E-08

00013

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 5
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Construction Worker (All Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E8)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
SAC = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
SAa = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	1
ABS = ABSORPTION FRACTION:	Chemical Specific
EFc = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EFa = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	120
EDc = CHILD EXPOSURE DURATION (YEARS):	1
EDa = ADULT EXPOSURE DURATION (YEARS):	1
BWc = BODY WEIGHT CHILD (KG):	1
BWa = BODY WEIGHT ADULT (KG):	70
ATc = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
ATa = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E8 \text{ MG})$

DOSEchild = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	2.55E-07
DOSEadult = (CF2)*(C)*(ABS)	CF2 =	1.78E-05			

00017

00020

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 5
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker (All Soil), CTE

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		CHILD:	
IR:	240	IR:	0
EF:	80	EF:	120
Fi:	1	Fi:	1
ED:	1	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	365	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:	CHILD:	ADULT/CHILD (CANCER RISK):
CF: 7.51E-07 (AVG ANNUAL DOSE)	CF: 0.00E+00 (AVG ANNUAL DOSE)	CF: 1.07E-08

00021

00024

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 5
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/88

EXPOSURE SCENARIO: Construction Worker (All Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
S _{Ac} = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
S _{Aa} = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	0.2
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	80
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	1
BW _c = BODY WEIGHT CHILD (KG):	15
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	3.40E-08
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	2.38E-06			

00025

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER

SITE NAME: ZONE 5
 LOCATION: NSB-NLON, Groton, CT
 DATE: 2/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker, RME

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

$$DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DA_{event} = ABSORBED DOSE PER EVENT (MG/CM**2/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS:
 FOR ORGANICS:

$$DA_{event} = K_p \times C \times t_{event} \times CF$$

$$\text{IF } t_{event} < t^*, DA_{event} = 2K_p \times C \times CF \times (6T \times t_{event}/3.141592654)^{0.5}$$

$$\text{IF } t_{event} > t^*, DA_{event} = K_p \times C \times CF \times ((t_{event}/(1 + B)) + (2T \times ((1+3B)/(1 + B))))$$

WHERE: K_p = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MGL)
 t_{event} = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1 L/1000 CM**3)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERIVED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

EV: 1
 ED: 1
 EF: 120
 A: 3800
 t_{event}: 8
 BW: 70
 AT(NON): 365
 AT(CAR): 25550

CONVERSION
 FACTOR (NONCAR) = 1.78E+01
 CONVERSION
 FACTOR (CARCIN) = 2.55E-01

00029

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

ZONE 5

EXPOSURE SCENARIO: Construction Worker, RME

CHEMICAL	CONC. (MG/L)	ORGANIC OR INORGANIC?	t* (HR)	T (HR)	Kp (CM/HR)	B	DAevent
Arsenic, filtered	0.0343	I			1.00E-03		2.74E-07
Barium	0.173	I			1.00E-03		1.38E-06
Manganese	4.14	I			1.00E-03		3.31E-05

00030

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER WATER (PAGE THREE)

ZONE 5

EXPOSURE SCENARIO: Construction Worker, RME

CALCULATE DOSES:

CHEMICAL	ANNUAL DERMAL DOSE (MG/KG/DAY)	DERMAL RfD (MG/KG/DAY)	HAZARD INDEX DERMAL
Arsenic, filtered	4.90E-06	2.80E-04	1.75E-02
Barium	2.47E-05	3.50E-03	7.06E-03
Manganese	5.91E-04	7.20E-04	8.21E-01

TOTAL RISK

8.46E-01

00031

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)

ZONE 5

EXPOSURE SCENARIO: Construction Worker, RME

CALCULATE INCREMENTAL CANCER RISKS:

CHEMICAL	LIFETIME AVERAGE DERMAL DOSE (MG/KG/DAY)	CSF DERMAL (KG/DAY/MG)	CANCER RISK DERMAL CONTACT
Arsenic, filtered	7.00E-08	1.60E+00	1.12E-07
Barium	3.53E-07	0.00E+00	0.00E+00
Manganese	8.44E-06	0.00E+00	0.00E+00

TOTAL RISK

1.12E-07

00032

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER

SITE NAME: ZONE 5
 LOCATION: NSB-NLON, Groton, CT
 DATE: 2/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker, CTE

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

$$DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DA_{event} = ABSORBED DOSE PER EVENT (MG/CM**2/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS:
 FOR ORGANICS:

$$DA_{event} = K_p \times C \times t_{event} \times CF$$

$$\text{IF } t_{event} < t^*, DA_{event} = 2K_p \times C \times CF \times (6T \times t_{event} / 3.141592654)^{0.5}$$

$$\text{IF } t_{event} > t^*, DA_{event} = K_p \times C \times CF \times ((t_{event} / (1 + B)) + (2T \times ((1 + 3B) / (1 + B))))$$

WHERE: K_p = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MG/L)
 t_{event} = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1 L/1000 CM**3)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERIVED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

EV: 1
 ED: 1
 EF: 80
 A: 3800
 t_{event}: 8
 BW: 70
 AT(NON): 365
 AT(CAR): 25550

CONVERSION
 FACTOR (NONCAR) = 1.19E+01
 CONVERSION
 FACTOR (CARCIN) = 1.70E-01

00033

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

ZONE 5

EXPOSURE SCENARIO: Construction Worker, CTE

CHEMICAL	CONC. (MG/L)	ORGANIC OR INORGANIC?	t* (HR)	T (HR)	Kp (CM/HR)	B	DAevent
Arsenic, filtered	0.0122	I			1.00E-03		9.76E-08
Barium	0.104	I			1.00E-03		8.32E-07
Manganese	1.66	I			1.00E-03		1.33E-05

00034

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER WATER (PAGE THREE)

ZONE 5

EXPOSURE SCENARIO: Construction Worker, CTE

CALCULATE DOSES:

CHEMICAL	ANNUAL DERMAL DOSE (MG/KG/DAY)	DERMAL RfD (MG/KG/DAY)	HAZARD INDEX DERMAL
Arsenic, filtered	1.16E-06	2.80E-04	4.15E-03
Barium	9.90E-06	3.50E-03	2.83E-03
Manganese	1.58E-04	7.20E-04	2.19E-01

TOTAL RISK

2.26E-01

00035

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)

ZONE 5

EXPOSURE SCENARIO: Construction Worker, CTE

CALCULATE INCREMENTAL CANCER RISKS:

CHEMICAL	LIFETIME AVERAGE DERMAL DOSE (MG/KG/DAY)	CSF DERMAL (KG/DAY/MG)	CANCER RISK DERMAL CONTACT
Arsenic, filtered	1.66E-08	1.60E+00	2.65E-08
Barium	1.41E-07	0.00E+00	0.00E+00
Manganese	2.26E-06	0.00E+00	0.00E+00

TOTAL RISK

2.65E-08

00036

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 5
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

**HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.**

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), RME

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		CHILD:	
IR:	100	IR:	0
EF:	150	EF:	120
Fi:	1	Fi:	1
ED:	25	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	9125	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:	CHILD:	ADULT/CHILD (CANCER RISK):
CF: 5.87E-07 (AVG ANNUAL DOSE)	CF: 0.00E+00 (AVG ANNUAL DOSE)	CF: 2.10E-07

00037

00040

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 5
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Full-Time Employees (Surface Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
SAC = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
SAa = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	1
ABS = ABSORPTION FRACTION:	Chemical Specific
EFc = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EFa = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
EDc = CHILD EXPOSURE DURATION (YEARS):	1
EDa = ADULT EXPOSURE DURATION (YEARS):	25
BWc = BODY WEIGHT CHILD (KG):	1
BWa = BODY WEIGHT ADULT (KG):	70
ATc = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
ATa = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	9125
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSEchild = (CF1)*(C)*(ABS)
 DOSEadult = (CF2)*(C)*(ABS)

CF1 = 0.00E+00
 CF2 = 2.23E-05

CANCER RISK = (CF3)*(C)*(ABS)

CF3 = 7.97E-06

00041

00044

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 5
 LOCATION: NSB-NLON, Groton, CT
 DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), CTE

RELEVANT EQUATION: $IEX = (C \times IR \times F_i \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
 C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
 IR = SOIL INGESTION RATE (MG/EVENT)
 EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
 F_i = FRACTION FROM CONTAMINATED SOURCE
 ED = EXPOSURE DURATION (YEARS)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)
 BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		CHILD:	
IR:	50	IR:	0
EF:	150	EF:	120
F _i :	1	F _i :	1
ED:	6	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	2190	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:	CHILD:	ADULT/CHILD (CANCER RISK):
CF: 2.94E-07 (AVG ANNUAL DOSE)	CF: 0.00E+00 (AVG ANNUAL DOSE)	CF: 2.52E-08

00045

67000

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 5
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
SAC = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
SAA = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	0.2
ABS = ABSORPTION FRACTION:	Chemical Specific
EFc = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EFa = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
EDc = CHILD EXPOSURE DURATION (YEARS):	1
EDa = ADULT EXPOSURE DURATION (YEARS):	25
BWc = BODY WEIGHT CHILD (KG):	1
BWa = BODY WEIGHT ADULT (KG):	70
ATc = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
ATa = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	9125
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / ((AT \text{ DAYS}) \times (BW \text{ KG}) \times (1 \text{ KG/1E6 MG}))$

DOSEchild = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	1.59E-06
DOSEadult = (CF2)*(C)*(ABS)	CF2 =	4.46E-06			

00052

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 5
 LOCATION: NSB-NLON, GROTON, CT
 DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), RME

RELEVANT EQUATIONS: $IEX = (C \times IFadj \times Fi \times EF) / (AT \times CF)$ $IFadj = (IRc \times EDc) / BWc + (IRa \times EDa) / BWa$

WHERE:

- C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
- IFadj = AGE-ADJUSTED SOIL INGESTION FACTOR (MG YEAR/KG DAY)
- Fi = FRACTION FROM CONTAMINATED SOURCE (UNITLESS)
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- AT = AVERAGING TIME (DAYS)
- CF = CONVERSION FACTOR (1E+6 MG/KG)
- IRc = CHILD INGESTION RATE (MG/DAY)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- BWc = CHILD BODY WEIGHT (KG)
- IRa = ADULT INGESTION RATE (MG/DAY)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWa = ADULT BODY WEIGHT (KG)

ENTER INPUT PARAMETERS:

IRc: 200
 EDc: 6
 BWc: 15
 IRa: 100
 EDa: 24
 BWa: 70
 IFadj: 114.28571
 Fi: 1
 EF: 150
 AT(NONC) 10950
 AT(CARC): 25550

DETERMINE CONVERSION FACTORS:

NONCARC = 1.57E-06 CARCIN = 6.71E-07

00053

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 5
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA_{adj} \times AF \times ABS \times EF) / (AT \times 1E6)$ $SA_{adj} = (SA_a \times ED_a) / BW_a + (SA_c \times ED_c) / BW_c$

WHERE:

- C = CONCENTRATION IN SOIL (MG/KG)
- SA_c = CHILD SKIN SURFACE AREA (SQ CM/DAY)
- SA_a = ADULT SKIN SURFACE AREA (SQ CM/DAY)
- AF = ADHERENCE FACTOR (MG/SQ CM)
- ABS = ABSORPTION FRACTION
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- ED_c = CHILD EXPOSURE DURATION (YEARS)
- ED_a = ADULT EXPOSURE DURATION (YEARS)
- BW_c = BODY WEIGHT CHILD (KG)
- BW_a = BODY WEIGHT ADULT (KG)
- AT_n = AVERAGING TIME (DAYS), NONCARCINOGENS
- AT_c = AVERAGING TIME (DAYS), CARCINOGENS
- SA_{adj} = AGE-ADJUSTED SKIN SURFACE AREA (SQ CM-YR/DAY-KG)

ENTER INPUT PARAMETERS

SA _c :	2094
SA _a :	3800
AF:	1
EF:	150
ED _c :	6
ED _a :	24
BW _c :	15
BW _a :	70
AT _n :	10950
AT _c :	25550
SA _{adj} :	2140

DETERMINE CONVERSION FACTORS:

NONCARC = 2.93E-05 CARCIN = 1.26E-05

00055

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 5
 LOCATION: NSB-NLON, GROTON, CT
 DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), CTE

RELEVANT EQUATIONS: $IEX = (C \times IF_{adj} \times F_i \times EF) / (AT \times CF)$ $IF_{adj} = (IR_c \times ED_c) / BW_c + (IR_a \times ED_a) / BW_a$

WHERE:
 C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
 IF_{adj} = AGE-ADJUSTED SOIL INGESTION FACTOR (MG YEAR/KG DAY)
 F_i = FRACTION FROM CONTAMINATED SOURCE (UNITLESS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 AT = AVERAGING TIME (DAYS)
 CF = CONVERSION FACTOR (1E+6 MG/KG)
 IR_c = CHILD INGESTION RATE (MG/DAY)
 ED_c = CHILD EXPOSURE DURATION (YEARS)
 BW_c = CHILD BODY WEIGHT (KG)
 IR_a = ADULT INGESTION RATE (MG/DAY)
 ED_a = ADULT EXPOSURE DURATION (YEARS)
 BW_a = ADULT BODY WEIGHT (KG)

ENTER INPUT PARAMETERS:

IR_c: 100
 ED_c: 2
 BW_c: 15
 IR_a: 50
 ED_a: 7
 BW_a: 70
 IF_{adj}: 18.333333
 F_i: 0.5
 EF: 150
 AT(NONC): 3285
 AT(CARC): 25550

DETERMINE CONVERSION FACTORS:

NONCARC = 4.19E-07 CARCIN = 5.38E-08

00057

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 5
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA_{adj} \times AF \times ABS \times EF) / (AT \times 1E6)$ $SA_{adj} = (SAa \times EDa) / BWa + (SAc \times EDc) / BWc$

WHERE:

- C = CONCENTRATION IN SOIL (MG/KG)
- SAc = CHILD SKIN SURFACE AREA (SQ CM/DAY)
- SAa = ADULT SKIN SURFACE AREA (SQ CM/DAY)
- AF = ADHERENCE FACTOR (MG/SQ CM)
- ABS = ABSORPTION FRACTION
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWc = BODY WEIGHT CHILD (KG)
- BWa = BODY WEIGHT ADULT (KG)
- ATn = AVERAGING TIME (DAYS), NONCARCINOGENS
- ATc = AVERAGING TIME (DAYS), CARCINOGENS
- SAadj = AGE-ADJUSTED SKIN SURFACE AREA (SQ CM-YR/DAY-KG)

ENTER INPUT PARAMETERS

SAc:	2094
SAa:	3800
AF:	0.2
EF:	150
EDc:	2
EDa:	7
BWc:	15
BWa:	70
ATn:	3285
ATc:	25550
SAadj:	659.2

DETERMINE CONVERSION FACTORS:

NONCARC = 6.02E-06 CARCIN = 7.74E-07

00059

APPENDIX I.10

ZONE 6

COC SCREENING FOR LOWER SUBBASE
 ZONE 6-SHALLOW SOIL (0-4 FEET)
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COPC? (4)	Rationale
Semivolatile Organic Compounds (mg/kg)													
2-METHYLNAPHTHALENE	1/4	0.03	0.33-0.36	0.144	LS6SB0050101	310	-	-	1000(5)	2500(5)	56(5)	N	2
ACENAPHTHENE	2/4	0.022-0.042	0.33-0.36	0.118	LS6SB0040101	470	-	29	1000(5)	2500(5)	84(5)	N	2
ACENAPHTHYLENE	1/4	0.029	0.33-0.36	0.144	LS6SB0050101	-	-	-	1000	2500	84	N	2
ANTHRACENE	3/4	0.035-0.086	0.33-0.36	0.107	LS6SB0040101	2300	-	590	1000	2500	400	N	2
BENZO(A)ANTHRACENE	4/4	0.04-0.33	0.33	0.169	LS6SB0040101	0.88	-	0.08	1	7.8	1	Y	3, 5
BENZO(A)PYRENE	3/4	0.031-0.46	0.33	0.196	LS6SB0040101	0.088	-	0.4	1	1	1	Y	3
BENZO(B)FLUORANTHENE	3/4	0.037-0.24	0.33	0.153	LS6SB0040101	0.88	-	0.2	1	7.8	1	Y	3, 5
BENZO(G,H,I)PERYLENE	3/4	0.026-0.11	0.33	0.111	LS6SB0020201	-	-	-	1000(5)	2500(5)	40(5)	N	2
BENZO(K)FLUORANTHENE	3/4	0.026-0.28	0.33	0.147	LS6SB0040101	8.8	-	2	8.4	78	1	N	2
BUTYLBENZYL PHTHALATE	2/4	0.019	0.33-0.36	0.110	LS6SB0030201, LS6SB0040101	1600	930	810	1000	2500	200	N	2
CARBAZOLE	1/4	0.028	0.33-0.36	0.144	LS6SB0040101	32	-	0.03	31(5)	290(5)	0.36(5)	N	2
CHRYSENE	4/4	0.045-0.36	0.33	0.168	LS6SB0040101	88	-	8	84(5)	780(5)	0.96(5)	N	2
DI-N-OCTYL PHTHALATE	1/4	0.032	0.33-0.36	0.141	LS6SB0030201	160	10000	10000	1000	2500	20	N	2
DIBENZO(A,H)ANTHRACENE	1/4	0.05	0.33-0.36	0.145	LS6SB0020201	0.088	-	0.08	0.084(5)	0.78(5)	0.000096(5)	Y	3, 5
DIBENZOFURAN	1/4	0.03	0.33-0.36	0.144	LS6SB0050101	310	-	-	270(5)	2500(5)	5.6(5)	N	2
FLUORANTHENE	4/4	0.04-0.5	0.33	0.211	LS6SB0040101	310	-	210	1000	2500	56	N	2
FLUORENE	1/4	0.034	0.33-0.36	0.145	LS6SB0040101	310	-	28	1000	2500	56	N	2
INDENO(1,2,3-CD)PYRENE	3/4	0.026-0.13	0.33	0.117	LS6SB0040101	0.88	-	0.7	0.84(5)	7.8(5)	0.0096(5)	Y	3, 5
PHENANTHRENE	4/4	0.025-0.34	0.33	0.156	LS6SB0040101	-	-	-	1000	2500	40	N	2
PYRENE	4/4	0.056-1	0.33	0.354	LS6SB0040101	230	-	210	1000	2500	40	N	2
Metals (mg/kg)													
ALUMINUM	4/4	4660-6150	-	5734	LS6SB0030201	7800	-	-	-	-	-	N	2
ARSENIC	4/4	1.6-2.2	-	1.88	LS6SB0020201	0.43	750	1	10	10	-	Y	3
BARIUM	4/4	29.2-45	-	35.8	LS6SB0030201	550	690000	82	4700	140000	-	Y	3
BERYLLIUM	2/4	0.18-0.22	0.00014-0.00033	0.145	LS6SB0030201	0.15	1300	3	2	2	-	Y	3
CHROMIUM (total)	4/4	10.2-13.9	-	12.3	LS6SB0030201	39(6)	270	2	100(6)	100(6)	-	Y	3, 5
COBALT	4/4	3.5-5.1	-	4.5	LS6SB0030201	470	-	-	1000(5)	2500(5)	-	N	2
COPPER	4/4	8.7-24.5	-	13.82	LS6SB0030201	310	-	-	-	-	-	N	2
IRON	4/4	6720-10400	-	8400	LS6SB0030201	2300	-	-	-	-	-	N	2
LEAD	4/4	3.1-12.4	-	9.52	LS6SB0030201	400(7)	-	-	500	1000	-	N	2
MANGANESE	4/4	131-182	-	152.6	LS6SB0030201	180	-	-	1600(5)	47000(5)	-	Y	3
MERCURY	1/4	0.04	0.00001	0.012	LS6SB0030201	2.3	-	-	20	610	-	N	2
NICKEL	4/4	8.5-10.4	-	9.94	LS6SB0030201	160	13000	7	1400	7500	-	Y	3, 5
VANADIUM	4/4	13.3-23.1	-	17.44	LS6SB0050101	55	-	300	470	14000	-	N	2
ZINC	4/4	15.8-50.1	-	27.32	LS6SB0030201	2300	-	620	20000	610000	-	N	2
Miscellaneous (mg/kg)													
TPH	4/4	120-4000	0.025	1064.5	LS6SB0050101	-	-	-	500	2500	2500	Y	1, 3

0001

COC SCREENING FOR LOWER SUBBASE
ZONE 6-SHALLOW SOIL (0-4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Notes:

- Not available or Not applicable.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Residential Soil Ingestion is used for soil and sediment. Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with dilution and attenuation factor (DAF) of 1.0 are used.
- (3) CTDEP, January 1996. State Pollutant Mobility criteria for metals are not included since a direct comparison of the aqueous SPLP criteria (in ug/L) and the soil analytical results (in mg/kg) cannot be made. TCLP and SPLP results for soil samples are addressed in The Nature and Extent Section of the RI Report.
- (4) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (5) No value promulgated by CTDEP, calculated or surrogate value is used. Ceiling limit is used if calculated or surrogate value exceeds the ceiling limit.
- (6) Hexavalent chromium.
- (7) Value is based on OSWER soil screening level for residential land use (USEPA, July 14, 1994).

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Maximum exceeds migration to groundwater criteria only; chemical will not be quantitatively evaluated in the risk assessment.

000 2

**COC SCREENING FOR LOWER SUBBASE
ZONE 6-ALL SOIL (0-10 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 2**

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COPC? (4)	Rationale
Volatile Organic Compounds (mg/kg)													
2-METHYLNAPHTHALENE	1/8	0.03	0.33-0.36	0.161	LS6SB0050101	310	-	-	1000(5)	2500(5)	56	N	2
ACENAPHTHENE	2/8	0.022-0.042	0.33-0.36	0.147	LS6SB0040101	470	-	29	1000(5)	2500(5)	84	N	2
ACENAPHTHYLENE	1/8	0.029	0.33-0.36	0.160	LS6SB0050101	-	-	-	1000	2500	84	N	2
ANTHRACENE	4/8	0.019-0.086	0.33-0.36	0.126	LS6SB0040101	2300	-	590	1000	2500	400	N	2
BENZO(A)ANTHRACENE	6/8	0.04-0.33	0.33-0.36	0.156	LS6SB0040101	0.88	-	0.08	1	7.8	1	Y	3, 5
BENZO(A)PYRENE	4/8	0.031-0.46	0.33-0.36	0.187	LS6SB0040101	0.088	-	0.4	1	1	1	Y	3
BENZO(B)FLUORANTHENE	5/8	0.031-0.24	0.33-0.36	0.145	LS6SB0040101	0.88	-	0.2	1	7.8	1	Y	3, 5
BENZO(G,H,I)PERYLENE	4/8	0.026-0.11	0.33-0.36	0.135	LS6SB0020201	-	-	-	1000(5)	2500(5)	40(5)	N	2
BENZO(K)FLUORANTHENE	5/8	0.026-0.28	0.33-0.36	0.144	LS6SB0040101	8.8	-	2	8.4	78	1	N	2
BUTYLBENZYL PHTHALATE	4/8	0.019-0.043	0.33-0.36	0.114	LS6SB0020301	1600	930	810	1000	2500	200	N	2
CARBAZOLE	1/8	0.028	0.33-0.36	0.160	LS6SB0050101	32	-	0.03	31(5)	290(5)	0.36(5)	N	2
CHRYSENE	7/8	0.028-0.36	0.33-0.36	0.142	LS6SB0040101	88	-	8	84(5)	780(5)	0.96(5)	N	2
DI-N-OCTYL PHTHALATE	1/8	0.032	0.33-0.36	0.159	LS6SB0030201	160	10000	10000	1000	2500	20	N	2
DIBENZO(A,H)ANTHRACENE	1/8	0.05	0.33-0.36	0.161	LS6SB0020201	0.088	-	0.08	0.084(5)	0.78(5)	0.000096(5)	Y	3, 5
DIBENZOFURAN	1/8	0.03	0.33-0.36	0.161	LS6SB0050101	310	-	-	270(5)	2500(5)	5.6(5)	N	2
FLUORANTHENE	7/8	0.021-0.5	0.33-0.36	0.167	LS6SB0040101	310	-	210	1000	2500	56	N	2
FLUORENE	1/8	0.034	0.33-0.36	0.161	LS6SB0040101	310	-	28	1000	2500	56	N	2
INDENO(1,2,3-CD)PYRENE	4/8	0.026-0.13	0.33-0.36	0.137	LS6SB0040101	0.88	-	0.7	0.84(5)	7.8(5)	0.0096(5)	Y	3, 5
PHENANTHRENE	6/8	0.025-0.34	0.33-0.36	0.143	LS6SB0040101	-	-	-	1000	2500	40	N	2
PYRENE	7/8	0.033-1	0.33-0.36	0.254	LS6SB0040101	230	-	210	1000	2500	40	N	2
Metals (mg/kg)													
ALUMINUM	8/8	2410-8250	-	5022	LS6SB0030201	7800	-	-	-	-	-	Y	3, 4
ARSENIC	8/8	0.87-2.2	-	1.707	LS6SB0020201	0.43	750	1	10	10	-	Y	3
BARIUM	8/8	16.8-45	-	31.43	LS6SB0030201	550	690000	82	4700	140000	-	N	2
BERYLLIUM	2/8	0.18-0.22	0.08-0.33	0.1155	LS6SB0030201	0.15	1300	3	2	2	-	Y	3
CHROMIUM (total)	8/8	5.8-15.2	-	10.69	LS6SB0030201	39(6)	270	2	100(6)	100(6)	-	Y	3, 5
COBALT	8/8	2.1-6.4	-	3.9	LS6SB0030201	470	-	-	1000(5)	2500(5)	-	N	2
COPPER	8/8	6.8-24.5	-	11.18	LS6SB0030201	310	-	-	-	-	-	N	2
IRON	8/8	4010-10400	-	7071	LS6SB0030201	2300	-	-	-	-	-	Y	3, 4
LEAD	9/8	2-18	4.4	7.11	LS6SB0030201	400(7)	-	-	500	1000	-	N	2
MANGANESE	8/8	75.2-182	-	135.74	LS6SB0030201	180	-	-	1600(5)	47000(5)	-	Y	3
MERCURY	1/8	0.04	0.002-0.01	0.0081	LS6SB0030201	2.3	-	-	20	610	-	N	2
NICKEL	8/8	4.8-12.5	-	8.81	LS6SB0030201	160	13000	7	1400	7500	-	Y	3, 5
VANADIUM	8/8	8.5-23.1	-	14.27	LS6SB0050101	55	-	300	470	14000	-	N	2
ZINC	8/8	10.7-50.1	-	22.27	LS6SB0030201	2300	-	620	20000	610000	-	N	2
Miscellaneous (mg/kg)													
TPH	8/8	78-4000	25	776.05	LS6SB0050101	-	-	-	500	2500	2500	Y	1, 3

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**COC SCREENING FOR LOWER SUBBASE
ZONE 6-ALL SOIL (0-10 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2**

Notes:

- Not available or Not applicable.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Residential Soil Ingestion is used for soil and sediment. Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with dilution and attenuation factor (DAF) of 1.0 are used.
- (3) CTDEP, January 1996. State Pollutant Mobility criteria for metals are not included since a direct comparison of the aqueous SPLP criteria (in ug/L) and the soil analytical results (in mg/kg) cannot be made. TCLP and SPLP results for soil samples are addressed in The Nature and Extent Section of the RI Report.
- (4) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (5) No value promulgated by CTDEP, calculated or surrogate value is used. Ceiling limit is used if calculated or surrogate value exceeds the ceiling limit.
- (6) Hexavalent chromium.
- (7) Value is based on OSWER soil screening level for residential land use (USEPA, July 14, 1994).

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Maximum exceeds migration to groundwater criteria only; chemical will not be quantitatively evaluated in the risk assessment.

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COC SCREENING FOR LOWER SUBBASE
ZONE 6 - GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT

Parameter	Frequency	Range of Detection	Range of Nondetects	Location of Maximum	COC Screening Level (1)	EPA MCL (2)	State MCL (3)	State RSR Groundwater (4)	State AWQC		Selected as COC (6)	Rationale
									Saltwater (5)	Human Health (5)		
Semivolatiles (ug/L)												
Acenaphthene	2/5	2 - 3	11	MW2-6RI	220	-	-	420 (7)	-	1200	N	2
Acenaphthylene	2/5	0.6 - 0.8	11	MW2-6RI	-	-	-	420	-	0.0028	Y	3, 6
Fluoranthene	1/5	0.6	11 - 13	MW2-6RI	150	-	-	280	-	300	N	2
Fluorene	1/5	0.7	11 - 12	MW2-6RI	150	-	-	280	-	1300	N	2
Metals (ug/L)												
Antimony, filtered	1/5	2.8	2.5	MW2-6RI	1.5	6	6	6	-	14	Y	3
Barium	5/5	21.4 - 125	-	MW2-6RI	260	2000	2000	1000	-	-	N	2
Barium, filtered	5/5	21.8 - 374	-	MW3-6RI	260	2000	2000	1000	-	-	Y	3
Chromium (total)	2/5	0.89	3.1	MW2-6RI	18 (10)	100	100	50	50 (10)	170 (10)	N	2
Cobalt	2/5	0.94 - 0.99	2.9	MW2-6RI	220	-	-	420 (7)	-	-	N	2
Cobalt, filtered	2/5	0.88 - 1.2	2.9	MW2-6RI	220	-	-	420 (7)	-	-	N	2
Iron	2/5	557 - 619	15.8 - 24	MW2-6RI	1100	300 (8)	-	-	-	-	Y	3, 4
Iron, filtered	2/5	525 - 608	12.6 - 37.8	MW2-6RI	1100	300 (8)	-	-	-	-	Y	3, 4
Lead	1/5	2.5	1.3	MW2-6RI	-	15 (9)	-	15	8.1	50	N	2
Manganese	5/5	29 - 449	-	MW2-6RI	84	50 (8)	5000 (11)	160 (7)	-	-	Y	3
Manganese, filtered	5/5	30.7 - 428	-	MW2-6RI	84	50 (8)	5000 (11)	160 (7)	-	-	Y	3, 5
Sodium	5/5	11200 - 239000	-	MW2-6RI	-	-	28000 (12)	-	-	-	Y	1, 3
Sodium, filtered	5/5	11800 - 230000	-	MW2-6RI	-	-	28000 (12)	-	-	-	Y	1, 3
Thallium, filtered	1/5	6.2	4.8	MW2-6RI	0.26 (13)	2	2	5	-	1.7	Y	3
Vanadium, filtered	1/5	0.68	0.55 - 2.9	MW2-6RI	26	-	-	50	-	-	N	2
Zinc, filtered	1/5	98.5	7.9 - 19	MW3-6RI	1100	5000 (8)	-	5000	81	-	Y	3, 6

Notes:

- Not available or Not applicable.
- Bolded cell indicates that the maximum detected site concentration exceeds this criteria.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Tap Water Ingestion Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) Maximum Contaminant Level. (USEPA, October 1996).
- (3) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter II Environmental Health.
- (4) CDTEP, January 1996.
- (5) Connecticut Water Quality Standards, 1992. Chronic values for saltwater bodies and protection of human health values for water and organisms are presented.
- (6) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (7) No value promulgated by CTDEP, calculated value used.
- (8) Secondary MCL (SMCL) based on aesthetic water qualities.
- (9) Action Level.
- (10) Hexavalent chromium.
- (11) Current Connecticut Department of Public Health and Addiction Services Action Level.
- (12) Notification Level.
- (13) Thallic oxide.

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Unfiltered data, rather than filtered data, will be in quantitative risk assessment.
- (6) Maximum is greater than State AWQC only; chemical will not be quantitatively evaluated in the risk assessment.

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**95% UPPER CONFIDENCE LIMITS
ZONE 6 - SHALLOW SOIL (0-4 FT)
NSB - NLON, GROTON, CONNECTICUT**

PARAMETER	UNITS	DETECTS	COUNT	AVERAGE	W NORMAL	W LOGNORMAL	W TEST	DISTRIBUTION	UCL - NORMAL	UCL - LOGNORMAL	DETECTS - MAX	95% UCL ⁽¹⁾
ALUMINUM	mg/kg	4	4	5105	0.7461	0.7604	0.748	LOGNORMAL	5932.6018	6171.2733	6150	6150
ARSENIC	mg/kg	4	4	1.9	0.8839	0.8847	0.748	LOGNORMAL	2.2464	2.4071	2.2	2.2
BARIUM	mg/kg	4	4	35.1	0.8865	0.9189	0.748	LOGNORMAL	43.2719	47.2168	45	45
BERYLLIUM	mg/kg	2	4	0.14	0.9068	0.9099	0.748	LOGNORMAL	0.2243	0.7313	0.22	0.22
CALCIUM	mg/kg	4	4	1086.75	0.8559	0.9149	0.748	LOGNORMAL	1572.4392	2295.0822	1680	1680
CHROMIUM	mg/kg	4	4	11.575	0.8892	0.9049	0.748	LOGNORMAL	13.5516	14.2411	13.9	13.9
COBALT	mg/kg	4	4	4.025	0.7849	0.8105	0.748	LOGNORMAL	4.8808	5.2197	5.1	5.1
COPPER	mg/kg	4	4	14.225	0.8343	0.9157	0.748	LOGNORMAL	22.5115	43.4013	24.5	24.5
IRON	mg/kg	4	4	7950	0.804	0.8357	0.748	LOGNORMAL	9908.9579	10840.5785	10400	10400
LEAD	mg/kg	4	4	7.4	0.948	0.9544	0.748	LOGNORMAL	12.385	64.0634	12.4	12.4
MAGNESIUM	mg/kg	4	4	2540	0.7193	0.7504	0.748	LOGNORMAL	3541.6615	4469.4205	3810	3810
MANGANESE	mg/kg	4	4	151.25	0.9155	0.9269	0.748	LOGNORMAL	178.5112	189.2092	182	182
MERCURY	mg/kg	1	4	0.0138	0.6297	0.6297	0.748	NOT DEFINED	0.0343	3.8953	0.04	0.04
NICKEL	mg/kg	4	4	9.3	0.9205	0.933	0.748	LOGNORMAL	10.2363	10.5839	10.4	10.4
POTASSIUM	mg/kg	4	4	1450	0.7533	0.7735	0.748	LOGNORMAL	1759.0413	1879.8492	1840	1840
SODIUM	mg/kg	4	4	128.15	0.9345	0.9577	0.748	LOGNORMAL	166.3592	198.6735	172	172
VANADIUM	mg/kg	4	4	16.9	0.8841	0.9183	0.748	LOGNORMAL	22.0802	25.9436	23.1	23.1
ZINC	mg/kg	4	4	27.625	0.8475	0.893	0.748	LOGNORMAL	46.3774	134.6271	50.1	50.1
2-METHYLNAPHTHALENE	µg/kg	1	4	138.75	0.7005	0.6646	0.748	NOT DEFINED	224.451	9563.2879	30	30
ACENAPHTHENE	µg/kg	2	4	106	0.7849	0.8454	0.748	LOGNORMAL	206.9873	43657.4398	42	42
ACENAPHTHYLENE	µg/kg	1	4	138.5	0.7	0.664	0.748	NOT DEFINED	224.7865	11225.5613	29	29
ANTHRACENE	µg/kg	3	4	92.5	0.909	0.989	0.748	LOGNORMAL	165.522	1089.9062	86	86
BENZO(A)ANTHRACENE	µg/kg	4	4	170	0.9392	0.9208	0.748	NORMAL	310.8528	10971.5271	330	310.8528
BENZO(A)PYRENE	µg/kg	3	4	204	0.8836	0.9255	0.748	LOGNORMAL	417.6376	161343.7641	460	460
BENZO(B)FLUORANTHENE	µg/kg	3	4	150.5	0.9293	0.8137	0.748	NORMAL	249.3843	6116.8628	240	240
BENZO(G,H,I)PERYLENE	µg/kg	3	4	97.25	0.9927	0.9005	0.748	NORMAL	164.8851	3013.3163	110	110
BENZO(K)FLUORANTHENE	µg/kg	3	4	142.75	0.9885	0.946	0.748	NORMAL	269.4461	38308.4537	280	269.4461
BUTYLBENZYL PHTHALATE	µg/kg	2	4	95.75	0.7712	0.7479	0.748	NORMAL	200.2639	551208.6499	19	19
CARBAZOLE	µg/kg	1	4	138.25	0.6996	0.6633	0.748	NOT DEFINED	225.122	13301.6356	28	28
CHRYSENE	µg/kg	4	4	168.75	0.8983	0.982	0.748	LOGNORMAL	327.4958	8460.2698	360	360
DI-N-OCTYL PHTHALATE	µg/kg	1	4	135.5	0.7167	0.6726	0.748	NOT DEFINED	217.1037	6068.2391	32	32
DIBENZO(A,H)ANTHRACENE	µg/kg	1	4	140	0.7289	0.6877	0.748	NOT DEFINED	211.0785	1116.5374	50	50
DIBENZOFURAN	µg/kg	1	4	138.75	0.7005	0.6646	0.748	NOT DEFINED	224.451	9563.2879	30	30
FLUORANTHENE	µg/kg	4	4	222.5	0.9187	0.9743	0.748	LOGNORMAL	466.7241	178749.2031	500	500
FLUORENE	µg/kg	1	4	139.75	0.7023	0.6672	0.748	NOT DEFINED	223.1094	5438.7033	34	34
INDENO(1,2,3-CD)PYRENE	µg/kg	3	4	104.75	0.968	0.8491	0.748	NORMAL	174.4015	4236.0937	130	130
PHENANTHRENE	µg/kg	4	4	153.75	0.8984	0.9326	0.748	LOGNORMAL	310.0796	80645.0533	340	340
PYRENE	µg/kg	4	4	401.5	0.8579	0.9808	0.748	LOGNORMAL	888.3052	739820.5632	1000	1000
TPH	mg/kg	4	4	1327.5	0.7702	0.9921	0.748	LOGNORMAL	3452.1468	138909038.8	4000	4000

(1) The UCL Normal and UCL Lognormal values are the 95% UCL for normal and lognormal distributions, respectively; if these values exceeded the maximum concentration, then the maximum concentration was used as the 95% UCL. For undefined distributions, the maximum concentration was used as the 95%UCL.

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**95% UPPER CONFIDENCE LIMITS
ZONE 6 - SOILS (0-10 FT)
NSB - NLON, GROTON, CONNECTICUT**

PARAMETER	UNITS	DETECTS	COUNT	AVERAGE	W NORMAL	W LOGNORMAL	W TEST	DISTRIBUTION	UCL - NORMAL	UCL - LOGNORMAL	DETECTS - MAX	95% UCL ⁽¹⁾
ALUMINUM	mg/kg	8	8	4352.5	0.9628	0.915	0.818	NORMAL	5077.6029	5420.9168	6150	5077.6029
ARSENIC	mg/kg	8	8	1.7338	0.8914	0.7984	0.818	NORMAL	2.0123	2.1993	2.2	2.0123
BARIUM	mg/kg	8	8	29.8125	0.9504	0.9437	0.818	NORMAL	35.2131	37.31	45	35.2131
BERYLLIUM	mg/kg	2	8	0.1038	0.8401	0.9459	0.818	LOGNORMAL	0.1458	0.1786	0.22	0.1786
CALCIUM	mg/kg	8	8	911.875	0.7623	0.8733	0.818	LOGNORMAL	1135.6545	1163.3489	1680	1163.3489
CHROMIUM	mg/kg	8	8	9.5625	0.942	0.9304	0.818	NORMAL	11.3892	12.1692	13.9	11.3892
COBALT	mg/kg	8	8	3.4375	0.9475	0.9581	0.818	LOGNORMAL	4.0171	4.1966	5.1	4.1966
COPPER	mg/kg	8	8	11.2	0.7302	0.8701	0.818	LOGNORMAL	15.025	15.757	24.5	15.757
IRON	mg/kg	8	8	6468.75	0.9382	0.9752	0.818	LOGNORMAL	7821.2138	8262.1861	10400	8262.1861
LEAD	mg/kg	7	8	5.575	0.8898	0.9505	0.818	LOGNORMAL	8.0715	11.355	12.4	11.355
MAGNESIUM	mg/kg	8	8	2050	0.832	0.93	0.818	LOGNORMAL	2586.6685	2739.7189	3810	2739.7189
MANGANESE	mg/kg	8	8	131.8	0.9728	0.9378	0.818	NORMAL	155.4595	167.0918	182	155.4595
MERCURY	mg/kg	1	8	0.0089	0.497	0.7237	0.818	NOT DEFINED	0.0174	0.032	0.04	0.04
NICKEL	mg/kg	8	8	8.125	0.9395	0.8753	0.818	NORMAL	9.2664	9.7841	10.4	9.2664
POTASSIUM	mg/kg	8	8	1216.875	0.9428	0.9382	0.818	NORMAL	1455.6508	1560.5756	1840	1455.6508
SODIUM	mg/kg	8	8	107.1125	0.9602	0.9594	0.818	NORMAL	133.5767	149.2761	172	133.5767
VANADIUM	mg/kg	8	8	13.2875	0.8826	0.9434	0.818	LOGNORMAL	16.5416	17.4728	23.1	17.4728
ZINC	mg/kg	8	8	21.5375	0.7809	0.9279	0.818	LOGNORMAL	30.0326	33.3969	50.1	33.3969
2-METHYLNAPHTHALENE	µg/kg	1	8	159.375	0.4723	0.4452	0.818	NOT DEFINED	194.5748	324.8533	30	30
ACENAPHTHENE	µg/kg	2	8	143	0.5869	0.6059	0.818	NOT DEFINED	189.0405	441.3321	42	42
ACENAPHTHYLENE	µg/kg	1	8	159.25	0.4719	0.4448	0.818	NOT DEFINED	194.6855	331.864	29	29
ANTHRACENE	µg/kg	4	8	116.125	0.7953	0.8214	0.818	LOGNORMAL	163.8122	372.1217	86	86
BENZO(A)ANTHRACENE	µg/kg	6	8	154	0.8735	0.8223	0.818	NORMAL	214.9522	369.7127	330	214.9522
BENZO(A)PYRENE	µg/kg	4	8	192	0.7208	0.7346	0.818	NOT DEFINED	272.108	468.1831	460	460
BENZO(B)FLUORANTHENE	µg/kg	5	8	140.375	0.8872	0.7691	0.818	NORMAL	188.9621	368.2709	240	188.9621
BENZO(G,H,I)PERYLENE	µg/kg	4	8	127.375	0.8561	0.7754	0.818	NORMAL	165.9873	269.4009	110	110
BENZO(K)FLUORANTHENE	µg/kg	5	8	138.375	0.9236	0.8068	0.818	NORMAL	195.6161	488.5961	280	195.6161
BUTYLBENZYL PHTHALATE	µg/kg	4	8	101	0.7281	0.7569	0.818	NOT DEFINED	155.2362	555.8107	43	43
CARBAZOLE	µg/kg	1	8	159.125	0.4716	0.4443	0.818	NOT DEFINED	194.7962	339.4125	28	28
CHRYSENE	µg/kg	7	8	136.5	0.8676	0.9563	0.818	LOGNORMAL	207.5092	388.0301	360	360
DI-N-OCTYL PHTHALATE	µg/kg	1	8	157.75	0.5108	0.4648	0.818	NOT DEFINED	192.0937	306.4012	32	32
DIBENZO(A,H)ANTHRACENE	µg/kg	1	8	160	0.5231	0.4808	0.818	NOT DEFINED	190.1227	243.9468	50	50
DIBENZOFURAN	µg/kg	1	8	159.375	0.4723	0.4452	0.818	NOT DEFINED	194.5748	324.8533	30	30
FLUORANTHENE	µg/kg	7	8	167.875	0.8532	0.9784	0.818	LOGNORMAL	272.9788	773.4235	500	500
FLUORENE	µg/kg	1	8	159.875	0.4737	0.4472	0.818	NOT DEFINED	194.1321	301.3919	34	34
INDENO(1,2,3-CD)PYRENE	µg/kg	4	8	129.875	0.8631	0.7691	0.818	NORMAL	168.3334	277.9472	130	130
PHENANTHRENE	µg/kg	6	8	137.75	0.9082	0.9361	0.818	LOGNORMAL	204.7453	423.4508	340	340
PYRENE	µg/kg	7	8	275.625	0.7344	0.9754	0.818	LOGNORMAL	484.0578	1382.7675	1000	1000
TPH	mg/kg	8	8	958.75	0.6751	0.9595	0.818	LOGNORMAL	1818.3862	5653.7133	4000	4000

(1) The UCL Normal and UCL Lognormal values are the 95% UCL for normal and lognormal distributions, respectively; if these values exceeded the maximum concentration, then the maximum concentration was used as the 95% UCL. For undefined distributions, the maximum concentration was used as the 95% UCL.

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**SUMMARY OF MAXIMUM AND AVERAGE CONCENTRAIONS
ZONE 6 - GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT**

Parameter	Maximum Detected Concentration	Average Concentration
Semivolatile Organic Compounds (ug/L)		
ACENAPHTHENE	2.50	4.75
ACENAPHTHYLENE	0.70	4.30
FLUORANTHENE	3.55	5.01
FLUORENE	3.35	4.96
Metals (ug/L)		
ANTIMONY, FILTERED	2.03	1.44
BARIUM	124.50	57.80
BARIUM, FILTERED	374.00	136.10
CALCIUM	107,500.00	41,500.00
CALCIUM, FILTERED	101,450.00	39,237.50
CHROMIUM	0.89	1.39
COBALT	0.97	1.33
COBALT, FILTERED	1.04	1.35
IRON	588.00	154.09
IRON, FILTERED	566.50	149.56
LEAD	1.58	0.88
MAGNESIUM	26,850.00	8,902.50
MAGNESIUM, FILTERED	25,550.00	8,490.00
MANGANESE	448.00	211.25
MANGANESE, FILTERED	423.00	206.50
POTASSIUM	15,300.00	9,675.00
POTASSIUM, FILTERED	14,400.00	9,175.00
SODIUM	232,500.00	94,000.00
SODIUM, FILTERED	225,500.00	90,425.00
THALLIUM, FILTERED	4.30	2.88
VANADIUM, FILTERED	0.48	1.21
ZINC, FILTERED	98.50	29.52

00012

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 6
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

**HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.**

EXPOSURE SCENARIO: Construction Worker (All Soil), RME

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	480	IR:	0
EF:	120	EF:	120
Fi:	1	Fi:	1
ED:	1	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	365	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:		YOUTH:		ADULT/YOUTH (CANCER RISK):
CF:	2.25E-06 (AVG ANNUAL DOSE)	CF:	0.00E+00 (AVG ANNUAL DOSE)	CF: 3.22E-08

00013

00016

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 6
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Construction Worker (All Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
SA _c = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
SA _a = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	1
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	120
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	1
BW _c = BODY WEIGHT CHILD (KG):	1
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	2.55E-07
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	1.78E-05			

00017

00020

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER

SITE NAME: ZONE 6
 LOCATION: NSB-NLON, Groton, CT
 DATE: 2/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker, RME

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

$$DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DA_{event} = ABSORBED DOSE PER EVENT (MG/CM**2/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS:
 FOR ORGANICS:

$$DA_{event} = K_p \times C \times t_{event} \times CF$$

IF $t_{event} < t^*$, $DA_{event} = 2K_p \times C \times CF \times (6T \times t_{event} / 3.141592654)^{0.5}$
 IF $t_{event} > t^*$, $DA_{event} = K_p \times C \times CF \times ((t_{event} / (1 + B)) + (2T \times ((1 + 3B) / (1 + B))))$

WHERE: K_p = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MG/L)
 t_{event} = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1 L/1000 CM**3)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERIVED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

EV: 1
 ED: 1
 EF: 120
 A: 3800
 t_{event}: 8
 BW: 70
 AT(NON): 365
 AT(CAR): 25550

CONVERSION
 FACTOR (NONCAR) = 1.78E+01

CONVERSION
 FACTOR (CARCIN) = 2.55E-01

00021

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

ZONE 6

EXPOSURE SCENARIO: Construction Worker, RME

CHEMICAL	CONC. (MG/L)	ORGANIC OR INORGANIC?	t* (HR)	T (HR)	Kp (CM/HR)	B	DAevent
Antimony, filtered	0.002	I			1.00E-03		1.60E-08
Barium, filtered	0.374	I			1.00E-03		2.99E-06
Manganese	0.448	I			1.00E-03		3.58E-06
Thallium, filtered	0.0043	I			1.00E-03		3.44E-08

00022

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER WATER (PAGE THREE)

ZONE 6

EXPOSURE SCENARIO: Construction Worker, RME

CALCULATE DOSES:

CHEMICAL	ANNUAL DERMAL DOSE (MG/KG/DAY)	DERMAL RfD (MG/KG/DAY)	HAZARD INDEX DERMAL
Antimony, filtered	2.86E-07	4.00E-04	7.14E-04
Barium, filtered	5.34E-05	3.50E-03	1.53E-02
Manganese	6.40E-05	7.20E-04	8.88E-02
Thallium, filtered	6.14E-07	3.50E-06	1.75E-01

TOTAL RISK

2.80E-01

00023

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)

ZONE 6

EXPOSURE SCENARIO: Construction Worker, RME

CALCULATE INCREMENTAL CANCER RISKS:

CHEMICAL	LIFETIME AVERAGE DERMAL DOSE (MG/KG/DAY)	CSF DERMAL (KG/DAY/MG)	CANCER RISK DERMAL CONTACT
Antimony, filtered	4.08E-09	0.00E+00	0.00E+00
Barium, filtered	7.63E-07	0.00E+00	0.00E+00
Manganese	9.14E-07	0.00E+00	0.00E+00
Thallium, filtered	8.77E-09	0.00E+00	0.00E+00

TOTAL RISK

0.00E+00

00024

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 6
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker (All Soil), CTE

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	240	IR:	0
EF:	80	EF:	120
Fi:	1	Fi:	1
ED:	1	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	365	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:	YOUTH:	ADULT/YOUTH (CANCER RISK):
CF: 7.51E-07 (AVG ANNUAL DOSE)	CF: 0.00E+00 (AVG ANNUAL DOSE)	CF: 1.07E-08

00025

00028

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 6
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Construction Worker (All Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
SAC = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
SAa = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	0.2
ABS = ABSORPTION FRACTION:	Chemical Specific
EFc = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EFa = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	80
EDc = CHILD EXPOSURE DURATION (YEARS):	1
EDa = ADULT EXPOSURE DURATION (YEARS):	1
BWc = BODY WEIGHT CHILD (KG):	15
BWa = BODY WEIGHT ADULT (KG):	70
ATc = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
ATa = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / ((AT \text{ DAYS}) \times (BW \text{ KG}) \times (1 \text{ KG}/1E6 \text{ MG}))$

DOSEchild = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	3.40E-08
DOSEadult = (CF2)*(C)*(ABS)	CF2 =	2.38E-06			

00029

00032

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER

SITE NAME: ZONE 6
LOCATION: NSB-NLON, Groton, CT
DATE: 2/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS.
ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker, CTE

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

$$DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
DA_{event} = ABSORBED DOSE PER EVENT (MG/CM²/EVENT)
EV = EVENT FREQUENCY (EVENTS/DAY)
ED = EXPOSURE DURATION (YEARS)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM²)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)

FOR INORGANICS:
FOR ORGANICS:

$$DA_{event} = K_p \times C \times t_{event} \times CF$$
$$\text{IF } t_{event} < t^*, DA_{event} = 2K_p \times C \times CF \times (6T \times t_{event} / 3.141592654)^{0.5}$$
$$\text{IF } t_{event} > t^*, DA_{event} = K_p \times C \times CF \times ((t_{event} / (1 + B)) + (2T \times ((1 + 3B) / (1 + B))))$$

WHERE: K_p = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
C = CONCENTRATION OF CHEMICAL IN WATER (MG/L)
t_{event} = DURATION OF EVENT (HR/EVENT)
CF = CONVERSION FACTOR (1 L/1000 CM³)
t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
T = LAG TIME (HOUR)
B = PARTITIONING CONSTANT DERIVED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

EV:	1	CONVERSION	
ED:	1	FACTOR (NONCAR) =	1.19E+01
EF:	80		
A:	3800	CONVERSION	
t _{event} :	8	FACTOR (CARCIN) =	1.70E-01
BW:	70		
AT(NON):	365		
AT(CAR):	25550		

00033

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

ZONE 6

EXPOSURE SCENARIO: Construction Worker, CTE

CHEMICAL	CONC. (MG/L)	ORGANIC OR INORGANIC?	t* (HR)	T (HR)	Kp (CM/HR)	B	DAevent
Antimony, filtered	0.0014	I			1.00E-03		1.12E-08
Barium, filtered	0.136	I			1.00E-03		1.09E-06
Manganese	0.211	I			1.00E-03		1.69E-06
Thallium, filtered	0.0029	I			1.00E-03		2.32E-08

00034

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER WATER (PAGE THREE)

ZONE 6

EXPOSURE SCENARIO: Construction Worker, CTE

CALCULATE DOSES:

CHEMICAL	ANNUAL DERMAL DOSE (MG/KG/DAY)	DERMAL RfD (MG/KG/DAY)	HAZARD INDEX DERMAL
Antimony, filtered	1.33E-07	4.00E-04	3.33E-04
Barium, filtered	1.29E-05	3.50E-03	3.70E-03
Manganese	2.01E-05	7.20E-04	2.79E-02
Thallium, filtered	2.76E-07	3.50E-06	7.89E-02

TOTAL RISK

1.11E-01

00035

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)

ZONE 6

EXPOSURE SCENARIO: Construction Worker, CTE

CALCULATE INCREMENTAL CANCER RISKS:

CHEMICAL	LIFETIME AVERAGE DERMAL DOSE (MG/KG/DAY)	CSF DERMAL (KG/DAY/MG)	CANCER RISK DERMAL CONTACT
Antimony, filtered	1.90E-09	0.00E+00	0.00E+00
Barium, filtered	1.85E-07	0.00E+00	0.00E+00
Manganese	2.87E-07	0.00E+00	0.00E+00
Thallium, filtered	3.94E-09	0.00E+00	0.00E+00

TOTAL RISK

0.00E+00

00036

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 6
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), RME

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	100	IR:	0
EF:	150	EF:	120
Fi:	1	Fi:	1
ED:	25	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	9125	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:	YOUTH:	ADULT/YOUTH (CANCER RISK):
CF: 5.87E-07 (AVG ANNUAL DOSE)	CF: 0.00E+00 (AVG ANNUAL DOSE)	CF: 2.10E-07

00037

00040

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 6
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Full-Time Employees (Surface Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
S _{Ac} = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
S _{Aa} = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	1
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	25
BW _c = BODY WEIGHT CHILD (KG):	1
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	9125
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	7.97E-06
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	2.23E-05			

00041

00044

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 6
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), CTE

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		YOUTH:	
IR:	50	IR:	0
EF:	150	EF:	120
Fi:	1	Fi:	1
ED:	6	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	2190	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:	YOUTH:	ADULT/YOUTH (CANCER RISK):
CF: 2.94E-07 (AVG ANNUAL DOSE)	CF: 0.00E+00 (AVG ANNUAL DOSE)	CF: 2.52E-08

00045

00048

67000

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 6
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
S _{Ac} = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
S _{Aa} = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	0.2
ABS = ABSORPTION FRACTION:	Chemical Specific
E _{Fc} = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
E _{Fa} = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
E _{Dc} = CHILD EXPOSURE DURATION (YEARS):	1
E _{Da} = ADULT EXPOSURE DURATION (YEARS):	25
B _{Wc} = BODY WEIGHT CHILD (KG):	1
B _{Wa} = BODY WEIGHT ADULT (KG):	70
A _{Tc} = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
A _{Ta} = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	9125
A _T = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	1.59E-08
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	4.46E-06			

00052

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 6
LOCATION: NSB-NLON, GROTON, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), RME

RELEVANT EQUATIONS: $IEX = (C \times IF_{adj} \times F_i \times EF) / (AT \times CF)$ $IF_{adj} = (IR_c \times ED_c) / BW_c + (IR_a \times ED_a) / BW_a$

WHERE:

- C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
- IF_{adj} = AGE-ADJUSTED SOIL INGESTION FACTOR (MG YEAR/KG DAY)
- F_i = FRACTION FROM CONTAMINATED SOURCE (UNITLESS)
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- AT = AVERAGING TIME (DAYS)
- CF = CONVERSION FACTOR (1E+6 MG/KG)
- IR_c = CHILD INGESTION RATE (MG/DAY)
- ED_c = CHILD EXPOSURE DURATION (YEARS)
- BW_c = CHILD BODY WEIGHT (KG)
- IR_a = ADULT INGESTION RATE (MG/DAY)
- ED_a = ADULT EXPOSURE DURATION (YEARS)
- BW_a = ADULT BODY WEIGHT (KG)

ENTER INPUT PARAMETERS:

IR_c: 200
ED_c: 6
BW_c: 15
IR_a: 100
ED_a: 24
BW_a: 70
IF_{adj}: 114.28571
F_i: 1
EF: 150
AT(NONC): 10950
AT(CARC): 25550

DETERMINE CONVERSION FACTORS:

NONCARC = 1.57E-06 CARCIN = 6.71E-07

00053

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 6
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA_{adj} \times AF \times ABS \times EF) / (AT \times 1E6)$ $SA_{adj} = (SA_a \times ED_a) / BW_a + (SA_c \times ED_c) / BW_c$

WHERE:

- C = CONCENTRATION IN SOIL (MG/KG)
- SA_c = CHILD SKIN SURFACE AREA (SQ CM/DAY)
- SA_a = ADULT SKIN SURFACE AREA (SQ CM/DAY)
- AF = ADHERENCE FACTOR (MG/SQ CM)
- ABS = ABSORPTION FRACTION
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- ED_c = CHILD EXPOSURE DURATION (YEARS)
- ED_a = ADULT EXPOSURE DURATION (YEARS)
- BW_c = BODY WEIGHT CHILD (KG)
- BW_a = BODY WEIGHT ADULT (KG)
- AT_n = AVERAGING TIME (DAYS), NONCARCINOGENS
- AT_c = AVERAGING TIME (DAYS), CARCINOGENS
- SA_{adj} = AGE-ADJUSTED SKIN SURFACE AREA (SQ CM-YR/DAY-KG)

ENTER INPUT PARAMETERS

SA _c :	2094
SA _a :	3800
AF:	1
EF:	150
ED _c :	6
ED _a :	24
BW _c :	15
BW _a :	70
AT _n :	10950
AT _c :	25550
SA _{adj} :	2140

DETERMINE CONVERSION FACTORS:

NONCARC = 2.93E-05 CARCIN = 1.26E-05

00055

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 6
LOCATION: NSB-NLON, GROTON, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), CTE

RELEVANT EQUATIONS: $IEX = (C \times IFadj \times Fi \times EF) / (AT \times CF)$ $IFadj = (IRc \times EDc) / BWc + (IRa \times EDa) / BWa$

WHERE:

- C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
- IFadj = AGE-ADJUSTED SOIL INGESTION FACTOR (MG YEAR/KG DAY)
- Fi = FRACTION FROM CONTAMINATED SOURCE (UNITLESS)
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- AT = AVERAGING TIME (DAYS)
- CF = CONVERSION FACTOR (1E+6 MG/KG)
- IRc = CHILD INGESTION RATE (MG/DAY)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- BWc = CHILD BODY WEIGHT (KG)
- IRa = ADULT INGESTION RATE (MG/DAY)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWa = ADULT BODY WEIGHT (KG)

ENTER INPUT PARAMETERS:

IRc: 100
EDc: 2
BWc: 15
IRa: 50
EDa: 7
BWa: 70
IFadj: 18.333333
Fi: 0.5
EF: 150
AT(NONC): 3285
AT(CARC): 25550

DETERMINE CONVERSION FACTORS:

NONCARC = 4.19E-07 CARCIN = 5.38E-08

00057

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 6
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA_{adj} \times AF \times ABS \times EF) / (AT \times 1E6)$ $SA_{adj} = (SAa \times EDa) / BWa + (SAC \times EDc) / BWc$

WHERE:

- C = CONCENTRATION IN SOIL (MG/KG)
- SAC = CHILD SKIN SURFACE AREA (SQ CM/DAY)
- SAa = ADULT SKIN SURFACE AREA (SQ CM/DAY)
- AF = ADHERENCE FACTOR (MG/SQ CM)
- ABS = ABSORPTION FRACTION
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWc = BODY WEIGHT CHILD (KG)
- BWa = BODY WEIGHT ADULT (KG)
- ATn = AVERAGING TIME (DAYS), NONCARCINOGENS
- ATc = AVERAGING TIME (DAYS), CARCINOGENS
- SAadj = AGE-ADJUSTED SKIN SURFACE AREA (SQ CM-YR/DAY-KG)

ENTER INPUT PARAMETERS

SAC:	2094
SAa:	3800
AF:	0.2
EF:	150
EDc:	2
EDa:	7
BWc:	15
BWa:	70
ATn:	3285
ATc:	25550
SAadj:	659.2

DETERMINE CONVERSION FACTORS:

NONCARC = 6.02E-06 CARCIN = 7.74E-07

00059

APPENDIX I.11

ZONE 7

COC SCREENING FOR LOWER SUBBASE
 ZONE 7-SHALLOW SOIL (0-4 FEET)
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COPC? (4)	Rationale
Volatile Organic Compounds (mg/kg)													
ACETONE	2/10	0.009-0.023	0.003-0.008	0.005025	20TB5-0002 (93)	780	100000	0.8	500	1000	140	N	2
METHYLENE CHLORIDE	2/10	0.005	0.0025-0.003	0.0021	20TB4-0002 (93), 20TB5-0002 (93)	85	13	0.001	82	760	1	Y	3, 5
Semivolatile Organic Compounds (mg/kg)													
2-METHYLNAPHTHALENE	5/21	0.022-0.3	0.0825-2.75	0.181	LS7SB0110101	310	-	-	1000(5)	2500(5)	56(5)	N	2
4-CHLORO-3-METHYLPHENOL	1/21	0.034	0.0825-2.75	0.170	LS7SB0030201	-	-	-	-	-	-	Y	1
ACENAPHTHENE	6/21	0.019-0.62	0.0825-2.75	0.218	LS7SB0110101	470	-	29	1000(5)	2500(5)	84(5)	N	2
ACENAPHTHYLENE	6/21	0.029-0.6	0.0825-2.75	0.204	LS7SB0110101	-	-	-	1000	2500	84	N	2
ANTHRACENE	10/21	0.046-2.5	0.085-2.75	0.397	LS7SB0110101	2300	-	590	1000	2500	400	N	2
BENZO(A)ANTHRACENE	14/21	0.23-9.5	0.09-2.75	1.291	20MW6-0204 (93)	0.88	-	0.08	1	7.8	1	Y	3
BENZO(A)PYRENE	14/21	0.21-14	0.09-2.75	1.549	20MW6-0204 (93)	0.088	-	0.4	1	1	1	Y	3
BENZO(B)FLUORANTHENE	15/21	0.24-16	0.09-0.0975	2.137	20MW6-0204 (93)	0.88	-	0.2	1	7.8	1	Y	3
BENZO(G,H,I)PERYLENE	12/21	0.22-7.3	0.085-2.75	0.955	20MW6-0204 (93)	-	-	-	1000(5)	2500(5)	40(5)	N	2
BENZO(K)FLUORANTHENE	10/21	0.23-9.7	0.0825-2.75	0.784	20MW6-0204 (93)	8.8	-	2	-	78	1	Y	3
CARBAZOLE	9/21	0.017-0.95	0.085-2.75	0.230	LS7SB0110101	32	-	0.03	31(5)	290(5)	0.36(5)	Y	3, 5
CHRYSENE	14/21	0.25-11	0.09-2.75	1.394	20MW6-0204 (93)	88	-	8	84(5)	780(5)	0.96(5)	Y	3, 5
DI-N-BUTYL PHTHALATE	2/21	0.018-0.03	0.0825-2.75	0.169	LS7SB0070101	7800	2300	270	1000	2500	140	N	2
DIBENZO(A,H)ANTHRACENE	7/20	0.12-3.1	0.0825-2.75	0.406	LS7SB0110101	0.088	-	0.08	0.084(5)	0.78(5)	0.000096(5)	Y	3
DIBENZO(FURAN)	5/21	0.035-0.53	0.0825-2.75	0.202	LS7SB0110101	310	-	-	270(5)	2500(5)	5.6(5)	N	2
FLUORANTHENE	16/21	0.2-19	0.09-0.0975	2.929	20MW6-0204 (93)	310	-	210	1000	2500	56	N	2
FLUORENE	6/21	0.019-1.2	0.0825-2.75	0.252	LS7SB0110101	310	-	28	1000	2500	56	N	2
INDENO(1,2,3-CD)PYRENE	12/21	0.19-7	0.085-2.75	0.915	20MW6-0204 (93)	0.88	-	0.7	0.84(5)	7.8(5)	0.00096(5)	Y	3
NAPHTHALENE	3/21	0.056-0.51	0.0825-2.75	0.197	LS7SB0110101	310	-	4	1000	2500	56	N	2
PHENANTHRENE	15/21	0.14-13	0.09-0.0975	1.679	20MW3-0204 (93)	-	-	-	1000	2500	40	N	2
PYRENE	15/21	0.41-14	0.09-0.0975	2.462	20MW6-0204 (93)	230	-	210	1000	2500	40	N	2
Metals (mg/kg)													
ALUMINUM	14/14	136-7740	-	4789.714286	LS7SB01000201	7800	-	-	-	-	-	N	2
ANTIMONY	4/14	0.92-7.8	0.1025-1895	68.837232	20TB4-0002 (93)	3.1	-	0.3	27	8200	-	Y	3
ARSENIC	14/14	0.32-6	-	1.536429	LS7SB01000201	0.43	750	1	10	10	-	Y	3
BARIUM	14/14	24.1-364	-	69.985714	20TB4-0002 (93)	550	690000	82	4700	140000	-	Y	3, 5
BERYLLIUM	6/14	0.22-0.32	0.0125-0.0725	0.125625	LS7SB01000201	0.15	1300	3	2	2	-	Y	3
BORON	1/10	2.9	0.3-0.925	0.5125	20TB4-0002 (93)	700	-	-	-	-	-	N	2
CADMIUM	2/14	0.25-2	0.01-1.7	0.249821	LS7SB01000201	3.9	1800	0.4	34	1000	-	Y	3, 5
CHROMIUM (TOTAL)	13/14	4.1-16.9	1.025	7.986607	LS7SB01000201	39(6)	270	2	100(6)	100(6)	-	Y	3, 5
COBALT	12/14	1.1-5.3	0.65-0.7	2.883929	20MW4-0204 (93)	470	-	-	1000(5)	2500(5)	-	N	2
COPPER	14/14	3-122	-	31.092857	20MW5-0002 (93)	310	-	-	-	-	-	N	2
CYANIDE	1/10	0.18	0.04-0.0525	0.0385	20MW3-0204 (93)	160	-	2	1400	41000	-	N	2
IRON	14/14	4510-10400	-	6925	20MW4-0204 (93)	2300	-	-	-	-	-	Y	3, 4
LEAD	14/14	1.8-189000	-	13764.92857	20MW6-0204 (93)	400(7)	-	-	500	1000	-	Y	3
MANGANESE	14/14	32.7-162	-	114.821429	20TB4-0002 (93)	180	-	-	1600(5)	47000(5)	-	N	2
MERCURY	6/14	0.01-0.36	0.0025-0.3	0.064732	LS7SB01000201	2.3	-	-	20	610	-	N	2
NICKEL	14/14	1.8-12.8	-	6.492857	LS7SB01000201	160	13000	7	1400	7500	-	Y	3, 5
VANADIUM	14/14	1.9-21.6	-	12.557143	LS7SB01000201	55	-	300	470	14000	-	N	2
ZINC	14/14	13.6-961	-	169.05	LS7SB01000201	2300	-	620	20000	610000	-	Y	3, 5
Miscellaneous (mg/kg)													
TPH	11/11	45-2600	-	0.635	LS7SB01000201	-	-	-	500	2500	2500	Y	1, 3

00001

COC SCREENING FOR LOWER SUBBASE
ZONE 7-SHALLOW SOIL (0-4 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Notes:

- Not available or Not applicable.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Residential Soil Ingestion is used for soil and sediment. Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with dilution and attenuation factor (DAF) of 1.0 are used.
- (3) CTDEP, January 1996. State Pollutant Mobility criteria for metals are not included since a direct comparison of the aqueous SPLP criteria (in ug/L) and the soil analytical results (in mg/kg) cannot be made. TCLP and SPLP results for soil samples are addressed in The Nature and Extent Section of the RI Report.
- (4) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (5) No value promulgated by CTDEP, calculated or surrogate value is used. Ceiling limit is used if calculated or surrogate value exceeds the ceiling limit.
- (6) Hexavalent chromium.
- (7) Value is based on OSWER soil screening level for residential land use (USEPA, July 14, 1994).

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Maximum exceeds migration to groundwater criteria only; chemical will not be quantitatively evaluated in the risk assessment.

00002

COC SCREENING FOR LOWER SUBBASE
 ZONE 7-ALL SOIL (0-10 FEET)
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2

Parameter	Frequency	Range of Detection	Range of Nondetects	Average	Location of Maximum	COC Screening Level (1)	SSL Inhalation (2)	SSL Migration to Groundwater (2)	State Residential Direct Exposure (3)	State Industrial Direct Exposure (3)	State Pollutant Mobility (GB) (3)	Select as COPC7 (4)	Rationale
Volatile Organic Compounds (mg/kg)													
ACETONE	2/14	0.009-0.023	0.012-0.035	0.01075	20TB5-0406(93)	780	100000	0.8	500	1000	140	N	2
CARBON DISULFIDE	1/14	0.007	0.01-0.012	0.00560714	20MW5-0608 (93)	20000	720	2	500(5)	1000(5)	140(5)	N	2
METHYLENE CHLORIDE	2/14	0.005	0.01-0.013	0.00553571	20TB4-0002(93),20TB5-0002 (93), 20TB5-0406 (93)	85	13	0.001	82	760	1	Y	3, 5
Semivolatile Organic Compounds (mg/kg)													
2-METHYLNAPHTHALENE	11/36	0.022-0.3	0.33-11	0.476	LS7SB0110101	310	-	-	1000(5)	2500(5)	56(5)	N	2
4-CHLORO-3-METHYLPHENOL	1/36	0.034	0.33-11	0.502	LS7SB0030201	-	-	-	-	-	-	Y	1
ACENAPHTHENE	13/36	0.019-1.1	0.33-11	0.539	20MW3-0810 (93)	470	-	29	1000(5)	2500(5)	84(5)	N	2
ACENAPHTHYLENE	12/36	0.02-0.6	0.33-11	0.497	LS7SB0110101	-	-	-	1000	2500	84	N	2
ANTHRACENE	16/36	0.046-2.5	0.33-11	0.727	LS7SB0110101	2300	-	590	1000	2500	400	N	2
BENZO(A)ANTHRACENE	23/36	0.027-9.5	0.33-11	1.427	20MW6-0204 (93)	0.88	-	0.08	1	7.8	1	Y	3
BENZO(A)PYRENE	23/35	0.028-14	0.33-11	1.561	20MW6-0204 (93)	0.088	-	0.4	1	1	1	Y	3
BENZO(B)FLUORANTHENE	24/35	0.024-16	0.33-1.5	1.870	20MW6-0204 (93)	0.88	-	0.2	1	7.8	1	Y	3
BENZO(G,H,I)PERYLENE	20/35	0.028-7.3	0.33-11	1.072	20MW6-0204 (93)	-	-	-	1000(5)	2500(5)	40(5)	N	2
BENZO(K)FLUORANTHENE	15/35	0.023-9.7	0.33-11	0.833	20MW6-0204 (93)	8.8	-	2	8.4	78	1	Y	3
CARBAZOLE	15/36	0.017-0.95	0.33-11	0.545	LS7SB0110101	32	-	0.03	31(5)	290(5)	0.36(5)	Y	3, 5
CHRYSENE	23/36	0.036-11	0.33-11	1.483	20MW6-0204 (93)	88	-	8	84(5)	780(5)	0.96(5)	Y	3, 5
DI-N-BUTYL PHTHALATE	2/36	0.018-0.03	0.33-11	0.499	LS7SB0070101	7800	2300	270	1000	2500	140	N	2
DIBENZO(A,H)ANTHRACENE	14/34	0.021-3.1	0.33-11	0.720	LS7SB0110101	0.088	-	0.08	0.084(5)	0.78(5)	0.000096(5)	Y	3
DIBENZOFURAN	11/36	0.022-0.53	0.33-11	0.513	LS7SB0110101	310	-	-	270(5)	2500(5)	5.6(5)	N	2
FLUORANTHENE	28/36	0.018-19	0.36-0.39	2.700	20MW6-0204 (93)	310	-	210	1000	2500	56	N	2
FLUORENE	13/36	0.019-1.2	0.33-11	0.589	20MW3-0810 (93), LS7SB0110101	310	-	28	1000	2500	56	N	2
INDENO(1,2,3-CD)PYRENE	20/35	0.031-7	0.33-11	1.042	20MW6-0204 (93)	0.88	-	0.7	0.84(5)	7.8(5)	0.00096(5)	Y	3
NAPHTHALENE	9/36	0.041-0.51	0.33-11	0.505	LS7SB0110101	310	-	4	1000	2500	56	N	2
PHENANTHRENE	23/36	0.02-13	0.33-1.5	1.620	20MW3-0204 (93)	-	-	-	1000	2500	40	N	2
PYRENE	27/36	0.025-14	0.36-0.39	2.448	20MW6-0204 (93)	230	-	210	1000	2500	40	N	2
Metals (mg/kg)													
ALUMINUM	22/22	136-12000	-	5190.272	LS7SB0090201	7800	-	-	-	-	-	Y	3, 4
ANTIMONY	6/22	0.92-160	0.35-7580	181.502727	LS7SB01000301	3.1	-	0.3	27	8200	-	Y	3
ARSENIC	21/22	0.32-19	0.55	2.386136	LS7SB01000301	0.43	750	1	10	10	-	Y	3
BARIUM	22/22	20.3-364	-	65.177273	20MW5-0608	550	690000	82	4700	140000	-	Y	3, 5
BERYLLIUM	11/22	0.22-0.55	0.05-0.29	0.207273	LS7SB01000301	0.15	1300	3	2	2	-	Y	3
BORON	1/14	2.9	1.2-37	1.185714	20TB4-0002 (93)	700	-	-	6100(5)	18000(5)	-	N	2
CADMIUM	5/22	0.16-2	0.04-6.8	0.438864	LS7SB01000201	3.9	1800	0.4	34	1000	-	Y	3, 5
CHROMIUM (total)	20/22	4.1-16.9	4.1	8.704545	LS7SB01000201	39(6)	270	2	100(6)	100(6)	-	Y	3, 5
COBALT	19/22	1.1-5.3	2.2-2.8	3.245455	20MW4-0204 (93)	470	-	-	1000(5)	2500(5)	-	N	2
COPPER	22/22	3-5810	-	292277273	LS7SB01000301	310	-	-	-	-	-	Y	3, 4
CYANIDE	1/14	0.18	0.16-0.21	0.98571	20MW4-0204 (93)	160	-	2	1400	41000	-	N	2
IRON	22/22	4510-16000	-	7513.63636	LS7SB0090201	2300	-	-	-	-	-	Y	3, 4
LEAD	22/22	1.8-189000	-	9533.29091	20MW6-0204 (93)	400(7)	-	-	500	1000	-	Y	3
MANGANESE	22/22	32.7-253	-	119.322727	LS7SB0090201	180	-	-	1600(5)	47000(5)	-	Y	3
MERCURY	9/22	0.01-1.9	0.01-1.2	0.16727	LS7SB01000301	2.3	-	-	20	610	-	N	2
NICKEL	22/22	1.8-20.9	-	7.4	LS7SB01000301	160	13000	7	1400	7500	-	Y	3, 5
SELENIUM	2/22	0.44-2.5	0.14-33.3	7	LS7SB01000301	39	-	0.3	340	10000	-	Y	3, 5
SILVER	1/22	1.5	0.15-5.4	0.3518	LS7SB01000301	39	-	2	340	10000	-	N	2
VANADIUM	22/22	1.9-246	-	23.809091	LS7SB01000301	55	-	300	470	14000	-	Y	3
ZINC	22/22	13.1-1-1420	-	198.395455	LS7SB01000301	2300	-	620	20000	610000	-	Y	3, 5
Miscellaneous (mg/kg)													
TPH	15/15	45-2600	-	758.333333	LS7SB01000201	-	-	-	500	2500	2500	Y	1, 3

0010

COC SCREENING FOR LOWER SUBBASE
ZONE 7-ALL SOIL (0-10 FEET)
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Notes:

- Not available or Not applicable.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Residential Soil Ingestion is used for soil and sediment. Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) USEPA Soil Screening Levels (USEPA, May 1996). For migration to groundwater, values associated with dilution and attenuation factor (DAF) of 1.0 are used.
- (3) CTDEP, January 1996. State Pollutant Mobility criteria for metals are not included since a direct comparison of the aqueous SPLP criteria (in ug/L) and the soil analytical results (in mg/kg) cannot be made. TCLP and SPLP results for soil samples are addressed in The Nature and Extent Section of the RI Report.
- (4) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (5) No value promulgated by CTDEP, calculated or surrogate value is used. Ceiling limit is used if calculated or surrogate value exceeds the ceiling limit.
- (6) Hexavalent chromium.
- (7) Value is based on OSWER soil screening level for residential land use (USEPA, July 14, 1994).

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in the risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Maximum exceeds migration to groundwater criteria only; chemical will not be quantitatively evaluated in the risk assessment.

001100
401104

COC SCREENING FOR LOWER SUBBASE
 ZONE 7 - GROUNDWATER
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2

Parameter	Frequency	Range of Detection	Range of Nondetects	Location of Maximum	COC Screening Level (1)	EPA MCL (2)	State MCL (3)	State RSR Groundwater (4)	State AWQC		Selected as COC (6)	Rationale
									Saltwater (5)	Human Health (5)		
Volatiles (ug/L)												
1,1,1-Trichloroethane	1/6	0.6	1	20MW6	54	200	200	200	-	-	N	2
Chloroform	1/6	2	1	20MW4	0.15	100/80	100	6	-	5.7	Y	3
Trichloroethene	1/6	0.6	1	20MW6	1.6	5	5	5	-	2.7	N	2
Semivolatiles (ug/L)												
2-Methylnaphthalene	2/19	1 - 3	11 - 13	20MW7	150	-	-	280 (7)	-	-	N	2
Acenaphthene	7/19	0.6 - 10	11 - 13	20MW3	220	-	-	420 (7)	-	1200	N	2
Acenaphthylene	2/19	1	10 - 13	20MW3, 20MW4	-	-	-	420	-	0.0028	Y	3, 6
Anthracene	1/19	2	10 - 13	MW2-7RI	1100	-	-	2000	-	9600	N	2
Carbazole	1/19	1	10 - 13	MW2-7RI	3.4	-	-	108 (7)	-	-	N	2
Chrysene	1/19	0.9	10 - 13	MW2-7RI	9.2	-	-	4.8 (7)	-	0.0028	Y	3, 6
Dibenzofuran	1/19	1	10 - 13	MW2-7RI	15	-	-	28 (7)	-	-	N	2
Fluoranthene	2/18	1 - 5	10 - 13	MW2-7RI	150	-	-	280	-	300	N	2
Fluorene	3/19	2 - 3	10 - 13	20MW7, MW2-7RI	150	-	-	280	-	1300	N	2
Naphthalene	1/19	0.7	10 - 13	MW2-7RI	150	-	-	280	-	-	N	2
Phenanthrene	2/19	1 - 9	10 - 13	MW2-7RI	-	-	-	200	-	0.0028	Y	3, 6
Pyrene	2/19	1 - 5	10 - 13	MW2-7RI	110	-	-	200	-	960	N	2
Metals (ug/L)												
Aluminum	1/19	339	10 - 225	20MW3	3700	50 TO 200 (8)	-	-	-	-	Y	3, 4
Aluminum, filtered	5/19	133 - 163	10 - 169	20MW5	3700	50 TO 200 (8)	-	-	-	-	Y	3, 4
Antimony	5/19	9.3 - 15.7	2.5 - 30	20MW6	1.5	6	6	6	-	14	Y	3
Antimony, filtered	4/19	4.5 - 10.7	2.5 - 30	MW5-7RI	1.5	6	6	6	-	14	Y	3, 5
Arsenic	10/19	2.8 - 18.8	2.5 - 4.9	20MW7	0.045	50	50	50	36	0.018	Y	3
Arsenic, filtered	12/19	2.7 - 20	2 - 4.9	20MW7	0.045	50	50	50	36	0.018	Y	3, 5
Barium	15/19	7.9 - 966	27.3 - 72.8	20MW5	260	2000	2000	1000	-	-	Y	3
Barium, filtered	18/19	6.9 - 1200	72.8	20MW5	260	2000	2000	1000	-	-	Y	3, 5
Boron, filtered	5/6	241 - 939	261	20MW4	330	-	-	630 (7)	-	-	Y	3
Cadmium, filtered	1/19	3.1	0.22 - 2	20MW2	1.8	5	5	5	9.3	16	Y	3
Chromium (total)	1/19	2.9	0.68 - 4	20MW3	18 (10)	100	100	50	50 (10)	170 (10)	N	2
Cobalt	6/19	0.82 - 4.4	0.8 - 3	20MW2	220	-	-	420 (7)	-	-	N	2
Cobalt, filtered	4/19	0.83 - 3.1	0.8 - 3	20MW2	220	-	-	420 (7)	-	-	N	2
Copper	2/19	22.7 - 24.4	0.74 - 11.4	20MW6	150	1300 (9)	-	1300	2.4	1300	Y	3, 6
Copper, filtered	1/19	21.1	1.5 - 7.8	20MW6	150	1300 (9)	-	1300	2.4	1300	Y	3, 6
Iron	13/19	375 - 22600	44.3 - 1910	MW5-7RI	1100	300 (8)	-	-	-	-	Y	3, 4
Iron, filtered	16/19	28.3 - 20100	13 - 256	MW5-7RI	1100	300 (8)	-	-	-	-	Y	3, 4
Lead	9/19	6 - 117	1 - 2.2	20MW6	-	15 (9)	-	15	8.1	50	Y	3
Lead, filtered	7/19	1.5 - 97.5	1.3 - 1.6	20MW6	-	15 (9)	-	15	8.1	50	Y	3, 5
Manganese	16/19	28 - 3490	11.9 - 156	20MW2	84	50 (8)	5000 (11)	160 (7)	-	-	Y	3
Manganese, filtered	17/19	16.9 - 3600	11.4 - 152	20MW2	84	50 (8)	5000 (11)	160 (7)	-	-	Y	3, 5
Nickel	7/19	0.78 - 13.2	0.75 - 9	MW5-7RI	73	100	100	100	8.2	610	Y	3, 6
Nickel, filtered	7/19	0.93 - 16.1	0.75 - 9	MW5-7RI	73	100	100	100	8.2	610	Y	3, 6
Selenium	4/19	1.3 - 56.1	1 - 3.1	20MW7	18	50	50	50	71	100	Y	3
Selenium, filtered	1/19	1.2	1 - 1.9	20MW6	18	50	50	50	71	100	N	2

00005

COC SCREENING FOR LOWER SUBBASE
 ZONE 7 - GROUNDWATER
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 2 OF 2

Parameter	Frequency	Range of Detection	Range of Nondetects	Location of Maximum	COC Screening Level (1)	EPA MCL (2)	State MCL (3)	State RSR Groundwater (4)	State AWQC		Selected as COC (6)	Rationale
									Saltwater (5)	Human Health (5)		
Metals (ug/L)												
Sodium	19/19	11400 - 156000	-	20MW3	-	-	28000 (12)	-	-	-	Y	1, 3
Sodium, filtered	19/19	18600 - 148000	-	20MW2	-	-	28000 (12)	-	-	-	Y	1, 3
Thallium, filtered	4/19	1.2 - 2	1 - 4.8	20MW4	0.26 (13)	2	2	5	-	1.7	Y	3
Vanadium	1/19	2.3	0.55 - 5	20MW3	26	-	-	50	-	-	N	2
Vanadium, filtered	1/19	1.8	0.55 - 5	20MW3	26	-	-	50	-	-	N	2
Zinc	7/19	26.6 - 816	3.2 - 14.4	20MW6	1100	5000 (8)	-	5000	81	-	Y	3, 6
Zinc, filtered	15/19	3.5 - 780	3 - 15.5	20MW6	1100	5000 (8)	-	5000	81	-	Y	3, 6

Notes:

- Not available or Not applicable.
- Bolded cell indicates that the maximum detected site concentration exceeds this criteria.
- (1) Based on current USEPA Region III guidance (USEPA Region III, October 22, 1997). Tap Water Ingestion Value for noncarcinogens is based on a target hazard quotient of 0.1. Value for carcinogens is based on a cancer risk of 1E-6.
- (2) Maximum Contaminant Level. (USEPA, October 1996).
- (3) Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter II Environmental Health.
- (4) CDTEP, January 1996.
- (5) Connecticut Water Quality Standards, 1992. Chronic values for saltwater bodies and protection of human health values for water and organisms are presented.
- (6) Contaminant of Concern; Yes (Y) indicates the maximum concentration exceeds one or more criteria; No (N) indicates the maximum does not exceed any of the criteria.
- (7) No value promulgated by CTDEP, calculated value used.
- (8) Secondary MCL (SMCL) based on aesthetic water qualities.
- (9) Action Level.
- (10) Hexavalent chromium.
- (11) Current Connecticut Department of Public Health and Addiction Services Action Level.
- (12) Notification Level.
- (13) Thallic oxide.

Rational Designations:

- (1) No toxicity criteria available; exposure to chemical will be qualitatively addressed in risk assessment.
- (2) Maximum is less than all criteria.
- (3) Maximum is greater than or equal to one or more criteria.
- (4) USEPA Region I does not advocate quantitative evaluation of this chemical.
- (5) Unfiltered data, rather than filtered data, will be in quantitative risk assessment.
- (6) Maximum is greater than State AWQC only; chemical will not be quantitatively evaluated in the risk assessment.

90000

**95% UPPER CONFIDENCE LIMITS
ZONE 7 - SOILS (0 - 4 FT)
NSB - NLON, GROTON, CONNECTICUT**

PARAMETER	UNITS	DETECTS	COUNT	AVERAGE	W NORMAL	W LOGNORMAL	W TEST	DISTRIBUTION	UCL - NORMAL	UCL - LOGNORMAL	DETECTS - MAX	95% UCL ⁽¹⁾
ALUMINUM	mg/kg	14	14	4789.7143	0.9313	0.5367	0.874	NORMAL	5667.1989	13657.3042	7740	5667.1989
ANTIMONY	mg/kg	4	14	272.4732	0.2982	0.6196	0.874	UNDEFINED	751.6694	848.3836	7.8	7.8
ARSENIC	mg/kg	14	14	1.5364	0.6805	0.9603	0.874	LOGNORMAL	2.1988	2.5273	6	6
BARIUM	mg/kg	14	14	69.9857	0.5495	0.7529	0.874	UNDEFINED	114.1505	112.1754	364	364
BERYLLIUM	mg/kg	6	14	0.1661	0.939	0.9224	0.874	NORMAL	0.2108	0.2822	0.32	0.2108
BORON	mg/kg	1	10	1.18	0.7584	0.8839	0.842	LOGNORMAL	1.5897	1.6785	2.9	2.9
CADMIUM	mg/kg	2	14	0.5171	0.4905	0.7645	0.874	UNDEFINED	0.9743	1.3	2	2
CALCIUM	mg/kg	14	14	2512.2143	0.5087	0.8458	0.874	UNDEFINED	4558.374	4764.5913	16800	16800
CHROMIUM	mg/kg	13	14	8.0964	0.9278	0.9027	0.874	NORMAL	9.7587	11.0308	16.9	9.7587
COBALT	mg/kg	12	14	3.0286	0.9235	0.8714	0.874	NORMAL	3.6172	4.1152	5.3	3.6172
COPPER	mg/kg	14	14	31.0929	0.7819	0.9623	0.874	LOGNORMAL	47.1273	82.8462	122	122
CYANIDE	mg/kg	1	10	0.1	0.6048	0.694	0.842	UNDEFINED	0.1168	0.1157	0.18	0.18
IRON	mg/kg	14	14	6925	0.9458	0.9797	0.874	LOGNORMAL	7672.5771	7763.5107	10400	10400
LEAD	mg/kg	14	14	13764.9286	0.303	0.9198	0.874	LOGNORMAL	37638.3612	757883.4625	189000	189000
MAGNESIUM	mg/kg	14	14	1845.5643	0.9203	0.5598	0.874	NORMAL	2227.9538	5522.2521	3730	2227.9538
MANGANESE	mg/kg	14	14	114.8214	0.8719	0.6774	0.874	NORMAL	128.9446	144.0031	162	128.9446
MERCURY	mg/kg	6	14	0.1068	0.6162	0.9535	0.874	LOGNORMAL	0.1866	0.3881	0.36	0.36
NICKEL	mg/kg	14	14	6.4929	0.9579	0.9567	0.874	LOGNORMAL	8.0406	9.387	12.8	12.8
POTASSIUM	mg/kg	14	14	1212.8571	0.97	0.6672	0.874	NORMAL	1480.2191	2889.814	2370	1480.2191
SODIUM	mg/kg	13	14	110.1893	0.9407	0.7998	0.874	NORMAL	128.6644	150.2311	164	128.6644
VANADIUM	mg/kg	14	14	12.5571	0.9667	0.7752	0.874	NORMAL	14.9302	18.9576	21.6	14.9302
ZINC	mg/kg	14	14	169.05	0.6067	0.9255	0.874	LOGNORMAL	299.1488	557.35	961	961
ACETONE	µg/kg	2	10	10.5	0.8143	0.9011	0.842	LOGNORMAL	13.6572	14.5206	23	23
METHYLENE CHLORIDE	µg/kg	2	10	5.4	0.7943	0.7926	0.842	UNDEFINED	5.5833	5.9778	5	5
2-METHYLNAPHTHALENE	µg/kg	5	21	661.4762	0.3729	0.7374	0.908	UNDEFINED	1267.5154	1156.5037	300	300
4-CHLORO-3-METHYLPHENOL	µg/kg	1	21	675.6667	0.3519	0.5108	0.908	UNDEFINED	1279.5243	838.9663	34	34
ACENAPHTHENE	µg/kg	6	21	692.8095	0.3902	0.7548	0.908	UNDEFINED	1296.0612	1162.9831	620	620
ACENAPHTHYLENE	µg/kg	6	21	678.3333	0.3844	0.7335	0.908	UNDEFINED	1283.1805	1055.6987	600	600
ANTHRACENE	µg/kg	10	21	847.8571	0.4964	0.7843	0.908	UNDEFINED	1463.6746	1566.9045	2500	2500
BENZO(A)ANTHRACENE	µg/kg	14	21	1527.1429	0.5805	0.8543	0.908	UNDEFINED	2497.2102	3096.4082	9500	9500
BENZO(A)PYRENE	µg/kg	14	21	1784.7619	0.5165	0.8499	0.908	UNDEFINED	3095.8224	3512.2232	14000	14000
BENZO(B)FLUORANTHENE	µg/kg	15	21	2176.1905	0.537	0.8718	0.908	UNDEFINED	3715.2553	4865.903	16000	16000
BENZO(G,H,I)PERYLENE	µg/kg	12	21	1203.0952	0.5431	0.7988	0.908	UNDEFINED	1986.1451	2193.6309	7300	7300
BENZO(K)FLUORANTHENE	µg/kg	10	21	1044.5238	0.4281	0.7471	0.908	UNDEFINED	1907.5551	1521.7978	9700	9700
CARBAZOLE	µg/kg	9	21	687	0.4159	0.8646	0.908	UNDEFINED	1293.7701	1652.9549	950	950
CHRYSENE	µg/kg	14	21	1629.5238	0.56	0.8625	0.908	UNDEFINED	2709.5681	3280.6342	11000	11000
DI-N-BUTYL PHTHALATE	µg/kg	2	21	669.1905	0.359	0.6163	0.908	UNDEFINED	1273.9914	1017.9383	30	30
DIBENZO(A,H)ANTHRACENE	µg/kg	7	20	892	0.4817	0.6539	0.905	UNDEFINED	1550.9427	1451.0723	3100	3100
DIBENZOFURAN	µg/kg	5	21	683.1905	0.3761	0.6667	0.908	UNDEFINED	1286.98	974.7063	530	530
FLUORANTHENE	µg/kg	16	21	2961.9048	0.5911	0.8989	0.908	UNDEFINED	4927.946	8620.294	19000	19000
FLUORENE	µg/kg	6	21	726.1429	0.4163	0.7698	0.908	UNDEFINED	1329.9829	1257.8729	1200	1200
INDENO(1,2,3-CD)PYRENE	µg/kg	12	21	1163.0952	0.5398	0.7795	0.908	UNDEFINED	1924.9015	2089.0024	7000	7000
NAPHTHALENE	µg/kg	3	21	699.4762	0.3811	0.6493	0.908	UNDEFINED	1301.4028	932.1107	510	510
PHENANTHRENE	µg/kg	15	21	1718.5714	0.5641	0.7847	0.908	UNDEFINED	2926.7258	4276.2086	13000	13000
PYRENE	µg/kg	15	21	2501.4286	0.6233	0.8927	0.908	UNDEFINED	4019.8054	6854.1908	14000	14000

(1) The UCL Normal and UCL Lognormal values are the UCL for normal and lognormal distributions, respectively; if these values exceeded the maximum concentration, then the maximum concentration was used as the 95% UCL. For undefined distributions, the maximum concentration was used as the 95% UCL.

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95 % UPPER CONFIDENCE LIMITS
 ZONE 7 - SOILS (0 - 10 FT)
 NSB - NLON, GROTON, CONNECTICUT

PARAMETER	UNITS	DETECTS	COUNT	AVERAGE	W NORMAL	W LOGNORMAL	W TEST	DISTRIBUTION	UCL - NORMAL	UCL - LOGNORMAL	DETECTS - MAX	95% UCL ⁽¹⁾
ALUMINIUM	mg/kg	22	22	5190.2727	0.9238	0.601	0.911	NORMAL	6033.5578	9525.7421	12000	
ANTIMONY	mg/kg	6	22	181.5027	0.236	0.7556	0.911	UNDEFINED	477.487	235.1194	160	
ARSENIC	mg/kg	21	22	2.3861	0.4931	0.9452	0.911	LOGNORMAL	3.8524	3.9079	19	
BARIUM	mg/kg	22	22	65.1773	0.587	0.8349	0.911	UNDEFINED	93.939	88.7694	364	
BERYLLIUM	mg/kg	11	22	0.2073	0.8984	0.9557	0.911	LOGNORMAL	0.2597	0.3204	0.55	
BORON	mg/kg	1	14	1.1857	0.8016	0.9199	0.874	LOGNORMAL	1.4796	1.5151	2.9	
CADMIUM	mg/kg	5	22	0.4389	0.5003	0.8474	0.911	UNDEFINED	0.7324	0.9008	2	
CALCIUM	mg/kg	22	22	2437.3636	0.5502	0.8558	0.911	UNDEFINED	3847.5853	3738.2519	16800	
CHROMIUM	mg/kg	20	22	8.7045	0.9402	0.9165	0.911	NORMAL	10.2604	11.5779	16.9	
COBALT	mg/kg	19	22	3.2455	0.9092	0.8402	0.911	UNDEFINED	3.7301	4.1587	5.3	
COPPER	mg/kg	22	22	292.2773	0.2399	0.8395	0.911	UNDEFINED	744.6528	301.4536	5810	
CYANIDE	mg/kg	1	14	0.0986	0.5852	0.6901	0.874	UNDEFINED	0.1102	0.1087	0.18	
IRON	mg/kg	22	22	7513.6364	0.8268	0.945	0.911	LOGNORMAL	8433.2258	8410.9141	16000	
LEAD	mg/kg	22	22	9533.2909	0.2514	0.9578	0.911	LOGNORMAL	24277.5969	212339.019	189000	189000
MAGNESIUM	mg/kg	22	22	1847.1773	0.9266	0.5328	0.911	NORMAL	2104.02	3369.6634	3730	
MANGANESE	mg/kg	22	22	119.3227	0.8418	0.8247	0.911	UNDEFINED	134.1665	139.9799	253	
MERCURY	mg/kg	9	22	0.1627	0.4069	0.9267	0.911	LOGNORMAL	0.3139	0.3548	1.9	
NICKEL	mg/kg	22	22	7.4	0.8988	0.9823	0.911	LOGNORMAL	9.0256	9.9378	20.9	
POTASSIUM	mg/kg	22	22	1237.7273	0.9722	0.6257	0.911	NORMAL	1413.7507	2014.4191	2370	
SELENIUM	mg/kg	2	22	0.2757	0.4023	0.7312	0.911	UNDEFINED	0.4686	0.3438	2.5	
SILVER	mg/kg	1	22	0.3759	0.4544	0.8131	0.911	UNDEFINED	0.5937	0.5168	1.5	
SODIUM	mg/kg	21	22	134.7614	0.8882	0.8938	0.911	UNDEFINED	157.9684	172.1506	278	
VANADIUM	mg/kg	22	22	23.8091	0.3122	0.7756	0.911	UNDEFINED	42.1248	29.4311	246	
ZINC	mg/kg	22	22	198.3955	0.5713	0.9221	0.911	LOGNORMAL	328.279	504.0796	1420	
ACETONE	µg/kg	2	14	10.75	0.839	0.9226	0.874	LOGNORMAL	13.0997	13.4932	23	
CARBON DISULFIDE	µg/kg	1	14	5.6071	0.7332	0.761	0.874	UNDEFINED	5.8379	6.1343	7	
METHYLENE CHLORIDE	µg/kg	2	14	5.5357	0.8353	0.8433	0.874	UNDEFINED	5.7318	6.1315	5	
2-METHYLNAPHTHALENE	µg/kg	11	36	476.4167	0.3281	0.8047	0.935	UNDEFINED	827.2351	550.1311	300	
4-CHLORO-3-METHYLPHENOL	µg/kg	1	36	502.4722	0.3011	0.5263	0.935	UNDEFINED	850.9306	477.9856	34	
ACENAPHTHENE	µg/kg	13	36	539.3889	0.3656	0.8178	0.935	UNDEFINED	888.4839	670.5051	1100	
ACENAPHTHYLENE	µg/kg	12	36	497.4167	0.3414	0.8176	0.935	UNDEFINED	847.4025	582.423	600	
ANTHRACENE	µg/kg	16	36	727.0833	0.5088	0.8578	0.935	UNDEFINED	1087.0617	1009.6241	2500	
BENZO(A)ANTHRACENE	µg/kg	23	36	1427.2778	0.6494	0.9508	0.935	LOGNORMAL	2046.8357	3450.8713	9500	
BENZO(A)PYRENE	µg/kg	23	35	1561.4286	0.5593	0.9677	0.934	LOGNORMAL	2370.239	3415.6828	14000	
BENZO(B)FLUORANTHENE	µg/kg	24	35	1870.2857	0.5763	0.9723	0.934	LOGNORMAL	2824.6283	4582.6169	16000	
BENZO(G,H,I)PERYLENE	µg/kg	20	35	1072	0.6011	0.9394	0.934	LOGNORMAL	1553.1732	1866.0152	7300	
BENZO(K)FLUORANTHENE	µg/kg	15	35	833.4286	0.4237	0.8821	0.934	UNDEFINED	1353.1756	1138.337	9700	
CARBAZOLE	µg/kg	15	36	544.7778	0.3894	0.8918	0.935	UNDEFINED	894.8792	814.6183	950	
CHRYSENE	µg/kg	23	36	1482.5278	0.6237	0.9568	0.935	LOGNORMAL	2155.6121	3252.8608	11000	
DI-N-BUTYL PHTHALATE	µg/kg	2	36	498.6944	0.3069	0.6038	0.935	UNDEFINED	847.5242	521.6775	30	
DIBENZO(A,H)ANTHRACENE	µg/kg	14	34	719.7941	0.4891	0.8775	0.933	UNDEFINED	1107.5014	1107.5559	3100	
DIBENZOFURAN	µg/kg	11	36	512.9722	0.3379	0.7864	0.935	UNDEFINED	861.4781	581.1593	530	
FLUORANTHENE	µg/kg	28	36	2700.25	0.6537	0.9653	0.935	LOGNORMAL	3926.2244	10735.3945	19000	
FLUORENE	µg/kg	13	36	588.6944	0.4072	0.8459	0.935	UNDEFINED	938.731	755.7118	1200	
INDENO(1,2,3-CD)PYRENE	µg/kg	20	35	1041.5714	0.6001	0.9311	0.934	UNDEFINED	1509.8879	1770.3169	7000	
NAPHTHALENE	µg/kg	9	36	505	0.3334	0.7526	0.935	UNDEFINED	854.0245	519.2063	510	
PHENANTHRENE	µg/kg	23	36	1620.4444	0.6113	0.9038	0.935	UNDEFINED	2402.4496	3947.8122	13000	
PYRENE	µg/kg	27	36	2447.7778	0.6752	0.9543	0.935	LOGNORMAL	3493.0077	8287.0139	14000	

(1) The UCL Normal and UCL Lognormal values are the UCL for normal and lognormal distributions, respectively; if these values exceeded the maximum concentration, then the maximum concentration was used as the 95% UCL. For undefined distributions, the maximum concentration was used as the 95% UCL.

6000

00010

**SUMMARY OF MAXIMUM AND AVERAGE CONCENTRATIONS
 ZONE 7 - GROUNDWATER
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 1 OF 2**

Parameter	Maximum Detected Concentration	Average Concentration
Volatile Organic Compounds (ug/L)		
1,1,1-TRICHLOROETHANE	0.60	0.52
CHLOROFORM	2.00	0.75
TRICHLOROETHENE	0.60	0.52
Semivolatile Organic Compound (ug/L)		
2-METHYLNAPHTHALENE	2.00	5.68
ACENAPHTHENE	10.00	4.78
ACENAPHTHYLENE	1.00	5.14
ANTHRACENE	2.00	5.64
CARBAZOLE	1.00	5.55
CHRYSENE	0.90	5.54
DIBENZOFURAN	1.00	5.55
FLUORANTHENE	5.00	5.45
FLUORENE	3.00	5.09
NAPHTHALENE	0.70	5.52
PHENANTHRENE	9.00	5.82
PYRENE	5.00	5.45
Metals (ug/L)		
ALUMINUM	217.25	56.14
ALUMINUM, FILTERED	101.63	50.86
ANTIMONY	13.75	6.80
ANTIMONY, FILTERED	10.30	5.98
ARSENIC	11.00	5.14
ARSENIC, FILTERED	11.23	5.23
BARIUM	682.00	106.26
BARIUM, FILTERED	791.00	274.00
BORON, FILTERED	939.00	394.42
CADMIUM, FILTERED	1.61	0.46
CALCIUM	73,500.00	35,421.82
CALCIUM, FILTERED	70,300.00	34,235.91
CHROMIUM	2.45	1.31
COBALT	2.40	1.29
COBALT, FILTERED	1.75	1.18
COPPER	14.96	3.30
COPPER, FILTERED	12.39	2.25
IRON	22,250.00	4,171.59
IRON, FILTERED	19,550.00	3,883.77
LEAD	105.15	12.28
LEAD, FILTERED	59.40	6.18
MAGNESIUM	14,910.00	8,401.14
MAGNESIUM, FILTERED	15,290.00	8,217.50
MANGANESE	2,188.00	535.30

00011

SUMMARY OF MAXIMUM AND AVERAGE CONCENTRATIONS
ZONE 7 - GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT
PAGE 2 OF 2

Parameter	Maximum Detected Concentration	Average Concentration
Metals (ug/L)		
MANGANESE, FILTERED	2,256.00	517.70
NICKEL	13.20	5.17
NICKEL, FILTERED	13.60	5.64
POTASSIUM	20,100.00	10,575.45
POTASSIUM, FILTERED	19,800.00	10,397.05
SELENIUM	28.30	4.29
SELENIUM, FILTERED	1.08	0.86
SODIUM	128,000.00	65,088.64
SODIUM, FILTERED	135,500.00	71,788.64
THALLIUM, FILTERED	2.20	2.08
VANADIUM	2.40	1.36
VANADIUM, FILTERED	2.15	1.36
ZINC	580.00	99.69
ZINC, FILTERED	576.00	128.75

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 7
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

**HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.**

EXPOSURE SCENARIO: Construction Worker (All Soil), RME

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		CHILD:	
IR:	480	IR:	0
EF:	120	EF:	120
Fi:	1	Fi:	1
ED:	1	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	365	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:		CHILD:		ADULT/CHILD (CANCER RISK):
CF:	2.25E-06 (AVG ANNUAL DOSE)	CF:	0.00E+00 (AVG ANNUAL DOSE)	CF: 3.22E-08

00013

00016

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 7
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Construction Worker (All Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
S _{Ac} = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
S _{Aa} = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	1
ABS = ABSORPTION FRACTION:	Chemical Specific
E _{Fc} = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
E _{Fa} = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	120
E _{Dc} = CHILD EXPOSURE DURATION (YEARS):	1
E _{Da} = ADULT EXPOSURE DURATION (YEARS):	1
B _{Wc} = BODY WEIGHT CHILD (KG):	1
B _{Wa} = BODY WEIGHT ADULT (KG):	70
A _{Tc} = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
A _{Ta} = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
A _T = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) \times (BW \text{ KG}) \times (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	2.55E-07
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	1.78E-05			

00017

00020

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER

SITE NAME: ZONE 7
 LOCATION: NSB-NLON, Groton, CT
 DATE: 2/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker, RME

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

$$DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DA_{event} = ABSORBED DOSE PER EVENT (MG/CM**2/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS:
 FOR ORGANICS:

$$DA_{event} = K_p \times C \times t_{event} \times CF$$

$$\text{IF } t_{event} < t^*, DA_{event} = 2K_p \times C \times CF \times (6T \times t_{event} / 3.141592654)^{0.5}$$

$$\text{IF } t_{event} > t^*, DA_{event} = K_p \times C \times CF \times ((t_{event} / (1 + B)) + (2T \times ((1 + 3B) / (1 + B))))$$

WHERE: K_p = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MG/L)
 t_{event} = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1 L/1000 CM**3)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERIVED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

EV:	1	CONVERSION	
ED:	1	FACTOR (NONCAR) =	1.78E+01
EF:	120		
A:	3800	CONVERSION	
t _{event} :	8	FACTOR (CARCIN) =	2.55E-01
BW:	70		
AT(NON):	365		
AT(CAR):	25550		

00021

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

ZONE 7

EXPOSURE SCENARIO: Construction Worker, RME

CHEMICAL	CONC. (MG/L)	ORGANIC OR INORGANIC?	t* (HR)	T (HR)	Kp (CM/HR)	B	DAevent
Chloroform	0.002	O	1.10E+00	4.70E-01	8.90E-03	9.30E-03	1.58E-07
Antimony	0.0138	I			1.00E-03		1.10E-07
Arsenic	0.011	I			1.00E-03		8.80E-08
Barium	0.682	I			1.00E-03		5.46E-06
Boron, filtered	0.939	I			1.00E-03		7.51E-06
Cadmium, filtered	0.0016	I			1.00E-03		1.28E-08
Manganese	2.19	I			1.00E-03		1.75E-05
Selenium	0.0283	I			1.00E-03		2.26E-07
Thallium, filtered	0.002	I			1.00E-03		1.60E-08

00022

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER WATER (PAGE THREE)

ZONE 7

EXPOSURE SCENARIO: Construction Worker, RME

CALCULATE DOSES:

CHEMICAL	ANNUAL DERMAL DOSE (MG/KG/DAY)	DERMAL RfD (MG/KG/DAY)	HAZARD INDEX DERMAL
Chloroform	2.82E-06	1.00E-02	2.82E-04
Antimony	1.97E-06	4.00E-04	4.93E-03
Arsenic	1.57E-06	2.80E-04	5.61E-03
Barium	9.74E-05	3.50E-03	2.78E-02
Boron, filtered	1.34E-04	4.50E-03	2.98E-02
Cadmium, filtered	2.28E-07	2.50E-05	9.14E-03
Manganese	3.13E-04	7.20E-04	4.34E-01
Selenium	4.04E-06	1.00E-03	4.04E-03
Thallium, filtered	2.86E-07	3.50E-06	8.16E-02

TOTAL RISK

5.97E-01

00023

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)

ZONE 7

EXPOSURE SCENARIO: Construction Worker, RME

CALCULATE INCREMENTAL CANCER RISKS:

CHEMICAL	LIFETIME AVERAGE DERMAL DOSE (MG/KG/DAY)	CSF DERMAL (KG/DAY/MG)	CANCER RISK DERMAL CONTACT
Chloroform	4.03E-08	6.10E-03	2.46E-10
Antimony	2.81E-08	0.00E+00	0.00E+00
Arsenic	2.24E-08	1.60E+00	3.59E-08
Barium	1.39E-06	0.00E+00	0.00E+00
Boron, filtered	1.92E-06	0.00E+00	0.00E+00
Cadmium, filtered	3.26E-09	0.00E+00	0.00E+00
Manganese	4.47E-06	0.00E+00	0.00E+00
Selenium	5.77E-08	0.00E+00	0.00E+00
Thallium, filtered	4.08E-09	0.00E+00	0.00E+00

TOTAL RISK

3.61E-08

00024

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 7
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

**HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.**

EXPOSURE SCENARIO: Construction Worker (All Soil), CTE

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		CHILD:	
IR:	240	IR:	0
EF:	80	EF:	120
Fi:	1	Fi:	1
ED:	1	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	365	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:		CHILD:		ADULT/CHILD (CANCER RISK):
CF:	7.51E-07 (AVG ANNUAL DOSE)	CF:	0.00E+00 (AVG ANNUAL DOSE)	CF: 1.07E-08

00025

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 7
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Construction Worker (All Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
Sa _c = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
Sa _a = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	0.2
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	80
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	1
BW _c = BODY WEIGHT CHILD (KG):	15
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	365
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	3.40E-08
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	2.38E-06			

00029

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER

SITE NAME: ZONE 7
LOCATION: NSB-NLON, Groton, CT
DATE: 2/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Construction Worker, CTE

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

$$DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DA_{event} = ABSORBED DOSE PER EVENT (MG/CM²/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM²)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS: DA_{event} = K_p x C x t_{event} x CF
FOR ORGANICS: IF t_{event} < t*, DA_{event} = 2K_p x C x CF x (6T x t_{event}/3.141592654)^{0.5}
 IF t_{event} > t*, DA_{event} = K_p x C x CF x ((t_{event}/(1 + B)) + (2T x ((1+3B)/(1 + B))))

WHERE: K_p = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MG/L)
 t_{event} = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1 L/1000 CM³)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERIVED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

EV:	1	CONVERSION	
ED:	1	FACTOR (NONCAR) =	1.19E+01
EF:	80		
A:	3800	CONVERSION	
t _{event} :	8	FACTOR (CARCIN) =	1.70E-01
BW:	70		
AT(NON):	365		
AT(CAR):	25550		

00033

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

ZONE 7

EXPOSURE SCENARIO: Construction Worker, CTE

CHEMICAL	CONC. (MG/L)	ORGANIC OR INORGANIC?	t* (HR)	T (HR)	Kp (CM/HR)	B	DAevent
Chloroform	0.00075	O	1.10E+00	4.70E-01	8.90E-03	9.30E-03	5.93E-08
Antimony	0.0068	I			1.00E-03		5.44E-08
Arsenic	0.0051	I			1.00E-03		4.08E-08
Barium	0.106	I			1.00E-03		8.48E-07
Boron, filtered	0.394	I			1.00E-03		3.15E-06
Cadmium, filtered	0.00046	I			1.00E-03		3.68E-09
Manganese	0.535	I			1.00E-03		4.28E-06
Selenium	0.0043	I			1.00E-03		3.44E-08
Thallium, filtered	0.002	I			1.00E-03		1.60E-08

00034

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER WATER (PAGE THREE)

ZONE 7

EXPOSURE SCENARIO: Construction Worker, CTE

CALCULATE DOSES:

CHEMICAL	ANNUAL DERMAL DOSE (MG/KG/DAY)	DERMAL RfD (MG/KG/DAY)	HAZARD INDEX DERMAL
Chloroform	7.06E-07	1.00E-02	7.06E-05
Antimony	6.47E-07	4.00E-04	1.62E-03
Arsenic	4.85E-07	2.80E-04	1.73E-03
Barium	1.01E-05	3.50E-03	2.88E-03
Boron, filtered	3.75E-05	4.50E-03	8.33E-03
Cadmium, filtered	4.38E-08	2.50E-05	1.75E-03
Manganese	5.09E-05	7.20E-04	7.07E-02
Selenium	4.09E-07	1.00E-03	4.09E-04
Thallium, filtered	1.90E-07	3.50E-06	5.44E-02

TOTAL RISK

1.42E-01

00035

RISK ASSESSMENT SPREADSHEET - DERMAL CONTACT WITH GROUNDWATER (PAGE FOUR)

ZONE 7

EXPOSURE SCENARIO: Construction Worker, CTE

CALCULATE INCREMENTAL CANCER RISKS:

CHEMICAL	LIFETIME AVERAGE DERMAL DOSE (MG/KG/DAY)	CSF DERMAL (KG/DAY/MG)	CANCER RISK DERMAL CONTACT
Chloroform	1.01E-08	6.10E-03	6.15E-11
Antimony	9.25E-09	0.00E+00	0.00E+00
Arsenic	6.93E-09	1.60E+00	1.11E-08
Barium	1.44E-07	0.00E+00	0.00E+00
Boron, filtered	5.36E-07	0.00E+00	0.00E+00
Cadmium, filtered	6.26E-10	0.00E+00	0.00E+00
Manganese	7.27E-07	0.00E+00	0.00E+00
Selenium	5.85E-09	0.00E+00	0.00E+00
Thallium, filtered	2.72E-09	0.00E+00	0.00E+00

TOTAL RISK

1.12E-08

00136

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 7
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

**HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
ASSUMPTIONS ARE OUTLINED BELOW.**

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), RME

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
IR = SOIL INGESTION RATE (MG/EVENT)
EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
Fi = FRACTION FROM CONTAMINATED SOURCE
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)
BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		CHILD:	
IR:	100	IR:	0
EF:	150	EF:	120
Fi:	1	Fi:	1
ED:	25	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	9125	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:	CHILD:	ADULT/YOUTH (CANCER RISK):
CF: 5.87E-07 (AVG ANNUAL DOSE)	CF: 0.00E+00 (AVG ANNUAL DOSE)	CF: 2.10E-07

00037

00040

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 7
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Full-Time Employees (Surface Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
SA _c = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
SA _a = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	1
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	25
BW _c = BODY WEIGHT CHILD (KG):	1
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	9125
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) \times (BW \text{ KG}) \times (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	7.97E-06
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	2.23E-05			

00041

00044

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 7
LOCATION: NSB-NLON, Groton, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), CTE

RELEVANT EQUATION: $IEX = (C \times IR \times Fi \times BIO \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:
 C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
 IR = SOIL INGESTION RATE (MG/EVENT)
 EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
 Fi = FRACTION FROM CONTAMINATED SOURCE
 ED = EXPOSURE DURATION (YEARS)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)
 BIO = BIOAVAILABILITY

ENTER INPUT PARAMETERS:

ADULT:		CHILD:	
IR:	50	IR:	0
EF:	150	EF:	120
Fi:	1	Fi:	1
ED:	6	ED:	10
BW:	70	BW:	43
AT(CAR):	25550	AT(CAR):	25550
AT(NON):	2190	AT(NON):	3650

DETERMINE CONVERSION FACTORS:

ADULT:		CHILD:		ADULT/CHILD (CANCER RISK):
CF:	2.94E-07 (AVG ANNUAL DOSE)	CF:	0.00E+00 (AVG ANNUAL DOSE)	CF: 2.52E-08

00045

00048

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 7
 LOCATION: NSB - NLON, Groton, CT
 DATE: 09/23/98

EXPOSURE SCENARIO: Full-Time Employee (Surface Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA \times AF \times ABS \times EF \times ED) / (BW \times AT \times 1E6)$

WHERE:

C = CONCENTRATION IN SOIL (MG/KG)	
SA _c = CHILD SKIN SURFACE AREA (SQ CM/DAY):	0
SA _a = ADULT SKIN SURFACE AREA (SQ CM/DAY):	3800
AF = ADHERENCE FACTOR (MG/SQ CM):	0.2
ABS = ABSORPTION FRACTION:	Chemical Specific
EF _c = CHILD EXPOSURE FREQUENCY (DAYS/YEAR):	1
EF _a = ADULT EXPOSURE FREQUENCY (DAYS/YEAR):	150
ED _c = CHILD EXPOSURE DURATION (YEARS):	1
ED _a = ADULT EXPOSURE DURATION (YEARS):	25
BW _c = BODY WEIGHT CHILD (KG):	1
BW _a = BODY WEIGHT ADULT (KG):	70
AT _c = AVERAGING TIME (DAYS), NONCARCINOGENS (CHILD):	365
AT _a = AVERAGING TIME (DAYS), NONCARCINOGENS (ADULT):	9125
AT = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

$DEX = (C) \times (SA \text{ SQ CM}) \times (AF \text{ MG/SQ CM}) \times (ABS) \times (EF \text{ DAYS/YEAR}) \times (ED \text{ YEARS}) / (AT \text{ DAYS}) / (BW \text{ KG}) / (1 \text{ KG}/1E6 \text{ MG})$

DOSE _{child} = (CF1)*(C)*(ABS)	CF1 =	0.00E+00	CANCER RISK = (CF3)*(C)*(ABS)	CF3 =	1.59E-06
DOSE _{adult} = (CF2)*(C)*(ABS)	CF2 =	4.46E-06			

67000

00052

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 7
LOCATION: NSB-NLON, GROTON, CT
DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), RME

RELEVANT EQUATIONS: $IEX = (C \times IFadj \times Fi \times EF) / (AT \times CF)$ $IFadj = (IRc \times EDc) / BWc + (IRa \times EDa) / BWa$

WHERE:

- C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
- IFadj = AGE-ADJUSTED SOIL INGESTION FACTOR (MG YEAR/KG DAY)
- Fi = FRACTION FROM CONTAMINATED SOURCE (UNITLESS)
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- AT = AVERAGING TIME (DAYS)
- CF = CONVERSION FACTOR (1E+6 MG/KG)
- IRc = CHILD INGESTION RATE (MG/DAY)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- BWc = CHILD BODY WEIGHT (KG)
- IRa = ADULT INGESTION RATE (MG/DAY)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWa = ADULT BODY WEIGHT (KG)

ENTER INPUT PARAMETERS:

IRc: 200
 EDc: 6
 BWc: 15
 IRa: 100
 EDa: 24
 BWa: 70
 IFadj: 114.28571
 Fi: 1
 EF: 150
 AT(NONC): 10950
 AT(CARC): 25550

DETERMINE CONVERSION FACTORS:

NONCARC = 1.57E-06 CARCIN = 6.71E-07

00053

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 7
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), RME

RELEVANT EQUATION: $DEX = (C \times SA_{adj} \times AF \times ABS \times EF) / (AT \times 1E6)$ $SA_{adj} = (SAa \times EDa) / BWa + (SAc \times EDc) / BWc$

WHERE:

- C = CONCENTRATION IN SOIL (MG/KG)
- SAc = CHILD SKIN SURFACE AREA (SQ CM/DAY)
- SAa = ADULT SKIN SURFACE AREA (SQ CM/DAY)
- AF = ADHERENCE FACTOR (MG/SQ CM)
- ABS = ABSORPTION FRACTION
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWc = BODY WEIGHT CHILD (KG)
- BWa = BODY WEIGHT ADULT (KG)
- ATn = AVERAGING TIME (DAYS), NONCARCINOGENS
- ATc = AVERAGING TIME (DAYS), CARCINOGENS
- SAadj = AGE-ADJUSTED SKIN SURFACE AREA (SQ CM-YR/DAY-KG)

ENTER INPUT PARAMETERS

SAc:	2094
SAa:	3800
AF:	1
EF:	150
EDc:	6
EDa:	24
BWc:	15
BWa:	70
ATn:	10950
ATc:	25550
SAadj:	2140

DETERMINE CONVERSION FACTORS:

NONCARC = 2.93E-05 CARCIN = 1.26E-05

00055

RISK ASSESSMENT SPREADSHEET - INCIDENTAL INGESTION OF SOIL

SITE NAME: ZONE 7
 LOCATION: NSB-NLON, GROTON, CT
 DATE: 02/11/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), CTE

RELEVANT EQUATIONS: $IEX = (C \times IFadj \times Fi \times EF) / (AT \times CF)$ $IFadj = (IRc \times EDc) / BWc + (IRa \times EDa) / BWa$

WHERE:

- C = MEAN CONCENTRATION IN SOIL SAMPLE (MG/KG)
- IFadj = AGE-ADJUSTED SOIL INGESTION FACTOR (MG YEAR/KG DAY)
- Fi = FRACTION FROM CONTAMINATED SOURCE (UNITLESS)
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- AT = AVERAGING TIME (DAYS)
- CF = CONVERSION FACTOR (1E+6 MG/KG)
- IRc = CHILD INGESTION RATE (MG/DAY)
- EDc = CHILD EXPOSURE DURATION (YEARS)
- BWc = CHILD BODY WEIGHT (KG)
- IRa = ADULT INGESTION RATE (MG/DAY)
- EDa = ADULT EXPOSURE DURATION (YEARS)
- BWa = ADULT BODY WEIGHT (KG)

ENTER INPUT PARAMETERS:

IRc: 100
 EDc: 2
 BWc: 15
 IRa: 50
 EDa: 7
 BWa: 70
 IFadj: 18.333333
 Fi: 0.5
 EF: 150
 AT(NONC): 3285
 AT(CARC): 25550

DETERMINE CONVERSION FACTORS:

NONCARC = 4.19E-07 CARCIN = 5.38E-08

00057

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH SOIL

SITE NAME: ZONE 7
LOCATION: NSB - NLON, Groton, CT
DATE: 09/23/98

HAZARD INDICES AND INCREMENTAL CANCER RISKS FOR RESIDENTS ARE CALCULATED BY THIS SPREADSHEET USING AGE-ADJUSTED EXPOSURE FACTORS. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Future Residents (Adult/Child) (All Soil), CTE

RELEVANT EQUATION: $DEX = (C \times SA_{adj} \times AF \times ABS \times EF) / (AT \times 1E6)$ $SA_{adj} = (SA_a \times ED_a) / BW_a + (SA_c \times ED_c) / BW_c$

WHERE:

- C = CONCENTRATION IN SOIL (MG/KG)
- SA_c = CHILD SKIN SURFACE AREA (SQ CM/DAY)
- SA_a = ADULT SKIN SURFACE AREA (SQ CM/DAY)
- AF = ADHERENCE FACTOR (MG/SQ CM)
- ABS = ABSORPTION FRACTION
- EF = EXPOSURE FREQUENCY (DAYS/YEAR)
- ED_c = CHILD EXPOSURE DURATION (YEARS)
- ED_a = ADULT EXPOSURE DURATION (YEARS)
- BW_c = BODY WEIGHT CHILD (KG)
- BW_a = BODY WEIGHT ADULT (KG)
- AT_n = AVERAGING TIME (DAYS), NONCARCINOGENS
- AT_c = AVERAGING TIME (DAYS), CARCINOGENS
- SA_{adj} = AGE-ADJUSTED SKIN SURFACE AREA (SQ CM-YR/DAY-KG)

ENTER INPUT PARAMETERS

SA _c :	2094
SA _a :	3800
AF:	0.2
EF:	150
ED _c :	2
ED _a :	7
BW _c :	15
BW _a :	70
AT _n :	3285
AT _c :	25550
SA _{adj} :	659.2

DETERMINE CONVERSION FACTORS:

NONCARC = 6.02E-06 CARCIN = 7.74E-07

00059

IEUBK MODEL - EXPOSURE TO LEAD (PAGE 1 OF 2)

SITE NAME: Zone 7
 LOCATION: NSB-NLON, Groton, Connecticut
 DATE: 2/12/98

EXPOSURE SCENARIO: RME/CTE

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
 Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
 WATER Consumption: DEFAULT

SOIL & DUST:

Soil: constant conc.
 Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	139250.0	139250.0
1-2	139250.0	139250.0
2-3	139250.0	139250.0
3-4	139250.0	139250.0
4-5	139250.0	139250.0
5-6	139250.0	139250.0
6-7	139250.0	139250.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
 Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	213.6	767.28	766.58
1-2:	228.5	1201.85	1200.99
2-3:	222.4	1214.53	1213.55
3-4:	218.3	1228.77	1227.79
4-5:	193.5	950.65	949.65
5-6:	173.5	880.48	879.38
6-7:	161.3	849.27	848.06

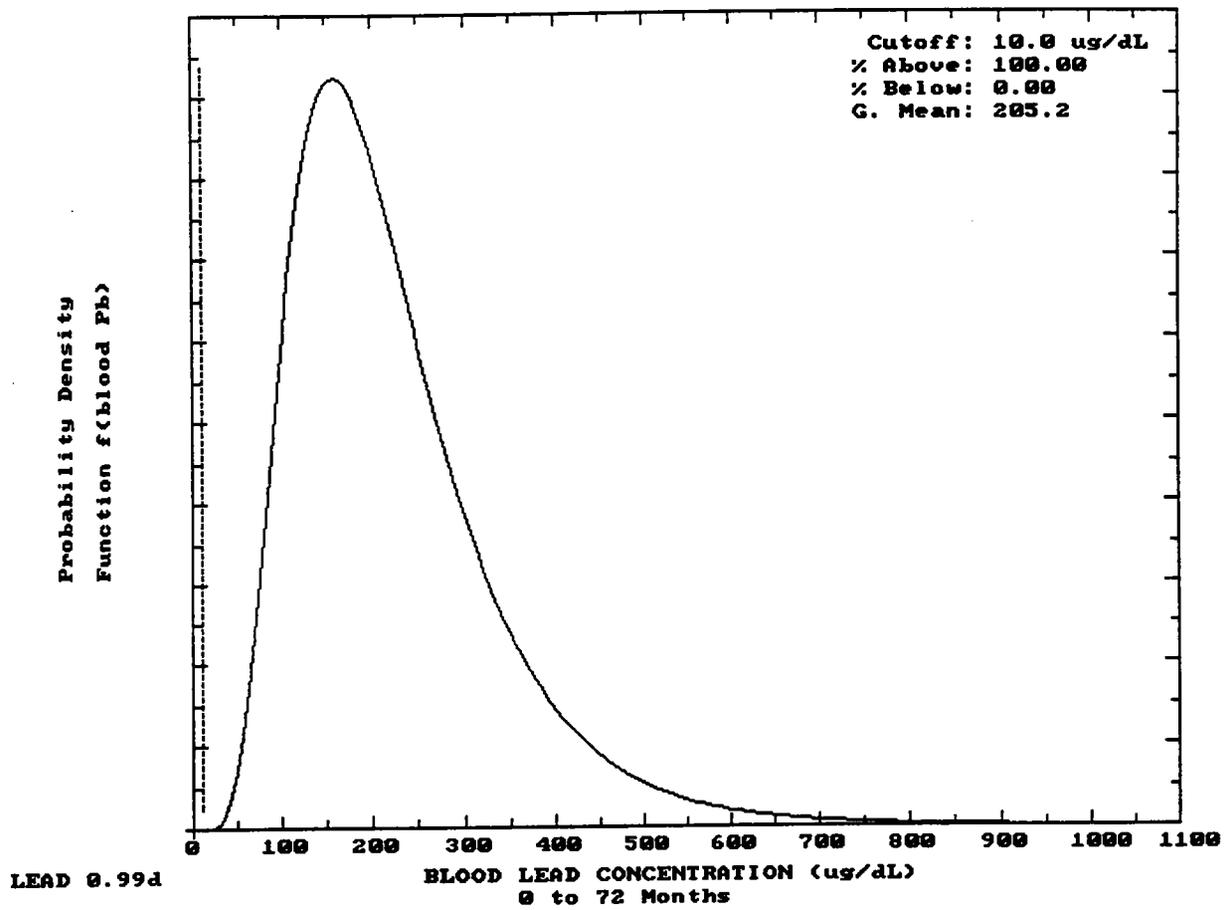
YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	0.60	0.09	0.00	0.02
1-2:	0.62	0.21	0.00	0.03
2-3:	0.70	0.22	0.00	0.06
3-4:	0.68	0.23	0.00	0.07
4-5:	0.68	0.25	0.00	0.07
5-6:	0.74	0.27	0.00	0.09
6-7:	0.84	0.28	0.00	0.09

00061

IEUBK MODEL - EXPOSURE TO LEAD (PAGE 2 OF 2)

SITE NAME: Zone 7
LOCATION: NSB-NLON, Groton, Connecticut
DATE: 2/12/98

EXPOSURE SCENARIO: RME/CTE



Calculations of 95th Percentile Fetal Blood Lead Concentrations for Adult Exposure to Soil

SITE NAME: Zone 7
LOCATION: NSB-NLON, Groton, Connecticut
DATE: February 11, 1998

OBJECTIVE: Adult exposure to lead in soil is addressed by an evaluation of the relationship between the site soil lead concentration and the blood lead concentration in the developing fetuses of adult women. This spreadsheet calculates a range of 95th percentile fetal blood lead concentrations from central estimates of blood lead concentrations in pregnant adult women using the exposure parameters identified below (U.S. EPA, Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil, December 1996).

RELEVANT EQUATIONS: $PbB_{adult, central} = PbB_{adult, 0} + [(PbS \times BKSF \times IR_s \times AF_s \times EF_s)/AT]$
 and
 $PbB_{fetal, 0.95} = PbB_{adult, central} \times GSD_{i, adult}^{1.645} \times R_{fetal/maternal}$

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Exposure Parameter	Description (units)	Future Employee		Construction Worker	
		RME	CTE	RME	CTE
PbB _{adult, 0}	Typical blood lead concentration in adult women of child-bearing age in absence of site exposures (ug/dL)	2.0	2.0	2.0	2.0
PbS	Site-specific soil lead concentration (mg/kg)	189000	189000	189000	189000
BKSF	Biokinetic slope factor (ug/dl)/(ug/day)	0.4	0.4	0.4	0.4
IR _s	Intake rate of soil, includes outdoor soil and indoor soil-derived dust (g/day)	0.100	0.050	0.480	0.240
AF _s	Absolute gastrointestinal absorption fraction (unitless)	0.12	0.12	0.12	0.12
EF _s	Exposure frequency (days/year)	150	150	120	80
AT	Averaging time (days/year)	365	365	365	365
GSD _{i, adult}	Estimate of individual geometric standard deviation among adults (unitless)	2.1	2.1	2.1	2.1
R _{fetal/maternal}	Constant of proportionality between fetal blood lead concentration at birth and maternal blood lead concentration (unitless)	0.9	0.9	0.9	0.9
PbB _{adult, central}	Calculated central estimate of blood lead concentrations in adult women of child-bearing age from site exposures (ug/dL)	374.82	188.41	1433.64	(1)
PbB _{fetal, 0.95}	Calculated 95th percentile blood lead concentrations among fetuses born to women having site exposures (ug/dL)	1143.19	574.64	4372.52	(1)

Notes:

- (1) According to the cited guidance document, this adult exposure model is not applicable for infrequent site exposures, where the EF_s is less than 1 day/week or 90 days/year.

APPENDIX I.12

THAMES RIVER

**SUMMARY OF COC SELECTION
THAMES RIVER - UNFILTERED SHALLOW SURFACE WATER
NSB-NLON, GROTON, CONNECTICUT**

Chemical	Frequency of Detection (1)	Range of Detection (1) (ug/L)	Location of Maximum	Range of Nondetects (2) (ug/L)	AWQC (3) (ug/L)	BCF (4) (L/kg)	Estimated Max Finfish Conc (5) (mg/kg)	Risk-based COC Screening Level For Fish (6) (mg/kg)	Risk-based COC Screening Level For Water (7) (ug/L)	Selected as COC? (Tissue/Water)	Rationale (Tissue/Water)
Trichloroethene	1/8	3	6SW1	10	2.7	97	0.291	0.29	1.6	Y/Y	3/3
Butyl benzyl phthalate	1/8	0.5	6SW1	10	3000	47000	23.5	27	730	N/N	2/2
Di-n-butyl phthalate	1/8	0.6	T3SW1S	10	2700	47000	28.2	14	370	N -Y/N	4 -2/2
Aluminum	7/8	16.3 - 79.6	T3SW1S	14	-	1	0.0796	140	3700	N/N	2/2
Barium	1/1	25.9	T3SW1S	-	-	1	0.0259	9.5	260	N/N	2/2
Boron	8/8	518 - 2210	T3SW3S	-	-	1	2.21	12	330	N/Y	2/3
Cadmium	1/8	10.2	8SW1	2	16	64	0.6528	0.068	1.8	Y/Y	3/3
Calcium	8/8	50900 - 176000	T3SW3S	-	-	1	176	-	-	N/N	1/1
Iron	8/8	95.9 - 425	T3SW1S	-	-	1	0.425	41	1100	N/N	2/2
Lead	3/8	1 - 1.5	T3SW1AS	1 - 10	50	1	0.0015	-	15 (8)	N/N	1/2
Magnesium	8/8	128000 - 57500	T3SW3S	-	-	1	575	-	-	N/N	1/1
Manganese	8/8	16.7 - 148	T3SW1S	-	-	1	0.148	0.00 - 3.2	18 - 88	N/Y	2/3
Mercury	8/8	0.24 - 0.49	8SW1	-	0.14	1	0.00049	0.041	1.1	N/N	2/2
Potassium	8/8	46700 - 288000	T3SW3S	-	-	1	288	-	-	N/N	1/1
Sodium	8/8	118000 - 59600	T3SW3S	-	-	1	596	-	-	N/N	1/1
Vanadium	2/8	5.3 - 6.9	T3SW1AS	5	-	1	0.0069	0.95	26	N/N	2/2
Zinc	1/8	6.7	T3SW1S	2	-	47	0.3149	41	1100	N/N	2/2

Footnote:

- 1 Sample and duplicate considered to be separate samples.
- 2 Sample-specific.
- 3 Ambient Water Quality Criteria for water and/or inorganics (USEPA, June 14, 1991).
- 4 Bioconcentration factor (presented in Section 3.2).
- 5 Maximum surface water concentration (mg/L) multiplied by BCF (L/kg). BCF assumed to be 1.0 for various metals
- 6 For fish ingestion, based on target hazard quotient of 0.1 or incremental cancer risk of 1E-6 (USEPA, Region III, October 20, 1995).
- 7 For drinking water ingestion, (USEPA, Region III, October 20, 1995).
- 8 Federal Action Level for drinking water.

Rationale Designations:

- 1 No toxicity criteria available; exposure to chemical will be addressed in uncertainty section of risk assessment.
- 2 Maximum is less than the COC screening level.
- 3 Maximum is greater than or equal to the COC screening level.
- 4 USEPA Region I does not advocate quantitative evaluation of this chemical.

Revisions
08/19/96

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**SUMMARY OF MAXIMUM AND AVERAGE CONCENTRATION
THAMES RIVER - UNFILTERED SHALLOW SURFACE WATER
NSB-NLON, GROTON, CONNECTICUT**

Chemical	Maximum	Average
Organics (ug/L)		
Trichloroethene	3	4.7143
Butyl benzyl phthalate	0.5	4.3571
Di-n-butyl phthalate	0.6	4.3714
Inorganics (ug/L)		
Aluminum	79.6	29.1429
Barium	25.9	25.9
Boron	2210	1646.8571
Cadmium	10.2	2.3143
Calcium	176000	133128.5714
Iron	425	159.4143
Lead	1.5	2.6429
Magnesium	575000	426285.7143
Manganese	148	38.7286
Mercury	0.49	0.3221
Potassium	288000	198100
Sodium	596000	433928.5714
Vanadium	5.3	3.2143
Zinc	6.7	1.8143

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000004

**SUMMARY OF COC SELECTION
THAMES RIVER - FILTERED SHALLOW SURFACE WATER
NSB-NLON, GROTON, CONNECTICUT**

Chemical	Frequency of Detection (1)	Range of Detection (1) (ug/L)	Location of Maximum	Range of Nondetects (2) (ug/L)	AWQC (3) (ug/L)	BCF (4) (L/kg)	Estimated Max Finfish Conc (5) (mg/kg)	Risk-based COC Screening Level For Fish (6) (mg/kg)	Risk-based COC Screening Level for Water (7) (ug/L)	Selected as COC? (Tissue/Water)	Rationale (Tissue/Water)
Aluminum	1/5	14	6SW1S	14	-	1	0.014	140	3700	N/N	1/1
Barium	5/5	5.8 - 7.8	T3SW1AS	-	-	1	0.0078	9.5	260	N/N	1/1
Boron	5/5	1560 - 2160	8SW1S	-	-	1	2.16	12	330	N/N	1/1
Calcium	5/5	130000 - 17700	8SW1S	-	-	1	177	-	-	N/N	1/1
Chromium (total)	1/5	3.1	8SW1S	3	170	16	0.0496	0.68 (8)	18 (8)	N/N	2/2
Magnesium	5/5	411000 - 57800	8SW1S	-	-	1	578	-	-	N/N	1/1
Manganese	5/5	19.9 - 26.9	6SW1S	-	-	1	0.0269	0.68 3.2	18 08	N/N	1/1
Potassium	5/5	183000 - 28900	8SW1S	-	-	1	289	-	-	N/N	1/1
Vanadium	3/5	4.05 - 5.8	8SW1S	5	-	1	0.0058	0.95	26	N/N	1/1

Footnote:

- 1 Sample and duplicate considered to be separate samples.
- 2 Sample-specific.
- 3 Ambient Water Quality Criteria for water and/or inorganics (USEPA, June 14, 1991).
- 4 Bioconcentration factor (presented in Section 3.2).
- 5 Maximum surface water concentration (mg/L) multiplied by BCF (L/kg). BCF assumed to be 1.0 for various metals.
- 6 For fish ingestion, based on target hazard quotient of 0.1 or incremental cancer risk of 1E-6 (USEPA, Region III, October 20, 1995).
- 7 For drinking water ingestion, (USEPA, Region III, October 20, 1995).
- 8 Hexavalent chromium.

Rationale Designations:

- 1 Chemical detected in unfiltered samples; unfiltered results used in risk assessment.
- 2 Chemical not detected in unfiltered samples; maximum greater than or equal to COC screening level.

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*Revisions
08/19/96
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**SUMMARY OF COC SELECTION
THAMES RIVER - UNFILTERED BOTTOM SURFACE WATER
NSB-NLON, GROTON, CONNECTICUT**

Chemical	Frequency of Detection (1)	Range of Detection (1) (ug/L)	Location of Maximum	Range of Nondetects (2) (ug/L)	AWQC (3) (ug/L)	BCF (4) (L/kg)	Estimated Max Finfish Conc (5) (mg/kg)	Risk-based COC Screening Level For Fish (6) (mg/kg)	Risk-based COC Screening Level for Water (7) (ug/L)	Selected as COC? (Tissue/Water)	Rationale (Tissue/Water)
Endrin aldehyde	1/7	0.14	T3SW2B	0.1	0.76	310	0.0434	-	-	N/N	1/1
Boron	7/7	2430 - 3330	8SW1B	-	-	1	3.33	12	330	N/N	2/3
Calcium	7/7	191000 - 26100	8SW1B	-	-	1	261	-	-	N/N	1/1
Iron	7/7	51 - 90.2	T3SW1BB	-	-	1	0.0902	41	1100	N/N	2/2
Magnesium	7/7	630000 - 85800	8SW1B	-	-	1	858	-	-	N/N	1/1
Manganese	7/7	6.2 - 15.7	T3SW1BB	-	-	1	0.0157	0.68 3.2	10 88	N/N	2/2
Mercury	7/7	0.26 - 0.39	T3SW2B	-	0.14	1	0.00039	0.041	1.1	N/N	2/2
Potassium	7/7	324000 - 50300	8SW1B	-	-	1	503	-	-	N/N	1/1
Sodium	7/7	17000 - 673000	T3SW1BB	-	-	1	6730	-	-	N/N	1/1
Vanadium	3/7	5 - 6.9	T3SW1BB	5	-	1	0.0069	0.95	26	N/N	2/2

Footnote:

- 1 Sample and duplicate considered to be separate samples.
- 2 Sample-specific.
- 3 Ambient Water Quality Criteria for water and/or organisms (USEPA, June 14, 1991).
- 4 Bioconcentration factor (presented in Section 3.2).
- 5 Maximum surface water concentration (mg/L) multiplied by BCF (L/kg). BCF assumed to be 1.0 for various metals.
- 6 For fish ingestion, based on target hazard quotient of 0.1 or incremental cancer risk of 1E-6 (USEPA, Region III, October 20, 1995).
- 7 For drinking water ingestion, (USEPA, Region III, October 20, 1995).

Rationale Designations:

- 1 No toxicity criteria available; exposure to chemical will be addressed in uncertainty section of risk assessment.
- 2 Maximum is less than the COC screening level.
- 3 Surface water results used in risk assessment to address risks to human receptors.

700007

Revisions
08/19/96
HUS

000008

**SUMMARY OF MAXIMUM AND AVERAGE CONCENTRATION
THAMES RIVER - UNFILTERED BOTTOM SURFACE WATER
NSB-NLON, GROTON, CONNECTICUT**

Chemical	Maximum	Average
Organics (ug/L)		
Endrin aldehyde	0.14	0.065
Inorganics (ug/L)		
Boron	3330	2960.8333
Calcium	261000	230500
Iron	88.15	69.9417
Magnesium	858000	762916.6667
Manganese	14.25	8.8583
Mercury	0.39	0.3233
Potassium	503000	429083.3333
Sodium	3711500	1190416.667
Vanadium	6.7	3.775

000009

000010

**SUMMARY OF COC SELECTION
THAMES RIVER - FILTERED BOTTOM SURFACE WATER
NSB-NLON, GROTON, CONNECTICUT**

Chemical	Frequency of Detection (1)	Range of Detection (1) (ug/L)	Location of Maximum	Range of Nondetects (2) (ug/L)	AWQC (3) (ug/L)	BCF (4) (L/kg)	Estimated Max Finfish Conc (5) (mg/kg)	Risk-based COC Screening Level For Fish (6) (mg/kg)	Risk-based COC Screening Level for Water (7) (ug/L)	Selected as COC? (Tissue/Water)	Rationale (Tissue/Water)
Barium	2/2	5.2	SW1B/8SW1	-	-	1	0.0052	9.5	260	N/N	2/2
Boron	2/2	2580 - 3210	8SW1B	-	-	1	3.21	12	330	N/N	1/1
Calcium	2/2	208000 - 25800	8SW1B	-	-	1	258	-	-	N/N	1/1
Chromium (total)	1/2	3.4	6SW1B	3	170	16	0.0544	0.68 (8)	18 (8)	N/N	2/2
Magnesium	2/2	680000 - 85200	8SW1B	-	-	1	852	-	-	N/N	1/1
Manganese	1/2	16.2	6SW1B	8.6	-	1	0.0162	0.68 3.2	18 88	N/N	1/1
Potassium	2/2	363000 - 49900	8SW1B	-	-	1	499	-	-	N/N	1/1

Footnote:

- 1 Sample and duplicate considered to be separate samples.
- 2 Sample-specific.
- 3 Ambient Water Quality Criteria for water and/or inorganics (USEPA, June 14, 1991).
- 4 Bioconcentration factor (presented in Section 3.2).
- 5 Maximum surface water concentration (mg/L) multiplied by BCF (L/kg). BCF assumed to be 1.0 for various metals.
- 6 For fish ingestion, based on target hazard quotient of 0.1 or incremental cancer risk of 1E-6 (USEPA, Region III, October 20, 1995).
- 7 For drinking water ingestion, (USEPA, Region III, October 20, 1995).
- 8 Hexavalent chromium.

Rationale Designations:

- 1 Chemical detected in unfiltered samples; unfiltered results used in risk assessment.
- 2 Chemical not detected in unfiltered samples; maximum is greater than or equal to the COC screening level.

000011

*Rensons
08/19/96
KMS*

000012

**SUMMARY OF COC SELECTION
THAMES RIVER - CLAMS (MG/KG) (1)
NSB-NLON, GROTON, CONNECTICUT**

Chemical	Frequency of Detection (2)	Range of Detection (2)	Location of Maximum	Range of Nondetects (3)	Risk-based COC Screening Level (4)	Selected as COC?	Rationale
Benzoic acid	1/3	5.4	BVC2	0.8 - 1.6	540	N	2
Benzyl alcohol	1/3	0.57	BVC2	0.33	41	N	2
Bis(2-ethylhexyl)phthalate	2/3	0.059 - 0.082	BVC2	0.33	0.23	N	2
gamma-Chlordane	1/3	0.0021	BVC1	0.017	.0024 (5)	N	2
Heptachlor	2/3	0.002 - 0.0021	BVC1	0.017	0.0007	Y	3
Arsenic	3/3	4.1 - 6.7	BVC2	-	0.041	Y	3
Barium	3/3	0.5 - 0.86	BVC3	-	9.5	N	2
Cadmium	3/3	0.11 - 0.59	BVC2	-	0.068	Y	3
Calcium	3/3	885 - 2580	BVC3	-	-	N	1
Chromium (total)	3/3	0.98 - 4.1	BVC2	-	0.68 (6)	Y	3
Copper	3/3	2.9 - 7.5	BVC1	-	5.4	YN	2 4
Iron	3/3	36.3 - 48	BVC2	-	41	YN	2 4
Magnesium	3/3	726 - 790	BVC1	-	-	N	1
Manganese	3/3	5.1 - 15.1	BVC2	-	0.68 3, 2	Y	3
Nickel	3/3	1.1 - 1.7	BVC2	-	2.7	N	2
Potassium	3/3	1960 - 2020	BVC1	-	-	N	1
Selenium	3/3	0.27 - 0.95	BVC2	-	0.68	Y	3
Silver	1/3	1.1	BVC2	0.1	0.68	Y	3
Sodium	3/3	4390 - 4740	BVC1	-	-	N	1
Vanadium	2/3	0.22 - 0.58	BVC2	0.15	0.95	N	2
Zinc	3/3	18.1 - 34.6	BVC2	-	41	N	2

000013

Footnotes:

- 1 Results presented in mg/kg unless otherwise noted.
- 2 Sample and duplicate counted as separate samples. Non-validated, rejected, composite, and excavated samples/results not used in risk assessment.
- 3 Sample-specific.
- 4 For fish ingestion, values are based on a target hazard quotient of 0.1 or an incremental cancer risk of 1E-6 (USEPA Region III, October 20, 1995).
- 5 Total chlordane.
- 6 Hexavalent chromium.

Rationale Designations:

- 1 No toxicity criteria available; exposure to chemical will be addressed in uncertainty section of risk assessment.
- 2 Maximum is less than the COC screening level.
- 3 Maximum is greater than or equal to the COC screening level.
- 4 USEPA Region I does not advocate quantitative evaluation of this chemical.

*Revisions
02/19/96
JMS*

000014

**SUMMARY OF MAXIMUM AND AVERAGE CONCENTRATION
THAMES RIVER - CLAMS
NSB-NLON, GROTON, CONNECTICUT**

Chemical	Maximum	Average
Organics (ug/kg)		
Benzoic acid	5400	2200
Benzyl alcohol	570	300
Bis(2-ethylhexyl)phthalate	82	102
gamma-Chlordane	2.1	6.3667
Heptachlor	2.1	4.2
Inorganics (mg/kg)		
Arsenic	6.7	5.3667
Barium	0.86	0.6933
Cadmium	0.59	0.28
Calcium	2580	1645
Chromium (total)	4.1	2.16
Copper	7.5	5.6667
Iron	48	41.5
Magnesium	790	757.6667
Manganese	15.1	9.4333
Nickel	1.7	1.4
Potassium	2020	1990
Selenium	0.95	0.5267
Silver	1.1	0.4
Sodium	4740	4516.6667
Vanadium	0.58	0.2917
Zinc	34.6	24.1667

000015

**SUMMARY OF COC SELECTION
THAMES RIVER - OYSTERS (MG/KG) (1)
NSB-NLON, GROTON, CONNECTICUT**

Chemical	Frequency of Detection (2)	Range of Detection (2)	Location of Maximum	Range of Nondetects (3)	Risk-based COC Screening Level (4)	Selected as COC?	Rationale
Bis(2-ethylhexyl)phthalate	3/5	0.089 - 0.16	BV04	0.0825	0.23	N	2
Heptachlor	5/5	0.002 - 0.0031	BV04	-	0.0007	Y	3
Aluminum	4/5	33.6 - 40.6	BV03	5.275	140	N	2
Arsenic	5/5	0.9 - 1.5	BV03	-	0.041	Y	3
Barium	5/5	0.83 - 1.5	BV03	-	9.5	N	2
Cadmium	5/5	0.61 - 0.92	BV04	-	0.068	Y	3
Calcium	5/5	981 - 3470	BV03	-	-	N	1
Chromium (total)	5/5	1 - 1.5	BV03	-	0.68 (5)	Y-N	3-4
Copper	5/5	62.9 - 253	BV02	-	5.4	Y-N	3-4
Iron	5/5	48.3 - 79.1	BV01	-	41	Y	3
Magnesium	5/5	548 - 776	BV03-D	-	-	N	1
Manganese	5/5	2.3 - 3.8	BV03	-	0.68 3.2	Y	3
Nickel	5/5	0.6 - 1.1	BV03	-	2.7	N	2
Potassium	5/5	1760 - 2480	BV03	-	-	N	1
Selenium	5/5	0.32 - 0.42	BV03	-	0.68	N	2
Silver	5/5	0.79 - 2.5	BV04	-	0.68	Y	3
Sodium	5/5	2720 - 5020	BV03-D	-	-	N	1
Vanadium	2/5	0.16 - 0.2	BV02	0.0376	0.95	N	2
Zinc	5/5	1210 - 2960	BV02	-	41	Y	3

Footnotes:

- 1 Results presented in mg/kg unless otherwise noted.
- 2 Sample and duplicate counted as separate samples. Non-validated, rejected, composite, and excavated samples/results not used in risk assessment
- 3 Sample-specific.
- 4 For fish ingestion, values are based on a target hazard quotient of 0.1 or an incremental cancer risk of 1E-6 (USEPA Region III, October 20, 1995).
- 5 Hexavalent chromium.

Rationale Designations:

- 1 No toxicity criteria available; exposure to chemical will be addressed in uncertainty section of risk assessment.
- 2 Maximum is less than the COC screening level.
- 3 Maximum is greater than or equal to the COC screening level.
- 4 USEPA Region I does not advocate quantitative evaluation of this chemical.

000017

Revisions
08/13/96
JMS

000018

**SUMMARY OF MAXIMUM AND AVERAGE CONCENTRATION
THAMES RIVER - OYSTERS
NSB-NLON, GROTON, CONNECTICUT**

Chemical	Maximum	Average
Organics (ug/kg)		
Bis(2-ethylhexyl)phthalate	160	128
Heptachlor	3.1	2.4025
Inorganics (mg/kg)		
Aluminum	37.9	33.5688
Arsenic	1.2	1.1375
Barium	1.3	1.125
Cadmium	0.92	0.7988
Calcium	3150	2062.75
Chromium (total)	1.4	1.25
Copper	253	151.7875
Iron	79.1	70.1
Magnesium	662.5	608.625
Manganese	3.2	2.925
Nickel	0.96	0.7675
Potassium	2330	2080
Selenium	0.41	0.36
Silver	2.5	1.9113
Sodium	3920	3545
Vanadium	0.2	0.1275
Zinc	2960	2048.75

009020

RISK ASSESSMENT SPREADSHEET - INGESTION OF CLAMS

SITE NAME: Thames River
LOCATION: NSB-NLON, Groton, CT
DATE: 01/09/86

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
EXPOSURES THROUGH INGESTION OF CLAMS ARE CONSIDERED.
ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Recreational Adult User; CTE

REFERENCE: EPA, DECEMBER 1989

RELEVANT EQUATION: $IEX = (C \times IR \times FI \times EF \times ED) / (BW \times AT)$

ASSUMPTIONS:

C = CONCENTRATION IN CLAM (MG/KG)	
IR = INGESTION RATE (KG/MEAL):	0.003
FI = FRACTION INGESTED FROM CONTAMINATED SOURCE: (DIMENSIONLESS)	0.5
EF = EXPOSURE FREQUENCY (MEALS/YEAR):	234
ED = EXPOSURE DURATION (YEARS):	9
BW = RECEPTOR BODY WEIGHT (KG):	70
AT1 = AVERAGING TIME (DAYS), NON-CARCINOGENS:	3285
AT2 = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

ANNUAL AVERAGE INTAKE:	CF1 =	1.37E-05
LIFETIME AVERAGE INTAKE:	CF2 =	1.77E-06

000021

RISK ASSESSMENT SPREADSHEET - INGESTION OF OYSTERS

SITE NAME: Thames River
LOCATION: NSB-NLON, Groton, CT
DATE: 01/09/96

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
EXPOSURES THROUGH INGESTION OF OYSTERS ARE CONSIDERED.
ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Recreational Adult User; CTE

REFERENCE: EPA, DECEMBER 1989

RELEVANT EQUATION: $IEX = (C \times IR \times FI \times EF \times ED) / (BW \times AT)$

ASSUMPTIONS:

C = CONCENTRATION IN OYSTER (MG/KG)	
IR = INGESTION RATE (KG/MEAL):	0.003
FI = FRACTION INGESTED FROM CONTAMINATED SOURCE: (DIMENSIONLESS)	0.5
EF = EXPOSURE FREQUENCY (MEALS/YEAR):	234
ED = EXPOSURE DURATION (YEARS):	9
BW = RECEPTOR BODY WEIGHT (KG):	70
AT1 = AVERAGING TIME (DAYS), NONCARCINOGENS:	3285
AT2 = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

ANNUAL AVERAGE INTAKE:	CF1 =	1.37E-05
LIFETIME AVERAGE INTAKE:	CF2 =	1.77E-06

000023

RISK ASSESSMENT SPREADSHEET - INGESTION OF FINFISH

SITE NAME: Thames River
LOCATION: NSB-NLON, Groton, CT
DATE: 01/09/96

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
EXPOSURES THROUGH INGESTION OF OYSTERS ARE CONSIDERED.
ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Recreational Adult User; CTE

REFERENCE: EPA, DECEMBER 1989

RELEVANT EQUATION: $IEX = (C \times IR \times FI \times EF \times ED) / (BW \times AT)$

ASSUMPTIONS:

C = CONCENTRATION IN FISH (MG/KG)	
IR = INGESTION RATE (KG/MEAL):	0.0095
FI = FRACTION INGESTED FROM CONTAMINATED SOURCE: (DIMENSIONLESS)	0.8
EF = EXPOSURE FREQUENCY (MEALS/YEAR):	234
ED = EXPOSURE DURATION (YEARS):	9
BW = RECEPTOR BODY WEIGHT (KG):	70
AT1 = AVERAGING TIME (DAYS), NONCARCINOGENS:	3285
AT2 = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

ANNUAL AVERAGE INTAKE:	CF1 =	4.35E-05
LIFE TIME AVERAGE INTAKE:	CF2 =	5.59E-06

000025

RISK ASSESSMENT SPREADSHEET - SURFACE WATER EXPOSURES

SITE NAME: Thames River
 LOCATION: NBB-NLON, Groton, CT
 DATE: 01/09/88

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS.
 TWO EXPOSURE ROUTES ARE CONSIDERED. INCIDENTAL INGESTION AND DERMAL CONTACT.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Recreational Adult User (Waterskier), CTE

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

INGESTION: $IEX = (C \times CR \times ET \times EF \times ED) / (BW \times AT)$

WHERE: C = SURFACE WATER CONCENTRATION (MG/L)
 CR = CONTACT RATE (L/HR)
 ET = EXPOSURE TIME (HRS/EVENT)
 EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
 ED = EXPOSURE DURATION (YEARS)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

DERMAL CONTACT: $DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DA_{event} = ABSORBED DOSE PER EVENT (MG/CM**2/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS: $DA_{event} = Kp \times C \times t_{event} \times CF$
 FOR ORGANICS: IF $t_{event} < t^*$, $DA_{event} = 2(Kp \times C \times CF \times (t^* \times t_{event} / 3.141692654))^{0.6}$
 IF $t_{event} > t^*$, $DA_{event} = Kp \times C \times CF \times ((t_{event} / (1 + B)) + (2T \times ((1 + 3B) / (1 + B))))$

WHERE: Kp = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MG/L)
 t_{event} = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1000 CM**3/L)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERIVED BY BUNGE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

INGESTION:

CR: 0.05
 ET: 2.6
 EF: 8
 ED: 8
 BW: 70
 AT(NONC): 3285
 AT(CAR): 25550

CONVERSION
 FACTOR (NONCAR) = 4.07E-05
 CONVERSION
 FACTOR (CARCIN) = 5.23E-06

DERMAL CONTACT:

EV: 1
 ED: 8
 EF: 8
 A: 20000
 t_{event}: 2.6
 BW: 70
 AT(NON): 3285
 AT(CAR): 25550

CONVERSION
 FACTOR (NONCAR) = 8.28E+00
 CONVERSION
 FACTOR (CARCIN) = 8.05E-01

000027

RISK ASSESSMENT SPREADSHEET - INGESTION OF CLAMS

SITE NAME: Thames River
LOCATION: NSB-NLON, Groton, CT
DATE: 01/09/96

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
EXPOSURES THROUGH INGESTION OF CLAMS ARE CONSIDERED.
ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Recreational Adult User; RME

REFERENCE: EPA, DECEMBER 1989

RELEVANT EQUATION: $IEX = (C \times IR \times FI \times EF \times ED) / (BW \times AT)$

ASSUMPTIONS:

C = CONCENTRATION IN CLAM (MG/KG)	
IR = INGESTION RATE (KG/MEAL):	0.055
FI = FRACTION INGESTED FROM CONTAMINATED SOURCE: (DIMENSIONLESS)	1
EF = EXPOSURE FREQUENCY (MEALS/YEAR):	350
ED = EXPOSURE DURATION (YEARS):	30
BW = RECEPTOR BODY WEIGHT (KG):	70
AT1 = AVERAGING TIME (DAYS), NON CARCINOGENS:	10950
AT2 = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

ANNUAL AVERAGE INTAKE:	CF1 =	7.53E-04
LIFE TIME AVERAGE INTAKE:	CF2 =	3.23E-04

000031

RISK ASSESSMENT SPREADSHEET - INGESTION OF OYSTERS

SITE NAME: Thames River
LOCATION: NSB-NLON, Groton, CT
DATE: 01/09/96

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
EXPOSURES THROUGH INGESTION OF OYSTERS ARE CONSIDERED.
ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Recreational Adult User; RME

REFERENCE: EPA, DECEMBER 1989

RELEVANT EQUATION: $IEX = (C \times IR \times FI \times EF \times ED) / (BW \times AT)$

ASSUMPTIONS:

C = CONCENTRATION IN OYSTER (MG/KG)	
IR = INGESTION RATE (KG/MEAL):	0.055
FI = FRACTION INGESTED FROM CONTAMINATED SOURCE: (DIMENSIONLESS)	1
EF = EXPOSURE FREQUENCY (MEALS/YEAR):	360
ED = EXPOSURE DURATION (YEARS):	30
BW = RECEPTOR BODY WEIGHT (KG):	70
AT1 = AVERAGING TIME (DAYS), NONCARCINOGENS:	10950
AT2 = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

ANNUAL AVERAGE INTAKE:	CF1 =	7.53E-04
LIFETIME AVERAGE INTAKE:	CF2 =	3.23E-04

000033

RISK ASSESSMENT SPREADSHEET - INGESTION OF FINFISH

SITE NAME: Thames River
LOCATION: NSB-NLON, Groton, CT
DATE: 01/09/96

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY THIS SPREADSHEET.
EXPOSURES THROUGH INGESTION OF OYSTERS ARE CONSIDERED.
ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Recreational Adult User; RME

REFERENCE: EPA, DECEMBER 1989

RELEVANT EQUATION: $IEX = (C \times IR \times FI \times EF \times ED) / (BW \times AT)$

ASSUMPTIONS:

C = CONCENTRATION IN FISH (MG/KG)	
IR = INGESTION RATE (KG/MEAL):	0.054
FI = FRACTION INGESTED FROM CONTAMINATED SOURCE: (DIMENSIONLESS)	1
EF = EXPOSURE FREQUENCY (MEALS/YEAR):	350
ED = EXPOSURE DURATION (YEARS):	30
BW = RECEPTOR BODY WEIGHT (KG):	70
AT1 = AVERAGING TIME (DAYS), NONCARCINOGENS:	10950
AT2 = AVERAGING TIME (DAYS), CARCINOGENS:	25550

DETERMINE CONVERSION FACTORS:

ANNUAL AVERAGE INTAKE:	CF1 =	7.40E-04
LIFE TIME AVERAGE INTAKE:	CF2 =	3.17E-04

00135

RISK ASSESSMENT SPREADSHEET - SURFACE WATER EXPOSURES

SITE NAME: Thames River
 LOCATION: NSB - N.LON, Groton, CT
 DATE: 01/09/96

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS.
 TWO EXPOSURE ROUTES ARE CONSIDERED: INCIDENTAL INGESTION AND DERMAL CONTACT.
 ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO: Recreational Adult User (Waterskier), RME

REFERENCES: EPA, DECEMBER 1989 AND JANUARY 1992

INGESTION: $IEX = (C \times CR \times ET \times EF \times ED) / (BW \times AT)$

WHERE: C = SURFACE WATER CONCENTRATION (MG/L)
 CR = CONTACT RATE (L/HR)
 ET = EXPOSURE TIME (HRS/EVENT)
 EF = EXPOSURE FREQUENCY (EVENTS/YEAR)
 ED = EXPOSURE DURATION (YEARS)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

DERMAL CONTACT: $DAD = (DA_{event} \times EV \times ED \times EF \times A) / (BW \times AT)$

WHERE: DAD = DERMALLY ABSORBED DOSE (MG/KG/DAY)
 DA_{event} = ABSORBED DOSE PER EVENT (MG/CM**2/EVENT)
 EV = EVENT FREQUENCY (EVENTS/DAY)
 ED = EXPOSURE DURATION (YEARS)
 EF = EXPOSURE FREQUENCY (DAYS/YEAR)
 A = SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
 BW = BODY WEIGHT (KG)
 AT = AVERAGING TIME (DAYS)

FOR INORGANICS:
 FOR ORGANICS:

$DA_{event} = Kp \times C \times t_{event} \times CF$
 IF $t_{event} < t^*$, $DA_{event} = 2Kp \times C \times CF \times (6T \times t_{event} / 3.141692654)^{0.5}$
 IF $t_{event} > t^*$, $DA_{event} = Kp \times C \times CF \times ((t_{event} / (1 + B)) + (2T \times ((1 + 3B) / (1 + B))))$

WHERE: Kp = PERMEABILITY COEFFICIENT FROM WATER (CM/HR)
 C = CONCENTRATION OF CHEMICAL IN WATER (MG/L)
 t_{event} = DURATION OF EVENT (HR/EVENT)
 CF = CONVERSION FACTOR (1000 CM**3/L)
 t* = TIME IT TAKES TO REACH STEADY-STATE (HOUR)
 T = LAG TIME (HOUR)
 B = PARTITIONING CONSTANT DERIVED BY BUNCE MODEL (DIMENSIONLESS)

INPUT PARAMETERS:

INGESTION:

CR:	0.05	CONVERSION
ET:	2.8	FACTOR (NONCAR) = 8.14E-05
EF:	18	
ED:	30	CONVERSION
BW:	70	FACTOR (CARCIN) = 3.49E-05
AT(NONC):	10950	
AT(CAR):	25550	

DERMAL CONTACT:

EV:	1	CONVERSION
ED:	30	FACTOR (NONCAR) = 1.25E+01
EF:	18	
A:	20000	CONVERSION
t _{event} :	2.8	FACTOR (CARCIN) = 5.37E+00
BW:	70	
AT(NON):	10950	
AT(CAR):	25550	

000037

SUMMARY OF COMPARISON TO STATE STANDARDS (1)
THAMES RIVER SURFACE - UNFILTERED SURFACE WATER (UG/L)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Maximum	Average of Positive Hits	Water Quality Standards (2)			
			Aquatic Life		Human Health	
			Freshwater	Saltwater	Organisms	Water and Organisms
Trichloroethene	3	3	-	-	81	2.7 *
Butyl benzyl phthalate	0.5	0.50	-	-	-	-
Di-N-butyl phthalate	0.6	0.60	-	-	12000	2700
Aluminum	79.6	32.1	-	-	-	-
Barium	25.9	25.9	-	-	-	-
Boron	2210	1646	-	-	-	-
Cadmium	10.2	10.2	660	9.3 *	170	16
Calcium	176000	133238	-	-	-	-
Iron	425	155	-	-	-	-
Lead	1.5	1.3	1.3 *	8.5	-	50
Magnesium	575000	426375	-	-	-	-
Manganese	148	37	-	-	-	-
Mercury	0.49	0.31	0.012 *	0.025 *	0.15 *	0.14 *
Potassium	288000	197338	-	-	-	-
Sodium	596000	431125	-	-	-	-
Vanadium	6.9	6.1	-	-	-	-
Zinc	6.7	6.7	12.3	86	-	-

Footnotes:

- 1 * - Indicates that maximum detection exceeds this standard.
- 2 Connecticut Water Quality Standards, 1992.
- 3 Chromium (hexavalent).

00041

**SUMMARY OF COMPARISON TO STATE STANDARDS (1)
THAMES RIVER SURFACE - FILTERED SURFACE WATER (UG/L)
NSB-NLON, GROTON, CONNECTICUT**

Parameter	Maximum	Average of Positive Hits	Water Quality Standards (2)			
			Aquatic Life		Human Health	
			Freshwater	Saltwater	Organisms	Water and Organisms
Aluminum	14	14	-	-	-	-
Barium	7.8	6.8	-	-	-	-
Boron	2160	1719	-	-	-	-
Calcium	177000	141800	-	-	-	-
Chromium (total)	3.1	3.1	11 (3)	50 (3)	3400 (3)	170 (3)
Magnesium	578000	453400	-	-	-	-
Manganese	25.9	24.4	-	-	-	-
Potassium	289000	209000	-	-	-	-
Vanadium	5.8	5.2	-	-	-	-

Footnotes:

- 1 * - Indicates that maximum detection exceeds this standard.
- 2 Connecticut Water Quality Standards, 1992.
- 3 Chromium (hexavalent).

000042

SUMMARY OF COMPARISON TO STATE STANDARDS (1)
THAMES RIVER BOTTOM - UNFILTERED SURFACE WATER (UG/L)
NSB-NLON, GROTON, CONNECTICUT

Parameter	Maximum	Average of Positive Hits	Water Quality Standards (2)			
			Aquatic Life		Human Health	
			Freshwater	Saltwater	Organisms	Water and Organisms
Endrin aldehyde	0.14	0.14	-	-	0.81	0.76
Boron	3330	2889	-	-	-	-
Calcium	261000	225000	-	-	-	-
Iron	90.2	72.5	-	-	-	-
Magnesium	858000	744571	-	-	-	-
Manganese	15.7	9.6	-	-	-	-
Mercury	0.39	0.32	0.012 *	0.025 *	0.15 *	0.14 *
Potassium	503000	414714	-	-	-	-
Sodium	6730000	1550571	-	-	-	-
Vanadium	6.9	6.2	-	-	-	-

Footnotes:

- 1 * - Indicates that maximum detection exceeds this standard.
- 2 Connecticut Water Quality Standards, 1992.
- 3 Chromium (hexavalent).

000043

**SUMMARY OF COMPARISON TO STATE STANDARDS (1)
THAMES RIVER BOTTOM - FILTERED SURFACE WATER (UG/L)
NSB-NLON, GROTON, CONNECTICUT**

Parameter	Maximum	Average of Positive Hits	Water Quality Standards (2)			
			Aquatic Life		Human Health	
			Freshwater	Saltwater	Organisms	Water and Organisms
Barium	5.2	5.2	-	-	-	-
Boron	3210	2895	-	-	-	-
Calcium	258000	233000	-	-	-	-
Chromium (total)	3.4	3.4	11 (3)	50 (3)	3400 (3)	170 (3)
Magnesium	852000	766000	-	-	-	-
Manganese	16.2	16.2	-	-	-	-
Potassium	499000	431000	-	-	-	-

Footnotes:

- 1 * - Indicates that maximum detection exceeds this standard.
- 2 Connecticut Water Quality Standards, 1992.
- 3 Chromium (hexavalent).

000044

APPENDIX I.13

Summary Of Work Completed To Determine The Optimal Soil Sample Size For Lead

APPENDIX F

1.0 PURPOSE

To respond to USEPA's Comment No. 1 on the draft final Lower Subbase RI WP/SAP, it is necessary to develop an appropriate method for determining the optimal soil sample size for lead for each zone at the Lower Subbase. The reason for needing the optimal soil sample size is to justify that the number of samples in the proposed sampling program, along with the existing data, will provide sufficient information for the USEPA's model for evaluating risks to adults from lead. This model requires a representative mean concentration of lead. The exercise is also necessary to limit the additional samples that the Navy will have to collect in the future. By defining the decision making information prior to sampling and having the acceptance of the regulators, the Navy can eliminate unnecessary sampling at the Lower Subbase in the future.

2.0 APPROACH

The approach selected by B&R Environmental (i.e., the Navy's contractor) for this task is summarized below. The method selected by B&R Environmental was used to determine if the Navy's combined analytical data set for soil (i.e., existing data and proposed data) will be adequate for human health risk assessment purposes.

Two common goals of the EPA and the regulated community are to minimize expenditures by eliminating unnecessary data and to collect data of sufficient quality and quantity to support defensible decision making. As an efficient method of accomplishing both goals, the EPA has developed the Data Quality Objectives (DQO) Process.

The DQO Process is a strategic planning approach based on the Scientific Method. Implementing this process assures that representative data is utilized to support effective decision-making. The EPA's DQO guidance [EPA QA / G-4 (Guidance for the Data Quality Objectives Process); September 1994] as well as the EPA's 'Methods for Evaluating the Attainment of Cleanup Standards: Volume 1: Soils and Solid Media' [EPA 230/02-89-042 (1989)] suggest standard formulas for determining the number of samples that are sufficient to meet the limits on decision errors that have been specified and the DQO constraints for comparing a mean against a regulatory threshold.

Soil samples have been collected and analyzed for lead in six of the seven zones. The sample size needed to characterize lead relative to its action level have been determined by using the sample size formula for testing mean of normal distribution versus an action level [Equation (8) from Appendix C of EPA's DQO Guidance].

$$n = \frac{(Z_{1-\alpha} + Z_{1-\beta})\sigma^2}{\Delta^2} + 0.5 Z_{1-\alpha}$$

where: n = sample size;

Z_p = p^{th} percentile of the standard normal distribution;

α = the false positive (Type I) error rate [deciding the site is contaminated when it truly is not];

β = the false negative (Type II) error rate [deciding the site is not contaminated when it truly is];

σ^2 = variance;

Δ = width of the 'gray region'; ($U - AL$); U is a constant value greater than the action level (AL).

An appropriate null hypothesis (H_0) for this situation is:

$H_0: \mu \leq AL$ (*The average concentration within the soil of the zone is less than the action level*)

The consequence of a Type I error [rejecting H_0 when it is true] is unnecessary remediation and the associated expenses. The consequence of a Type II error [accepting H_0 when it is false] is incomplete remediation which could possibly endanger human health and the environment.

Values are assigned to α , β , and Δ to reflect the tolerable probability for the occurrence of decision errors. The EPA's 'Soil Screening User's Guide' [EPA 540/R-96-01B (1996)] makes recommendations for these error rates. "Strive to achieve a false negative error rate of 5 percent...EPA also strives to achieve a 20 percent false positive error rate...EPA has defined the 'gray region' as one-half to two times the action level". These specifications give: $1-\beta = 0.95$, $1-\alpha = 0.80$, and $U = 1.5xAL$ to $3.0xAL$. The EPA's 'Guidance for Data Useability in Risk Assessment' [EPA 540/G-90/008 (1990)] reports minimum recommended performance measures of $1-\beta = 0.90$ and $1-\alpha = 0.80$.

For this exercise, ranges of $1-\beta$ of 0.50 to 0.99, $1-\alpha$ of 0.80 to 0.90, and U of $1.5xAL$ to $3.0xAL$ were used to estimate a range of required numbers of samples. One set of criteria was then selected (i.e., the USEPA's specifications of $1-\beta = 0.95$, $1-\alpha = 0.80$, and $U = 1.5xAL$) and the derived number of samples for these criteria were tabulated.

The action level selected for the calculations was the CTDEP's lead industrial remediation standard for soil which is 1,000 mg/kg. This criteria is appropriate because the Lower Subbase is currently used for industrial purposes, and the Navy intends to maintain the industrial nature of the Lower Subbase in the future.

3.0 RESULTS

The calculations performed for this task were completed by spreadsheet. All of the spreadsheets that were created are included in Attachment 1. The spreadsheets are grouped by Zone and data set (i.e., (validated) or (validated and unvalidated)).

Table 1 summarizes the existing and proposed soil samples that have been or will be analyzed for lead. Table 2 summarizes the derived sample numbers using only

validated data. Table 3 summarizes the derived sample numbers using validated and unvalidated data. Table 4 summarizes the arithmetic average lead concentrations using two data sets {i.e., (validated) and (validated and unvalidated)}.

4.0 CONCLUSIONS

By comparing the results presented in Tables 2 and 3 with the number of samples provided in Table 1, the following conclusions can be made:

- The current sampling program is adequate for Zones 1, 2 and 5.
- There is a potential that additional sampling will be required at Zone 3, and it is likely that additional sampling will be required in Zones 4 and 7 because of the high levels of previously detected lead.
- No data is available for Zone 6, therefore no conclusions can be made in regard to the number of required samples at this time.

After evaluating the mean concentrations summarized in Table 4, the following conclusions can be made:

- The average concentrations of lead calculated for Zones 1, 2 and 5 are relatively consistent and independent of the data set {i.e., (validated) or (validated and unvalidated)}.
- The average concentrations of lead calculated for Zone 3 vary, but are of the same order of magnitude.
- The average concentrations of lead calculated for Zones 4 and 7 are variable with depth and indicate that high levels of contamination are present in the shallow soil of these zones and remediation of these hot spots will probably be necessary.

TABLES

**TABLE 1
SUMMARY OF EXISTING AND PROPOSED SOIL SAMPLES - LEAD ANALYSIS
LOWER SUBASE REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT**

Zone	# of Existing Shallow Samples ⁽¹⁾	# of Existing Deep Samples ⁽¹⁾	Total # of Existing Samples	# of Proposed Shallow Samples ⁽²⁾	# of Proposed Deep Samples ⁽²⁾	Total # of Proposed Samples	Total Samples After Field Work
1	4	13	17	3	0	3	20
2	3	4	7	0	3	3	10
3	5	2	7	3	3	6	13
4	4	6	10	3	3	6	16
5	3	0	3	2	2	4	7
6	0	0	0	5	5	10	10
7	9	5	14	4	4	8	22

1 - Only analytical data for unexcavated, validated, grab samples are included in the data set

2 - From the draft final Lower Subbase RI WP/SAP, July 1997

**TABLE 2 - EXPOSURE SCENARIO = INDUSTRIAL
SUMMARY OF DERIVED NUMBER OF SOIL SAMPLES FOR LEAD - VALIDATED DATA ONLY
LOWER SUBBASE REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT**

Zone	VALIDATED DATA ⁽¹⁾			VALIDATED DATA WITH HOT SPOT(S) REMOVED ⁽¹⁾		
	Derived Sample Size Shallow Sample Results ⁽²⁾	Derived Sample Size Deep Sample Results ⁽²⁾	Derived Sample Size - Shallow & Deep Sample Results ^(2,3)	Derived Sample Size Shallow Sample Results ⁽²⁾	Derived Sample Size Deep Sample Results ⁽²⁾	Derived Sample Size - Shallow & Deep Sample Results ^(2,3)
1	1	1	1	NA	NA	NA
2	1	2	1	NA	NA	NA
3	9	2	7	1 ⁽⁴⁾	NA	1 ⁽⁴⁾
4	541	9	320	NA	NA	NA
5	NA	NA	1	NA	NA	NA
6	NA	NA	NA	NA	NA	NA
7	88203	5	55119	2 ⁽⁵⁾	NA	3 ⁽⁵⁾

1 - Only analytical data for unexcavated, validated, grab samples are included in the data set
 2 - 1-a=0.80, 1-B=0.95, U=1.5xAL (Soil Screening User's Guide, USEPA, 1996); AL = 1000 mg/kg (CTDEP Industrial Scenario)
 3 - Combined Sample Set of Shallow and Deep Samples
 4 - Excludes Sample 13TB18-0103
 5 - Excludes Sample 20MW6-0204

**TABLE 3 - EXPOSURE SCENARIO = INDUSTRIAL
SUMMARY OF DERIVED NUMBER OF SOIL SAMPLES FOR LEAD - VALIDATED & UNVALIDATED DATA
LOWER SUBBASE REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT**

Zone	VALIDATED & UNVALIDATED DATA			VALIDATED & UNVALIDATED DATA WITH HOT SPOT(S) REMOVED		
	Derived Sample Size Shallow Sample Results ⁽²⁾	Derived Sample Size Deep Sample Results ⁽²⁾	Derived Sample Size - Shallow & Deep Sample Results ^(2,3)	Derived Sample Size Shallow Sample Results ⁽²⁾	Derived Sample Size Deep Sample Results ⁽²⁾	Derived Sample Size - Shallow & Deep Sample Results ^(2,3)
1	1	1	1	NA	NA	NA
2	1	2	1	NA	NA	NA
3	15	27	20	NA	NA	NA
4	366	15	248	NA	NA	NA
5	1	1	1	NA	NA	NA
6	NA	NA	NA	NA	NA	NA
7	63004	180	32613	2 ⁽⁴⁾	NA	92 ⁽⁴⁾

1 - All analytical data, except for excavated samples, are included in the data set
 2 - 1-a=0.80, 1-B=0.95, U=1.5xAL (Soil Screening User's Guide, USEPA, 1996); AL = 1000 mg/kg (CTDEP Industrial Scenario)
 3 - Combined Sample Set of Shallow and Deep Samples
 4 - Excludes Sample 20MW6-0204

**TABLE 4 - ARITHMETIC AVERAGE
LEAD ANALYTICAL RESULTS - VALIDATED & UNVALIDATED DATA
LOWER SUBBASE REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT**

Zone	VALIDATED DATA			VALIDATED & UNVALIDATED DATA		
	Average Shallow Sample Results ⁽¹⁾	Average Deep Sample Results ⁽¹⁾	Average - Shallow & Deep Sample Results ⁽¹⁾	Average Shallow Sample Results ⁽²⁾	Average Deep Sample Results ⁽²⁾	Average - Shallow & Deep Sample Results ⁽²⁾
1	56.35	44.31	47.14	46.62	44.31	44.95
2	159.00	104.75	128.00	159.00	104.75	128.00
3	303.39	142.30	257.36	272.81	374.50	313.13
4	4816.25	295.32	2103.69	4237.14	428.32	2094.68
5	NA	NA	11.08	13.82	6.17	10.67
6	NA	NA	NA	NA	NA	NA
7	19032.62	188.43	11966.05	13635.62	969.28	7537.01

1 - Only analytical data for unexcavated, validated, grab samples are included in the data set
2 - All analytical data, except for excavated samples, are included in the data set

ATTACHMENT 1

ZONE 1

VALIDATED
DATA

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 2 Shallow

LEAD (MG/KG)			
Sample Variance =	271.000	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	2	2

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	2	2

Boldface values are less than or equal to 3 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \frac{(z_{1-\alpha} + z_{1-\beta})^2}{\Delta^2} = \frac{(0.5)z^2}{\Delta^2}$$

n=required # of samples
σ²=variance
in concentration
z_p=the pth percentile of
the standard normal
distribution
Δ=width of gray region
(U-AL)

SITE	RESULT	QUAL	VALUE	3 SAMPLES
110890-13MW11(2-4)	178	J	178	
13TB8-0103	149		149	
13TB9-0103	150		150	
Sample Variance =	271.000			
Average Value =	159.000			

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
consequences of making a decision error are relatively minor.
The gray region is bounded on the lower side by the action level
and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

VALIDATED
DATA

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 2 Deep

LEAD (MG/KG)			
Sample Variance =	39805.557	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	1	2	4
U = 1.10 x AL	4	8	13

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	3
U = 1.25 x AL	2	4	5
U = 1.10 x AL	10	17	23

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	2	3
U = 1.25 x AL	4	6	7
U = 1.10 x AL	19	27	36

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	3	4
U = 1.25 x AL	5	7	9
U = 1.10 x AL	25	35	45

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	3	4
U = 1.25 x AL	7	10	12
U = 1.10 x AL	41	53	65

Boldface values are less than or equal to 4 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \frac{z_p^2 (2.1 + 2.1) + (0.5)^2}{\Delta^2}$$

n = required # of samples
 σ^2 = variance in concentration
 z_p = the p^{th} percentile of the standard normal distribution
 Δ = width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE	4 SAMPLES
111290-13MW17(8-10)	5.4	J	5.4	
111390-13MW6(14-16)	2	J	2	
110890-13MW10(6-8)	7.6	J	7.6	
13TB11-0406	404		404	
Sample Variance =		39805.557		
Average Value =		104.750		

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
 α : probability that a Type I (false positive) error will be made.
 That is rejecting H₀ when it is True. **Confidence Interval**
 β : probability that a Type II (false negative) error will be made.
 That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor.
 The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/ detection limit is used to calculate value, average value, and sample

nce for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 2 Shallow and Deep

VALIDATED
DATA

LEAD (MG/KG)			
Sample Variance =	20833.987	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	3
U = 1.10 x AL	2	5	7

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	2	3	4
U = 1.10 x AL	6	9	13

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	3
U = 1.25 x AL	2	4	5
U = 1.10 x AL	10	15	20

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	3
U = 1.25 x AL	3	4	5
U = 1.10 x AL	14	19	24

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	2	3
U = 1.25 x AL	4	6	7
U = 1.10 x AL	22	28	35

Boldface values are less than or equal to 7 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \frac{(z_p \cdot \sigma + U - AL)^2}{\Delta^2}$$

n=required # of samples
σ²=variance
in concentration
z_p=the pth percentile of
the standard normal
distribution
Δ=width of gray region
(U-AL)

SITE	RESULT	QUAL	VALUE	7 SAMPLES
111290-13MW17(8-10)	5.4	J	5.4	
111390-13MW6(14-16)	2	J	2	
110890-13MW10(6-8)	7.6	J	7.6	
13TB11-0406	404		404	
110890-13MW11(2-4)	178	J	178	
13TB8-0103	149		149	
13TB9-0103	150		150	
Sample Variance =	20833.987			
Average Value =	128.000			

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
consequences of making a decision error are relatively minor.
The gray region is bounded on the lower side by the action level
and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

**Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 2 Shallow**

LEAD (MG/KG)	
Sample Variance =	271.000
Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	2	2

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	2	2

Boldface values are less than or equal to 3 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$n = \frac{z_p^2 \cdot \sigma^2}{\Delta^2}$	(0.5)
---	-------

VALIDATED & UNVALIDATED

n=required # of samples
σ^2 =variance in concentration
z_p =the p th percentile of the standard normal distribution
Δ =width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE	
110890-13MW11(2-4)	178	J	178	3 SAMPLES
13TB8-0103	149		149	
13TB9-0103	150		150	
Sample Variance =		271.000		
Average Value =		159.000		

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H ₀
α : probability that a Type I (false positive) error will be made. That is rejecting H ₀ when it is True. Confidence Interval
β : probability that a Type II (false negative) error will be made. That is failing to rejecting H ₀ when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the action limit is used to calculate value, average value, and sample variance for effects (samples with 'U' in QUAL column).

**Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 2 Deep**

LEAD (MG/KG)			
Sample Variance =	39805.557	Action Level⁽¹⁾ =	1000

$1-\beta = 0.50$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	1	2	4
U = 1.10 x AL	4	8	13

$1-\beta = 0.75$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	3
U = 1.25 x AL	2	4	5
U = 1.10 x AL	10	17	23

$1-\beta = 0.90$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	2	3
U = 1.25 x AL	4	6	7
U = 1.10 x AL	19	27	36

$1-\beta = 0.95$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	3	4
U = 1.25 x AL	5	7	9
U = 1.10 x AL	25	35	45

$1-\beta = 0.99$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	3	4
U = 1.25 x AL	7	10	12
U = 1.10 x AL	41	53	65

Boldface values are less than or equal to 4 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$n = \frac{z_p^2 (2.303 + 4.753z_p + 3.645z_p^2 + 0.174z_p^3)}{(\Delta)^2}$	(0.5)
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VALIDATED & UNVALIDATED

n=required # of samples
σ^2 =variance in concentration
z_p =the p^{th} percentile of the standard normal distribution
Δ =width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE
111290-13MW17(8-10)	5.4	J	5.4
111390-13MW6(14-16)	2	J	2
110890-13MW10(6-8)	7.6	J	7.6
13TB11-0406	404		404
Sample Variance =	39805.557		
Average Value =	104.750		

**4
SAMPLES**

Null Hypothesis (H_0): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H_0
α : probability that a Type I (false positive) error will be made. That is rejecting H_0 when it is True. Confidence Interval
β : probability that a Type II (false negative) error will be made. That is failing to rejecting H_0 when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

(1) = Action Level based on Industrial Risk Criteria.

(2) = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

**Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 2 Shallow and Deep**

LEAD (MG/KG)			
Sample Variance =	20833.987	Action Level⁽¹⁾ =	1000

$1-\beta = 0.50$	$1-\beta = 0.80$	$1-\beta = 0.90$	$1-\beta = 0.95$
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	3
U = 1.10 x AL	2	5	7

$1-\beta = 0.75$	$1-\beta = 0.80$	$1-\beta = 0.90$	$1-\beta = 0.95$
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	2	3	4
U = 1.10 x AL	6	9	13

$1-\beta = 0.90$	$1-\beta = 0.80$	$1-\beta = 0.90$	$1-\beta = 0.95$
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	3
U = 1.25 x AL	2	4	5
U = 1.10 x AL	10	15	20

$1-\beta = 0.95$	$1-\beta = 0.80$	$1-\beta = 0.90$	$1-\beta = 0.95$
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	3
U = 1.25 x AL	3	4	5
U = 1.10 x AL	14	19	24

$1-\beta = 0.99$	$1-\beta = 0.80$	$1-\beta = 0.90$	$1-\beta = 0.95$
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	2	3
U = 1.25 x AL	4	6	7
U = 1.10 x AL	22	28	35

Boldface values are less than or equal to 7 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \left(\frac{z_p \cdot \sigma}{\Delta} \right)^2 \quad (0.5)$$

VALIDATED & UNVALIDATED

n=required # of samples
 σ^2 =variance in concentration
 z_p =the pth percentile of the standard normal distribution
 Δ =width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE	7 SAMPLES
111290-13MW17(8-10)	5.4	J	5.4	
111390-13MW6(14-16)	2	J	2	
110890-13MW10(6-8)	7.6	J	7.6	
13TB11-0406	404		404	
110890-13MW11(2-4)	178	J	178	
13TB8-0103	149		149	
13TB9-0103	150		150	
Sample Variance =	20833.987			
Average Value =	128.000			

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
 α : probability that a Type I (false positive) error will be made.
 That is rejecting H₀ when it is True. **Confidence Interval**
 β : probability that a Type II (false negative) error will be made.
 That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor.
 The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 t action limit is used to calculate value, average value, and sample variance for tectets (samples with 'U' in QUAL column).

ZONE 3

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 3 Shallow - Δ

VALIDATED
DATA

LEAD (MG/KG)	
Sample Variance = 326597.215	Action Level ⁽¹⁾ = 1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	3
U = 1.50 x AL	2	3	5
U = 1.25 x AL	5	10	16
U = 1.10 x AL	24	55	90

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	2	3	4
U = 1.50 x AL	4	6	9
U = 1.25 x AL	13	21	30
U = 1.10 x AL	76	126	178

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	2	3	5
U = 1.50 x AL	7	10	13
U = 1.25 x AL	24	36	47
U = 1.10 x AL	148	216	282

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	3	4	5
U = 1.50 x AL	9	13	16
U = 1.25 x AL	33	46	58
U = 1.10 x AL	203	281	355

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	4	6	7
U = 1.50 x AL	14	18	22
U = 1.25 x AL	53	69	84
U = 1.10 x AL	329	426	517

Boldface values are less than or equal to 5 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \frac{\sigma^2(z_{1-\beta} + z_{1-\alpha})^2}{\Delta^2} \quad \Delta = (0.5)z_{1-\alpha}$$

n=required # of samples
σ²=variance
in concentration
z_p=the pth percentile of
the standard normal
distribution
Δ=width of gray region
(U-AL)

SITE	RESULT	QUAL	VALUE ⁽²⁾
13TB18-0103	1320	J	1320
13TB5A-1.5-3.5	151	J	151
13TB7-0103	36.8	J	36.8
SB14-2.0-TAL	3.1		3.1
SB06-4.0-AVG	12.05	U	6.025
Sample Variance =	326597.215		
Average Value =	303.385		

5
SAMPLES

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
consequences of making a decision error are relatively minor.
The gray region is bounded on the lower side by the action level
and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 3 Shallow - B

VALIDATED
DATA
(13TB18-0103 Removed)

LEAD (MG/KG)	
Sample Variance = 4835.429	Action Level ⁽¹⁾ = 1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	2	3

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	2
U = 1.10 x AL	2	3	4

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	3
U = 1.10 x AL	3	4	6

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	3
U = 1.10 x AL	4	5	7

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	2	2	3
U = 1.10 x AL	6	8	9

Boldface values are less than or equal to 4 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \left(\frac{z_p \cdot \sigma}{\Delta} \right)^2 \quad (0.5)$$

n=required # of samples
σ²=variance
in concentration
z_p=the pth percentile of
the standard normal
distribution
Δ=width of gray region
(U-AL)

SITE	RESULT	QUAL	VALUE	4 SAMPLES
13TB5A-1.5-3.5	151	J	151	
13TB7-0103	36.8	J	36.8	
SB14-2.0-TAL	3.1		3.1	
SB06-4.0-AVG	12.05	U	6.025	
Sample Variance =		4835.429		
Average Value =		49.231		

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
consequences of making a decision error are relatively minor.
The gray region is bounded on the lower side by the action level
and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 detection limit is used to calculate value, average value, and sample var for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 3 Deep

VALIDATED
DATA

LEAD (MG/KG)			
Sample Variance =	39032.180	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	1	2	4
U = 1.10 x AL	4	8	12

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	3
U = 1.25 x AL	2	4	5
U = 1.10 x AL	10	16	23

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	2	3
U = 1.25 x AL	4	5	7
U = 1.10 x AL	18	27	35

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	3	4
U = 1.25 x AL	5	7	9
U = 1.10 x AL	25	35	44

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	3	4
U = 1.25 x AL	7	9	12
U = 1.10 x AL	40	52	63

Boldface values are less than or equal to 2 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \frac{\sigma^2 (z_p + z_{1-\alpha})^2}{\Delta^2}$$

n=required # of samples
σ²=variance
in concentration
z_p=the pth percentile of
the standard normal
distribution
Δ=width of gray region
(U-AL)

SITE	RESULT	QUAL	VALUE	
110890-13MW12(8-10)	2.6	J	2.6	2
13TB12-0406	282	J	282	
Sample Variance =		39032.180		SAMPLES
Average Value =		142.300		

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
consequences of making a decision error are relatively minor.
The gray region is bounded on the lower side by the action level
and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 3 Shallow and Deep - A

VALIDATED
DATA

LEAD (MG/KG)			
Sample Variance =	230415.025	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	3	4
U = 1.25 x AL	3	7	12
U = 1.10 x AL	17	39	64

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	3
U = 1.50 x AL	3	5	7
U = 1.25 x AL	9	15	22
U = 1.10 x AL	54	89	126

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	2	3	4
U = 1.50 x AL	5	7	10
U = 1.25 x AL	17	26	33
U = 1.10 x AL	105	153	199

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	2	3	4
U = 1.50 x AL	7	9	12
U = 1.25 x AL	24	33	42
U = 1.10 x AL	143	199	251

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	3	4	5
U = 1.50 x AL	10	13	16
U = 1.25 x AL	38	49	60
U = 1.10 x AL	232	301	365

Boldface values are less than or equal to 7 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \frac{z_p^2 - z_{1-\alpha}^2}{2(1-\alpha) - z_{1-\alpha}^2}$$

n=required # of samples
σ²=variance
in concentration
z_p=the pth percentile of
the standard normal
distribution
Δ=width of gray region
(U-AL)

SITE	RESULT	QUAL	VALUE
13TB18-0103	1320	J	1320
13TB5A-1.5-3.5	151	J	151
110890-13MW12(8-10)	2.6	J	2.6
13TB12-0406	282	J	282
13TB7-0103	36.8	J	36.8
SB14-2.0-TAL	3.1		3.1
SB06-4.0-AVG	12.05	U	6.025
Sample Variance =	230415.025		
Average Value =	257.361		

7
SAMPLES

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
consequences of making a decision error are relatively minor.
The gray region is bounded on the lower side by the action level
and on the upper side by the other bound (U).

(1) = Action Level based on Industrial Risk Criteria.

(2) = 1/2 detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 3 Shallow and Deep - B

VALIDATED
DATA

(13TB18-0103 REMOVED)

LEAD (MG/KG)			
Sample Variance =	13017.505	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	2
U = 1.10 x AL	2	3	5

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	1	2	3
U = 1.10 x AL	4	6	9

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	2	3	4
U = 1.10 x AL	7	10	13

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	2	3	4
U = 1.10 x AL	9	12	16

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	3
U = 1.25 x AL	3	4	5
U = 1.10 x AL	14	18	22

Boldface values are less than or equal to 6 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \left(\frac{z_p + z_{1-\alpha}}{\Delta} \right)^2 \cdot \sigma^2$$

n=required # of samples
σ ² =variance in concentration
z _p =the p th percentile of the standard normal distribution
Δ=width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE
13TB5A-1.5-3.5	151	J	151
110890-13MW12(8-10)	2.6	J	2.6
13TB12-0406	282	J	282
13TB7-0103	36.8	J	36.8
SB14-2.0-TAL	3.1		3.1
SB06-4.0-AVG	12.05	U	6.025
Sample Variance =	13017.505		
Average Value =	80.254		

6
SAMPLES

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H ₀
α: probability that a Type I (false positive) error will be made. That is rejecting H ₀ when it is True. Confidence Interval
β: probability that a Type II (false negative) error will be made. That is failing to rejecting H ₀ when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

(1) = Action Level based on Industrial Risk Criteria.

(2) = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 3 Shallow

Sample Variance = 644266.677 Action Level⁽¹⁾ = 1000

1	2	3
2	6	8
7	16	26
41	94	155

2	3	6
6	10	14
22	36	60
131	217	305

3	6	7
11	16	21
42	61	79
255	372	485

4	6	8
16	21	26
67	79	100
350	485	613

7	9	11
24	31	37
91	119	144
567	736	892

Boldface values are less than or equal to 70 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

VALIDATED & UNVALIDATE

n=required # of samples
σ²=variance
in concentration
z_α=the pth percentile of
the standard normal
distribution
Δ=width of gray region
(U-AL)

		70
		SAMPLES
2-EXWW-ALBACORE-06 (04)	4390	4390
EXSW-ALBACORE-06 (04)	4173	4173
EXWW-ALBACORE-06 (04)	1880	1880
13TB16-0103	1320 J	1320
13TB12-0204-X	567 J	567
SB13-2.0-D	463	463
EXWW01-07 (04)	437	437
SB30-2.0	413	413
SB25-2.0	389	389
EXSW02-06 (04)	364	364
3-EXSW09-06 (04)	351	351
SB25-4.0-D	351	351
EXSW-BULLHEAD-06 (04)	341	341
2-EXBE78-06 (04)	330	330
EXBE-BULLHEAD-07 (04)	285	285
EXSW03-07 (04)	264	264
SB29-4.0	238	238
2-EXNW78-09 (04)	233	233
SB20-2.0	229	229
SB13-2.0	186	186
EXSW01-07 (04)	184	184
SB30-4.0	163	163
13TB5A-1.5-3.5	151 J	151
EXEW-BULLHEAD-06 (04)	134	134
SB33-2.0	123	123
13TB5A-1.5-3.5-X	113 J	113
2-EXSW78-09 (04)	97.9	97.9
EXEW02-06 (04)	92.4	92.4
2-EXNW09-06 (04)	72.7	72.7
SB21-2.0	69.8	69.8
SB15-2.0	69.2	69.2
EXNW04-06 (04)	67.4	67.4
SB15-4.0	44.5	44.5
13TB7-0103	36.8 J	36.8
SB13-4.0	32.6	32.6
SB32-2.0	31.4	31.4
SB26-2.0	30.1	30.1
SB09-2.0	27.5	27.5
SB25-4.0	26.8	26.8
SB20-4.0	26.4	26.4
SB20-4.0-D	25.8	25.8
EXNW03-07 (04)	24.3	24.3
4-EXEW03-07 (04)	21.4	21.4
EXNW02-06 (04)	19.9	19.9
SB27-2.0	19.8	19.8
SB06-4.0	19.3 U(b)	19.3
SB19-4.0	15.7	15.7
SB07-2.0	13.7	13.7
SB10-4.0	13.7	13.7
EXSW04-06 (04)	10.9	10.9
SB09-4.0	9.8	9.8
SB19-2.0	9.7	9.7
SB21-4.0	9.3	9.3
2-EXWW09-06 (04)	8.4	8.4
SB22-4.0	8.1	8.1
SB10-2.0	7.9	7.9
EXWW02-06 (04)	7.4	7.4
SB23-4.0	6.7	6.7
SB14-4.0	6.3	6.3
SB06-2.0	5.9	5.9
SB22-2.0	5.4	5.4
SB06-4.0-D	4.8 U(b)	4.8
SB27-4.0	4	4
SB14-2.0-TAL	3.1	3.1
SB07-4.0	3.1	3.1
SB14-2.0	3.1	3.1
SB26-4.0	3	3
SB12-4.0	2.9	2.9
SB12-2.0	2.8	2.8
SB23-2.0	2.8	2.8
Sample Variance =	644266.677	
Average Value =	272.807	

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. Confidence Interval
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. Power
Gray Region: A range of values of the mean concentration where
consequences of making a decision error are relatively minor.
The gray region is bounded on the lower side by the action level
and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

**Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 3 Deep**

Sample Variance = 1075711.505	Action Level⁽¹⁾ = 1000
--------------------------------------	--

U = 2.00 x AL	2	3	5
U = 1.50 x AL	4	8	13
U = 1.25 x AL	13	30	48
U = 1.10 x AL	77	178	293

U = 2.00 x AL	3	5	8
U = 1.50 x AL	11	18	25
U = 1.25 x AL	40	67	94
U = 1.10 x AL	248	413	581

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	6	8	11
U = 1.50 x AL	20	30	39
U = 1.25 x AL	78	114	149
U = 1.10 x AL	486	708	923

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	8	11	13
U = 1.50 x AL	27	38	48
U = 1.25 x AL	107	149	188
U = 1.10 x AL	666	923	1166

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	12	15	19
U = 1.50 x AL	44	57	70
U = 1.25 x AL	174	225	273
U = 1.10 x AL	1080	1402	1698

Boldface values are less than or equal to 46 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

VALIDATED & UNVALIDATED

n=required # of samples
σ ² =variance in concentration
z _p =the p th percentile of the standard normal distribution
Δ=width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE
2-EXBE-ALBACORE-04 (94)	6060		6060
EXBE-ALBACORE-03 (94)	3330		3330
EXBE-ALBACORE-04-D (94)	1870		1870
EXBE05-04 (94)	1290		1290
EXNW08-07 (94)	1030		1030
2-EXWW06-06 (94)	429		429
SB16-6.0	339		339
EXBE02-04 (94)	322		322
SB17-6.0	302		302
13TB12-0406	282 J		282
EXSW08-07 (94)	234		234
EXSW07-04 (94)	213		213
EXBE06-07 (94)	162		162
SB19-6.0	144		144
EXWW06-07 (94)	142		142
SB06-6.0	134		134
EXBE03-04 (94)	134		134
SB29-6.0	127		127
13TB12-0608-X	107 J		107
SB30-6.0	57.2		57.2
SB20-6.0	49.8		49.8
EXBE01-04 (94)	49.6		49.6
SB13-6.0	42.9		42.9
SB15-6.0	40		40
SB07-6.0	39.5		39.5
EXEW07-05 (94)	33.3		33.3
SB22-6.0	32.6		32.6
SB22-6.0-TAL	32.6		32.6
SB08-6.0	30		30
EXEW07-05-D (94)	27.6		27.6
SB26-6.0	25.4		25.4
EXBE07-03 (94)	15.2		15.2
SB09-6.0	14.6		14.6
EXWW08-07 (94)	14.4		14.4
SB10-6.0	9.1		9.1
SB12-6.0	8.8		8.8
SB10-6.0-D	8.76		8.76
SB23-6.0	7.7		7.7
SB25-6.0	7		7
SB21-6.0	6.8		6.8
SB14-6.0	5.1		5.1
SB24-6.0	4.9		4.9
EXNW07-05 (94)	4.3		4.3
SB27-6.0	3.5		3.5
110890-13MW12(8-10)	2.6 J		2.6
EXWW07-05 (94)	2.6		2.6
Sample Variance =	1075711.505		
Average Value =	374.497		

**46
SAMPLES**

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H ₀
α: probability that a Type I (false positive) error will be made. That is rejecting H ₀ when it is True. Confidence Interval
β: probability that a Type II (false negative) error will be made. That is failing to rejecting H ₀ when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

**Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 3 Shallow and Deep**

Sample Variance = 761986.655	Action Level⁽¹⁾ = 1000
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U = 0.01 x AL	1	3	4
U = 0.05 x AL	3	6	10
U = 0.10 x AL	9	21	35
U = 0.25 x AL	55	126	208

U = 0.50 x AL	3	4	6
U = 1.00 x AL	8	13	18
U = 1.25 x AL	29	48	67
U = 1.50 x AL	176	293	412

U = 2.00 x AL	4	6	8
U = 1.50 x AL	15	21	28
U = 1.25 x AL	56	81	106
U = 1.10 x AL	344	502	654

U = 2.00 x AL	6	8	10
U = 1.50 x AL	20	27	35
U = 1.25 x AL	76	106	134
U = 1.10 x AL	472	654	826

U = 2.00 x AL	9	11	14
U = 1.50 x AL	31	41	50
U = 1.25 x AL	123	160	194
U = 1.10 x AL	766	993	1204

Boldface values are less than or equal to 116 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

VALIDATED & UNVALIDATED

n=required # of samples
 σ^2 =variance in concentration
 z_p =the p^{th} percentile of the standard normal distribution
 Δ =width of gray region (U-AL)

U = 0.01 x AL	1	3	4
U = 0.05 x AL	3	6	10
U = 0.10 x AL	9	21	35
U = 0.25 x AL	55	126	208

SITE	RESULT	QUAL	VALUE	116 SAMPLES
110890-13MW12(8-10)	2.6	J	2.6	
13TB12-0406	282	J	282	
13TB12-0608-X	107	J	107	
13TB12-0204-X	567	J	567	
13TB18-0103	1320	J	1320	
13TB5A-1.5-3.5	151	J	151	
13TB5A-1.5-3.5-X	113	J	113	
13TB7-0103	36.8	J	36.8	
2-EXBE-ALBACORE-04 (94)	6060		6060	
2-EXBE78-06 (94)	330		330	
2-EXNW09-06 (94)	72.7		72.7	
2-EXNW78-09 (94)	233		233	
2-EXSW78-09 (94)	97.9		97.9	
2-EXWW-ALBACORE-06 (94)	4390		4390	
2-EXWW06-06 (94)	429		429	
2-EXWW09-06 (94)	8.4		8.4	
3-EXSW09-06 (94)	351		351	
4-EXEW03-07 (94)	21.4		21.4	
EXBE-ALBACORE-03 (94)	3330		3330	
EXBE-ALBACORE-04-D (94)	1870		1870	
EXBE-BULLHEAD-07 (94)	285		285	
EXBE01-04 (94)	49.6		49.6	
EXBE02-04 (94)	322		322	
EXBE03-04 (94)	134		134	
EXBE05-04 (94)	1290		1290	
EXBE06-07 (94)	162		162	
EXBE07-03 (94)	15.2		15.2	
EXEW-BULLHEAD-08 (94)	134		134	
EXEW02-06 (94)	92.4		92.4	
EXEW07-05 (94)	33.3		33.3	
EXEW07-05-D (94)	27.6		27.6	
EXNW02-06 (94)	19.9		19.9	
EXNW03-07 (94)	24.3		24.3	
EXNW04-06 (94)	67.4		67.4	
EXNW07-05 (94)	4.3		4.3	
EXNW08-07 (94)	1030		1030	
EXSW-ALBACORE-06 (94)	4173		4173	
EXSW-BULLHEAD-08 (94)	341		341	
EXSW01-07 (94)	184		184	
EXSW02-06 (94)	364		364	
EXSW03-07 (94)	264		264	
EXSW04-06 (94)	10.9		10.9	
EXSW07-04 (94)	213		213	
EXSW08-07 (94)	234		234	
EXWW-ALBACORE-06 (94)	1880		1880	
EXWW01-07 (94)	437		437	
EXWW02-06 (94)	7.4		7.4	
EXWW06-07 (94)	142		142	
EXWW07-05 (94)	2.6		2.6	
EXWW08-07 (94)	14.4		14.4	
SB14-2.0-TAL	3.1		3.1	
SB22-6.0-TAL	32.6		32.6	
SB06-2.0	5.9		5.9	
SB06-4.0	19.3	U(b)	19.3	
SB06-4.0-D	4.8	U(b)	4.8	
SB06-6.0	134		134	
SB07-2.0	13.7		13.7	
SB07-4.0	3.1		3.1	
SB07-6.0	39.5		39.5	

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

**Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 3 Shallow and Deep**

SB08-6.0	30	30
SB09-2.0	27.5	27.5
SB09-4.0	9.8	9.8
SB09-6.0	14.6	14.6
SB10-2.0	7.9	7.9
SB10-4.0	13.7	13.7
SB10-6.0	9.1	9.1
SB10-6.0-D	8.76	8.76
SB12-2.0	2.8	2.8
SB12-4.0	2.9	2.9
SB12-6.0	8.8	8.8
SB13-2.0	186	186
SB13-2.0-D	463	463
SB13-4.0	32.6	32.6
SB13-6.0	42.9	42.9
SB14-2.0	3.1	3.1
SB14-4.0	6.3	6.3
SB14-6.0	5.1	5.1
SB15-2.0	69.2	69.2
SB15-4.0	44.5	44.5
SB15-6.0	40	40
SB16-6.0	339	339
SB17-6.0	302	302
SB19-2.0	9.7	9.7
SB19-4.0	15.7	15.7
SB19-6.0	144	144
SB20-2.0	229	229
SB20-4.0	26.4	26.4
SB20-4.0-D	25.8	25.8
SB20-6.0	49.8	49.8
SB21-2.0	69.8	69.8
SB21-4.0	9.3	9.3
SB21-6.0	6.8	6.8
SB22-2.0	5.4	5.4
SB22-4.0	8.1	8.1
SB22-6.0	32.6	32.6
SB23-2.0	2.8	2.8
SB23-4.0	6.7	6.7
SB23-6.0	7.7	7.7
SB24-6.0	4.9	4.9
SB25-2.0	389	389
SB25-4.0	26.8	26.8
SB25-4.0-D	351	351
SB25-6.0	7	7
SB26-2.0	30.1	30.1
SB26-4.0	3	3
SB26-6.0	25.4	25.4
SB27-2.0	19.8	19.8
SB27-4.0	4	4
SB27-6.0	3.5	3.5
SB29-4.0	238	238
SB29-6.0	127	127
SB30-2.0	413	413
SB30-4.0	163	163
SB30-6.0	57.2	57.2
SB32-2.0	31.4	31.4
SB33-2.0	123	123
Sample Variance =	761986.655	
Average Value =	313.132	

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H ₀
α : probability that a Type I (false positive) error will be made. That is rejecting H ₀ when it is True. Confidence Interval
β : probability that a Type II (false negative) error will be made. That is failing to rejecting H ₀ when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

(1) = Action Level based on Industrial Risk Criteria.

(2) = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

ZONE 4

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 4 Shallow

VALIDATED
DATA

LEAD (MG/KG)	
Sample Variance = 21834256.250	Action Level ⁽¹⁾ = 1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	16	37	61
U = 1.50 x AL	63	145	238
U = 1.25 x AL	248	575	947
U = 1.10 x AL	1547	3587	5909

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	51	85	119
U = 1.50 x AL	202	335	472
U = 1.25 x AL	804	1338	1881
U = 1.10 x AL	5020	8355	11747

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	99	145	189
U = 1.50 x AL	395	575	750
U = 1.25 x AL	1576	2296	2994
U = 1.10 x AL	9843	14345	18700

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	136	188	238
U = 1.50 x AL	541	749	947
U = 1.25 x AL	2161	2993	3783
U = 1.10 x AL	13500	18700	23631

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	220	286	346
U = 1.50 x AL	877	1138	1379
U = 1.25 x AL	3507	4549	5511
U = 1.10 x AL	21914	28423	34435

Boldface values are less than or equal to 4 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

n=required # of samples
σ ² =variance in concentration
z _p =the p th percentile of the standard normal distribution
Δ=width of gray region (U-AL)

$$n = \frac{\sigma^2 (z_p + z_{1-\alpha})^2}{\Delta^2}$$

SITE	RESULT	QUAL	VALUE	4 SAMPLES
13TB2A-0406	1880	J	1880	
13TB3A-2.5-4.5-AVG	6505	J	6505	
13TB4A-0002	280	J	280	
13WE4A-0002	10600	J	10600	
Sample Variance =	21834256.250			
Average Value =	4816.250			

Null Hypothesis (H ₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H ₀
α: probability that a Type I (false positive) error will be made. That is rejecting H ₀ when it is True. Confidence Interval
β: probability that a Type II (false negative) error will be made. That is failing to rejecting H ₀ when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 4 Deep

VALIDATED
DATA

LEAD (MG/KG)			
Sample Variance =	331662.874	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	3
U = 1.50 x AL	2	4	5
U = 1.25 x AL	5	10	16
U = 1.10 x AL	24	56	92

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	2	3	4
U = 1.50 x AL	4	6	9
U = 1.25 x AL	13	22	30
U = 1.10 x AL	77	128	180

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	2	4	5
U = 1.50 x AL	7	10	13
U = 1.25 x AL	25	36	47
U = 1.10 x AL	150	219	286

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	3	4	5
U = 1.50 x AL	9	13	16
U = 1.25 x AL	34	47	59
U = 1.10 x AL	206	285	361

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	4	6	7
U = 1.50 x AL	14	19	23
U = 1.25 x AL	54	70	86
U = 1.10 x AL	334	433	525

Boldface values are less than or equal to 6 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \frac{\sigma^2(z_p + z_{1-\alpha})^2}{\Delta^2} + (0.5)z_p^2$$

n=required # of samples
σ²=variance
in concentration
z_p=the pth percentile of
the standard normal
distribution
Δ=width of gray region
(U-AL)

SITE	RESULT	QUAL	VALUE	6 SAMPLES
QW-1 (94)	1470		1470	
111290-13MW15(12-14)	55.3		55.3	
111390-13MW13(8-10)-AVG	37.7	J	37.7	
111390-13MW14(12-14)-AVG	68.7		68.7	
111290-13MW16(10-12)	41.3		41.3	
13TB6-0507	98.9	J	98.9	
Sample Variance =	331662.874			
Average Value =	295.317			

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
consequences of making a decision error are relatively minor.
The gray region is bounded on the lower side by the action level
and on the upper side by the other bound (U).

(1) = Action Level based on Industrial Risk Criteria.

(2) = 1/2 detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 4 Shallow and Deep

VALIDATED
DATA

LEAD (MG/KG)			
Sample Variance =	12912699.423	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	10	23	37
U = 1.50 x AL	37	86	142
U = 1.25 x AL	147	341	561
U = 1.10 x AL	915	2122	3495

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	31	51	71
U = 1.50 x AL	120	199	280
U = 1.25 x AL	476	792	1113
U = 1.10 x AL	2969	4942	6948

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	59	86	112
U = 1.50 x AL	234	341	444
U = 1.25 x AL	932	1359	1771
U = 1.10 x AL	5822	8484	11060

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	81	112	142
U = 1.50 x AL	320	444	561
U = 1.25 x AL	1278	1771	2238
U = 1.10 x AL	7984	11060	13976

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	130	169	205
U = 1.50 x AL	519	674	816
U = 1.25 x AL	2074	2691	3260
U = 1.10 x AL	12960	16810	20366

Boldface values are less than or equal to 10 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \frac{\sigma^2(z_p + z_{1-\alpha})^2}{\Delta^2} + (0.5)z_p$$

n=required # of samples
σ²=variance
in concentration
z_p=the pth percentile of
the standard normal
distribution
Δ=width of gray region
(U-AL)

SITE	RESULT	QUAL	VALUE ⁽²⁾
13TB2A-0406	1880	J	1880
13TB3A-2.5-4.5-AVG	6505	J	6505
13TB4A-0002	280	J	280
13WE4A-0002	10600	J	10600
QW-1 (94)	1470		1470
111290-13MW15(12-14)	55.3		55.3
111390-13MW13(8-10)-AVG	37.7	J	37.7
111390-13MW14(12-14)-AVG	68.7		68.7
111290-13MW16(10-12)	41.3		41.3
13TB6-0507	98.9	J	98.9
Sample Variance =		12912699.423	
Average Value =		2103.690	

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SAMPLES

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
consequences of making a decision error are relatively minor.

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

**Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 4 Shallow**

LEAD (MG/KG)	
Sample Variance = 14758690.476	Action Level⁽¹⁾ = 1000

$1-\beta = 0.50$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	11	26	42
U = 1.50 x AL	43	98	162
U = 1.25 x AL	168	389	641
U = 1.10 x AL	1046	2425	3995

$1-\beta = 0.75$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	35	58	81
U = 1.50 x AL	137	227	319
U = 1.25 x AL	544	905	1272
U = 1.10 x AL	3393	5648	7941

$1-\beta = 0.90$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	67	98	128
U = 1.50 x AL	267	389	507
U = 1.25 x AL	1065	1553	2024
U = 1.10 x AL	6654	9697	12641

$1-\beta = 0.95$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	92	128	162
U = 1.50 x AL	366	507	641
U = 1.25 x AL	1461	2024	2557
U = 1.10 x AL	9125	12640	15974

$1-\beta = 0.99$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	149	193	235
U = 1.50 x AL	593	770	933
U = 1.25 x AL	2371	3075	3726
U = 1.10 x AL	14813	19213	23277

Boldface values are less than or equal to 7 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

Sample Variance = 14758690.476	Average Value = 4237.143
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VALIDATED & UNVALIDATED

n=required # of samples
σ^2 =variance in concentration
z_p =the p^{th} percentile of the standard normal distribution
Δ =width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE	7 SAMPLES
13TB2A-0406	1880	J	1880	
13TB2A-0406-X	2080	J	2080	
13TB3A-2.5-4.5	8240	J	8240	
13TB3A-2.5-4.5-D	4770	J	4770	
13TB4A-0002	280	J	280	
13TB4A-0002-X	1810	J	1810	
13WE4A-0002	10600	J	10600	
Sample Variance = 14758690.476				
Average Value = 4237.143				

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H ₀
α : probability that a Type I (false positive) error will be made. That is rejecting H ₀ when it is True. Confidence Interval
β : probability that a Type II (false negative) error will be made. That is failing to rejecting H ₀ when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 4 Deep

LEAD (MG/KG)			
Sample Variance =	562026.517	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	3
U = 1.50 x AL	2	5	8
U = 1.25 x AL	7	16	26
U = 1.10 x AL	41	94	154

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	2	3	5
U = 1.50 x AL	6	10	14
U = 1.25 x AL	22	36	50
U = 1.10 x AL	130	216	304

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	3	5	7
U = 1.50 x AL	11	16	21
U = 1.25 x AL	41	60	79
U = 1.10 x AL	254	371	483

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	4	6	8
U = 1.50 x AL	15	21	26
U = 1.25 x AL	56	78	99
U = 1.10 x AL	348	483	610

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	6	9	11
U = 1.50 x AL	23	31	37
U = 1.25 x AL	91	118	144
U = 1.10 x AL	565	733	888

Boldface values are less than or equal to 9 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

n = (z _p - z _{1-p}) ² / (0.5)Δ ²
2

VALIDATED & UNVALIDATED

n=required # of samples
σ ² =variance in concentration
z _p =the p th percentile of the standard normal distribution
Δ=width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE
QW-1 (94)	1470		1470
111290-13MW15(12-14)	34.4		34.4
111390-13MW13(8-10)	50.2	J	50.2
111390-13MW14(12-14)	68.7		68.7
111290-13MW16(10-12)	41.3		41.3
111390-13MW14(12-14)-D	76.2		76.2
111390-13MW13(8-10)-D	25.2	J	25.2
13TB3A-0608-X	1990	J	1990
13TB6-0507	98.9	J	98.9
Sample Variance =	562026.517		
Average Value =	428.322		

9
SAMPLES

Null Hypothesis (H ₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H ₀
α: probability that a Type I (false positive) error will be made. That is rejecting H ₀ when it is True. Confidence Interval
β: probability that a Type II (false negative) error will be made. That is failing to rejecting H ₀ when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

**Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 4 Shallow and Deep**

LEAD (MG/KG)	
Sample Variance = 10011341.256	Action Level⁽¹⁾ = 1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	8	18	29
U = 1.50 x AL	29	67	110
U = 1.25 x AL	114	264	435
U = 1.10 x AL	710	1646	2710

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	24	40	56
U = 1.50 x AL	93	155	217
U = 1.25 x AL	369	614	864
U = 1.10 x AL	2302	3832	5387

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	46	67	88
U = 1.50 x AL	181	264	345
U = 1.25 x AL	723	1054	1374
U = 1.10 x AL	4514	6578	8575

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	63	87	110
U = 1.50 x AL	248	344	435
U = 1.25 x AL	991	1373	1735
U = 1.10 x AL	6190	8575	10836

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	101	132	160
U = 1.50 x AL	403	523	633
U = 1.25 x AL	1608	2086	2528
U = 1.10 x AL	10048	13033	15790

Boldface values are less than or equal to 16 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	101	132	160
U = 1.50 x AL	403	523	633
U = 1.25 x AL	1608	2086	2528
U = 1.10 x AL	10048	13033	15790

VALIDATED & UNVALIDATED

n=required # of samples
 σ^2 =variance
 in concentration
 z_p =the p^{th} percentile of
 the standard normal
 distribution
 Δ =width of gray region
 (U-AL)

SITE	RESULT	QUAL	VALUE
QW-1 (94)	1470		1470
111290-13MW15(12-14)	34.4		34.4
111390-13MW13(8-10)	50.2	J	50.2
111390-13MW14(12-14)	68.7		68.7
111290-13MW16(10-12)	41.3		41.3
111390-13MW14(12-14)-D	76.2		76.2
111390-13MW13(8-10)-D	25.2	J	25.2
13TB3A-0608-X	1990	J	1990
13TB6-0507	98.9	J	98.9
13TB2A-0406	1880	J	1880
13TB2A-0406-X	2080	J	2080
13TB3A-2.5-4.5	8240	J	8240
13TB3A-2.5-4.5-D	4770	J	4770
13TB4A-0002	280	J	280
13TB4A-0002-X	1810	J	1810
13WE4A-0002	10600	J	10600
Sample Variance =	10011341.256		
Average Value =	2094.681		

**16
SAMPLES**

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
 α : probability that a Type I (false positive) error will be made.
 That is rejecting H₀ when it is True. **Confidence Interval**
 β : probability that a Type II (false negative) error will be made.
 That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
 consequences of making a decision error are relatively minor.
 The gray region is bounded on the lower side by the action level
 and on the upper side by the other bound (U).

⁽¹⁾ = Action level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 ti action limit is used to calculate value, average value, and sample variance for non-s (samples with 'U' in QUAL column).

ZONE 5

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 5 Shallow and Deep

VALIDATED
DATA

LEAD (MG/KG)			
Sample Variance =	28.936	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

Boldface values are less than or equal to 3 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

n=required # of samples
σ ² =variance in concentration
z _p =the p th percentile of the standard normal distribution
Δ=width of gray region (U-AL)

$$n = \frac{\sigma^2 (z_{1-\alpha} + z_{1-\beta})^2}{\Delta^2} \approx (0.5) z_{1-\beta}^2$$

SITE	RESULT	QUAL	VALUE ⁽²⁾
19TB4-0406 (93)	12.3		12.3
19TB4-0002 (93)	10.4	U	5.2
19TB4-0204 (93)	31.5	U	15.75
Sample Variance			28.936
Average Value =			11.083

**3
SAMPLES**

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H ₀
α: probability that a Type I (false positive) error will be made. That is rejecting H ₀ when it is True. Confidence Interval
β: probability that a Type II (false negative) error will be made. That is failing to rejecting H ₀ when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

**Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 5 Shallow**

LEAD (MG/KG)			
Sample Variance =	171.830	Action Level⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	2	2

Boldface values are less than or equal to 10 samples already taken.

<i>Probability</i>	<i>z-Score</i>
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \frac{\sigma^2(z_p + 1)^2}{\Delta^2} \quad (0.5)$$

VALIDATED & UNVALIDATED

n=required # of samples
 σ^2 =variance
 in concentration
 z_p =the p^{th} percentile of
 the standard normal
 distribution
 Δ =width of gray region
 (U-AL)

SITE	RESULT	QUAL	VALUE
19MW2-0204 (93)	6.6	S	6
19MW3-0002 (93)	13.3	S	13.3
19MW4-0004 (93)	12.5		12.5
19SS1 (93)	48.4		48.4
19TB1-0004 (93)	13.7		13.7
19TB2-0002 (93)	6.1	S	6.1
19TB3-0204 (93)	1.7	J	1.7
19TB4-0002 (93)	10.4	U	5.2
19TB4-0204 (93)	31.5	U	15.75
19MW1-0.252.25 (93)-AVG	15.55		15.55
Sample Variance =	171.830		
Average Value =	13.820		

**10
SAMPLES**

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
 α : probability that a Type I (false positive) error will be made.
 That is rejecting H₀ when it is True. **Confidence Interval**
 β : probability that a Type II (false negative) error will be made.
 That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
 consequences of making a decision error are relatively minor.
 The gray region is bounded on the lower side by the action level
 and on the upper side by the other bound (U).

⁽¹⁾ = Action level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 Detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 5 Deep

LEAD (MG/KG)			
Sample Variance =	27.632	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

Boldface values are less than or equal to 78 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \frac{(z_p + z_{1-\alpha})^2 \cdot \sigma^2}{\Delta^2}$$

VALIDATED & UNVALIDATED

n = required # of samples
 σ^2 = variance in concentration
 z_p = the pth percentile of the standard normal distribution
 Δ = width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE ⁽²⁾	7 SAMPLES
19MW2-0406 (93)-AVG	6	S	6	
19MW3-0406 (93)	14.6		14.6	
19MW4-0608 (93)	4.4	S	4.4	
19TB1-0608 (93)	1.3	S	1.3	
19TB2-0608 (93)	2.7	S	2.7	
19TB3-1012 (93)	1.9	S	1.9	
19TB4-0406 (93)	12.3		12.3	
Sample Variance =		27.632		
Average Value =		6.171		

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
 α : probability that a Type I (false positive) error will be made.
 That is rejecting H₀ when it is True. **Confidence Interval**
 β : probability that a Type II (false negative) error will be made.
 That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor.
 The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

**Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 5 Shallow and Deep**

LEAD (MG/KG)			
Sample Variance =	122.072	Action Level⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	1	2

Boldface values are less than or equal to 17 samples already taken.

<i>Probability</i>	<i>z-Score</i>
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

n = 22	0.5
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VALIDATED & UNVALIDATED

n=required # of samples
 σ^2 =variance in concentration
 z_p =the p^{th} percentile of the standard normal distribution
 Δ =width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE
19MW2-0406 (93)-AVG	6	S	6
19MW3-0406 (93)	14.6		14.6
19MW4-0608 (93)	4.4	S	4.4
19TB1-0608 (93)	1.3	S	1.3
19TB2-0608 (93)	2.7	S	2.7
19TB3-1012 (93)	1.9	S	1.9
19TB4-0406 (93)	12.3		12.3
19MW2-0204 (93)	6.6	S	6
19MW3-0002 (93)	13.3	S	13.3
19MW4-0004 (93)	12.5		12.5
19SS1 (93)	48.4		48.4
19TB1-0004 (93)	13.7		13.7
19TB2-0002 (93)	6.1	S	6.1
19TB3-0204 (93)	1.7	J	1.7
19TB4-0002 (93)	10.4	U	5.2
19TB4-0204 (93)	31.5	U	15.75
19MW1-0.252.25 (93)-AVG	15.55		15.55
Sample Variance =	122.072		
Average Value =	10.671		

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SAMPLES**

Null Hypothesis (H_0): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H_0
 α : probability that a Type I (false positive) error will be made.
 That is rejecting H_0 when it is True. **Confidence Interval**
 β : probability that a Type II (false negative) error will be made.
 That is failing to rejecting H_0 when it is False. **Power**
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor.
 The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 t. Action limit is used to calculate value, average value, and sample variance for non-d. (samples with 'U' in QUAL column).

ZONE 7

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 7 Shallow - A

VALIDATED
DATA

LEAD (MG/KG)	
Sample Variance = 3566577721.764	Action Level ⁽¹⁾ = 1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	2527	5859	9651
U = 1.50 x AL	10106	23432	38600
U = 1.25 x AL	40422	93724	154394
U = 1.10 x AL	252631	585766	964954

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	8199	13647	19188
U = 1.50 x AL	32793	54586	76745
U = 1.25 x AL	131171	218338	306976
U = 1.10 x AL	819813	1364609	1918590

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	16078	23432	30545
U = 1.50 x AL	64311	93724	122176
U = 1.25 x AL	257243	374891	488699
U = 1.10 x AL	1607764	2343061	3054362

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	22051	30545	38600
U = 1.50 x AL	88203	122176	154394
U = 1.25 x AL	352810	488699	617571
U = 1.10 x AL	2205057	3054361	3859811

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	35795	46427	56248
U = 1.50 x AL	143177	185704	224987
U = 1.25 x AL	572707	742813	899943
U = 1.10 x AL	3579415	4642576	5624634

Boldface values are less than or equal to 10 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \frac{\sigma^2 (z_{1-\beta} + z_{1-\alpha})^2}{\Delta^2} \quad (0.5) z_{1-\alpha}$$

n = required # of samples
σ² = variance
in concentration
z_p = the pth percentile of
the standard normal
distribution
Δ = width of gray region
(U-AL)

SITE	RESULT	QUAL	VALUE
20MW2-0002 (93)	65.1	J	65.1
20MW3-0204 (93)	60.7	J	60.7
20MW4-0204 (93)	20.4	J	20.4
20MW5-0002 (93)	128	J	128
20MW6-0204 (93)	189000	J	189000
20MW7-0204 (93)	6.3	J	6.3
20TB2-0204 (93)	33.6	J	33.6
20TB3-0204 (93)	66.1		66.1
20TB4-0002 (93)	726		726
20TB5-0002 (93)	220	J	220

10
SAMPLES

Sample Variance 3566577721.764
Average Value = 19032.620

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
consequences of making a decision error are relatively minor.
The gray region is bounded on the lower side by the action level

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 7 Shallow - B

VALIDATED
DATA

(20MW6-0204 Removed)

LEAD (MG/KG)			
Sample Variance =	51289.198	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	1	3	4
U = 1.10 x AL	4	10	16

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	1	2	3
U = 1.25 x AL	3	4	6
U = 1.10 x AL	13	21	29

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	3	4
U = 1.25 x AL	5	7	9
U = 1.10 x AL	24	35	46

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	3	4
U = 1.25 x AL	6	8	11
U = 1.10 x AL	33	45	57

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	3
U = 1.50 x AL	3	4	5
U = 1.25 x AL	9	12	15
U = 1.10 x AL	52	68	83

Boldface values are less than or equal to 9 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \left(\frac{z_p + z_{1-\alpha}}{\Delta} \right)^2 \times \sigma^2$$

n=required # of samples
σ ² =variance in concentration
z _p =the p th percentile of the standard normal distribution
Δ=width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE
20MW2-0002 (93)	65.1	J	65.1
20MW3-0204 (93)	60.7	J	60.7
20MW4-0204 (93)	20.4	J	20.4
20MW5-0002 (93)	128	J	128
20MW7-0204 (93)	6.3	J	6.3
20TB2-0204 (93)	33.6	J	33.6
20TB3-0204 (93)	66.1		66.1
20TB4-0002 (93)	726		726
20TB5-0002 (93)	220	J	220
Sample Variance	51289.198		
Average Value =	147.356		

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SAMPLES

Null Hypothesis (H ₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H ₀
α: probability that a Type I (false positive) error will be made. That is rejecting H ₀ when it is True. Confidence Interval
β: probability that a Type II (false negative) error will be made. That is failing to rejecting H ₀ when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

(1) = Action Level based on Industrial Risk Criteria.

(2) = 1/2 detection limit is used to calculate value, average value, and sample v

ce for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 7 Deep

VALIDATED
DATA

LEAD (MG/KG)			
Sample Variance =	174244.627	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	1	2	4
U = 1.25 x AL	3	6	9
U = 1.10 x AL	13	30	49

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	3
U = 1.50 x AL	2	4	6
U = 1.25 x AL	7	12	17
U = 1.10 x AL	41	68	96

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	2	2	3
U = 1.50 x AL	4	6	8
U = 1.25 x AL	13	20	26
U = 1.10 x AL	79	116	151

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	2	3	4
U = 1.50 x AL	5	7	9
U = 1.25 x AL	18	25	32
U = 1.10 x AL	109	151	190

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	3	4	5
U = 1.50 x AL	8	10	13
U = 1.25 x AL	29	38	46
U = 1.10 x AL	176	228	277

Boldface values are less than or equal to 6 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \frac{\sigma^2 (z_{1-\alpha} + z_{1-\beta})^2}{(\Delta)^2} \quad (0.5) z_{1-\alpha}$$

n=required # of samples
σ²=variance
in concentration
z_p=the pth percentile of
the standard normal
distribution
Δ=width of gray region
(U-AL)

SITE	RESULT	QUAL	VALUE	6 SAMPLES
20MW2-1416 (93)	2.3	J	2.3	
20MW3-0810 (93)	38.3	J	38.3	
20MW4-0406 (93)	12	J	12	
20MW5-0608 (93)	1040	J	1040	
20MW7-0406 (93)	6.2	J	6.2	
20TB5-0406 (93)	31.8	J	31.8	
Sample Variance		174244.627		
Average Value =		188.433		

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
consequences of making a decision error are relatively minor.
The gray region is bounded on the lower side by the action level
and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 7 Shallow and Deep - A

VALIDATED
DATA

LEAD (MG/KG)		
Sample Variance =	2228780557.383	Action Level ⁽¹⁾ = 1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1580	3662	6032
U = 1.50 x AL	6316	14643	24122
U = 1.25 x AL	25260	58569	96483
U = 1.10 x AL	157871	366050	603008

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	5124	8529	11991
U = 1.50 x AL	20493	34111	47959
U = 1.25 x AL	81970	136442	191832
U = 1.10 x AL	512307	852754	1198942

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	10048	14643	19089
U = 1.50 x AL	40189	58569	76350
U = 1.25 x AL	160753	234273	305393
U = 1.10 x AL	1004704	1464196	1908694

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	13780	19088	24122
U = 1.50 x AL	55119	76349	96483
U = 1.25 x AL	220474	305392	385926
U = 1.10 x AL	1377957	1908693	2412025

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	22369	29013	35151
U = 1.50 x AL	89473	116048	140597
U = 1.25 x AL	357889	464190	562382
U = 1.10 x AL	2236803	2901180	3514876

Boldface values are less than or equal to 16 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \left(\frac{z_p + z_{1-\alpha}}{\Delta} \right)^2 \cdot \sigma^2$$

n=required # of samples
σ²=variance
in concentration
z_p=the pth percentile of
the standard normal
distribution
Δ=width of gray region
(U-AL)

SITE	RESULT	QUAL	VALUE
20MW2-1416 (93)	2.3	J	2.3
20MW3-0810 (93)	38.3	J	38.3
20MW4-0406 (93)	12	J	12
20MW5-0608 (93)	1040	J	1040
20MW7-0406 (93)	6.2	J	6.2
20MW2-0002 (93)	65.1	J	65.1
20MW3-0204 (93)	60.7	J	60.7
20MW4-0204 (93)	20.4	J	20.4
20MW5-0002 (93)	128	J	128
20MW7-0204 (93)	6.3	J	6.3
20MW6-0204 (93)	189000	J	189000
20TB2-0204 (93)	33.6	J	33.6
20TB3-0204 (93)	66.1	J	66.1
20TB4-0002 (93)	726	J	726
20TB5-0002 (93)	220	J	220
20TB5-0406 (93)	31.8	J	31.8
Sample Variance		2228780557.383	
Average Value =		11966.050	

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SAMPLES

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
consequences of making a decision error are relatively minor.

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 detection limit is used to calculate value, average value, and sample variance for

detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 7 Shallow and Deep - B

VALIDATED DATA
(20MW6-0204 Removed)

LEAD (MG/KG)			
Sample Variance =	91972.236	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	3
U = 1.25 x AL	2	4	6
U = 1.10 x AL	7	16	27

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	3	4
U = 1.25 x AL	4	7	10
U = 1.10 x AL	22	37	51

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	3
U = 1.50 x AL	3	4	5
U = 1.25 x AL	7	11	14
U = 1.10 x AL	42	62	81

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	3
U = 1.50 x AL	3	4	6
U = 1.25 x AL	10	14	18
U = 1.10 x AL	58	80	101

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	2	3	3
U = 1.50 x AL	5	6	8
U = 1.25 x AL	16	20	25
U = 1.10 x AL	93	121	147

Boldface values are less than or equal to 15 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \left(\frac{z_p + z_{1-\alpha}}{\Delta} \right)^2 \sigma^2$$

n = required # of samples
σ² = variance
in concentration
z_p = the pth percentile of
the standard normal
distribution
Δ = width of gray region
(U-AL)

SITE	RESULT	QUAL	VALUE
20MW2-1416 (93)	2.3	J	2.3
20MW3-0810 (93)	38.3	J	38.3
20MW4-0406 (93)	12	J	12
20MW5-0608 (93)	1040	J	1040
20MW7-0406 (93)	6.2	J	6.2
20MW2-0002 (93)	65.1	J	65.1
20MW3-0204 (93)	60.7	J	60.7
20MW4-0204 (93)	20.4	J	20.4
20MW5-0002 (93)	128	J	128
20MW7-0204 (93)	6.3	J	6.3
20TB2-0204 (93)	33.6	J	33.6
20TB3-0204 (93)	66.1	J	66.1
20TB4-0002 (93)	726	J	726
20TB5-0002 (93)	220	J	220
20TB5-0406 (93)	31.8	J	31.8
Sample Variance	91972.236		
Average Value =	163.787		

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SAMPLES

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
consequences of making a decision error are relatively minor.
The gray region is bounded on the lower side by the action level
and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

**Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 7 Shallow - A**

LEAD (MG/KG)		
Sample Variance =	2547601047.734	Action Level⁽¹⁾ = 1000

1-β = 0.50	1-α = 0.50	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1805	4185	6894
U = 1.50 x AL	7219	16738	27572
U = 1.25 x AL	28873	66947	110284
U = 1.10 x AL	180454	418412	689266

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	5857	9749	13706
U = 1.50 x AL	23424	38991	54820
U = 1.25 x AL	93695	155959	219273
U = 1.10 x AL	585591	974738	1370447

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	11485	16738	21819
U = 1.50 x AL	45938	66947	87271
U = 1.25 x AL	183749	267784	349078
U = 1.10 x AL	1148424	1673645	2181726

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	15752	21819	27572
U = 1.50 x AL	63004	87270	110284
U = 1.25 x AL	252012	349077	441131
U = 1.10 x AL	1575069	2181726	2757058

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	25569	33163	40179
U = 1.50 x AL	102272	132649	160708
U = 1.25 x AL	409084	530591	642828
U = 1.10 x AL	2556771	3316186	4017668

Boldface values are less than or equal to 14 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

n = 14	0.5
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VALIDATED & UNVALIDATED

n=required # of samples
 σ^2 =variance
 in concentration
 z_p =the p^{th} percentile of
 the standard normal
 distribution
 Δ =width of gray region
 (U-AL)

SITE	RESULT	QUAL	VALUE
20MW2-0002 (93)	65.1	J	65.1
20MW3-0204 (93)	60.7	J	60.7
20MW4-0204 (93)	20.4	J	20.4
20MW5-0002 (93)	128	J	128
20MW6-0204 (93)	189000	J	189000
20MW7-0204 (93)	6.3	J	6.3
20TB1-0204 (93)	35.5		35.5
20TB2-0204 (93)	33.6	J	33.6
20TB3-0204 (93)	66.1		66.1
20TB4-0002 (93)	726		726
20TB5-0002 (93)	220	J	220
20TB6-0002 (93)	476		476
20TB7-3242 (93)	47.7		47.7
20MW1-0.52.5 (93)-AVG	13.3		13.3
Sample Variance =	2547601047.734		
Average Value =	13635.621		

**14
SAMPLES**

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
 α : probability that a Type I (false positive) error will be made.
 That is rejecting H₀ when it is True. **Confidence Interval**
 β : probability that a Type II (false negative) error will be made.
 That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
 consequences of making a decision error are relatively minor.
 The gray region is bounded on the lower side by the action level
 and on the upper side by the other bound (U).

⁽¹⁾ = Action level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 detection limit is used to calculate value, average value, and sample variance for samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 7 Shallow - B

(20MW6-0204 Removed)

LEAD (MG/KG)			
Sample Variance =	46559.376	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	1	3	4
U = 1.10 x AL	4	9	14

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	3
U = 1.25 x AL	3	4	6
U = 1.10 x AL	12	19	27

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	3	3
U = 1.25 x AL	4	6	8
U = 1.10 x AL	22	32	42

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	2
U = 1.50 x AL	2	3	4
U = 1.25 x AL	5	8	10
U = 1.10 x AL	30	41	52

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	2	3
U = 1.50 x AL	3	4	5
U = 1.25 x AL	8	11	14
U = 1.10 x AL	48	62	75

Boldface values are less than or equal to 13 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

n = 21.1 (0.5)
13

VALIDATED & UNVALIDATED

n=required # of samples
σ ² =variance in concentration
z _p =the p th percentile of the standard normal distribution
Δ=width of gray region (U-AL)

SITE	RESULT	QUAL	VALUES
20MW2-0002 (93)	65.1	J	65.1
20MW3-0204 (93)	60.7	J	60.7
20MW4-0204 (93)	20.4	J	20.4
20MW5-0002 (93)	128	J	128
20MW7-0204 (93)	6.3	J	6.3
20TB1-0204 (93)	35.5		35.5
20TB2-0204 (93)	33.6	J	33.6
20TB3-0204 (93)	66.1		66.1
20TB4-0002 (93)	726		726
20TB5-0002 (93)	220	J	220
20TB6-0002 (93)	476		476
20TB7-3242 (93)	47.7		47.7
20MW1-0.52.5 (93)-AVG	13.3		13.3
Sample Variance =	46559.376		
Average Value =	146.054		

13
SAMPLES

Null Hypothesis (H ₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H ₀
α: probability that a Type I (false positive) error will be made. That is rejecting H ₀ when it is True. Confidence Interval
β: probability that a Type II (false negative) error will be made. That is failing to rejecting H ₀ when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

(1) = Action Level based on Industrial Risk Criteria.

(2) = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

**Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 7 Deep**

LEAD (MG/KG)		
Sample Variance =	7225449.034	Action Level⁽¹⁾ = 1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 × AL	6	13	21
U = 1.50 × AL	21	49	80
U = 1.25 × AL	83	191	315
U = 1.10 × AL	513	1188	1957

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 × AL	17	29	41
U = 1.50 × AL	67	112	157
U = 1.25 × AL	267	444	624
U = 1.10 × AL	1662	2766	3889

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 × AL	33	49	64
U = 1.50 × AL	131	191	249
U = 1.25 × AL	522	761	992
U = 1.10 × AL	3258	4748	6190

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 × AL	46	63	80
U = 1.50 × AL	180	249	315
U = 1.25 × AL	716	991	1253
U = 1.10 × AL	4468	6189	7821

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 × AL	73	95	116
U = 1.50 × AL	291	378	458
U = 1.25 × AL	1161	1506	1825
U = 1.10 × AL	7252	9407	11397

Boldface values are less than or equal to 13 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

n = 13	z = 1.64485
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VALIDATED & UNVALIDATED

n=required # of samples
σ ² =variance in concentration
z _p =the p th percentile of the standard normal distribution
Δ=width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE
20MW2-1416 (93)	2.3	J	2.3
20MW3-0810 (93)	38.3	J	38.3
20MW4-0406 (93)	12	J	12
20MW5-0608 (93)	1040	J	1040
20MW7-0406 (93)	6.2	J	6.2
20TB1-0608 (93)-AVG	4.15	N	4.15
20TB7-4856 (93)-AVG	94.2		94.2
20TB2-1416 (93)	20.7	S	20.7
20TB3-1012 (93)	16.6		16.6
20TB4-1416 (93)	9770		9770
20TB5-0406 (93)	31.8	J	31.8
20TB6-0810 (93)	24.4		24.4
20MW6-1214 (93)	1540		1540
Sample Variance =	7225449.034		
Average Value =	969.281		

**13
SAMPLES**

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H ₀
α: probability that a Type I (false positive) error will be made. That is rejecting H ₀ when it is True. Confidence Interval
β: probability that a Type II (false negative) error will be made. That is failing to rejecting H ₀ when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2. Action level is used to calculate value, average value, and sample variance for 13 samples (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 7 Shallow and Deep - A

LEAD (MG/KG)		
Sample Variance =	1318729913.161	Action Level ⁽¹⁾ = 1000

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	935	2167	3570
U = 1.50 x AL	3737	8665	14273
U = 1.25 x AL	14946	34655	57088
U = 1.10 x AL	93410	216586	356790

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	3032	5047	7096
U = 1.50 x AL	12126	20184	28378
U = 1.25 x AL	48500	80731	113504
U = 1.10 x AL	303123	504560	709393

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	5946	8665	11295
U = 1.50 x AL	23779	34655	45175
U = 1.25 x AL	95115	138615	180696
U = 1.10 x AL	594466	866340	1129341

1-β = 0.85	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	8154	11295	14273
U = 1.50 x AL	32613	45175	57088
U = 1.25 x AL	130451	180696	228348
U = 1.10 x AL	815313	1129340	1427153

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	13236	17167	20799
U = 1.50 x AL	52940	68664	83189
U = 1.25 x AL	211757	274654	332752
U = 1.10 x AL	1323477	1716578	2079690

Boldface values are less than or equal to 27 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

Probability	z-Score
0.50	0.00000

VALIDATED & UNVALIDATED

n = required # of samples
σ² = variance in concentration
z_p = the pth percentile of the standard normal distribution
Δ = width of gray region (U-AL)

ITEM	RESULT	QUAL	VALUE	
20MW2-1416 (93)	2.3	J	2.3	27 SAMPLES
20MW3-0810 (93)	38.3	J	38.3	
20MW4-0406 (93)	12	J	12	
20MW5-0608 (93)	1040	J	1040	
20MW7-0406 (93)	6.2	J	6.2	
20TB1-0608 (93)-AVG	4.15	N	4.15	
20TB7-4856 (93)-AVG	94.2		94.2	
20TB2-1416 (93)	20.7	S	20.7	
20TB3-1012 (93)	16.6		16.6	
20TB4-1416 (93)	9770		9770	
20TB5-0406 (93)	31.8	J	31.8	
20TB6-0810 (93)	24.4		24.4	
20MW6-1214 (93)	1540		1540	
20MW2-0002 (93)	65.1	J	65.1	
20MW3-0204 (93)	60.7	J	60.7	
20MW4-0204 (93)	20.4	J	20.4	
20MW5-0002 (93)	128	J	128	
20MW6-0204 (93)	189000	J	189000	
20MW7-0204 (93)	6.3	J	6.3	
20TB1-0204 (93)	35.5		35.5	
20TB2-0204 (93)	33.6	J	33.6	
20TB3-0204 (93)	66.1		66.1	
20TB4-0002 (93)	726		726	
20TB5-0002 (93)	220	J	220	
20TB6-0002 (93)	476		476	
20TB7-3242 (93)	47.7		47.7	
20MW1-0.52.5 (93)-A	13.3		13.3	
Sample Variance =	1318729913.161			
Average Value =	7537.013			

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor.
The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 7 Shallow and Deep - B

(20MW6-0204 Removed)

LEAD (MG/KG)		
Sample Variance =	3666766.704	Action Level ⁽¹⁾ = 1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	3	7	12
U = 1.50 x AL	11	25	42
U = 1.25 x AL	42	98	161
U = 1.10 x AL	261	604	994

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	9	15	22
U = 1.50 x AL	35	57	81
U = 1.25 x AL	136	226	317
U = 1.10 x AL	844	1404	1974

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	17	25	33
U = 1.50 x AL	67	98	127
U = 1.25 x AL	265	387	504
U = 1.10 x AL	1654	2410	3142

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	24	33	42
U = 1.50 x AL	92	127	161
U = 1.25 x AL	364	504	637
U = 1.10 x AL	2268	3141	3970

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	38	49	60
U = 1.50 x AL	148	192	233
U = 1.25 x AL	590	765	927
U = 1.10 x AL	3681	4774	5784

Boldface values are less than or equal to 26 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	3	7	12
U = 1.50 x AL	11	25	42
U = 1.25 x AL	42	98	161
U = 1.10 x AL	261	604	994

VALIDATED & UNVALIDATED

n = required # of samples
σ² = variance in concentration
z_p = the pth percentile of the standard normal distribution
Δ = width of gray region (U - AL)

SITE	RESULT	QUAL	VALUE	26 SAMPLES
20MW2-1416 (93)	2.3	J	2.3	
20MW3-0810 (93)	38.3	J	38.3	
20MW4-0406 (93)	12	J	12	
20MW5-0608 (93)	1040	J	1040	
20MW7-0406 (93)	6.2	J	6.2	
20TB1-0608 (93)-AVG	4.15	N	4.15	
20TB7-4856 (93)-AVG	94.2		94.2	
20TB2-1416 (93)	20.7	S	20.7	
20TB3-1012 (93)	16.6		16.6	
20TB4-1416 (93)	9770		9770	
20TB5-0406 (93)	31.8	J	31.8	
20TB6-0810 (93)	24.4		24.4	
20MW6-1214 (93)	1540		1540	
20MW2-0002 (93)	65.1	J	65.1	
20MW3-0204 (93)	60.7	J	60.7	
20MW4-0204 (93)	20.4	J	20.4	
20MW5-0002 (93)	128	J	128	
20MW7-0204 (93)	6.3	J	6.3	
20TB1-0204 (93)	35.5		35.5	
20TB2-0204 (93)	33.6	J	33.6	
20TB3-0204 (93)	66.1		66.1	
20TB4-0002 (93)	726		726	
20TB5-0002 (93)	220	J	220	
20TB6-0002 (93)	476		476	
20TB7-3242 (93)	47.7		47.7	
20MW1-0.52.5 (93)-A	13.3		13.3	
Sample Variance =	3666766.704			
Average Value =	557.667			

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor.
The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the action limit is used to calculate value, average value, and sample variance for non-detects (samples with 'L' column).

AL column).

VALIDA DATA

Derived Sample Size (n) Based on Sample Variance and Action Level
Zone 1 Shallow

LEAD (MG/KG)			
Sample Variance =	1682.497	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	2	2

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	2	3

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	2	2	3

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	2
U = 1.10 x AL	2	3	4

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	2
U = 1.10 x AL	3	4	5

Boldface values are less than or equal to 4 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \frac{\sigma^2 (z_{1-\alpha} + z_{1-\beta})^2}{\Delta^2}$$

n=required # of samples
 σ^2 =variance in concentration
 z_p =the pth percentile of the standard normal distribution
 Δ =width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE ⁽²⁾
13TB13-0305	26.7	J	26.7
13TB15-0305	112		112
13TB16-0204	24.2		24.2
13TB17-0406	62.5	J	62.5
Sample Variance =	1682.497		
Average Value =	56.350		

4 SAMPLES

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
 α : probability that a Type I (false positive) error will be made. That is rejecting H₀ when it is True. **Confidence Interval**
 β : probability that a Type II (false negative) error will be made. That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

VALIDATED
DATA

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 1 Deep

LEAD (MG/KG)			
Sample Variance =	10871.389	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	2
U = 1.10 x AL	2	3	5

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	3
U = 1.10 x AL	3	5	8

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	2	2	3
U = 1.10 x AL	6	8	11

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	2	3	4
U = 1.10 x AL	8	11	14

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	3
U = 1.25 x AL	3	4	5
U = 1.10 x AL	12	15	19

Boldface values are less than or equal to 13 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	2
U = 1.10 x AL	2	3	5

n=required # of samples
σ²=variance
in concentration
z_p=the pth percentile of
the standard normal
distribution
Δ=width of gray region
(U-AL)

SITE	RESULT	QUAL	VALUE
110590-13MW1(12-14)	4.2	J	4.2
110590-13MW2(10-12)	22.8	J	22.8
110790-13MW3(12-14)	3	J	3
110790-13MW4(6-8)	383	J	383
110790-13MW9(6-8)	23.3	J	23.3
110890-13MW5(10-12)	17.6	J	17.6
110790-13MW8(8-10)	15.3	J	15.3
110790-13MW7(8-10)	3.8	J	3.8
13TB13-0911	3.6		3.6
13TB15-0709	6.4		6.4
13TB16-0810	87		87
13TB17-0608	3.4		3.4
13MW18-0911	2.6		2.6
Sample Variance =	10871.389		
Average Value =	44.308		

13
SAMPLES

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H₀
α: probability that a Type I (false positive) error will be made.
That is rejecting H₀ when it is True. **Confidence Interval**
β: probability that a Type II (false negative) error will be made.
That is failing to rejecting H₀ when it is False. **Power**
Gray Region: A range of values of the mean concentration where
consequences of making a decision error are relatively minor.
The gray region is bounded on the lower side by the action level
and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 detection limit is used to calculate value, average value, and sample variance

non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 1 Shallow and Deep

VALIDATED
DATA

LEAD (MG/KG)		
Sample Variance =	8496.734	Action Level ⁽¹⁾ = 1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	2
U = 1.10 x AL	1	3	4

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	3
U = 1.10 x AL	3	5	6

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	1	2	3
U = 1.10 x AL	5	7	9

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	2	2	3
U = 1.10 x AL	6	9	11

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	2	3	4
U = 1.10 x AL	9	12	15

Boldface values are less than or equal to 17 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

n = 2(2.32634) ² (8496.734) + (1000) ²
n = 17

n = required # of samples
σ ² = variance in concentration
z _p = the p th percentile of the standard normal distribution
Δ = width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE	17 SAMPLES
110590-13MW1(12-14)	4.2	J	4.2	
110590-13MW2(10-12)	22.8	J	22.8	
110790-13MW3(12-14)	3	J	3	
110790-13MW4(6-8)	383	J	383	
110790-13MW9(6-8)	23.3	J	23.3	
110890-13MW5(10-12)	17.6	J	17.6	
110790-13MW8(8-10)	15.3	J	15.3	
110790-13MW7(8-10)	3.8	J	3.8	
13TB13-0911	3.6		3.6	
13TB15-0709	6.4		6.4	
13TB16-0810	87		87	
13TB17-0608	3.4		3.4	
13MW18-0911	2.6		2.6	
13TB13-0305	26.7		26.7	
13TB15-0305	112		112	
13TB16-0204	24.2		24.2	
13TB17-0406	62.5		62.5	
Sample Variance =	8496.734			
Average Value =	47.141			

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H ₀
α: probability that a Type I (false positive) error will be made. That is rejecting H ₀ when it is True. Confidence interval
β: probability that a Type II (false negative) error will be made. That is failing to rejecting H ₀ when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 1 Shallow

LEAD (MG/KG)			
Sample Variance =	1735.237	Action Level ⁽¹⁾ =	1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	2	2

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	1	2
U = 1.10 x AL	1	2	3

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	2
U = 1.10 x AL	2	2	3

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	2
U = 1.10 x AL	2	3	4

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	2
U = 1.10 x AL	3	4	5

Boldface values are less than or equal to 5 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$n = \frac{z^2 \sigma^2}{\Delta^2}$	(0.5)
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VALIDATED & UNVALIDATED

n=required # of samples
σ^2 =variance in concentration
z_p =the p th percentile of the standard normal distribution
Δ =width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE
13TB13-0305	26.7	J	26.7
13TB15-0305	112		112
13TB16-0204	24.2		24.2
13TB17-0406	62.5	J	62.5
Pipe Chase (94)	7.7		7.7
Sample Variance =	1735.237		
Average Value =	46.620		

**5
SAMPLES**

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H ₀
α: probability that a Type I (false positive) error will be made. That is rejecting H ₀ when it is True. Confidence Interval
β: probability that a Type II (false negative) error will be made. That is failing to rejecting H ₀ when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

**Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 1 Deep**

LEAD (MG/KG)			
Sample Variance =	10871.389	Action Level⁽¹⁾ =	1000

$1-\beta = 0.50$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	2
U = 1.10 x AL	2	3	5

$1-\beta = 0.75$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	3
U = 1.10 x AL	3	5	8

$1-\beta = 0.90$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	2	2	3
U = 1.10 x AL	6	8	11

$1-\beta = 0.95$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	2	3	4
U = 1.10 x AL	8	11	14

$1-\beta = 0.99$	$1-\alpha = 0.80$	$1-\alpha = 0.90$	$1-\alpha = 0.95$
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	3
U = 1.25 x AL	3	4	5
U = 1.10 x AL	12	15	19

Boldface values are less than or equal to 13 samples already taken.

Probability	z-Score
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

$$n = \left(\frac{z_p \cdot \sigma}{U - AL} \right)^2 + 0.5$$

VALIDATED & UNVALIDATED

n=required # of samples
 σ^2 =variance
 in concentration
 z_p =the p^{th} percentile of
 the standard normal
 distribution
 Δ =width of gray region
 (U-AL)

SITE	RESULT	QUAL	VALUE
110590-13MW1(12-14)	4.2	J	4.2
110590-13MW2(10-12)	22.8	J	22.8
110790-13MW3(12-14)	3	J	3
110790-13MW4(6-8)	383	J	383
110790-13MW9(6-8)	23.3	J	23.3
110890-13MW5(10-12)	17.6	J	17.6
110790-13MW8(8-10)	15.3	J	15.3
110790-13MW7(8-10)	3.8	J	3.8
13TB13-0911	3.6		3.6
13TB15-0709	6.4		6.4
13TB16-0810	87		87
13TB17-0608	3.4		3.4
13MW18-0911	2.6		2.6
Sample Variance =	10871.389		
Average Value =	44.308		

**13
SAMPLES**

Null Hypothesis (H_0): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H_0
 α : probability that a Type I (false positive) error will be made.
 That is rejecting H_0 when it is True. **Confidence Interval**
 β : probability that a Type II (false negative) error will be made.
 That is failing to rejecting H_0 when it is False. **Power**
Gray Region: A range of values of the mean concentration where
 consequences of making a decision error are relatively minor.
 The gray region is bounded on the lower side by the action level
 and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 the detection limit is used to calculate value, average value, and sample variance for non-detects (samples with 'U' in QUAL column).

**Derived Sample Size (n) Based on
Sample Variance and Action Level
Zone 1 Shallow and Deep**

LEAD (MG/KG)		
Sample Variance =	8083.349	Action Level⁽¹⁾ = 1000

1-β = 0.50	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	2
U = 1.10 x AL	1	3	4

1-β = 0.75	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	1	2
U = 1.25 x AL	1	2	3
U = 1.10 x AL	3	4	6

1-β = 0.90	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	1	2	3
U = 1.10 x AL	4	7	9

1-β = 0.95	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	2	2	3
U = 1.10 x AL	6	8	11

1-β = 0.99	1-α = 0.80	1-α = 0.90	1-α = 0.95
U = 2.00 x AL	1	1	2
U = 1.50 x AL	1	2	2
U = 1.25 x AL	2	3	4
U = 1.10 x AL	9	12	15

Boldface values are less than or equal to 18 samples already taken.

<i>Probability</i>	<i>z-Score</i>
0.50	0.00000
0.75	0.67449
0.80	0.84162
0.90	1.28155
0.95	1.64485
0.99	2.32634

18	(0.5)
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VALIDATED & UNVALIDATED

n =required # of samples
σ² =variance in concentration
z_p =the p th percentile of the standard normal distribution
Δ =width of gray region (U-AL)

SITE	RESULT	QUAL	VALUE	18 SAMPLES
110590-13MW1(12-14)	4.2	J	4.2	
110590-13MW2(10-12)	22.8	J	22.8	
110790-13MW3(12-14)	3	J	3	
110790-13MW4(6-8)	383	J	383	
110790-13MW9(6-8)	23.3	J	23.3	
110890-13MW5(10-12)	17.6	J	17.6	
110790-13MW8(8-10)	15.3	J	15.3	
110790-13MW7(8-10)	3.8	J	3.8	
13TB13-0911	3.6		3.6	
13TB15-0709	6.4		6.4	
13TB16-0810	87		87	
13TB17-0608	3.4		3.4	
13MW18-0911	2.6		2.6	
13TB13-0305	26.7		26.7	
13TB15-0305	112		112	
13TB16-0204	24.2		24.2	
13TB17-0406	62.5		62.5	
Pipe Chase (94)	7.7		7.7	
Sample Variance =	8083.349			
Average Value =	44.950			

Null Hypothesis (H₀): the true mean is less than the action level.
Action Level (AL): value that determines acceptance or rejection of H ₀
α: probability that a Type I (false positive) error will be made. That is rejecting H ₀ when it is True. Confidence Interval
β: probability that a Type II (false negative) error will be made. That is failing to rejecting H ₀ when it is False. Power
Gray Region: A range of values of the mean concentration where consequences of making a decision error are relatively minor. The gray region is bounded on the lower side by the action level and on the upper side by the other bound (U).

⁽¹⁾ = Action Level based on Industrial Risk Criteria.

⁽²⁾ = 1/2 if action limit is used to calculate value, average value, and sample variance for non-de (samples with 'U' in QUAL column).

ZONE 2

APPENDIX J

SUPPORTING MATERIALS FOR THE ECOLOGICAL RISK ASSESSMENT

- J.1 ECOLOGICAL TOXICOLOGICAL PROFILES**
- J.2 NSB-NLON PHASE II RI BENTHIC MACROINVERTEBRATE
DATA SUMMARIES**
- J.3 NSB-NLON PHASE II RI CONTAMINANT CONCENTRATIONS
IN CAGED MUSSELS**

J.1 ECOLOGICAL TOXICOLOGICAL PROFILES

4-Methylphenol (*p*-cresol)

There are three common cresols found in the environment (*o*-,*m*-, and *p*-cresol). Cresols enter the environment from natural sources, car exhaust, combustion, manufacturing use and waste sites. They are common in the environment at low levels, since they quickly degrade in the atmosphere. In aquatic systems they do not evaporate, but can be removed by bacteria. They do not appear to accumulate in fish or meat.

Inhalational exposure results in respiratory tract irritation, with symptoms such as dryness, nasal constriction, and throat irritation. Ingestion of cresol effects the respiratory, gastrointestinal, and central nervous systems as well as the blood, liver, and kidney in humans. The USEPA has concluded that there is inadequate data available for the establishment of a RfC for mixed cresols, *o*-cresol, *m*-cresol, or *p*-cresol. Animal studies have reported developmental effects, but only at maternally toxic doses, and no reproductive effects from oral exposure to mixed cresols. Dermal administration of cresols suggest that they may act as tumor promoters. USEPA has classified them as possible human carcinogens (Group C).

Reference: Agency for Toxic Substances and Disease Registry. 1992. Toxicological profile for cresols: *o*-cresol, *p*-cresol, & *m*-cresol. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Acetone

Although not a large sink, small amounts of acetone will be removed from the atmosphere by wet deposition, which will transport acetone from the atmosphere to surface water and soil. The complete miscibility of acetone in water suggests that partitioning of acetone from the water column to sediments and suspended solids in water is not significant. In the absence of water, acetone vapor adsorbs rather strongly to the clay component of soil by hydrogen bonding. The sorption is dependent on relative humidity, and increasing the humidity decreases sorption drastically. In water-saturated soil or sediment, only organic carbon, and not hydrogen bonding may control the sorption of acetone (ATSDR, 1994a).

The two significant transport properties for acetone in soil are volatilization and leaching. Leaching transports acetone from soil to groundwater. The rate of leaching from soil by rainwater depends on the sorption characteristics of acetone in soil. Volatilization transports acetone from soil to the atmosphere. The volatility rate of acetone from soil depends on the soil characteristics (moisture content, soil porosity, etc.). Since the acetone is weakly sorbed to soil, the volatility depends primarily on the moisture content of the soil. In dry soil, the volatilization rate from soil surfaces is high due to the high vapor pressure of acetone. In moist soil, the rate of volatilization is similar to acetone in water and depends on the Henry's

law constant. Acetone volatilizes moderately under these conditions. The detection of acetone at higher concentrations in downwind air of a landfill site, compared to upwind air, indicates the importance of volatilization as a transport process in soil (ATSDR, 1994a).

No data regarding the transport of acetone from soil to plants were located. No data regarding the biomagnification potential of acetone in aquatic organisms were located; however, the low Kow value suggests that biomagnification of acetone from animals of lower to higher trophic level is unlikely (ATSDR, 1994a).

Aluminum

Because of its reactivity, aluminum is not found as a free metal in nature. Aluminum has only one oxidation state (+3), thus its behavior or fate and transport in the environment depends upon its coordination chemistry and the characteristics of the local environmental system. The transport and partitioning of aluminum in the environment is determined by the chemical properties of the element itself and the characteristics of the environmental matrix that affect solubility. At a pH greater than 5.5, naturally occurring aluminum compounds exist predominantly in an undissolved form, except in the presence of high amounts of dissolved organic material or fulvic acid, which binds with aluminum and can cause increased dissolved aluminum concentrations in streams and lakes. Organic acids have been found to be important weathering agents for dissolving and transporting aluminum in an alpine soil environment. In general, decreasing pH results in an increase in mobility for monomeric forms of aluminum which is of concern with respect to the occurrence of acid rain and the release of acid mine drainage (ATSDR, 1992a).

In groundwater or surface water systems, an equilibrium with a solid phase or form is established that largely controls the extent of aluminum dissolution which can occur. In addition to the effect of pH on mobility, the type of acid entering environmental systems may also be important (ATSDR, 1992a).

Although present in food in varying amounts, aluminum (Al) is not an essential element for mammals. The aluminum content of plants typically depends on the soil aluminum concentration and ranges from 10 to 30 mg/kg fresh weight; studies have indicated that this element stimulates the growth of several pasture plant species (Hackett 1962). As summarized in Venugopal and Luckey (1978), aluminum is not readily absorbed through the skin and gastrointestinal absorption of ingested aluminum is poor due to the transformation of aluminum salts into insoluble aluminum phosphate. The lack of accumulation of aluminum in animals with age or of any increase in tissue levels of aluminum following fairly high dietary intake, suggests that mammals possess a homeostatic mechanism for this element. For most terrestrial

organisms, aluminum compounds are generally not harmful and are considered to be toxicologically inert, except in cases of high experimental doses or prolonged inhalation (Venugopal and Luckey 1978).

Data on the toxicity of aluminum to aquatic organisms is somewhat limited. EPA (1988b) stated that freshwater organisms should not be adversely affected if aluminum concentrations do not exceed 87 mg/L when pH is between 6.5 and 9.0. Some studies have shown that the acute toxicity of aluminum increases with pH, whereas other studies found the opposite to be true (EPA 1988b). The occurrence of pH effects in fish depends on aluminum and calcium concentrations in the water. Laboratory studies have established that low pH is toxic to fish, that aluminum concentrations found in acidified waters (particularly inorganic monomeric aluminum) are toxic, and that calcium is ameliorative (Suter 1993).

Sublethal effects were also reviewed by EPA (1988b). It was found that 169 mg Al/L at a pH of 6.5 to 6.6 caused a 24 percent reduction in the growth of young brook trout (*Salvelinus fontinalis*). Cleveland et al. (1991) determined that brook trout accumulated significantly higher aluminum residues at pH 5.3 than at pH 6.1 or pH 7.2. They also determined that elimination of aluminum during depuration was more rapid at pH 5.3 than at pH 6.1 or pH 7.2.

Aluminum is not expected to biomagnify in terrestrial food chains. Aluminum has been studied in several aquatic species. Data reported in EPA (1988b) indicated this metal does not bioconcentrate; bioconcentration factors range from 50 to 231 for brook trout (geometric mean value = 82). Bioconcentration of aluminum in fish is a function of the water quality (e.g., pH and total organic carbon). Aluminum residue analyses in brook trout have shown that whole-body aluminum content decreases as the fish advance from larvae to juveniles. No information was found on the biomagnification of aluminum in aquatic food chains (ATSDR, 1992a).

Antimony

Antimony is released to the atmosphere in the form of particulate matter or adsorbed to particulate matter. It is dispersed by wind and removed by gravitational settling and dry and wet deposition. The removal rate and distance traveled from the source will depend on source characteristics (e.g., stack height), particle size and density, and meteorological conditions. Little is known of the adsorptive behavior of antimony, its compounds, and ions. The binding of antimony to soil is determined by the nature of the soil and the form of antimony deposited on the soil. Some forms of antimony may bind to inorganic and organic ligands. On the other hand, a mineral form would be unavailable for binding. Some studies suggest that antimony is fairly mobile under diverse environmental conditions, while others suggest that it is strongly adsorbed to soil (ATSDR, 1992b).

These studies indicated that antimony deposited on the soil surface accumulates primarily in the surface layer, and that aquifers beneath antimony waste piles are not grossly contaminated. Mobilization of elements deposited on soil in fly ash is a potential source of terrestrial and aquatic pollution. Leaching of antimony is low. Antimony does not appear to bioconcentrate appreciably in fish and aquatic organisms. No detectable bioconcentration occurred during a 28-day test in bluegills. Only low levels of antimony have been reported in fish and aquatic organisms collected off the coast of Africa, Australia, and the Danube River in Austria. Uptake from soil is minor and appears to be correlated with the amount of available antimony (that which is soluble or easily exchangeable). Antimony bioconcentration was measured in voles, shrews, rabbits, and invertebrates around a smelter. Analysis of antimony in organs of the small mammals, compared with estimates of their antimony intake from food, showed that, although the amount of antimony in the organs was elevated, it was low compared to the amount ingested. The results suggest that antimony does not biomagnify from lower to higher trophic levels in the food chain (ATSDR, 1992b).

Arsenic

Arsenic may be released to the atmosphere as a gas or vapor, or adsorbed to particulate matter and transported to other media by dry or wet deposition. Arsenic in surface water can undergo a complex pattern of transformations: oxidation-reduction, ligand exchange, biotransformation, precipitation, and adsorption. As a consequence of these reactions, arsenic is extremely mobile in aquatic systems, and riverborne arsenic is capable of being transported great distances. In aquatic systems, bioconcentration of arsenic primarily occurs in algae and lower invertebrates, but biomagnification does not appear to be significant (EPA, 1979). Plants may accumulate arsenic via root uptake, with uptake being dependent on the species, soil arsenic concentration, and soil characteristic.

Exposure of animal species to either trivalent or pentavalent arsenic leads to the initial accumulation of arsenic in liver, kidney, lung, spleen, aorta, skin, hair, and upper gastrointestinal tract. Animal studies have shown that chronic arsenic exposure may cause body weight changes, decreased blood hemoglobin, liver damage, and kidney damage (Toxicological Profile for Arsenic, U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry. July 1992).

Barium

Most barium released to the environment from industrial sources is in forms that do not become widely dispersed. In the atmosphere, barium is likely to be present in particulate form. Although chemical reactions may cause changes in speciation of barium in air, the main mechanisms for the removal of

barium compounds from the atmosphere are likely to be wet and dry deposition. In aquatic media, barium is likely to precipitate out of solution as an insoluble salt (i.e., as $BaSO_4$ or $BaCO_3$). Waterborne barium may also adsorb to suspended particulate matter. Precipitation of barium sulfate salts is accelerated when rivers enter the ocean because of the high sulfate content in the ocean. Sedimentation of suspended solids removes a large portion of the barium content from surface waters. Coarse silt sediment in a turbulent environment will often grind and cleave the barium sulfate from the sediment particles leaving a buildup of dense barites. The uptake of barium by fish and marine organisms is also an important removal mechanism. Barium was found to bioconcentrate in marine plants by a factor of 1,000 times the level present in the water. Bioconcentration factors in marine animals, plankton, and in brown algae of 100, 120, and 260, respectively, have been reported (ATSDR, 1992c).

Barium added to soils may either be taken up by vegetation or transported through soil with precipitation. Relative to the amount of barium found in soils, little is bioconcentrated by plants. However, this transport pathway has not been comprehensively studied. Barium is not very mobile in most soil systems. The rate of transportation of barium in soil is dependent on the characteristics of the soil material. Soil properties that influence the transportation of barium to groundwater are cation exchange capacity and calcium carbonate ($CaCO_3$) content. In soil with a high cation exchange capacity (e.g., fine textured mineral soils or soils with high organic matter content), barium mobility will be limited by adsorption. High $CaCO_3$ content limits mobility by precipitation of the element as $BaCO_3$. Barium will also precipitate as barium sulfate in the presence of sulfate ions. Barium is more mobile and is more likely to be leached from soils in the presence of chloride due to the increased solubility of barium chloride as compared to other chemical forms of barium. Barium complexes with fatty acids (e.g., in acidic landfill leachate) will be much more mobile in the soil due to the lower charge of these complexes and subsequent reduction in adsorption capacity (ATSDR, 1992c).

BHC (Gamma-BHC, Lindane)

HCH can be released to the environment during the formulation process and through its use as a pesticide. Once released to the environment, HCH can partition to all environmental media. HCH in the atmosphere, either as a vapor or adsorbed to particulates, can be photolytically degraded but is primarily removed from the atmosphere by rain-out and dry deposition. Biodegradation is believed to be the dominant decomposition process for HCH in soil and water. The rates of degradation depend on the ambient environmental conditions. HCH has been detected in air, surface water, groundwater, sediment, soil, fish and other aquatic organisms, and wildlife.

Animals that have been fed γ - and α -HCH have had convulsions, and animals fed β -HCH have become comatose. All isomers can produce liver and kidney effects. Reduced ability to fight infection was reported in animals fed γ -HCH, and injury to the ovaries and testes was reported in animals given γ -HCH or β -HCH. Animals fed γ -HCH during pregnancy may have an increased number of fetuses with extra ribs. HCH isomers are changed by the body into other chemical products, some of which may be responsible for the harmful effects. Long-term oral administration of α -, β -, γ -, or technical-grade HCH to laboratory rodents has been reported to result in liver cancer.

Beryllium

The major source of beryllium in the environment is the combustion of fossil fuels (Tepper, 1972). Beryllium enters the waterways through weathering of rocks and soils, atmospheric fallout, and discharges from industrial and municipal operations (USEPA, 1980b). Most common beryllium compounds are readily soluble in water. In aqueous solution, beryllium does not exist as actual Be^{+2} ions, but as hydrated complexes. Like a number of other metals, water hardness significantly affects the toxicity of this metal. Only a limited number of aquatic species have been tested, but the results of these tests suggest that freshwater invertebrates exhibit similar sensitivities to this metal. Acute and chronic toxicities of beryllium to aquatic species occur as low as 130 and 5.3 $\mu\text{g/L}$, respectively (USEPA, 1980b).

Boron

Atmospheric boron may be in the form of particulate matter or aerosols. Borates are relatively soluble in water, and will probably be removed from the atmosphere by precipitation and dry deposition. The half-life of airborne particles is usually on the order of days, depending on the size of the particle and atmospheric conditions. No specific information on the fate of atmospheric boron was located. Boron readily hydrolyzes in water to form the electrically neutral, weak monobasic acid H_3BO_3 and the monovalent ion $\text{B}(\text{OH})_4$. Water borne boron may be adsorbed by soils and sediments. Adsorption-desorption reactions are expected to be the only significant mechanism that will influence the fate of boron in water. The extent of boron adsorption depends on the pH of the water and the chemical composition of the soil. The greatest adsorption is generally observed at pH 7.5-9.0. The adsorption of boron may not be reversible in some soils. The lack of reversibility may be the result of solid-phase formation on mineral surfaces, and/or the slow release of boron by diffusion from the interior of clay minerals. In general, boron adsorption will be most significant in soils that contain high concentrations of amorphous aluminum and iron oxides and hydroxides such as the reddish Ultisols in the southeastern United States (ATSDR, 1993a).

It is unlikely that boron is bioconcentrated significantly by organisms from water. The BCFs of boron in marine and freshwater plants, fish, and invertebrates were estimated to be less than 100. Experimentally measured BCFs for fish have ranged from 52 to 198. These BCFs suggest that boron is not significantly bioconcentrated (ATSDR, 1993a).

Cadmium

Cadmium and cadmium compounds have negligible vapor pressures, but may exist in air as suspended particulate matter derived from sea spray, industrial emissions, combustion of fossil fuels, or the erosion of soils. Cadmium-containing particulates may dissolve in atmospheric water droplets and be removed from air by wet deposition. Cadmium complexed with humic substances is also an important form of cadmium in polluted waters. Cadmium concentration in water is inversely related to the pH and the concentration of organic material in the water. Because cadmium exists only in the +2 oxidation state, aqueous cadmium is not strongly influenced by the oxidizing or reducing potential of the water. However, under reducing conditions, cadmium may form cadmium sulfide which is poorly soluble and tends to precipitate. Precipitation and sorption to mineral surfaces and organic materials are the most important removal processes for cadmium compounds. Sediment bacteria may also assist in the partitioning of cadmium from water to sediments. Studies indicate that concentrations of cadmium in sediments are at least one order of magnitude higher than in the overlying water. However, cadmium may also redissolve from sediments under varying ambient conditions of pH, salinity, and redox potential. Cadmium is not known to form volatile compounds, so partitioning from water to the atmosphere does not occur (ATSDR, 1993b).

Cadmium in soils may leach into water, especially under acidic conditions. Cadmium-containing soil particles may also be entrained into the air or eroded into water, resulting in dispersion of cadmium into these media (ATSDR, 1993b).

To date, no evidence exists to suggest that cadmium (Cd) is either biologically essential or beneficial (Venugopal and Luckey 1978; FWS 1985a). Freshwater biota are particularly sensitive to this heavy metal; concentrations as low as 0.8 to 9.9 µg Cd/L produce lethality among insects, crustaceans, and fish (FWS 1985a; EPA 1985b). This heavy metal does not bioconcentrate to an appreciable extent; bioconcentration data listed in EPA (1985b) for freshwater species range from 3 (brook trout) to 4190 (caddisfly; *Hydropsyche betteni*) with a geometric mean value of 404.

Elemental cadmium (Cd) is insoluble in water, although its chloride and sulfate salts are freely soluble (FWS 1985a). The availability of cadmium to aquatic biota from their immediate physical and chemical environs depends on numerous factors, including adsorption and desorption rates of cadmium from

terigenous materials, pH, Eh, chemical speciation, and many other modifiers. Adsorption and desorption processes are likely to be major factors in controlling the concentration of cadmium in natural waters and tend to counteract changes in the concentration of cadmium ions in solution (FWS 1985a). Water hardness also alters the bioavailability of cadmium. Adsorption and desorption rates of cadmium are rapid on mud solids and particles of clay, silica, humic material, and other naturally occurring solids. It should be borne in mind that mobility and availability of cadmium, like most heavy metals, is a function of a large number of interrelated factors (e.g., CEC). Beyer et al. (1985) demonstrated that only a small portion of all metals measured in the soil become incorporated into plant foliage and suggested that most of the metal contamination detected in biota came from aerial deposition.

Compared to aquatic biota, mammals and birds are relatively less sensitive to cadmium exposure. Adult mallards fed a diet containing up to 200 mg Cd/kg survived and exhibited no loss in body weight, although egg production of laying hens was suppressed (White and Finely 1978). The lowest oral doses producing lethality among mammals were 250 and 150 mg Cd/kg body weight in rats and guinea pigs, respectively (EPA 1985b).

Aquatic and terrestrial organisms bioaccumulate cadmium. Cadmium concentrates in freshwater and marine animals to concentrations hundreds to thousands of times higher than in the water. The data indicate that cadmium bioaccumulates in all levels of the food chain. Cadmium accumulation has been reported in grasses and food crops, and in earthworms, poultry, cattle, horses, and wildlife. However, since cadmium accumulates largely in the liver and kidneys of vertebrates and not in the muscle tissue, and intestinal absorption of cadmium is low, biomagnification through the food chain may not be significant. Although some data indicate increased cadmium concentrations in animals at the top of the food chain, comparisons among animals at different trophic levels are difficult, and the data available on biomagnification are not conclusive (ATSDR, 1993b).

Carbon Disulfide

Releases of carbon disulfide to the environment as a result of industrial activity are expected to be primarily to the atmosphere. Any carbon disulfide released to surface waters in effluent streams is expected to partition rapidly to the atmosphere as a result of the high ratio of vapor pressure to the solubility (Henry's law constant = 1.01×10^{-2} atm \cdot m³/mol) of the compound. Hydrolysis is not a significant removal mechanism since the evaporation half-life from a saturated solution is estimated to be 11 minutes (EPA 1976). The partitioning of carbon disulfide from water onto sediments is not expected to be removed significantly from the aquatic phase through adsorption. Carbon disulfide released to soils in spills should

rapidly volatilize to the atmosphere, but a portion of the compound remaining on soil surfaces could be available for transport into groundwater since it does not have much affinity for soil particles.

No experimental data on biomagnification were found in the available literature. Estimated bioconcentration factor (BCF) values were calculated from solubility (equal to 2.94×10^3) and K_{ow} (log K_{ow} equals 2.16) data. The calculated values, 6.8 and 25.8 respectively for solubility and K_{ow} data, indicate carbon disulfide will not significantly bioaccumulate in aquatic organisms (EPA 1986b).

Studies in animals indicate that carbon disulfide can affect the normal functions of the brain, liver, and heart. After pregnant rats breathed carbon disulfide in the air, some of the newborn rats died or had birth defects. Animals fed food that contained carbon disulfide developed liver and heart disease, and some showed abnormal behavior. When animals received large doses of carbon disulfide during pregnancy, some of the newborns died or had birth defects. Rabbits developed blisters and ulcers on the treated areas of their ears.

Chloromethane

The physical properties of chloromethane that affect its transport and partitioning in the environment are: water solubility, log octanol/water partition coefficient, 0.91; Henry's law constant, 8.82×10^{-3} atm-m³ mol; vapor pressure, 4310 mm Hg at 25°C; log sediment sorption coefficient 0.7; and log BCF 0.46. Most chloromethane discharged to the environment will be released to air where it will be subjected to transport and diffusion into the stratosphere. The relatively uniform concentration of chloromethane in the northern and southern hemispheres indicates its widespread distribution and the importance of transport processes in its distribution. The water solubility of chloromethane indicates that small amounts may be removed from the atmosphere by precipitation; however, no information confirming this was located in the literature. The dominant transport process from water will be volatilization (ATSDR, 1990a).

In soil, the dominant transport mechanism for chloromethane that is present near the surface probably will be volatilization (based on its Henry's law constant, water solubility, and vapor pressure), but no experimental information was located in the literature to confirm this. The actual volatilization rate for a chemical in soil is influenced by a number of factors including surface roughness, soil type, rainfall, leaching, depth of incorporation, temperature, and ground cover. Since chloromethane is not expected to sorb to soils, any chloromethane present in lower layers of the soil will be expected to leach to lower horizons as well as diffuse to the surface and volatilize. The presence of chloromethane in groundwater confirms the importance of leaching as a transport route (ATSDR, 1990a).

Chlorophenols

The environmental fate and transport of chlorophenols are controlled by their physical and chemical properties and environmental conditions. Increasing chlorination increases the tendency of the chlorophenols to partition into sediments and lipids and to bioconcentrate. The higher vapor pressures of the monochlorophenols suggest that among the chlorophenols, these compounds are most likely to be found in air. The rate of chemical evaporation from an aqueous solution largely depends on a chemical's vapor pressure and water solubility (Henry's law constant). Volatilization of 2,4-DCP from water is expected to be slow and, therefore, not a major removal process from surface waters. Volatilization from near-surface soil is also not expected to be a significant removal process. The chlorophenols will all tend to partition into sediments. A sediment sorption study found sediment sorption capacity was extensive (up to 0.3 mmol/g), and up to 90% of the adsorption was irreversible.

The bioaccumulation potential of 2-CP, 4-CP, 2,4-DCP, 2,4,5-TCP, 2,4,6-TCP, and 2,3,4,6-TeCP was reviewed by Loehr and Krishnamoorthy (1988). Based on bioconcentration values and log octanol/water partition coefficients, they concluded that all chlorophenols studied had the potential for accumulation in aquatic organisms. Logs of bioconcentration factors ranged from 0.81–2.33 for 2-CP, 1.79–3.28 for 2,4,5-TCP, and 1.95–2.3 for 2,3,4,6-TeCP. The predictions for 4-CP, 2,4-DCP, and 2,4,6-TCP were based principally on high log octanol/water partition coefficients.

Research on biomagnification of chemical residues within the aquatic food chain indicates that the potential for residue accumulation by fish through food chains is relatively insignificant (<10%) for most compounds when compared to the tissue residues resulting from the bioconcentration process (i.e., direct uptake from water) (Barrows et al. 1980). Due to their relatively low bioconcentration factors (<1,000) and short biological half-lives (<7 days), monochlorophenols will probably not biomagnify within aquatic food chains (Barrows et al. 1980). Data regarding the biomagnification of the higher chlorophenols were not located.

Isensee and Jones (1971) studied the uptake of 2,4-DCP from solution and soil by oats and soybeans. The compound was taken up by the plants, with the concentrations decreasing as the plants matured. At maturity, 2,4-DCP in oat seeds was below detection (<0.001 µg/g) and in soybeans was 0.003 µg/g. The bioaccumulation of 2,3,4,6-TeCP was examined in earthworms (*Lumbricus rubellus*, *Aporrectodea caliginosa tuberculata*); 2,3,4,6-TeCP concentrations were 430 and 1,980 µg/g fat in *Lumbricuss* and *Aporrectodea*, respectively, while soil concentrations were 336 µg/g dry soil. It is not known if 2,3,4,6-TeCP biomagnifies up terrestrial food chain. Based on physical properties, the tetrachlorophenols, rather than lower chlorinated phenols, would have the greatest potential to biomagnify.

Animals that were given food or drinking water containing chlorophenols developed health effects. The major effects with high levels of chlorophenols were effects on the liver and the immune system. Also the animals that ate or drank chlorophenols did not gain as much weight as the animals that ate food and drank water without chlorophenols. High levels of chlorophenols given to pregnant female rats in the drinking water have tended to reduce the number of their newborn animals and to decrease their weights. The chlorophenols have not been shown to cause birth defects in animals even at high doses.

Feeding rats and mice high doses of 2,4-dichlorophenol for a long time did not cause cancer. However, long-term treatment of rats and mice with high doses of 2,4,6-trichlorophenol in food caused leukemia in rats and liver cancer in mice, suggesting that 2,4,6-trichlorophenol may be a carcinogen. Putting chlorophenols on the skin or eyes of animals causes severe injuries. Injury is greatest with exposure to the mono- and dichlorophenols. The signs of severe skin injury include redness, swelling, scabbing, and scar formation. The cornea was damaged when monochlorophenols were placed directly onto the eyes of rabbits.

Chromium

Chromium is present in the atmosphere primarily in particulate form. Naturally occurring gaseous forms of chromium are rare. The transport and partitioning of particulate matter in the atmosphere depend largely on particle size and density. Atmospheric particulate matter is deposited on land and water via wet and dry deposition. Wet removal of particulate chromium also occurs by rainout within a cloud and washout below a cloud, and acid rain may facilitate removal of acid-soluble chromium compounds from the atmosphere. Since chromium compounds cannot volatilize from water, transport of chromium from water to the atmosphere is not likely, except by transport in windblown sea sprays. Most of the chromium released into water will ultimately be deposited in the sediment. A very small percentage of chromium can be present in water in both soluble and insoluble forms. Soluble chromium generally accounts for a very small percentage of the total chromium (ATSDR, 1993c).

Most of the soluble chromium is present as chromium(VI) and soluble chromium(III) complexes. Soluble forms and suspended chromium can undergo intramedia transport. Chromium(VI) in water will eventually be reduced to chromium(III) by organic matter in the water. For example, the bioavailability of chromium(III) to freshwater invertebrates (*Daphnia pulex*) decreased with the addition of humic acid. This decrease in bioavailability was attributed to lower availability of the free form of the metal due to its complexation with humic acid (ATSDR, 1993c).

Although higher concentrations of chromium have been reported in plants growing in high chromium-containing soils (e.g., soil near ore deposits or chromium-emitting industries and soil fertilized by sewage sludge) compared with plants growing in normal soils, most of the increased uptake in plants is retained in roots, and only a small fraction is translocated in the above-ground part of edible plants. There is no indication of biomagnification of chromium along the terrestrial food chain (soil-plant-animal). Chromium in soil is present mainly as insoluble oxide Cr_2O_3 . Therefore, it is not very mobile in soil. Flooding of soils and the subsequent anaerobic decomposition of plant detritus matters may increase the mobilization of chromium(III) in soils due to formation of soluble complexes. This complexation may be facilitated by a lower soil pH. A smaller percentage of total chromium in soil exists as soluble chromium(VI) and chromium(III), which are more mobile in soil. The mobility of soluble chromium in soil will depend on the sorption characteristics of the soil. The relative retention of metals by soil is in the order of lead > antimony > copper > chromium > zinc > nickel > cobalt > cadmium. The sorption of chromium to soil depends primarily on the clay content of the soil and, to a lesser extent, on Fe_2O_3 and the organic content of soil. Chromium in soil may be transported to the atmosphere as an aerosol (ATSDR, 1993c).

Surface runoff from soil can transport both soluble and bulk precipitate of chromium to surface water. Soluble and unadsorbed chromium(VI) and chromium(III) complexes in soil may leach into groundwater. The leachability of chromium(VI) in the soil increases as the pH of the soil increases. On the other hand, lower pH present in acid rain may facilitate leaching of acid-soluble chromium(III) and chromium(VI) compounds in soil. Chromium has a low mobility for translocation from roots to aboveground parts of plants. However, depending on the geographical areas where the plants are grown, the concentration of chromium in aerial parts of certain plants may differ by a factor of 2-3 (ATSDR, 1993c).

Chromium VI generally does not exist in biological systems, as it is reduced rapidly to Chromium III. Chromium VI, however, is much more toxic to living systems than Chromium III. Several studies exist regarding the toxicity of Chromium VI in mammals. Mice given oral doses of 57, 120, and 234 mg CrVI/kg-day during early gestation experienced increased preimplantation and postimplantation losses, along with decreased litter size (Trivedi et al., 1989 as cited in ATSDR, 1993). A LOAEL of 57 mg/kg-day was reported for reproductive effects. A decrease in motor activity was seen in rats given oral doses of Chromium VI at 98 mg/kg-day for 28 days, and a NOAEL of 9.8 mg/kg-day was reported for these effects (Diaz-Mayans et al., 1986). In addition, mice fed potassium dichromate at 4.6 mg/kg-day exhibited reduced sperm count after 7 weeks, and morphologically altered sperm at 9.1 mg/kg-day after 7 weeks (Zahid et al., 1990, as cited in ATSDR, 1993).

Since Diaz-Mayans et al. (1986) established a clear dose-response relationship, the NOAEL was chosen for derivation of a benchmark value.

Only one avian study exists for Chromium VI. Chickens were fed diets up to 100 ppm Chromium VI and no adverse effects on survival or growth were observed after 32 days, suggesting a NOAEL of 100 ppm (Rosomer et al. 1961).

A multitude of studies exist on the effects of Chromium VI on fish. Since the NAWQC value of 0.011 mg/L was the most conservative value, it was chosen as the value for forage, small, and large fish. For fish and terrestrial organisms, the data show that Chromium VI does not effectively bioaccumulate. Chromium is not expected to biomagnify in the aquatic food chain (ATSDR, 1993c).

Cobalt

Cobalt is a relatively rare metal and one of the seven essential metals. Trace levels are essential in mammals for the production of red blood cells. Cobalt is produced primarily as a by-product of other metals, chiefly copper. Cobalt salts are generally well absorbed after oral ingestion. Despite this fact, increased exposure levels tend not to cause significant accumulation (Amdur et. al, 1991).

Plants are known to accumulate large quantities of cobalt and appear to have a mechanism of cobalt tolerance similar to that adopted by other metalliferous plant species. Symptoms of cobalt toxicity are seldom observed in nature, despite the wide range in plant tissue concentrations. Soil concentrations that may result in toxic effects to plants range from 20 to 50 mg/kg (Kabata-Pendias and Pendias, 1992).

Copper

Copper is released to the atmosphere in the form of particulate matter or adsorbed to particulate matter. It is removed by gravitational settling (bulk deposition), dry deposition (inertial impaction characterized by a deposition velocity), washout by rain (attachment to droplets within clouds), and rainout (scrubbing action below clouds). The removal rate and distance traveled from the source will depend on source characteristics, particle size, and wind velocity. Most copper deposited in soil from the atmosphere, agricultural use, and solid waste and sludge disposal will be strongly adsorbed and remain in the upper few centimeters of soil (ATSDR, 1990b).

Copper's movement in soil is determined by a host of physical and chemical interactions of copper with the soil components. In general, the copper will adsorb to organic matter, carbonate minerals, clay minerals, or hydrous iron and manganese oxides. Sandy soils with low pH have the greatest potential for leaching. In most temperate soil, the pH, organic matter, and ionic strength of the soil solutions are the key factors affecting adsorption. The ionic strength and Ph of the soil solution affect the surface charge of soils

and thereby influence ionic interaction. When the amount of organic matter is low, the mineral content of Fe, Mn and Al oxides become important in determining the adsorption of copper (ATSDR, 1990b).

Copper is an essential component of many enzymes and most animals have some ability to regulate its balance. Higher organisms typically employ cellular mechanisms to conserve copper when it is deficient and excrete it when body burdens increase. These copper regulatory mechanisms may successfully prevent severe abnormalities if neither periods of deficiency nor excess are extreme (Rand and Petrocelli, 1985).

The toxicity of copper to aquatic biota has been shown to be related primarily to the activity of the cupric ion (Cu^{+2}), and possibly to some of the hydroxy complexes. The cupric ion is highly reactive and forms moderate to strong complexes and subsequently precipitates with any inorganic and organic constituents of natural waters. The portion of copper present as a free cupric ion is generally low and may be less than 1% in eutrophic waters where complexation predominates. It appears that organic and inorganic copper complexes and precipitates are less toxic than free cupric ion, thus reducing the toxicity attributable to total copper. The chemistry of copper complicates the interpretation of its toxicity because the portion of free cupric ion present in solution is highly variable (Rand and Petrocelli, 1985). Like a number of other cation metals, both calcium hardness and carbonate alkalinity are also known to reduce the acute toxicity of copper; expression of Virginia water quality criteria allows adjustment for these water quality effects.

Data compiled by EPA (1984b) indicated that both freshwater invertebrates and fish exhibit a wide range of sensitivities to acute exposures to copper; neither group appeared to be more sensitive than the other to copper. Embryos of the blue mussel and the Pacific oyster were the most sensitive saltwater species tested, with acute values of 5.8 and 7.8 $\mu\text{g/L}$, respectively. Acute values for saltwater fish ranged from 13.93 to 411.7 $\mu\text{g/L}$, with embryo-larval forms more sensitive than adults.

The bioconcentration factor (BCF) of copper in fish obtained in field studies is 10-100, indicating a low potential for bioconcentration. The BCF is higher in molluscs, especially oysters, where it may reach 30,000. This may be due to the fact that they are filter feeders, and copper concentrations are higher in particulates than in water. However, there is abundant evidence that there is no biomagnification of copper in the food chain. Even at the lowest levels of the food chain, there is little evidence of copper bioaccumulation. In a study of earthworms and soil from 20 diverse sites in Maryland, Pennsylvania, and Virginia, copper concentrations in earthworms poorly correlated with that in soil (ATSDR, 1990b).

DDT, DDD, and DDE

DDT and its metabolites may be transported from one medium to another by the processes of solubilization, adsorption, bioaccumulation, or volatilization. Studies of DDT transformations in soils indicate prolonged persistence. During these extended periods of time, these compounds undergo extensive adsorption to soil particles. Since the compounds are bound strongly to soil, they are not easily displaced from their site of application (except by erosion), nor do they tend to leach to groundwater, and appreciable amounts may remain in the soil for extended periods of time (ATSDR, 1994b).

DDT in excess of water solubility limits is adsorbed onto sediments which act as the primary reservoir for excess quantities of DDT. There it is available for ingestion by organisms, such as bottom feeders. Volatilization of DDT, DDE, and DDD is known to account for considerable losses of these compounds from soil surfaces and water. The tendency of DDD to volatilize is approximately fivefold less than that of DDT or DDE. Laboratory studies of the air/water partition coefficient of DDE indicate that it will volatilize from seawater 10-20 times faster than from freshwater. DDT in soils is subject to volatilization, with an estimated half-life of 100 days. Small particles that carry DDT or its degradation products may also be distributed through the atmosphere. Precipitation is believed to account for the greatest rate of removal from the atmosphere. When DDT is released to water, it quickly adsorbs to particles and is subject to sedimentation, may bioconcentrate in microorganisms, and can become part of the food chain. DDT, DDE, and DDD are highly lipid soluble, as reflected by their log octanol-water partition coefficients (log K_{ow}) of 6.19, 7.00, and 6.20, respectively.

Despite being strongly bound to soil, DDT, DDE, and DDD are bioavailable to plants and soil invertebrates. Studies indicate that the majority of the residues found in the roots of the plant, and the lowest concentration of DDT residues was found in the shoots, indicating low translocation of DDT. Earthworms are capable of aiding the mobilization of soil-bound DDT residues to readily bioavailable forms (ATSDR, 1994b).

DDT has not been marketed in the United States since 1972, but is ubiquitous due to its widespread use in previous decades and its relatively long half-life. DDT's close structural analogs, DDE and DDD, are metabolites of DDT and have also been formulated as pesticides in the past (Hayes, 1982). Because of its persistent nature, coupled with its hydrophobic properties and solubility in lipids, DDT and its metabolites are concentrated from water by aquatic organisms at all trophic levels. It also readily enters the food web and is bioaccumulated by organisms at higher trophic levels (EPA, 1980f).

DDT is intermediate in toxicity to fish in comparison to other chlorinated hydrocarbon pesticides. It is less toxic than aldrin, dieldrin, endrin and toxaphene, but more toxic than chlordane, lindane and methoxychlor (EPA, 1980f). Invertebrates are, for the most part, more sensitive than fish species, but the range of species LC50s for macroinvertebrates (10,000) is much greater than that for fish (300). The least sensitive species listed in EPA (1980f) was a stonefly (*Pteronarcys californica*) with a 96 h LC50 of 1.8 mg/L. Week-old crayfish were the most sensitive reported species (LC50 = 0.00018 mg/L) although 10-week old crayfish of the same species had an LC50 of 0.003 mg/L. EPA (1980f) reported that of the species for which data were available, yellow perch was the most sensitive freshwater species tested (96 h LC50 of 0.6 µg/L) where as the least sensitive species was the goldfish (96 LC50 = 180 µg/L).

Data for DDE indicate that long-term dietary dosage at 2.8 to 3.0 mg/kg DDE (wet weight) can have adverse effects on reproduction of mallards, black ducks, and screech owls. Species that feed on saltwater animals containing DDT and its metabolites have exhibited reductions in their reproductive capacity (Rand and Petrocelli, 1985). Anderson et al. (1975) studied the impacts of DDT in northern anchovies (a species with a high lipid content) on the reproductive success of brown pelicans. The concentrations of this contaminant steadily declined in anchovies over this 5-year study and pelican reproduction improved; the authors concluded that even the lowest concentrations detected in anchovies (0.15 mg/kg) and the subsequent 97 mg/kg concentration in pelican eggs was unacceptably high, because pelican eggshell thickness was still too low and pelican recruitment was still not high enough to sustain a stable population.

DDT's high lipid solubility, combined with an extremely long half-life, has resulted in bioaccumulation (i.e., levels in organisms exceed those levels occurring in the surrounding environment). When they are present in ambient water, DDT and its metabolites are bioconcentrated in freshwater and marine plankton, insects, mollusks, other invertebrates, and fish. Bioconcentration factors from laboratory tests with DDT and saltwater organisms ranged from 1200 to 76300 for fish and shellfish, respectively (EPA, 1980f). As these organisms become part of the food chain, a progressive biomagnification of residues may result in high levels of residues in organisms at the top of the food chain. Rainbow trout may accumulate DDT, DDE, and DDD from ingesting fish lower on the food chain and from the surrounding media (i.e., water and sediment).

Endosulfan I, II, and Sulfate

Endosulfan has been released to the environment mainly as a result of its use as an insecticide. When applied to fruit trees, vegetables, and other crops, endosulfan is released directly to the atmosphere and is also released to the atmosphere as the result of volatilization from treated plant surfaces and surface

waters. Effluents from manufacturing and formulating facilities and surface runoff from treated croplands are sources of releases of the compound to surface waters. The main routes of release of endosulfan to soils are application of the compound to crops and land disposal of unused formulated pesticide products containing the compound.

Endosulfan released to soil is most likely subjected to photolysis (on soil surfaces), hydrolysis (under alkaline conditions), or biodegradation. The α - and β -isomers of endosulfan undergo photolysis upon exposure to sunlight on plant leaves. The α -isomer also undergoes isomerization to the β -isomer, which is relatively more stable (Dureja and Mukerjee 1982). A photolytic half-life of about 7 days was reported for endosulfan by EPA (1982). Endosulfan in aqueous solutions is also expected to undergo biodegradation. On plant surfaces, as in soils, numerous studies have demonstrated that endosulfan is oxidized to endosulfan sulfate. In most plant residue studies, endosulfan sulfate residue levels tend to increase relative to the parent isomers and other metabolites and appear to be very persistent (Coleman and Dolinger 1982).

The results of several laboratory and greenhouse studies indicate that endosulfan is strongly adsorbed to soil. Adsorption of endosulfan to soil particulates is also predicted based on the log soil organic carbon/water partition coefficient (K_{oc}) value of 3.5. Adsorption is also important in aquatic systems. For example, Greve and Wit (1971) found that 82%–85% of the endosulfan residues in water samples taken from the Rhine River (0.2–0.6 ppb) were associated with the particulate phase.

The clinical signs common to animals after acute exposure to high doses of endosulfan (e.g., hyperactivity, tremors, decreased respiration, dyspnea, salivation, tonic-clonic convulsions, and death) point to the nervous system as the major target of toxicity. However, neurotoxic effects are generally not seen following longer term, low-dose exposure. Target organs/systems of endosulfan identified in experimental animals include the gastrointestinal tract, blood, liver, kidneys, reproductive organs, and immune system. Developmental toxicity has also been noted in animals. The effects observed on the respiratory and cardiovascular systems are most likely secondary to effects of endosulfan on the central nervous system control of respiratory and cardiovascular function. Very few studies have examined the toxicity of endosulfan following inhalation or dermal exposure, but the effects reported (e.g., central nervous system stimulation and hepatic and renal effects) are similar to those seen after oral exposure.

Endrin and Endrin Aldehyde

Endrin is extremely persistent when released to the soil. Endrin on soil may be transported to surface water via runoff from rain or irrigation. Since endrin in solid form is hydrophobic and sorbs strongly to soil

particles, migration into groundwater would not generally be expected from normal agricultural application. However, endrin has been detected in some groundwaters, suggesting that leaching may be possible in some soils under certain conditions. Furthermore, since endrin formulations in solvent carriers such as xylene or hexane were also commonly used, endrin could move into groundwater from spills of such formulations. Similarly, migration to groundwater might also occur at waste sites where endrin residues become mixed with organic solvents. Unlike some other chlorinated pesticides, endrin volatilization was not enhanced after a rainfall. Small amounts of endrin in soil may also be transported to the air by dust particles.

The occurrence of significant concentrations of endrin transformation products (including endrin ketone, endrin aldehyde, and endrin alcohol) in a variety of plants grown in soil treated with endrin for periods as long as 15 years prior to planting indicates that there may be significant uptake of endrin and/or its transformation products by plants from endrin- treated soil.

When released to water, endrin strongly adsorbs to sediment and bioconcentrates significantly in aquatic organisms. Typical bioconcentration factors for freshwater and marine organisms range from 140 to 49,000. In addition to being bioconcentrated in aquatic organisms directly from water, endrin appears to be biomagnified slightly through various levels of the food chain (ATSDR, 1994c). Endrin was widely used as a broad spectrum pesticide until its registration was canceled in 1984. This chlorinated cyclodiene is highly toxic to humans; its long-term persistence and mammalian toxicity had been recognized at least as early as 1964 (EPA, 1993b). Like other organochlorine pesticides, endrin is lipophilic and bioaccumulates in lipid. Studies indicate that this pesticide can move across the placenta (EPA, 1994a).

Ethylbenzene

The physicochemical properties of ethylbenzene reveal a strong tendency for ethylbenzene to partition into the atmosphere. Depending upon site conditions, releases to surface soil can result in substantial losses to the atmosphere in addition to subsurface infiltration. Vapor phase transport will occur from subsurface releases (i.e., from leaking underground storage tanks) and during migration through partitioning into air pockets within unsaturated soil pore spaces. This vapor phase migration behavior is used in soil gas sampling methods. The magnitude of the Henry's law constant, which measures partitioning between water and air, indicates that a significant proportion of ethylbenzene will partition from water into air. Ethylbenzene dissolves in surface water, soil pore water, or groundwater and will thus migrate into an available atmospheric compartment until its saturated vapor concentration is reached (ATSDR, 1990c).

Heptachlor and Heptachlor Epoxide

Heptachlor can be widely distributed in the environment. Both heptachlor and heptachlor epoxide can travel long distances in the wind from places where they are released such as treated fields or manufacturing sites. Heptachlor can be deposited on plant leaves or plants can absorb it through contaminated soil. Animals that eat plants containing heptachlor can also absorb heptachlor. Heptachlor is then changed into heptachlor epoxide, which breaks down very slowly in the environment and can stay in soil and water for many years. Plant, fish, and cattle that absorb the heptachlor or heptachlor epoxide through air, water, or food sources can pass it on to the organisms that consume them, leading to bioaccumulation. Also, since both heptachlor and heptachlor epoxide can volatilize from soil.

The chemical and physical properties of heptachlor and heptachlor epoxide vary somewhat from one another. Their chemical formulas are $C_{10}H_5Cl_7$ and $C_{10}H_5Cl_7O$, respectively. Their molecular weights are 373.35 and 389.4, respectively. Both are crystalline solids, and the melting points are 95-96°C (pure) and 46-74°C (technical grade) (Worthing and Walker 1987) for heptachlor and 160-161.5°C for heptachlor epoxide. Heptachlor has a boiling point of 145°C, a density of 1.57 g/cm³ at 9°C, and a camphor-like odor; the odor threshold in air for both heptachlor and heptachlor epoxide is 0.3 mg/m³. The solubility of heptachlor in water at 25°C is 0.05 mg/L and that of heptachlor epoxide is 0.275 mg/L; both are soluble in most organic solvents. The partition coefficients for heptachlor and heptachlor epoxide are as follows: Log K_{ow} s are 5.44 and 5.40, respectively, and the Log K_{oc} s are 4.34 and 3.34-4.37, respectively. The vapor pressures at 20°C are 3×10^{-4} mmHg and 2.6×10^{-6} mmHg, respectively, and at 25°C the vapor pressure for heptachlor is 3×10^{-4} mmHg. Henry's law constant at 25°C for heptachlor is 3×10^{-3} atm-m³/mol and that for heptachlor epoxide is 3.210^{-5} atm-m³/mol.

The toxicities of heptachlor and heptachlor epoxide have been examined to some extent in animals via the oral route of exposure. The major target organ and system affected are the liver and the central nervous system. The effects, however, cannot be related directly to heptachlor or heptachlor epoxide. Available carcinogenicity data indicate that both heptachlor and heptachlor epoxide are liver carcinogens in the rat and mouse.

Iron

The ferrous, or bivalent (Fe^{++}), and the ferric, or trivalent (Fe^{+++}) forms of iron are of primary concern in the aquatic environment. Iron can exist in natural organometallic or humic compounds and colloidal forms. The national criterion for the protection of aquatic life is 1.0 mg Fe/L (EPA, 1986).

Lead

As summarized in FWS (1988), research to date has determined that lead (Pb) is neither essential nor beneficial and that all measured effects are adverse. Invertebrates exhibit a wide range of sensitivities to lead, and the toxicity of lead to fish has been found to be greater in soft water than in hard water. Organolead compounds are typically more toxic than inorganic compounds, food chain biomagnification is generally negligible, and younger organisms tend to be more sensitive to lead exposure than older individuals (FWS 1988). Reported bioconcentration factors are relatively low, ranging from 42 for brook trout to 1700 for a gastropod (*Lymnaea palustris*); the geometric mean value of data listed in EPA (1985c) for freshwater species is 403.

Lead modifies the function and structure of kidney, bone, the central nervous system, and the hematopoietic system, and produces adverse biochemical, histopathological, neuropsychological, fetotoxic, teratogenic, and reproductive effects (Boggess 1977; Nriagu 1978; De Michele 1984). Inorganic Pb absorbed into the mammalian body enters the bloodstream initially and attaches to the red blood cell. There is a further rapid distribution of the Pb between blood extracellular fluid and other storage sites that is so rapid that only about half of the freshly absorbed Pb remains in the blood after a few minutes. The storage sites for Pb are uncertain, although they are probably in soft tissues as well as bone; the half-time residence life (Tb 1/2) of inorganic Pb probably proceeds sequentially from gut, to blood, to bone and soft tissue, and by way of the bile to small intestine and fecal excretion (DeMichele 1984).

Tetraalkyllead mode of action differs from that of inorganic Pb. Although initial entry is still into the bloodstream, the Pb is evenly distributed between blood plasma and the red blood cells. Tetraalkylleads are lost rapidly from the bloodstream, although some reappear in 5 to 10 hours associated exclusively with the red blood cells, probably as tetraalkyllead, though a fraction may be converted to inorganic Pb. The organoleads concentrate in the liver, and it is there that tetraalkyllead is probably converted to trialkyllead. Otherwise, the Pb is widely dispersed throughout the body with Tb 1/2 values of 200 to 350 days (Harrison and Laxen 1981). Tetraalkyllead, by virtue of its liposolubility, is rapidly accumulated in bony tissues, particularly the brain, where the onset of signs of poisoning is rapid (Nriagu 1987). Short-term repeated exposures of rats (*Rattus* spp.) to EL results in a neurotoxic syndrome consisting of altered reactivity to noxious stimulation through disruption of forebrain-area function (Hong et al. 1983). Several fish species metabolize tetraalkyllead derivatives are considered responsible for the toxicity of the parent compound (Walsh and Tilson 1984). Trialkylleads and dialkylleads rapidly traverse biological membranes in bird eggs and accumulate in the yolk and developing embryo (Forsyth et al. 1985). At present, the organolead mode of action is poorly understood, but organolead compounds are known to inhibit amino acid transport, uncouple oxidative phosphorylation, and inhibit cerebral glucose metabolism (Hong et al. 1983).

Mammals have demonstrated 3 effects of lead toxicity. Rats receiving oral doses of lead for up to a year exhibited neurological deficits including disruption of conditioned responses and motor activity, both of which could impair the fight or flight response (and survival) in the wild (Krasovskii et al., 1979). Lead has caused symptoms of chronic toxicity and irregular estrus cycles in mammals which could disrupt seasonal reproductive cycles (Demayo et al. 1982; Hilderbrand et al. 1973).

Growth rate suppression was in chickens is the only toxic endpoints to be described for birds. Studies measuring reproductive endpoints of survival, egg laying, fertility, and eggshell thickness in American kestrels found no impairment of these parameters (Pattee, 1984).

The study by Davies et al. (1976) found that large fish exposed for 19 months to 7.6 mg/L developed "blacktail", a neurological condition that leads to curvature of the spine. Forage fish, small fish and daphnids had no data on the effects of lead toxicity.

As with a number of other metals, hardness has a major effect on the bioavailability of lead, although the observed effect is probably due to the presence of one or more interrelated ions such as hydroxide, carbonate, calcium, or magnesium (EPA 1985c).

Bioconcentration factors for lead ranged between 4.88 and 726 for fish and 500 for terrestrial invertebrates. However, earthworms and plants were not found to bioconcentrate lead to any significant degree.

Manganese

Elemental manganese and inorganic manganese compounds have negligible vapor pressures, but may exist in air as suspended particulate matter derived from industrial emissions or the erosion of soils. Manganese containing particles are mainly removed from the atmosphere by gravitational settling, with large particles tending to fall out faster than small particles. Removal by washout mechanisms such as rain may also occur, but is less important in removing manganese from the atmosphere than dry deposition. The tendency of soluble manganese compounds to adsorb to soils and sediments depends mainly on the cation exchange capacity and the organic composition of the soil. Manganese is a vital micronutrient for both plants and animals (ATSDR, 1992d).

The transport and partitioning of manganese in water is controlled by the solubility of the specific chemical form present, which in turn is determined by pH, Eh (oxidation-reduction potential), and the characteristics

of available anions. The metal may exist in water in any of four oxidation states (2+, 3+, 4+, or 7+). Divalent manganese (Mn^{+2}) predominates in most waters (pH 4-7), but may become oxidized at pH greater than 8 or 9. The principal anion associated with Mn^{+2} in water is usually carbonate, and the concentration of manganese is limited by the relatively low solubility (65 mg/L) of $MnCO_2$. In relatively oxidized water, the solubility of Mn^{+2} may be controlled by manganese oxide equilibria, with manganese being converted to the (+3) or (+4) valence states. In extremely reduced water, the fate of manganese tends to be controlled by formation of the poorly soluble sulfide. Manganese is often transported in rivers as suspended sediments. Manganese in water may be significantly bioconcentrated at lower trophic levels. Folsom et al. (1963) estimated that the BCF of manganese was 2,500-6,300 for phytoplankton, 300-5,500 for marine algae, 800-830 for intertidal mussels, and 35-930 for coastal fish (ATSDR, 1992d). McKee and Wolfe (1963) summarized the data concerning the toxicity of manganese to freshwater life. Manganese ions rarely occur in concentrations above 1 mg/L. The reported tolerance values for freshwater organisms range from 1.5 to >1000 mg Mn/L.

Mercury

The natural global biogeochemical cycling of mercury is characterized by degassing of the element from soils and surface waters, followed by atmospheric transport, deposition of mercury back to land and surface waters, and sorption of the compound to soil or sediment particulates. Particulate-bound mercury can be converted to insoluble mercury sulfide and precipitated or bioconverted into more volatile or soluble forms that re-enter the atmosphere or are taken up by biota and bioaccumulated in terrestrial and aquatic food chains (ATSDR, 1994d).

Mercury has three valence states. The specific state and form in which the compound is found in an environmental medium is dependent upon a number of factors, including the redox potential and pH of the medium. In soils and surface waters, mercury can exist in the mercuric (Hg^{+2}) and mercurous (Hg^{+1}) states as a number of complex ions with varying water solubilities. Mercuric mercury, present as complexes and chelates with ligands, is probably the predominant form of mercury present in surface waters. The transport and partitioning of mercury in surface waters and soils is influenced by the particular form of the compound. More than 97% of the dissolved gaseous mercury found in water consists of elemental mercury. Volatile forms (e.g., metallic mercury and dimethylmercury) are expected to evaporate to the atmosphere, whereas solid forms partition to particulates in the soil or water column and are transported downward to the sediments in the water column (ATSDR, 1994d).

Vaporization of mercury from soils may be controlled by temperature, with emissions from contaminated soils being greater in warmer weather when soil microbial reduction of Hg^{+2} to the more volatile elemental

mercury is greatest. Vapor-phase mercury volatilized from surface waters has been measured however, the dominant process controlling the distribution of mercury compounds in the environment appears to be the sorption of nonvolatile forms to soil and sediment particulates with little resuspension from the sediments back into the water column (ATSDR, 1994d).

Freshwater and marine sediments are important repositories for inorganic forms since they readily adsorb to inorganic and organic particles as well as dissolved organic carbon (DOC) (Benes and Havelik 1979; Rudd and Turner 1983; Rogers et al. 1984). The degree and extent of this binding, while not well understood, will affect the availability of mercury for methylation. Methylation of mercury in most aquatic systems is thought to be primarily a function of microbiological activity in the sediment (Winfrey and Rudd 1990). Rates of methylation peak at the sediment-water interface and decrease in the overlying water and subsurface sediment (Korthals and Winfrey 1987). Reduced pH also appears to increase the availability of methylated mercury by expediting its release from sediment into the water column.

In soils, leaching is a relatively insignificant transport process. However, surface runoff is an important mechanism for moving mercury from soil to water, particularly for soils with high humic content. Mobilization of sorbed mercury from particulates can occur through chemical or biological reduction to elemental mercury and bioconversion to volatile organic forms. Adsorption of mercury in soil is decreased with increasing pH and/or chloride ion concentrations. Metallic mercury may move through the top 3-4 cm of dry soil at atmospheric pressure; however, it is unlikely that further penetration would occur (ATSDR, 1994d).

The chemical speciation of mercury (Hg) is probably the most important variable influencing ecotoxicology of Hg, but Hg speciation is complicated, especially in natural environments (Boudou and Ribeyre 1983; FWS 1987a). Most mercury entering aquatic systems is inorganic (Hg II) although recent studies have measured methylated mercury (CH_3HgH^+) in rain and surface runoff (Bloom and Watras 1989; Lee and Hultberg 1990). Methyl mercury is the major form of mercury in fish and accumulates to a greater extent in biological tissue than inorganic mercury. Methylation of inorganic mercury takes place in the terrestrial environment, the water column, and in sediment. The net amount of methyl mercury in an aquatic system is the result not only of its rate of formation, but also the result of the rates of those processes that alter the availability of inorganic mercury for methylation, and methyl mercury decomposition (demethylation) (Winfrey and Rudd 1990).

In a recent review of the hazards of mercury (Hg) to fish, wildlife, and invertebrates, FWS (1987a) noted that mercury and its compounds have no known biological function; its presence is regarded as undesirable and potentially hazardous, and it is a mutagen, teratogen, and carcinogen. Forms of mercury

with relatively low toxicity can be transformed into forms with very high toxicity through biological and other processes. For all organisms tested, early developmental stages were the most sensitive, and organomercury compounds — especially methylmercury — were more toxic than inorganic forms. Numerous biotic and abiotic factors modify the toxicity of mercury compounds, sometimes by an order of magnitude or more, but mechanisms of action are unclear (FWS 1987a).

The most common organic form of mercury, methylmercury, is soluble, mobile, and quickly enters the aquatic food chain. This form of mercury can be bioconcentrated in organisms and biomagnified through food chains, returning mercury to upper trophic level consumers in a concentrated form. For example, methylmercury in surface waters is rapidly accumulated by aquatic organisms; bioconcentration factors in carnivorous fish range from 10,000 (brook trout) to 81,670 (fathead minnows). The geometric mean value of bioconcentration values listed in EPA (1985d) for freshwater organisms is 25,400. The bioaccumulation potential for methylmercury in fish is influenced by the pH of the water, with a greater bioaccumulation seen in waters with lower pH. Mercury concentrations in fish have also been negatively correlated with other water quality factors, such as alkalinity and dissolved oxygen content (ATSDR, 1994d).

Biomagnification factors for mercury in the food webs of Lakes Michigan and Ontario were lowest for amphipods feeding on mysids (1.1) and highest for fish feeding on plankton (10.4-11.8). Aquatic macrophytes also have been found to bioconcentrate methylmercury in almost direct proportion to the mercury concentration in the water. The potential for bioaccumulation in terrestrial food chains is demonstrated by the uptake of mercury by the edible mushroom *Pleurotus ostreatus*, grown on compost containing mercury at concentrations of up to 0.2 mg/kg. The bioaccumulation factor was 65-140, indicating that there are risks to human health if these mushrooms are eaten. However, other data indicate that virtually no mercury is taken up from the soil into the shoots of plants such as peas, although mercury concentrations in the roots may be significantly elevated and reflect the mercury concentrations of the surrounding soil (ATSDR, 1994d).

Methoxychlor

Methoxychlor is a relatively hydrophobic compound with log octanol/water partition coefficient (log KoW) values ranging from 4.68 to 5.08. Because of this, methoxychlor in water is expected to partition mainly to sediment and organic matter, although a significant fraction may remain in solution when the ratio of sediment mass to water volume is low. In sediments, the partitioning of methoxychlor was higher for silts and clays than it was for sand (ATSDR, 1994e).

The mobility of methoxychlor may be higher in sandy soils, since adsorption was significantly less in soil with lower organic carbon content and larger particle size. In addition to soil absorption, methoxychlor may become structurally bound to soil humic materials. Dechlorinated, dehydrochlorinated, and demethylated degradation products of methoxychlor were generally detected in lower levels of soil, suggesting that they are more mobile than methoxychlor (ATSDR, 1994e).

The bioconcentration of methoxychlor has been investigated in microorganisms, lower invertebrates, and in fish. Reported bioconcentration factors (BCFs) for methoxychlor ranged from 411-2,758 in *Aerobacter aerogenes*, 2,114-8,138 in *Bacillus subtilis*, 348-1,130 in stoneflies, 5,000-8,570 in snails and 1,500 in clams. In sheepshead minnows, BCFs were found to be concentration dependent, ranging from 113 at 3 mg/L to 264 at 23 mg/L. These data suggest that considerable species variation exists in the bioconcentration of methoxychlor in fish, perhaps as the result of species differences in the capacity to metabolize and eliminate methoxychlor (ATSDR, 1994e).

Nickel

Rats given a subchronic gavage study with nickel chloride in water experienced lethargy, ataxia, irregular breathing, reduced body temperature, and discolored extremities (EPA, 1994b). Inhalation of nickel subsulfide in rats increased the incidence of lung tumors (ATSDR, 1991). The CNS appears to be the target organ for nickel oral toxicity, while the lung is the target organ for inhalation exposure.

Phenol

As summarized in EPA (1980a), phenol is predominantly used as an intermediate in a wide variety of chemical processes including production of epoxy and phenolic resins, pharmaceutical, pesticides, dyes, and numerous industrially-important acids. The phenol molecule easily substitutes in the environment to form compounds such as halophenols, which may be more toxic than the parent compound. The acute toxicity of phenols to aquatic organisms has been characterized but information on chronic toxicity is limited. Acute toxicity of phenol to freshwater species has been expressed over 2 to 3 orders of magnitude. Test results have indicated that cladocerans are the most sensitive invertebrate species examined (*Daphnia pulex* LC50 = 5000 µg/l) while rainbow trout are among the most sensitive fish species tested (LC50 = 5020 µg/l). Bioconcentration factors range from 1.2 to 2.3 for goldfish (*Carassius auratus*), indicating that phenol is not likely to bioconcentrate or biomagnify (EPA, 1980a).

Phthalates

Phthalates, or phthalate esters such as Bis(2-ethylhexyl)phthalate, represent a large family of chemicals widely used as plasticizers. For the most part, these are colorless liquids with low volatility, and are poorly water soluble (EPA 1980b; Verschueren 1983). Available data indicate that the toxicity of phthalate varies widely. However, acute toxicity values reported by EPA (1980b) all exceed 1000 $\mu\text{g/L}$ while chronic values as low as 3 $\mu\text{g/L}$ had been determined for di(2-ethylhexyl)phthalate. Reported bioconcentration values ranged from 14 to 2680 (EPA 1980b).

Although di-n-butyl phthalate has low volatility, it has been reported as particulate in the atmosphere and as a vapor. In the air, di-n-butyl phthalate is transported from its origin and is subject to both wet (rain and snow) and dry (wind and settling) deposition on the earth's surface. Although di-n-butyl phthalate is only poorly soluble in water, it may be transported in water following formation of chemical complexes between di-n-butyl phthalate and humic substances. The adsorption of di-n-butyl phthalate onto particulate matter is greater in salt water than in fresh water. Adsorption onto soil and sediments appear to be a significant sink for di-n-butyl phthalate. It has been demonstrated that di-n-butyl phthalate is rapidly adsorbed from seawater onto marine sediment. In hazardous waste sites, the presence of common organic solvents such as alcohols and ketones may increase the solubility of relatively water insoluble compounds such as di-n-butyl phthalate, thus increasing the amounts that may leach from the site into the subsoil and into groundwater (ATSDR, 1990d).

Polyaromatic Hydrocarbons

Increased fossil fuel consumption in the United States has lead to a rise PAH emissions into the environment. The global movement of PAHs can be summarized as follows: PAHs released to the atmosphere are subject to short- and long-range transport and are removed by wet and dry deposition. In surface water, PAHs can volatilize, photodegrade, oxidize, biodegrade, bind to particulates, or accumulate in aquatic organisms (with bioconcentration factors often in the 100-2,000 range). In sediments, PAHs can biodegrade or accumulate in aquatic organisms. PAHs in soil can biodegrade or accumulate in plants; PAHs can enter groundwater and be transported within an aquifer (ATSDR, 1993d).

Transport and partitioning of PAHs in the environment are determined to a large extent by physical/chemical properties such as water solubility, vapor pressure, Henry's law constant, octanol-water partition coefficient (K_{ow}) and organic carbon partition coefficient (K_{oc}). In general, PAHs have low water solubilities. Because of their low solubility, PAHs in aquatic systems are primarily found sorbed to particles that either have settled to the bottom or are suspended in the water column. In an estuary, volatilization

and adsorption to suspended sediments with subsequent deposition are the primary removal processes for medium and high molecular weight PAHs, whereas volatilization and microbial degradation are the major removal processes for low molecular weight compounds (ATSDR, 1993d).

Sorption of PAHs to soil and sediments increases with increasing organic carbon content and is also directly dependent on particle size. PAHs have also been shown to be transported laterally within contaminated aquifers. PAHs can be accumulated in aquatic organisms from water, sediments, and food. Bioconcentration factors (BCFs) of PAHs in fish and crustaceans have frequently been reported to be in the range of 100-2,000. In general, bioconcentration was greater for the higher molecular weight compounds than for the lower molecular weight compounds. Biotransformation by the MFO system in the fish liver can result in the formation of carcinogenic and mutagenic intermediates; exposure to PAHs has been linked to the development of tumors in fish. The ability of fish to metabolize PAH, may explain why benzo(a)pyrene is frequently not detected or found only at very low levels in fish from environments heavily contaminated with PAHs. The breakdown products (polyhydroxy compounds) are eliminated in feces (via bile) and urine. Varanasi et al. (1985) ranked the amount of benzo(a)pyrene metabolism by aquatic organisms as follows: fish > shrimp > amphipod crustaceans > clams. Fish and crustaceans readily assimilate PAHs from contaminated food, whereas mollusks and polychaete worms have limited assimilation. Biomagnification has not been reported because of the tendency of many aquatic organisms to eliminate these compounds rapidly (ATSDR, 1993d).

Some PAHs are of environmental concern because they are known to be carcinogens and/or mutagens. An increase in fossil fuel consumption in the United States has resulted in an increase in emissions of PAHs to the environment. Sorption of PAHs onto solids in the water column and subsequent settling, as well as partitioning onto organic materials in the sediment, can significantly affect PAH transport.

Because of their complex chemical composition, the toxicity of PAHs is variable and not well understood (NAS 1985). In addition, research has demonstrated that different organisms and different life stages for a given species can vary widely in sensitivity to PAHs (FWS 1987b; NAS 1985; Neff and Anderson 1981). However, it is generally agreed that in aquatic ecosystems, the toxicity of PAHs is correlated with water solubility (Neff and Anderson 1981) and molecular weight, with high molecular weight PAHs exhibiting low acute toxicity (due to low water solubility) (FWS 1987b). In all but a few cases, PAH concentrations that are acutely toxic to aquatic organisms are several orders of magnitude higher than concentrations found in even the most heavily polluted waters. Sediment from polluted areas, however, may contain PAHs in concentrations approaching those similar to those which are acutely toxic, but their limited bioavailability would probably render them substantially less toxic than PAHs in solution (FWS 1987b).

Patton and Dieter (1980) fed mallards a diet that contained 4000 mg PAHs/kg (primarily naphthalenes, naphthenes, and phenanthrene) for 7 months. No mortality or visible signs of toxicity were noted but both liver weight and hepatic blood flow were significantly greater than that of the controls. However, the authors concluded that these modifications in the liver did not represent an adverse effect and that adult mallards could tolerate long-term exposures to relatively high concentrations of PAHs. Mammalian toxicity data are limited for PAHs but the ability of some PAHs to induce tumor formation is well documented (FWS 1987b). Bioaccumulated PAHs with a four-ring structure or less are rapidly metabolized. Therefore, long-term partitioning into biota is not considered a significant fate process (FWS 1987b; EPA 1993).

In general, PAHs obtained from the diet can contribute to total tissue concentrations to a limited extent. Tissues from plants grown in the treated soils were relatively enriched with low molecular weight PAHs (e.g., acenaphthene, fluorene, phenanthrene), but increased PAH concentrations (relative to tissues from plants grown in control plots that did not receive sludge amendments) were not consistently detected. The PAH concentrations in above ground plant parts were not strongly related to soil PAH levels but were probably the result of atmospheric deposition. The presence of PAHs in root crop tissues was probably due to adsorption of the compounds to root surfaces. PAHs may accumulate in terrestrial animals through the food chain or by ingestion of soil (ATSDR, 1993d).

PCBs

In water, adsorption to sediments or other organic matter is a major fate process for PCBs. Experimental and monitoring data have shown that PCB concentrations are higher in sediment and suspended matter than in the associated water column. Based on their water solubilities and octanol-water partition coefficients, the less chlorinated components of the Aroclors will sorb less strongly than the highly chlorinated components. Although adsorption and subsequent sedimentation may immobilize PCBs for relatively long periods of time in aquatic systems, redissolution (due to loss from the aquatic phase as a result of, for example, volatilization and subsequent release from sediment) into the water column has been shown to occur in the environment. The substantial quantities of PCBs contained in aquatic sediments can therefore act as an environmental reservoir from which PCBs may be released slowly over a long period of time. Environmental redistribution from aquatic sediments should be most significant for the PCBs contained in the top layers of the sedimentary deposit. PCBs reaching the lower layers of sedimentary deposits may be effectively sequestered from environmental redistribution. The depth distribution of PCBs in lake sediments provides a record of changes in PCB accumulation with time. PCBs may volatilize even more significantly from dams, waterfalls, and other waterways that have markedly higher aeration rates. Nonetheless, adsorption to sediment significantly decreases the volatilization rate of

highly chlorinated Aroclors from the aquatic phase. The rate of redissolution of PCBs from sediment to water will always be greater in summer than in winter because of more rapid volatilization from water. The low water solubility, high octanol-water partition coefficients of the PCBs demonstrates strong adsorption of PCBs to soils and sediment. The tendency to leach will be greatest among the least chlorinated congeners. Since the sorption of PCBs in soil is proportional to soil organic carbon content, leaching is expected to be greatest from soils with low organic carbon. PCBs in soil leach significantly in the presence of organic solvents, as might occur at a hazardous waste site. The volatilization rate will be greater from soil with low organic carbon, due to the weaker sorption of PCBs. The volatilization rates also will be greater in moist soils due to the codistillation of PCBs with water. Storm water runoff will also transport PCBs from soil to surface water (ATSDR, 1993f).

Polychlorinated biphenyls (PCBs) are a mixture of chlorinated biphenyl chemicals which occur individually as 209 congeners, comprised of various chlorine substitution patterns. PCBs are closely related to many chlorinated hydrocarbon pesticides (e.g., DDT, dieldrin, and aldrin) in their chemical, physical, and toxicological properties and in their widespread occurrence in the aquatic environment (Nimmo, 1985). Mixtures of PCBs were marketed under the trade name Aroclor, with a numeric designation that indicated their chlorine content. Although production and use was banned in 1979, the chemical group is extremely persistent in the environment and bioaccumulates through the foodchain. There is evidence that the most potent, dioxin-like PCB congeners are preferentially accumulated in higher organisms. Additional research indicates that there is evidence that PCB risks increase with increased chlorination because more highly chlorinated PCBs are retained more efficiently in fatty tissues (EPA, 1994b). The non-ortho-substituted coplanar PCB congeners, and some of the mono-ortho-substituted congeners, have been shown to exhibit dioxin-like effects. There is increasing evidence that many of the toxic effects of PCBs result from alterations in hormonal function. Consequently, the aggregate toxicity of a PCB mixture may increase as it moves up the foodchain (EPA, 1993b).

The three effects of PCB exposure on terrestrial wildlife are mortality, decreased reproductive success, and behavioral modifications (EPA, 1993b). Mink (*Mustela vison*) appear to be among the most sensitive species to the toxic effects of PCBs (Gillette et al., 1987). Single oral doses of PCBs administered to mink have produced LD₅₀ values of 750 mg/kg for Aroclor 1221 and 4000 mg/kg for Aroclor 1254 (Aulerich and Ringer, 1977; Ringer, 1983). The primary chronic effect documented as a result of dietary exposure to PCBs has been decreased reproductive success, as evidenced by reduced whelping rates, fetal death, and reduced growth among the young. Based on a review of available data, EPA determined that 30 µg/kg/d represented an NOEL value for reproductive effects of Aroclor 1254 (EPA, 1993b).

Birds have been shown to be more resistant than mammalian species to the acute effects of PCBs. PCB doses greater than 200 ppm in the diet (10 mg/kg body weight) caused some mortality among northern bobwhite (*Colinus virginians*), mallards (*Anas platyrhynchos*), and ring-necked pheasants (*Phasianus colchicus*). PCBs provided to these birds at dietary concentrations of 1500 ppm (100 mg/kg body weight) caused extensive mortality (FWS, 1986b). Exposure to PCBs resulted in some mortality among all the avian species tested, with lethal concentrations depending on the length of exposure and the particular PCB mixture (Aulerich et al., 1973). For all avian species, PCB residue concentrations of at least 310 mg/kg fresh weight in the brain were associated with an increased likelihood of death from PCB poisoning (FWS, 1986b). An evaluation of the results of various toxicity studies performed on a number of bird species led EPA (1993b) to conclude that 0.18 mg/kg/body weight represented an appropriate NOEL for avian wildlife.

When airborne PCBs are deposited onto the surface of water, they become enriched in the surface microlayer, and the concentrations of PCBs in the surface microlayer is 500 times higher than in deeper water. As a result, bioconcentration by fish was several orders of magnitude higher in this zone. Conversely, since the concentration of PCBs in sediments is several orders of magnitude higher than in water, the bioconcentration of PCBs in bottom feeding species is also expected to be high. According to a summary of experimentally determined BCFs (ratio of concentration in the organism over the concentration in water) of various Aroclors (1016, 1248, 1254, and 1260) in aquatic species (fish, shrimp, oyster), BCFs range from 26,000 to 660,000. The estimated BCFs for the same Aroclors in the fathead minnow is 43,000-200,000. There is evidence that PCBs will biomagnify within the food chain as indicated by the PCB levels in higher tropic levels of aquatic organisms and in several species of fish-consuming birds and seals.

Accumulation of PCBs in terrestrial vegetation can occur in the following ways: uptake from soil through the root and translocation to the aerial parts of plants; deposition of atmospheric particulates on aerial plant surfaces; and uptake of airborne vapors by aerial plant parts. The BCF for the first process is <0.02, indicating translocation from soil to aerial plant parts is not important for PCBs. The BCF in carrot peels was slightly higher than in other plant parts possibly due to adsorption from soil. However, the BCF for air to vegetation transfer of gaseous PCBs (concentration of PCBs in aerial plant parts [ng/g]/concentration of PCB vapor in air [ng/g, air density 1.19 g/L]) is reported to be 85,000. Therefore, the transfer of vapor-phase PCBs from air to aerial plant parts may be the main source of vegetation contamination. However, the tendency of PCBs to adsorb to airborne particulates will increase as the degree of chlorination increases. The fact that the PCBs have been detected in remote locations indicates these compounds will be transported long distances from their source of emission. PCBs in the atmosphere are

physically removed by wet and dry deposition. Dry deposition occurs only for PCBs in the particulate phase. (ATSDR, 1993f).

Selenium

The volatile selenium compounds that partition into the atmosphere include the inorganic compounds selenium dioxide and hydrogen selenide, which is rapidly oxidized to elemental selenium and water, and the organic compounds dimethyl selenide and dimethyl diselenide which can persist in air. Selenium compounds released to the atmosphere can be removed from it by dry or wet deposition to soils or to surface water (ATSDR, 1994f).

The forms of selenium expected to be found in surface water and the water contained in soils are the salts of selenic and selenious acids. The soluble salts of selenic acid are expected to occur in alkaline waters. Sodium selenate is one of the most mobile selenium compounds in the environment owing to its high solubility and inability to adsorb onto soil particles. Selenious acid (H_2SeO_3) is a weak acid, and the diselenite ion predominates in waters between pH 3.5 and 9. Most selenites are less soluble in water than the corresponding selenates. In soils, pH and Eh are determining factors in the transport and partitioning of selenium. Elemental selenium is essentially insoluble and may represent a major inert "sink" for selenium introduced into the environment under anaerobic conditions. Heavy metal selenides and selenium sulfides, which are also insoluble, predominate in acidic (low pH) soils and soils with high amounts of organic matter. Selenium in this form is immobile and will remain in the soil. The selenides of other metals such as copper and cadmium are of low solubility. Sodium and potassium selenites dominate in neutral, well-drained mineral soils, where some soluble metal selenites may be found as well. In alkaline (pH > 7.5), well-oxidized soil environments, selenates are the major selenium species. Due to their high solubility and low tendency to adsorb onto soil particles, the selenates are very mobile and are readily taken up by biological systems or leached through the soil. Selenite forms stable ferric oxide-selenite adsorption complexes in acid or neutral soils (ATSDR, 1994f).

When environments favor the soluble forms of selenium (alkaline and oxidizing conditions), these forms can be accumulated by plants. In addition, although both selenite (Se^{4-}) and selenate (Se^{6+}) are soluble forms of selenium, selenate was found to be the preferred form of selenium uptake by plants. Preferential uptake of selenate may be caused by its tendency to be less strongly adsorbed to soil particles and organic matter than selenite. Selenium uptake by plants is influenced by many factors including soil type, pH, colloidal content, concentration of organic material, oxidation-reduction potentials in the root-soil environment, and total level of selenium in the soil. Soluble selenates (principally sodium selenate) appear

to be responsible for most of the naturally occurring instances of plants accumulating high levels of selenium, although much of the total selenium in soil may be present in other forms (ATSDR, 1994f).

Silver

Numerous studies have indicated that free soluble silver (Ag) is among the most toxic metals to freshwater organisms. In most natural waters, the monovalent form of silver is of greatest concern. Silver may exist as a simple hydrated monovalent ion, or it may exist in various degrees of association with inorganic ions such as sulfate, bicarbonate, or nitrate (EPA 1980c). Silver is more toxic in soft water than in hard water (EPA 1980c). The sorption of silver by manganese dioxide, various ferric compounds, and clay minerals, and its subsequent partitioning by the sediment layer is strongly pH-dependent (Dyck 1968). Olcott (1950) administered 0.1% silver nitrate to rats in drinking water for 218 days. Upon necropsy, advanced pigmentation and ventricular hypertrophy were observed, although the hypertrophy was not attributed to silver toxicity.

Silver exhibits a limited ability to bioconcentrate. Bioconcentration factors for freshwater species reported by EPA (1980c) ranged from <1 for bluegill sunfish (*Lepomis macrochirus*) to 240 for a mayfly (*Ephemerella grandis*) with a geometric mean bioconcentration factor of 57. Based on studies of rats, chickens, and turkeys, the maximum tolerable level for silver in animal food is 100 mg/kg (NRC, 1980).

Styrene

In the atmosphere, styrene exists as a vapor. Styrene is an oily liquid that is slightly volatile. Physical processes such as precipitation and dry deposition are not significant mechanisms for removing styrene from the atmosphere due to its high photochemical reactivity. Styrene is only sparingly soluble in water, but its exact solubility is uncertain. Styrene in water may also partition to soils and sediments. The extent of adsorption of sparingly water-soluble compounds is often correlated with the organic carbon content of the adsorbent. Assuming that the solubility of styrene is 300 mg/L, a calculated KoC value for styrene is 260 which suggests that styrene is "moderately mobile" in soil. In surface soils, where the amount of organic carbon will be highest, the movement of styrene will be retarded by adsorption. In deeper subsurface environments where the amount of organic carbon may be low, adsorption may not be as significant. The K_{ow} of styrene has been measured to be 1,445 and 891, suggesting that styrene will partition to fat tissues. Even though styrene does tend to partition into fat, it does not tend to bioaccumulate to high levels, mainly because of its metabolism and excretion (ATSDR, 1992e).

The BCF for styrene is about 25. An experimentally-measured BCF for goldfish was 13.5. These low BCFs suggest that bioconcentration is not a significant fate of styrene released into the environment. No other measured BCFs were located to corroborate these reported values (ATSDR, 1992e).

Tetrachloroethene, Trichloroethene, and 1,2-Dichloroethene

Tetrachloroethylene (PCE) is a stable, colorless liquid likely to enter the environment through accidental releases to air, soil, or water. If released to soil, it is subject to volatilization and leaching into the water table. The half-life of PCE in soil is estimated at 180 to 360 days (Howard, 1991). Biodegradation may be an important process in anaerobic soils, based on laboratory tests with methanogenic columns (EPA, 1994b). When released into water, PCE evaporates with an estimated half-life ranging from <1 day to several weeks. PCE does not significantly biodegrade, bioconcentrate in aquatic organisms, or adsorb to sediment (EPA, 1994b). Acute toxicity tests performed on PCE resulted in a 48-h LC50 of 18 mg/L for *Daphnia magna*, a 96-h LC50 of 5 mg/L for *Salmo gairdneri* (rainbow trout), and a 96-h LC50 of 18.4 mg/L for *Pimephales promelas* (fathead minnow) (EPA, 1994b).

Trichloroethylene is a heavy stable liquid which is slightly soluble in water. It is used in metal degreasing, solvent extraction and dry cleaning. Its half life ranges from 180 to 360 days in both soil and surface water (Howard, 1991). Acute toxicity tests performed on trichloroethylene resulted in a 96-h LC50 of 66.8 mg/L for *Pimephales promelas* (fathead minnow)(Verschueren 1983). Toxicity data for TCE are limited. Prolonged inhalation exposure of animals effected the liver and kidneys. The main target organs are the CNS, heart, liver, and kidney. Exposure to TCE has been shown to cause increased incidence of liver tumors (gavage) and lymphomas (inhalation) in mice, and increased renal tumors in rats (gavage; EPA, 1988c).

1,2-Dichloroethylene may be released to the environment in emissions and wastewater or formed as breakdown products from common industrial solvents under anaerobic conditions. It is a clear, colorless, flammable liquid which consists of a mixture of the cis- and trans-isomers. 1,2-Dichloroethylene has shown slight acute and moderate chronic toxicity to aquatic species, but data is insufficient predict the short- or long-term effects of this contaminant on terrestrial receptors. It is slightly persistent in water, with a half-life of 2 to 20 days, and is lost mainly through volatilization. Biodegradation, adsorption to sediment, and bioconcentration in aquatic organisms is not significant (EPA, 1994b).

Thallium

Thallium (Th) is considered highly toxic. It was used medicinally to induce alopecia in cases of ringworm of the scalp, sometimes with deleterious side effects. Acute ingestion by laboratory animals induced

gastroenteritis, neuropathy, and renal and liver damage, while chronic ingestion causes alopecia (Kazanantzis, 1986). Rats treated with thallium compounds for 90 days experienced liver damage (EPA, March 1994). Several thallic compounds (thallic oxide, thallium acetate, thallium carbonate, thallium chloride, thallium nitrate, and thallium sulfate) were designated as weight-of-evidence Group D compounds; not classifiable as carcinogenic to humans. A chronic reference dose of 0.07 ug/kg/day has been established for human exposure to thallic oxide (EPA, March 1994).

Vanadium

Vanadium (V) is an ubiquitous element, frequently associated with petroleum refining and products. It is also used in the hardening of steel, production of pigments, and the manufacture of insecticides. It is common in many foods, particularly milk, cereals, and vegetables. While the majority of vanadium encountered in mammals is stored in fatty tissue, bone and teeth contribute to the body burden (Amdur et al. 1991). It has been postulated that homeostatic processes exist for this element in that normal tissue levels can be maintained in the face of excessive uptake. The toxic action of vanadium in mammals is largely confined to the respiratory tract. Acute vanadium poisoning via ingestion is characterized by effects on the nervous system, hemorrhage, and respiratory distress (Amdur et al. 1991). No reports exist regarding vanadium phytotoxicity under field conditions. However, experimental greenhouse studies have indicated that concentrations of 140 mg/kg in the soil and 0.5 mg/kg in the nutrient solution may be toxic to plants (Kabata-Pendias and Pendias 1992).

Xylenes

In a global sense, most (99.68%) of the xylenes released into the environment will ultimately partition into the atmosphere. When spilled on land, xylenes will volatilize or leach into the ground. In soils and sediments, xylene tends to be adsorbed to organic matter. A general trend for the relative retention of xylene in soil with increasing soil organic matter has been observed by a number of investigators. In subsurface soils with low organic carbon content, xylenes are more likely to infiltrate into groundwater from soil. (ATSDR, 1990e)

Zinc

Zinc occurs in the environment primarily in the +2 oxidation state. It dissolves in acids to form hydrated Zn^{+2} cations and in strong bases to form zincate anions. In most unpolluted waters, zinc exists primarily as the hydrated form of the divalent cation. In polluted waters, the metal often forms complexes with a variety of organic and inorganic ligands. Zinc can occur in both suspended and dissolved forms in surface water. Dissolved zinc may occur as the free (hydrated) zinc ion or as dissolved complexes and compounds with

varying degrees of stability. Suspended (undissolved) zinc may be dissolved following minor changes in water chemistry or may be sorbed to suspended matter. In the aquatic environment, zinc partitions to sediments or suspended solids in surface waters through sorption onto hydrous iron and manganese oxides, clay minerals, and organic material. In addition, the zinc content in sediment closely correlated with the depth, organic content, and clay content of the sediments. The stability of the zinc complex depends on the pH of the water and the nature of the complex. Zinc tends to sorb more readily at a high pH (pH >7) than at a low pH. Desorption of zinc from sediments occurs as salinity increases, apparently because of displacement of the adsorbed zinc ions by alkali and alkaline earth cations, which are abundant in brackish and saline waters. The mobility of zinc in soil depends on the solubility of the speciated forms of the element and on soil properties such as cation exchange capacity, pH, redox potential, and chemical species present in soil (ATSDR, 1994g).

Zinc toxicity endpoints in mammals include decreased sperm motility and reduced fertilizing capacity which could decrease the fecundity of wild populations. In birds, pancreatic lesions, decreased body weight and gizzard erosion have identified as endpoints of zinc toxicity. Toxic endpoints of zinc exposure have not been identified for other groups of animals (i.e. fish, daphnids, etc.).

Zinc is an essential nutrient and occurs in the tissues of organisms, even at normal ambient water and soil concentrations. Zinc can accumulate in freshwater animals at 51-1,130 times the concentration present in the water. Microcosm studies indicate, in general, that zinc does not biomagnify through food chains. Furthermore, although zinc actively bioaccumulates in aquatic systems, biota appears to represent a relatively minor sink compared to sediments. Steady-state zinc bioconcentration factors (BCFs) for 12 aquatic species range from ~4 to 24,000. Crustaceans and fish can accumulate zinc from both water and food. A BCF of 1,000 was reported for both aquatic plants and fish, and a value of 10,000 was reported for aquatic invertebrates. The high enrichment in oysters may be due to their ingestion of particulate matter containing higher concentrations of zinc than does ambient water. With respect to bioconcentration from soil by terrestrial plants, invertebrates, and mammals, BCFs of 0.4, 8, and 0.6, respectively, have been reported. The concentration of zinc in plants depends on the plant species, soil pH, and the composition of the soil. Plant species do not concentrate zinc above the levels present in soil. Wind-blown dust transports zinc bound to soil particulates into the atmosphere. The particulates may also contain other materials. Zinc-bearing particles in the atmosphere are transported to soil and water by wet deposition (rain and snow) and dry deposition (gravitational settling and deposition on water and soil surfaces) (ATSDR, 1994e).

**J.2 NSB-NLON PHASE II RI BENTHIC MACROINVERTEBRATE
DATA SUMMARIES**

**SUMMARY OF MACROINVERTEBRATE COMMUNITY INDICES FOR THE THAMES RIVER⁽¹⁾
NSB-NLON, GROTON, CONNECTICUT**

Sample Number	Taxa Richness	Total Number of Individuals	Shannon-Weaver Diversity Index	Species Richness	Ratio of Observed to Expected Number of Taxa
T1SD2	29	282.3	2.118	4.15	0.72
T1SD1	21	239.3	1.990	3.04	0.88
T3SD4	23	398.7	1.967	3.10	0.73
T4SD4	44	619.7	2.125	5.71	0.97
T5SD4	51	774.0	1.920	6.45	1.06
T3SD3	24	923.0	1.098	2.90	0.53
T4SD3	18	466.7	1.121	2.35	0.73
T5SD3	19	207.3	1.918	2.80	0.96
T3SD2	18	406.7	1.282	2.39	1.41
T4SD2	23	462.3	1.540	3.04	0.68
T5SD2	55	680.0	2.503	7.09	0.53
T3SD1	36	1242.7	1.581	4.26	1.29
T4SD1	48	601.3	2.230	6.27	1.29
T5SD1	27	273.3	2.040	3.88	1.67
T2SD2	31	284.7	2.096	4.44	0.83
T2SD1	22	178.7	1.852	3.34	2.55

1 Original Phase II RI macroinvertebrate sampling (November, 1993)

**RESULTS OF BRAY-CURTIS SIMILARITY INDEX^(1,2) FOR SQUARE-ROOT TRANSFORMED COUNTS OF
BENTHIC INVERTEBRATES BY SPECIES
THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**

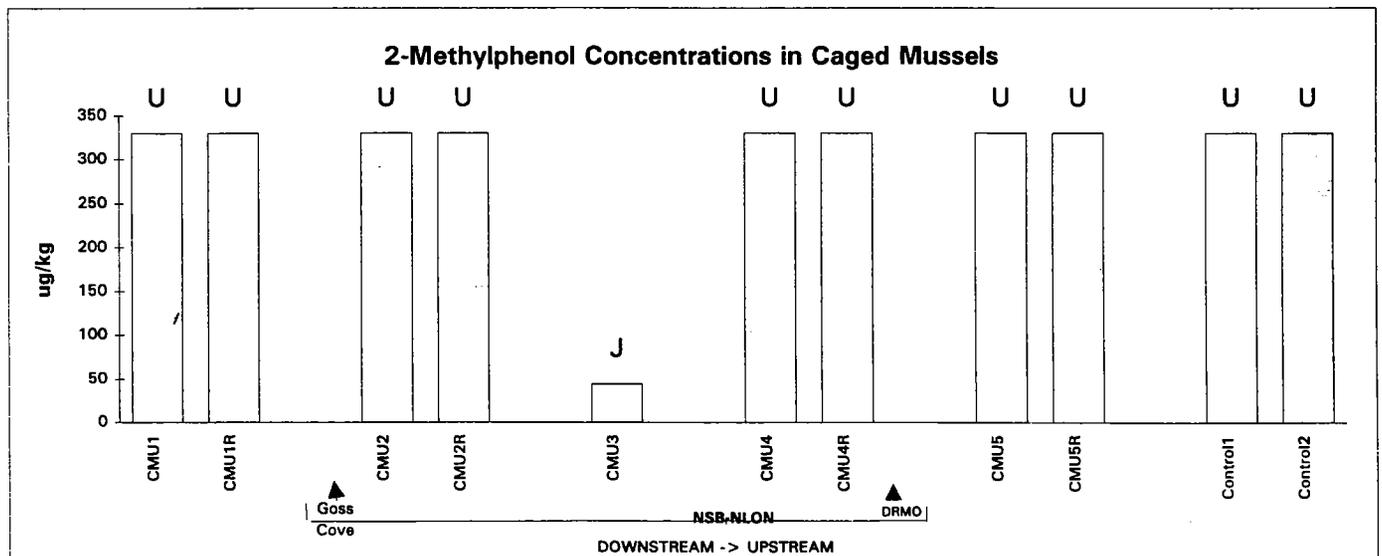
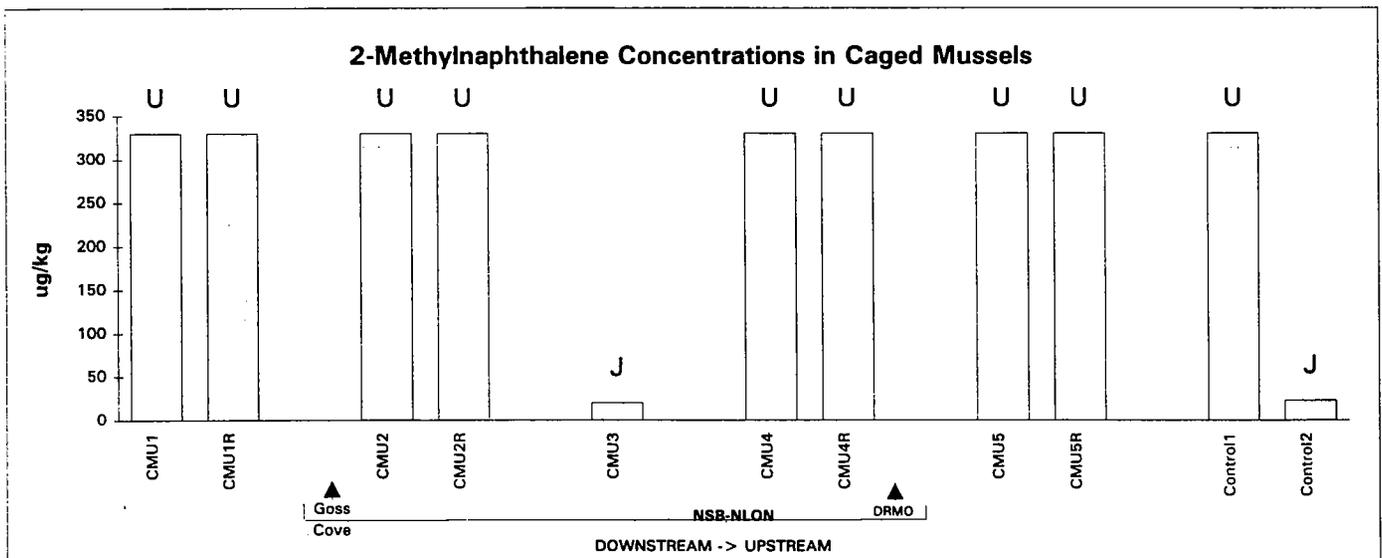
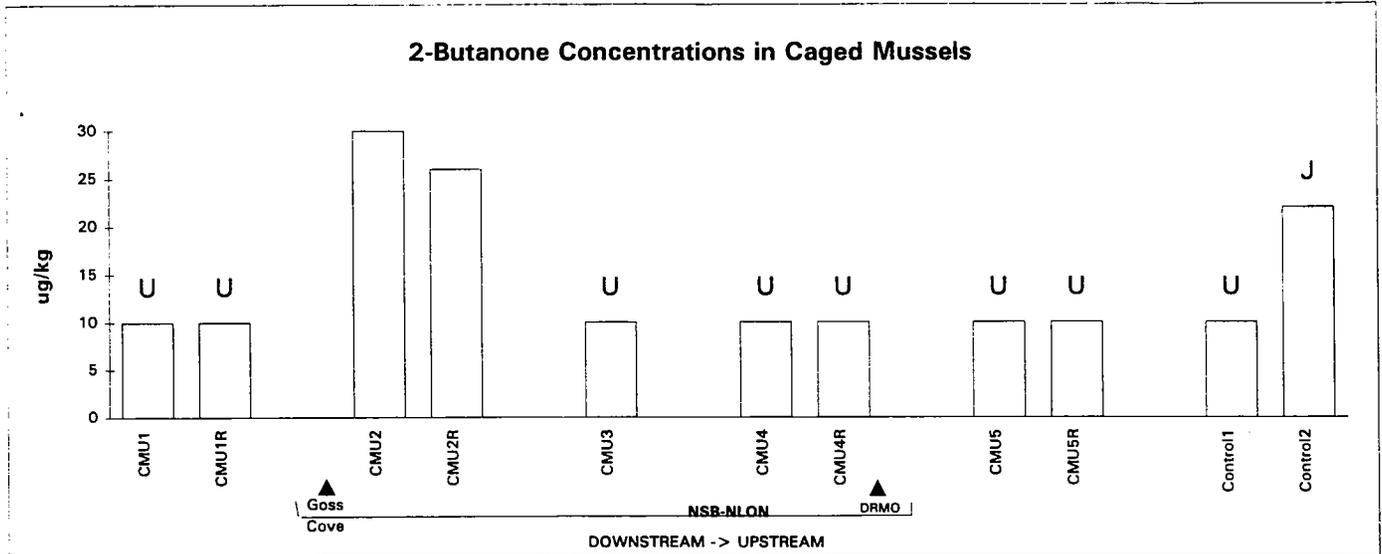
	Upstream Pier Line	Upstream Opposite	DRMO Near	DRMO Pier Line	DRMO Opposite	Pier 33 Near	Pier 33 Pier Line	Pier 33 Opposite	Pier 10 Near	Pier 10 Pier Line	Pier 10 Opposite	Goss Cove Near	Goss Cove Pier Line	Goss Cove Opposite	Down- stream Near	Down- stream Opposite
	T1SD2	T1SD1	T3SD4	T4SD4	T5SD4	T3SD3	T4SD3	T5SD3	T3SD2	T4SD2	T5SD2	T3SD1	T4SD1	T5SD1	T2SD2	T2SD1
T1SD2		0.62	0.64	0.51	0.44	0.60	0.58	0.65	0.55	0.62	0.53	0.51	0.57	0.66	0.7	0.58
T1SD1			0.72	0.48	0.48	0.65	0.52	0.77	0.51	0.61	0.47	0.43	0.41	0.7	0.62	0.69
T3SD4				0.52	0.5	0.67	0.55	0.74	0.61	0.67	0.57	0.49	0.47	0.71	0.69	0.64
T4SD4					0.55	0.49	0.47	0.47	0.36	0.50	0.47	0.44	0.48	0.48	0.57	0.44
T5SD4						0.46	0.37	0.47	0.33	0.48	0.65	0.42	0.36	0.5	0.46	0.42
T3SD3							0.64	0.87	0.65	0.71	0.51	0.61	0.51	0.62	0.58	0.58
T4SD3								0.55	0.62	0.66	0.42	0.61	0.57	0.53	0.55	0.46
T5SD3									0.62	0.61	0.50	0.43	0.43	0.76	0.68	0.74
T3SD2										0.62	0.43	0.52	0.43	0.62	0.57	0.58
T4SD2											0.55	0.55	0.53	0.66	0.63	0.64
T5SD2												0.42	0.44	0.53	0.49	0.45
T3SD1													0.70	0.43	0.53	0.37
T4SD1														0.44	0.57	0.39
T5SD1															0.67	0.7
T2SD2																0.68
T2SD1																

1 Index approaches 1.0 for similar stations; Index approaches 0.0 for dissimilar stations

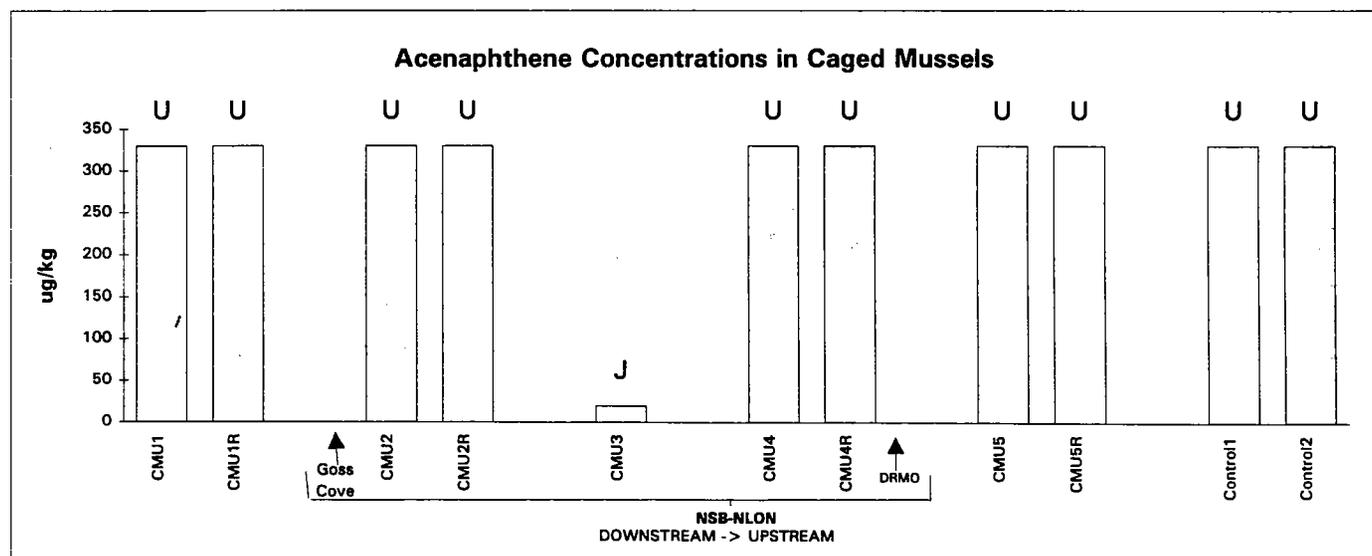
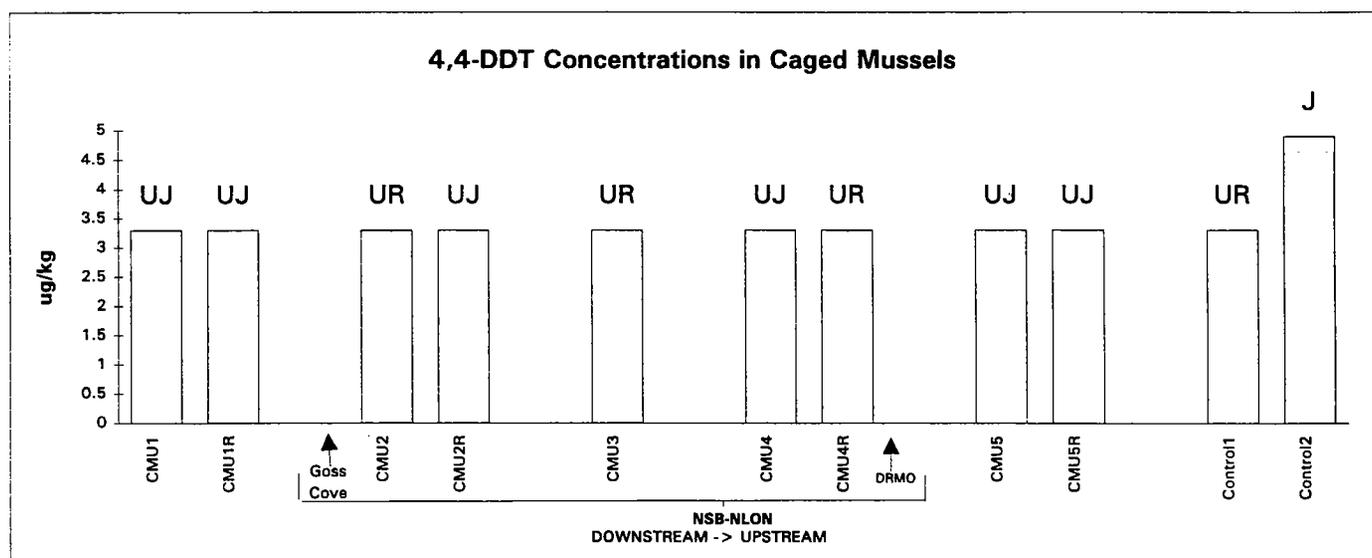
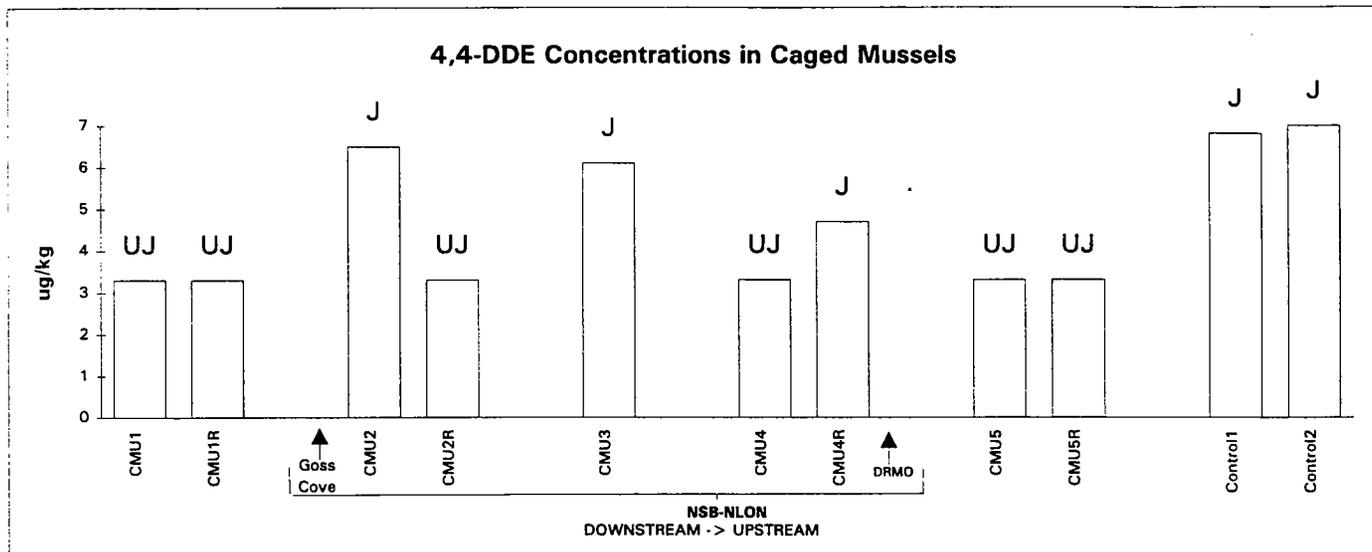
2 Indices > 0.6 (similar) are shaded

**J.3 NSB-NLON PHASE II RI CONTAMINANT CONCENTRATIONS
IN CAGED MUSSELS**

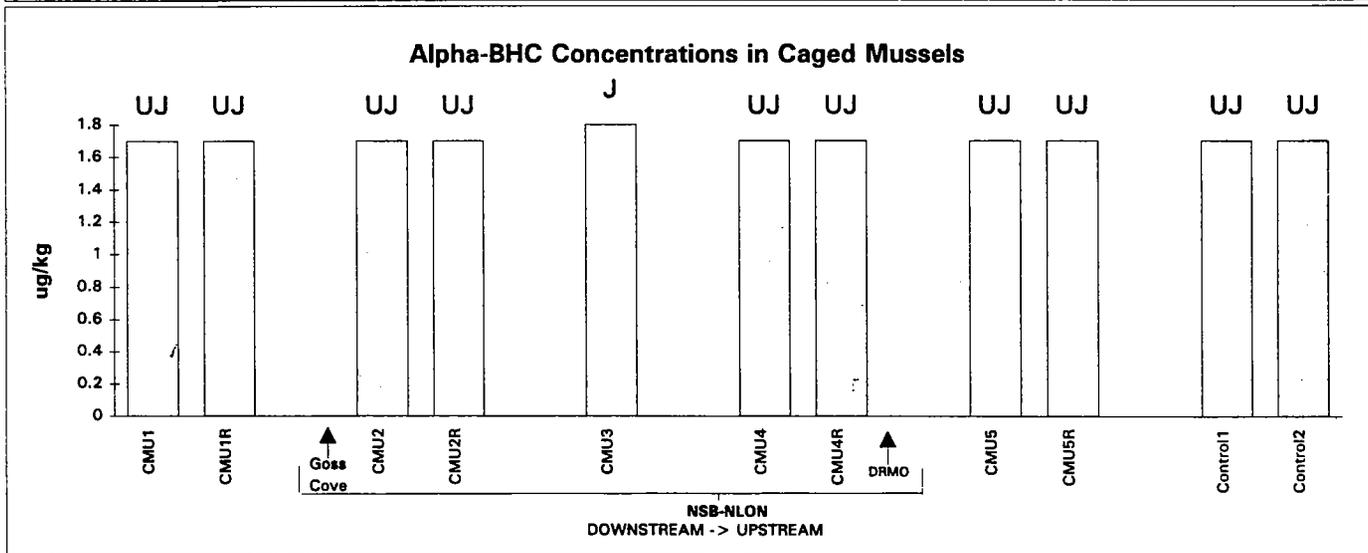
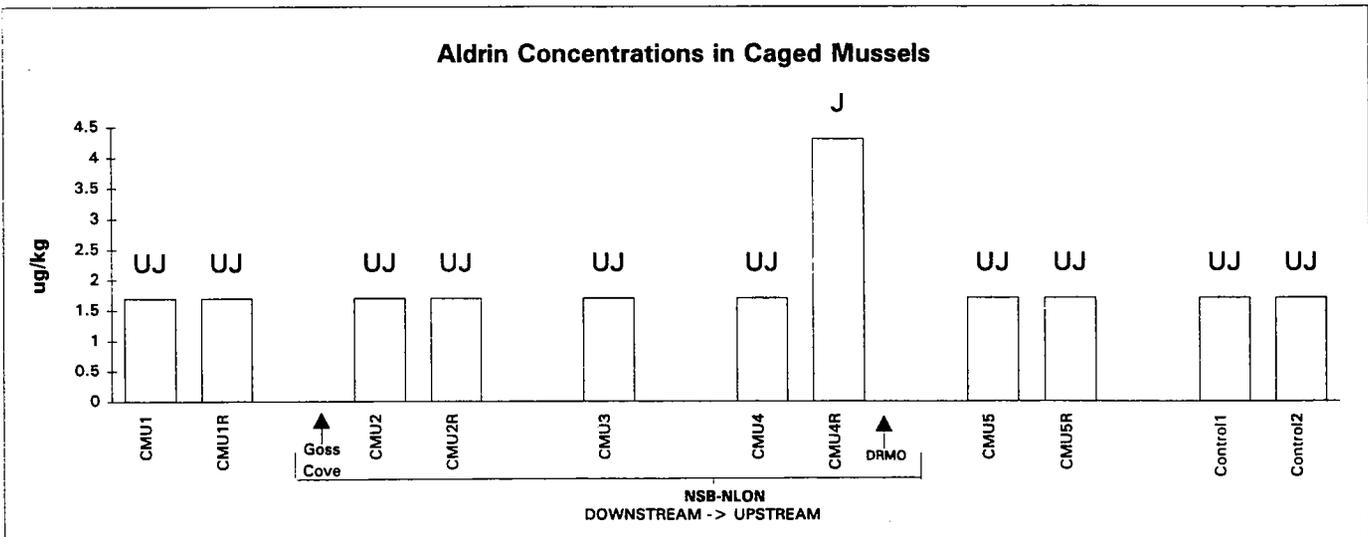
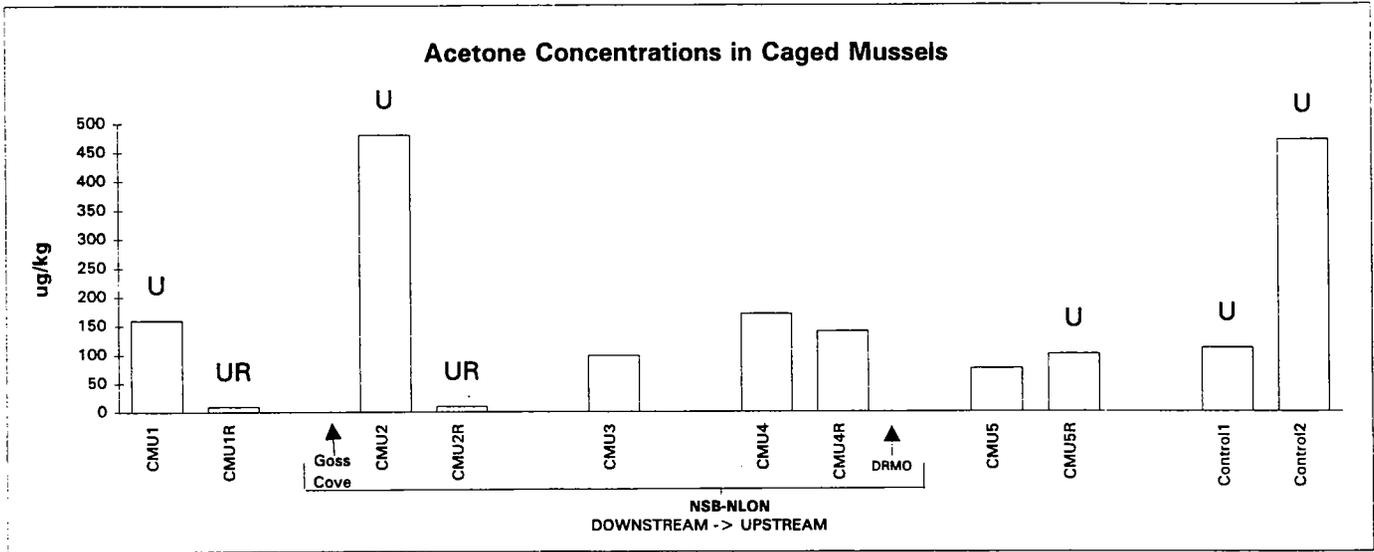
**CONTAMINANT CONCENTRATIONS IN CAGED MUSSELS
THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**



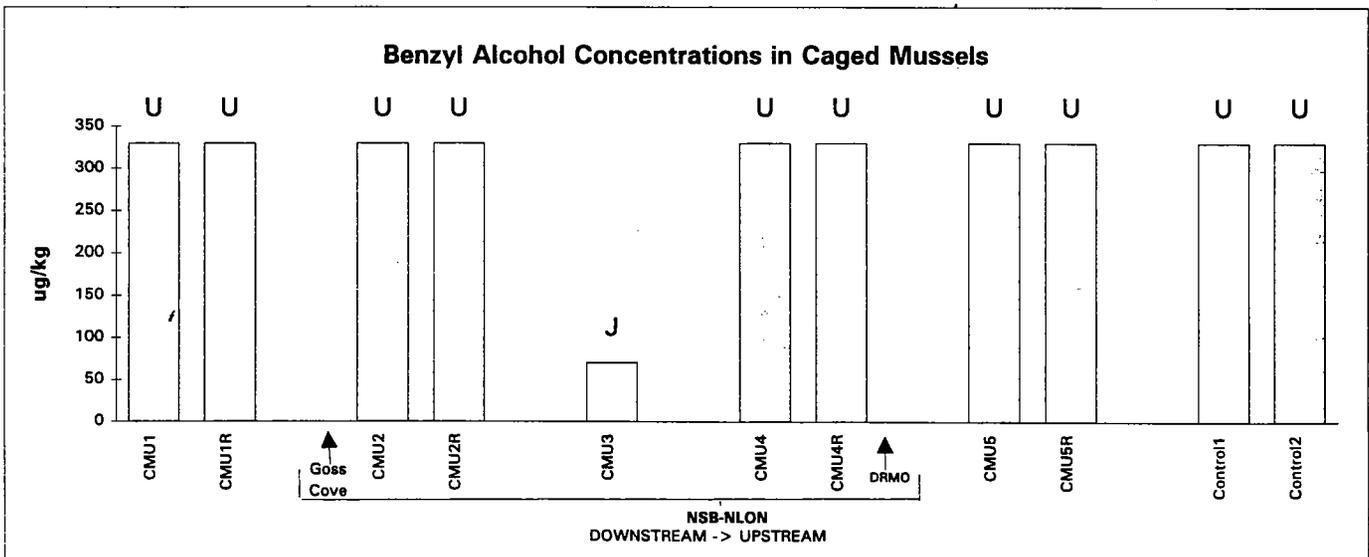
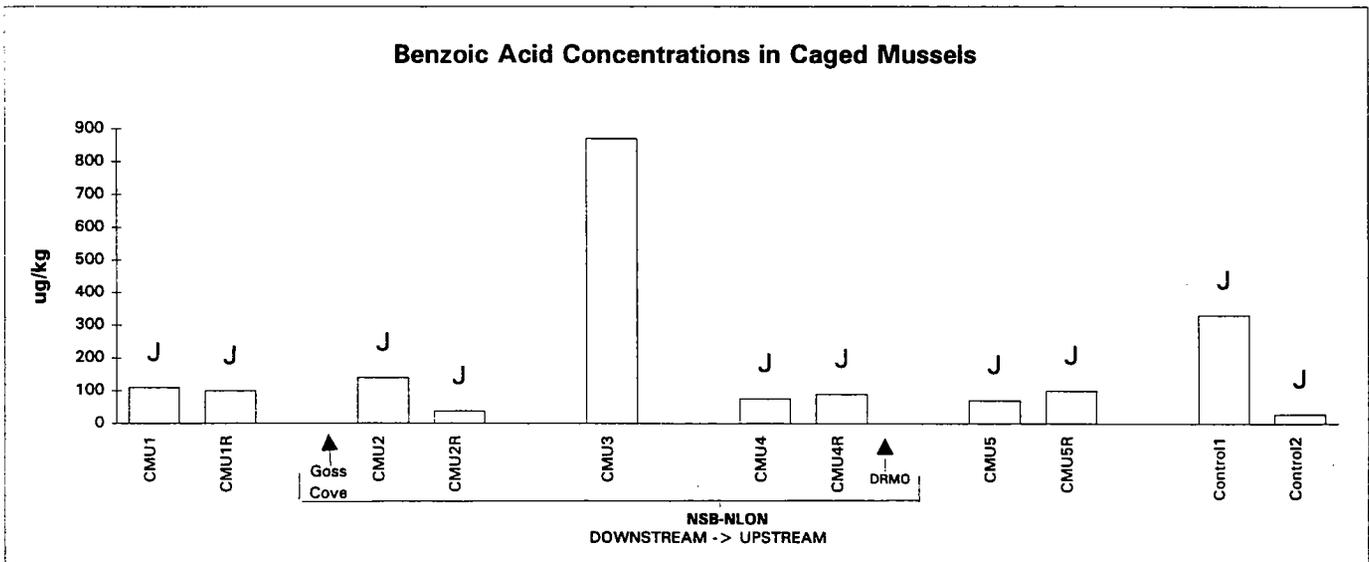
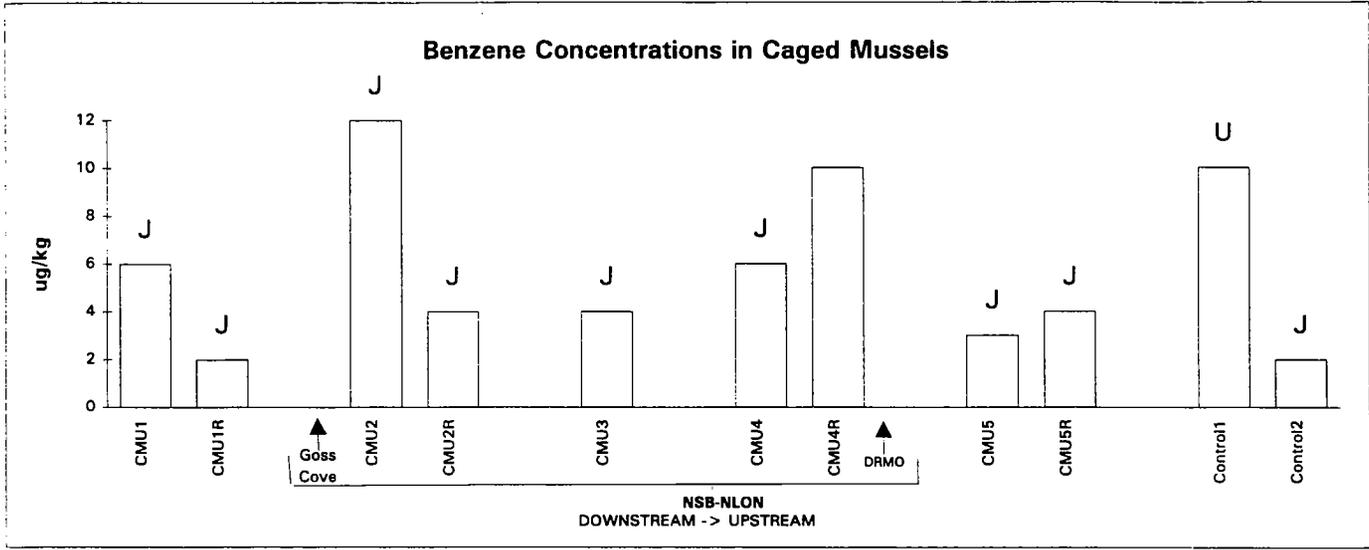
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THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**



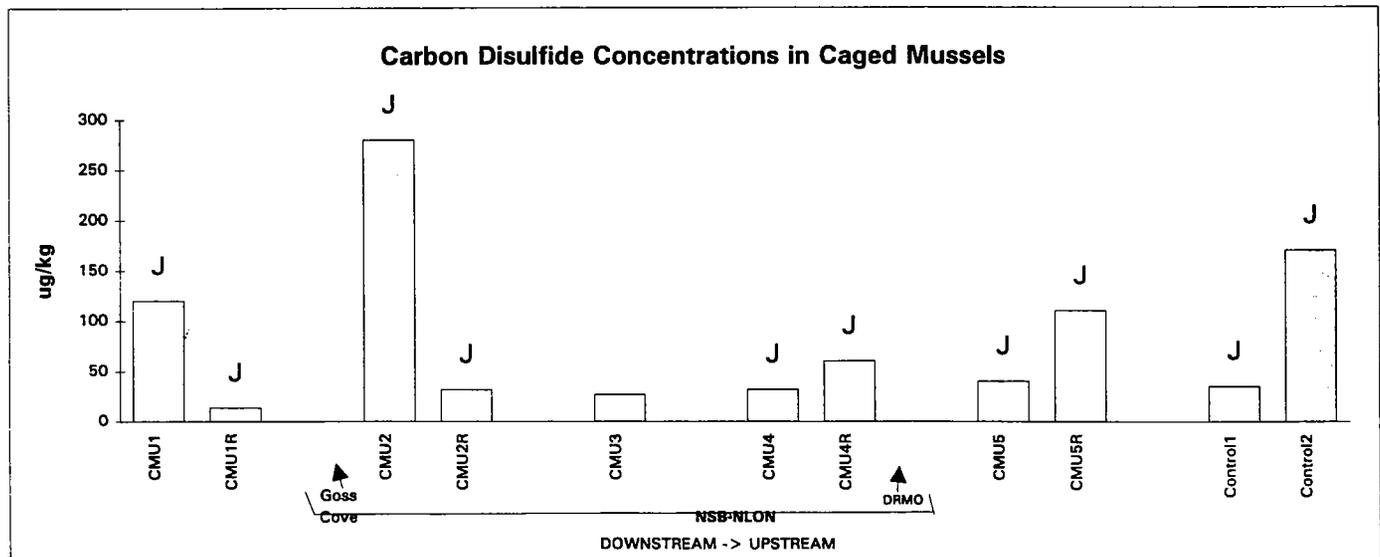
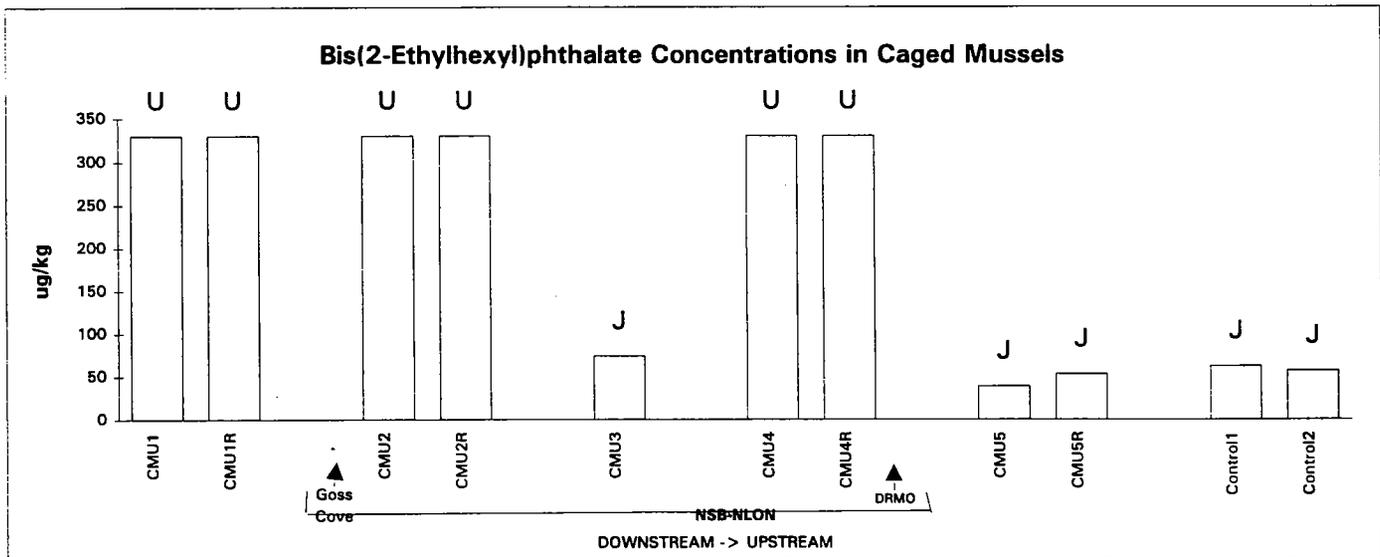
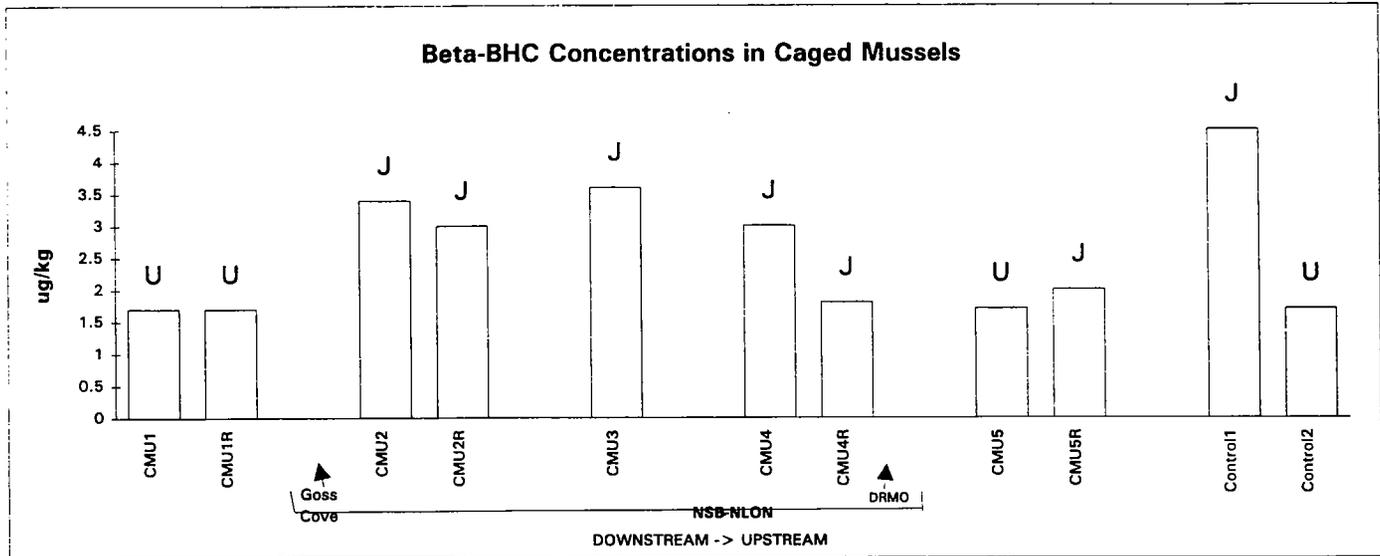
**CONTAMINANT CONCENTRATIONS IN CAGED MUSSELS
THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**



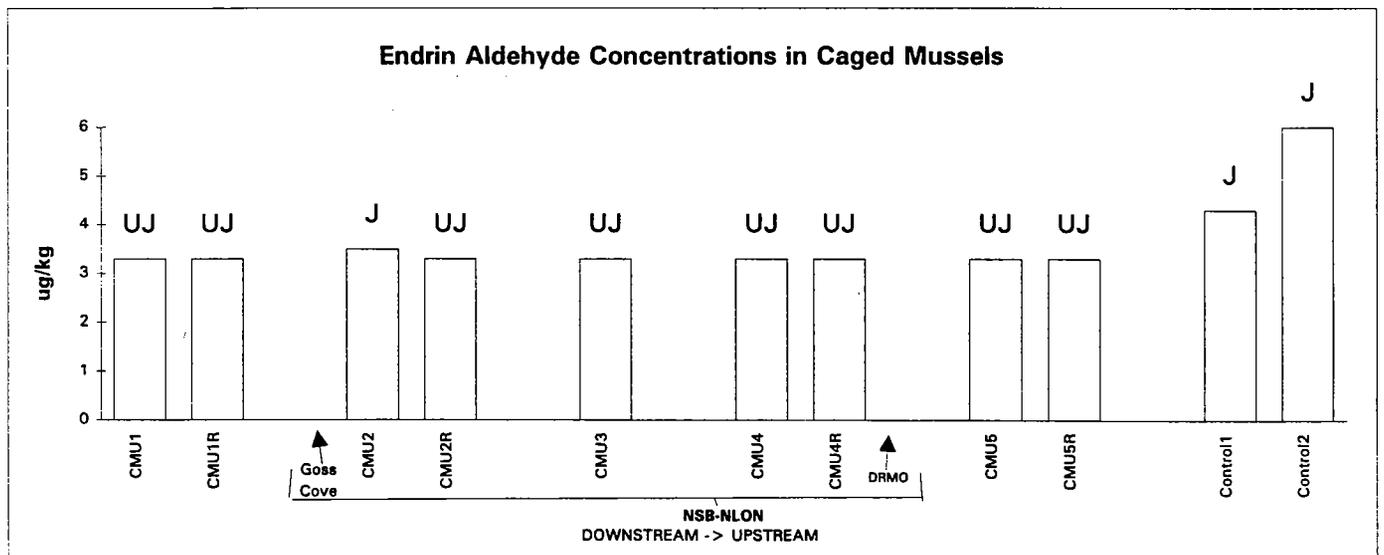
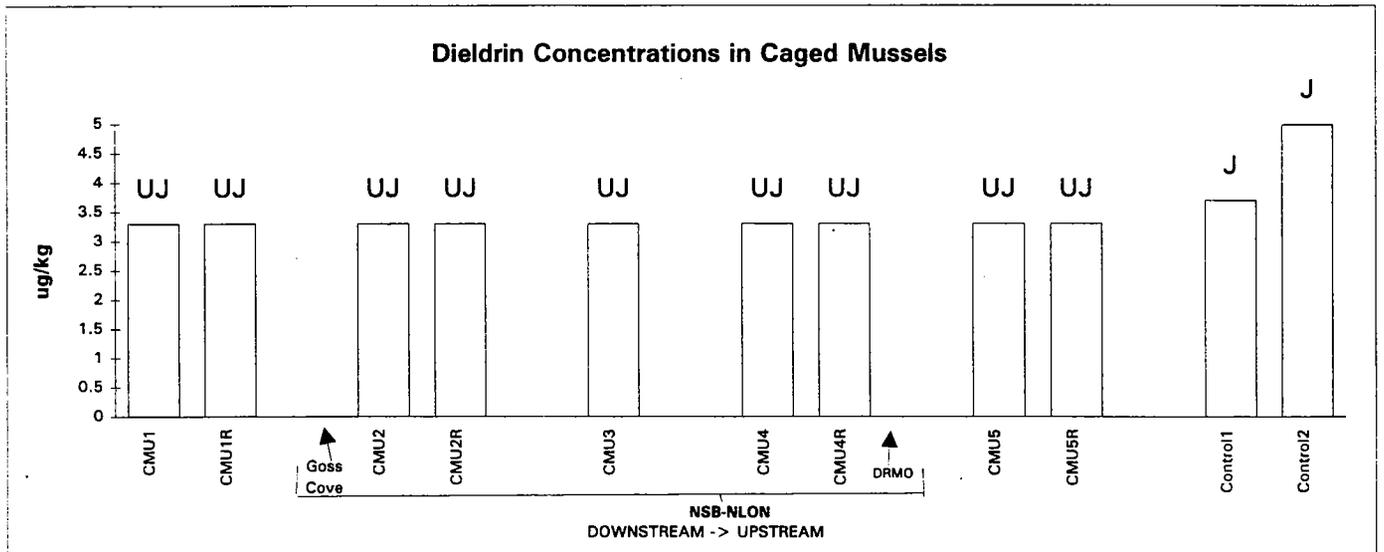
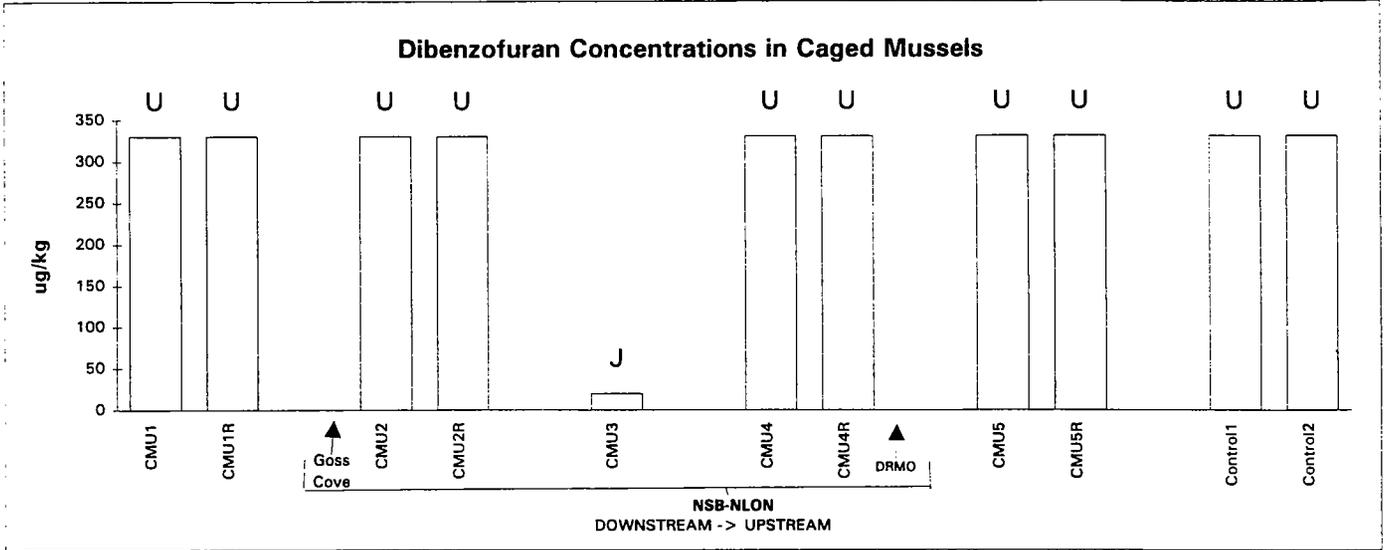
**CONTAMINANT CONCENTRATIONS IN CAGED MUSSELS
THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**



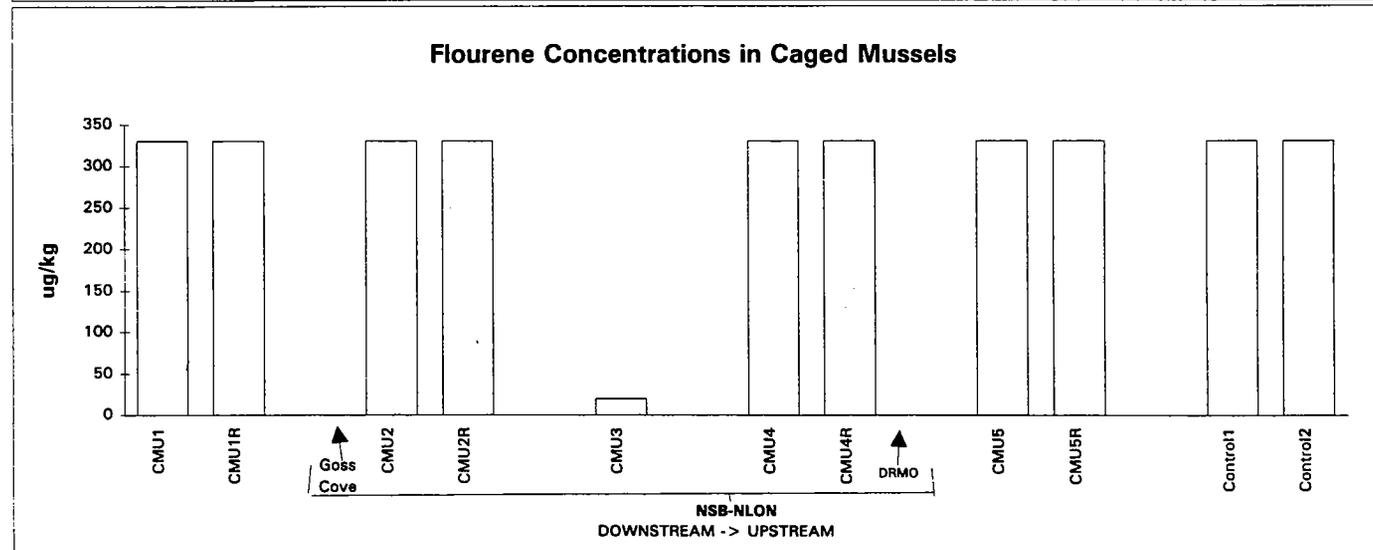
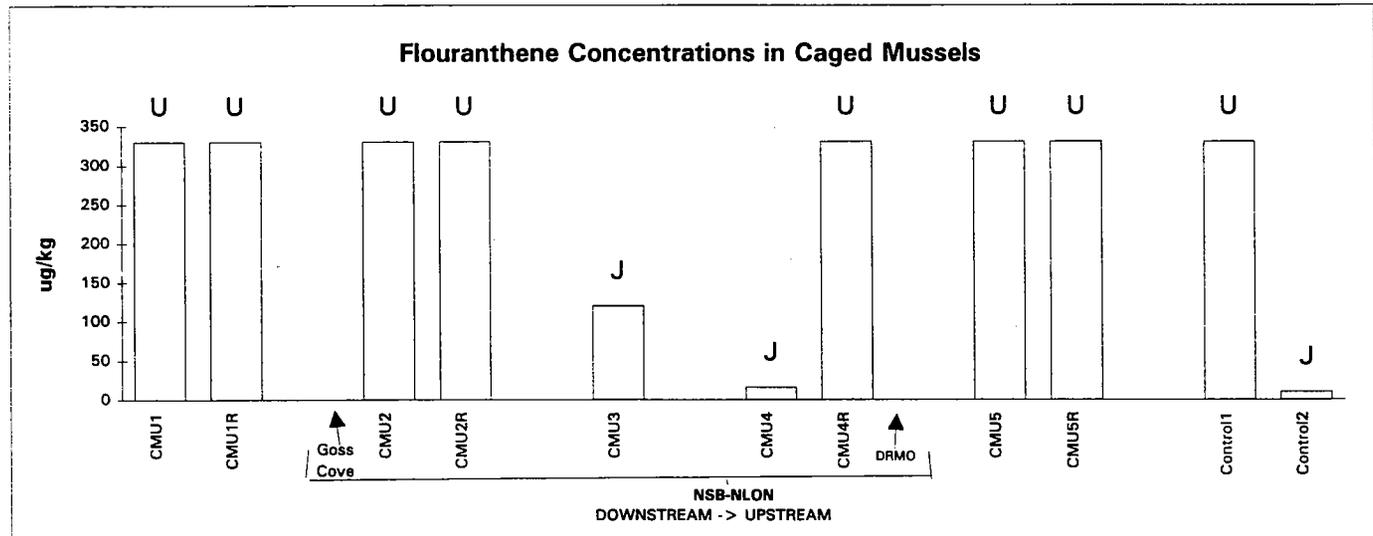
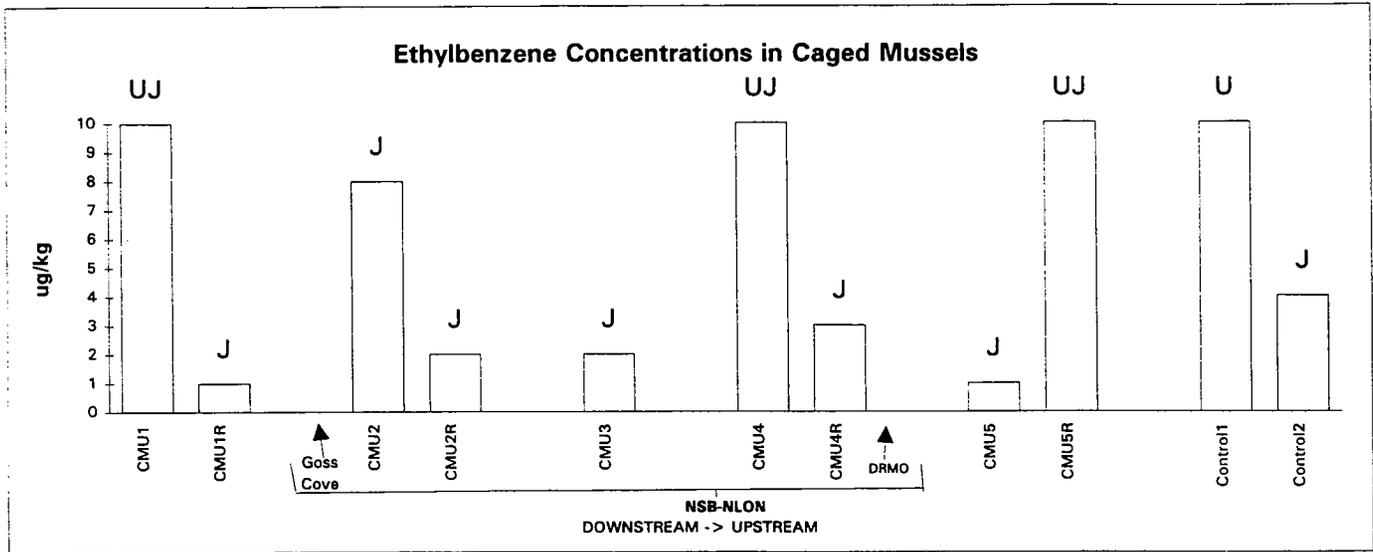
**CONTAMINANT CONCENTRATIONS IN CAGED MUSSELS
THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**



**CONTAMINANT CONCENTRATIONS IN CAGED MUSSELS
THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**

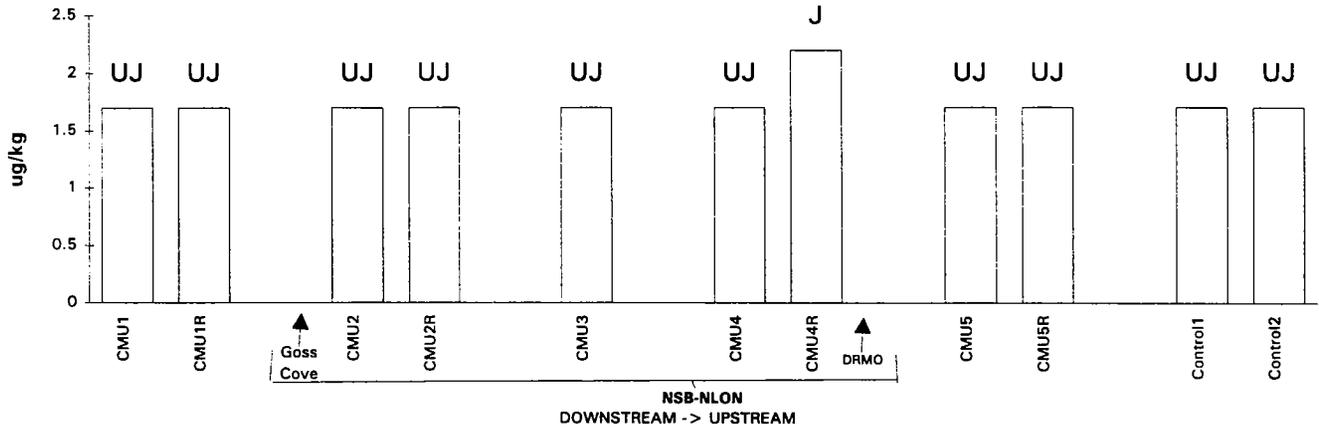


**CONTAMINANT CONCENTRATIONS IN CAGED MUSSELS
THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**

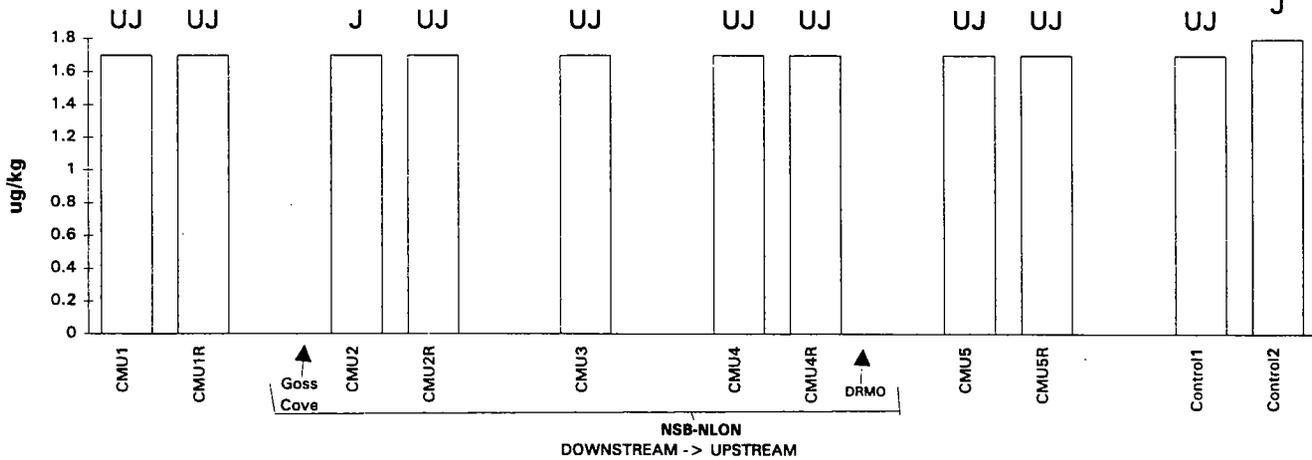


**CONTAMINANT CONCENTRATIONS IN CAGED MUSSELS
THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**

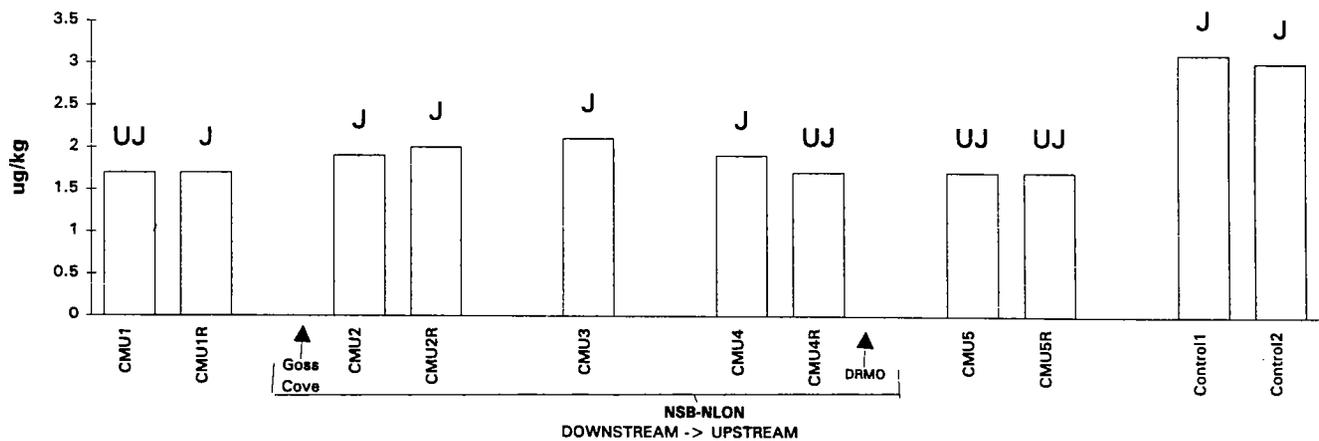
Gamma-BHC (Lindane) Concentrations in Caged Mussels



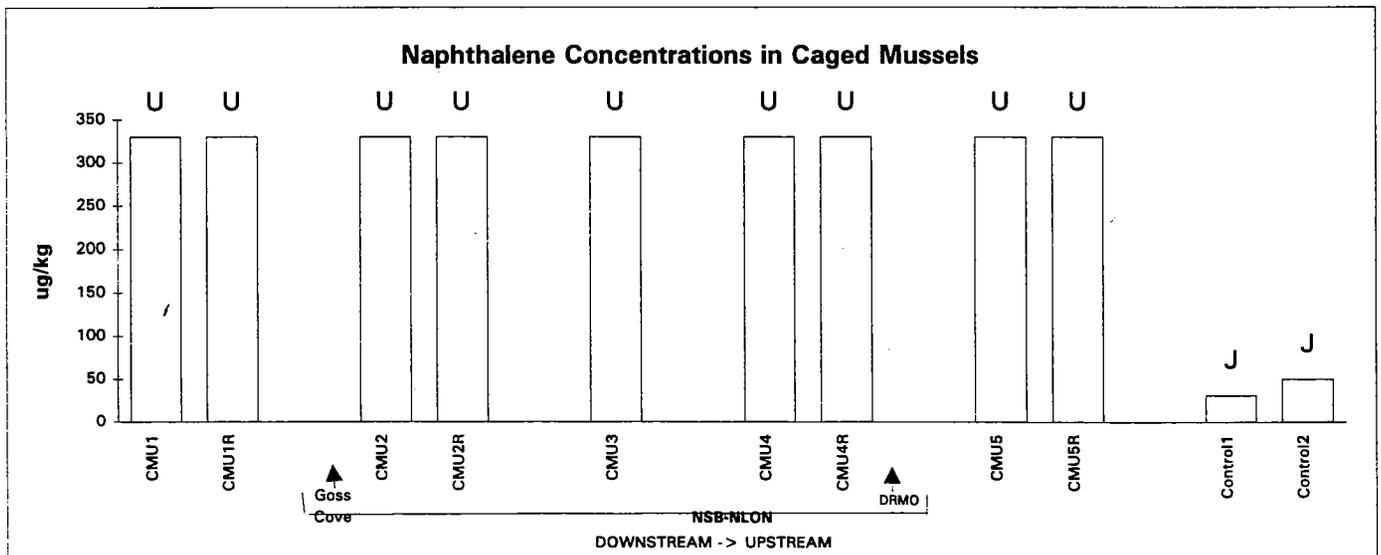
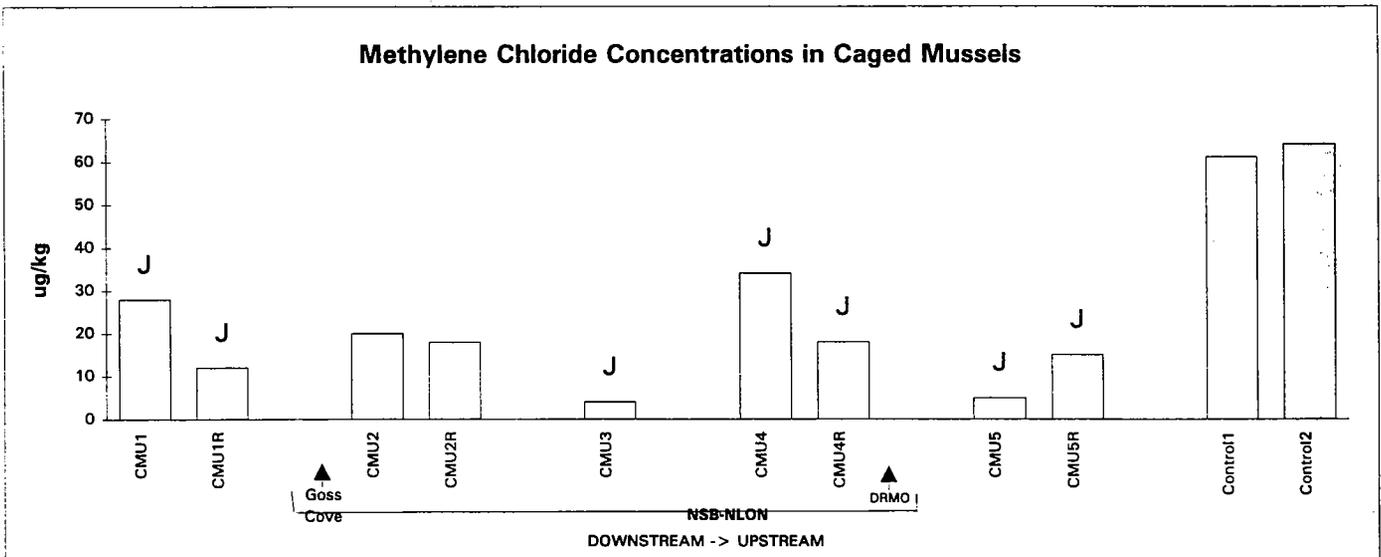
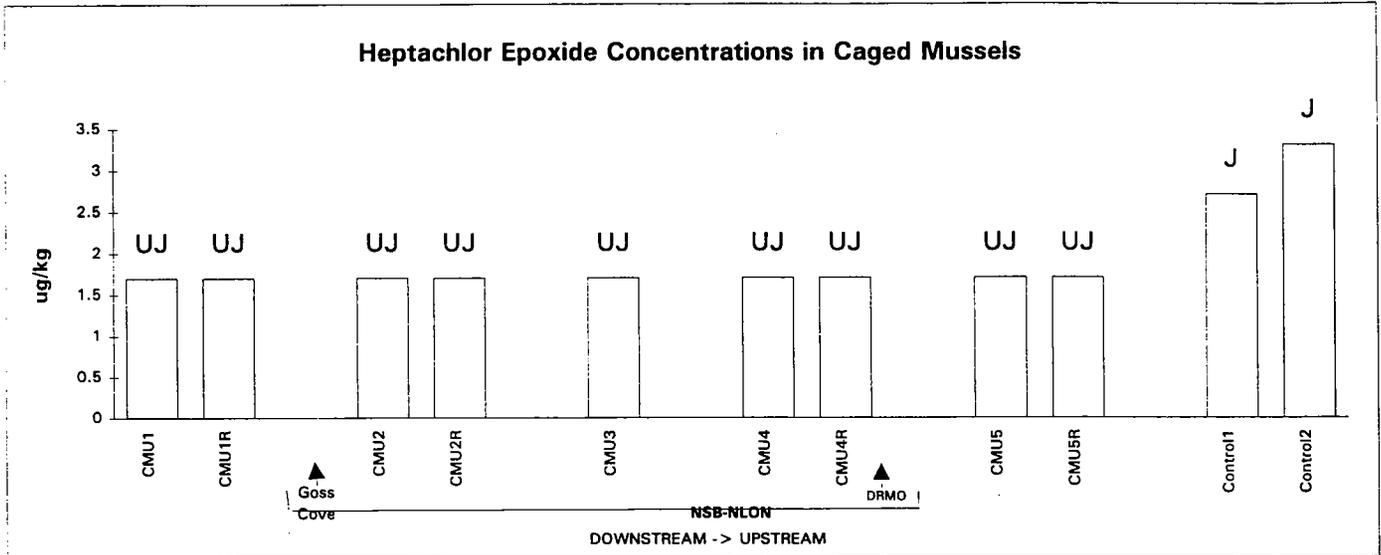
Gamma Chlordane Concentrations in Caged Mussels



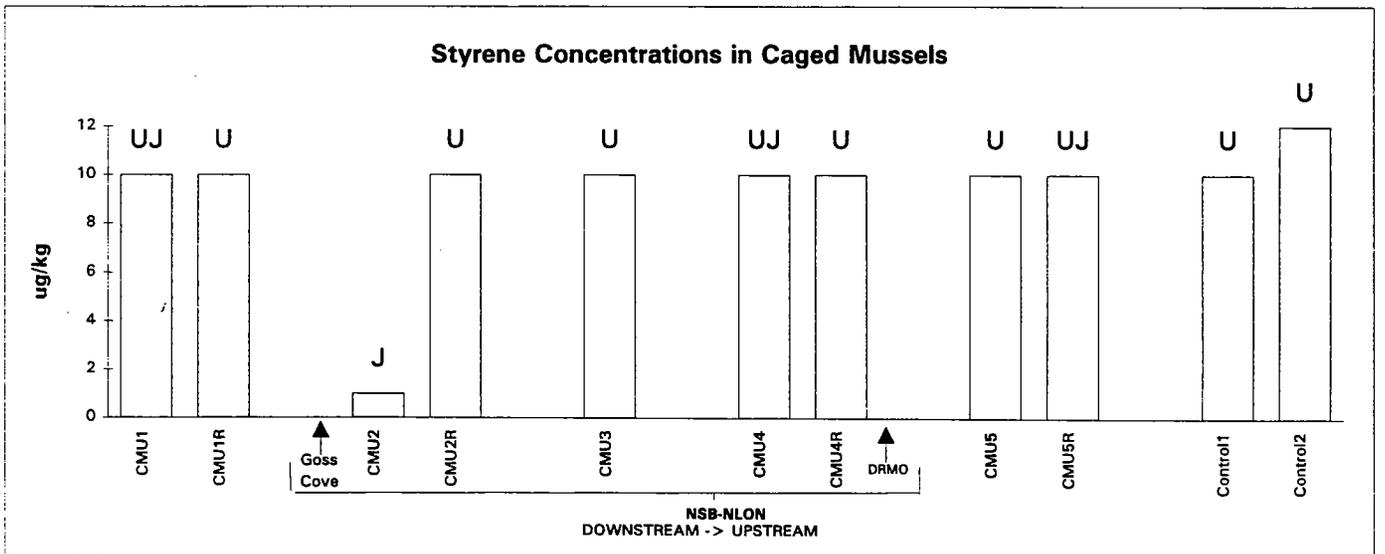
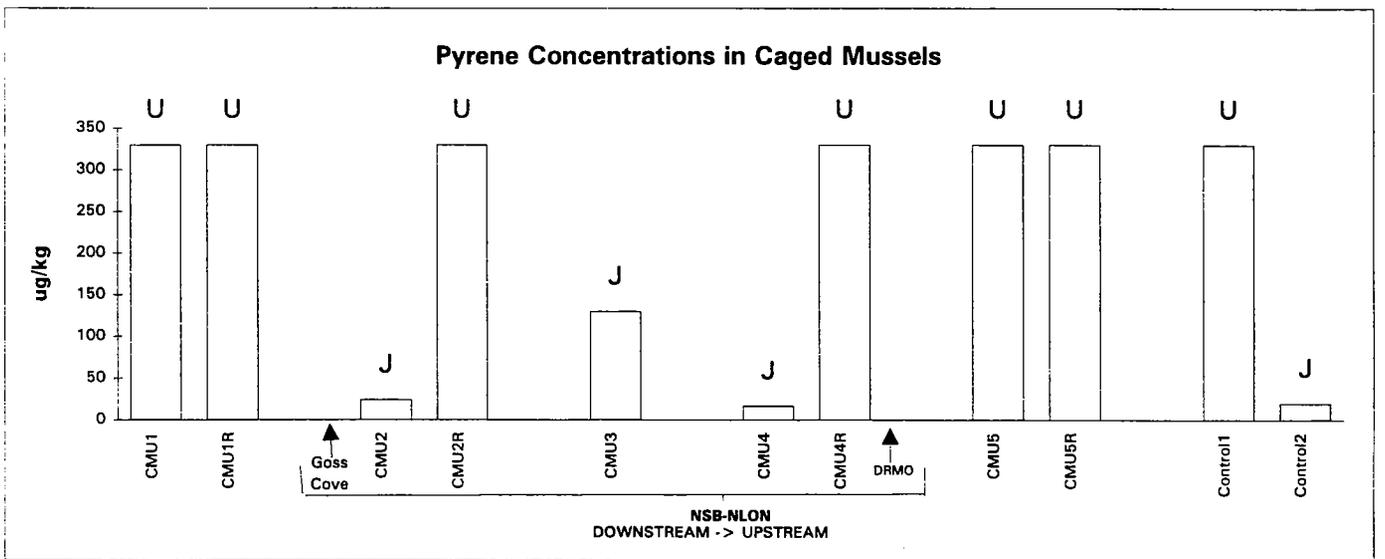
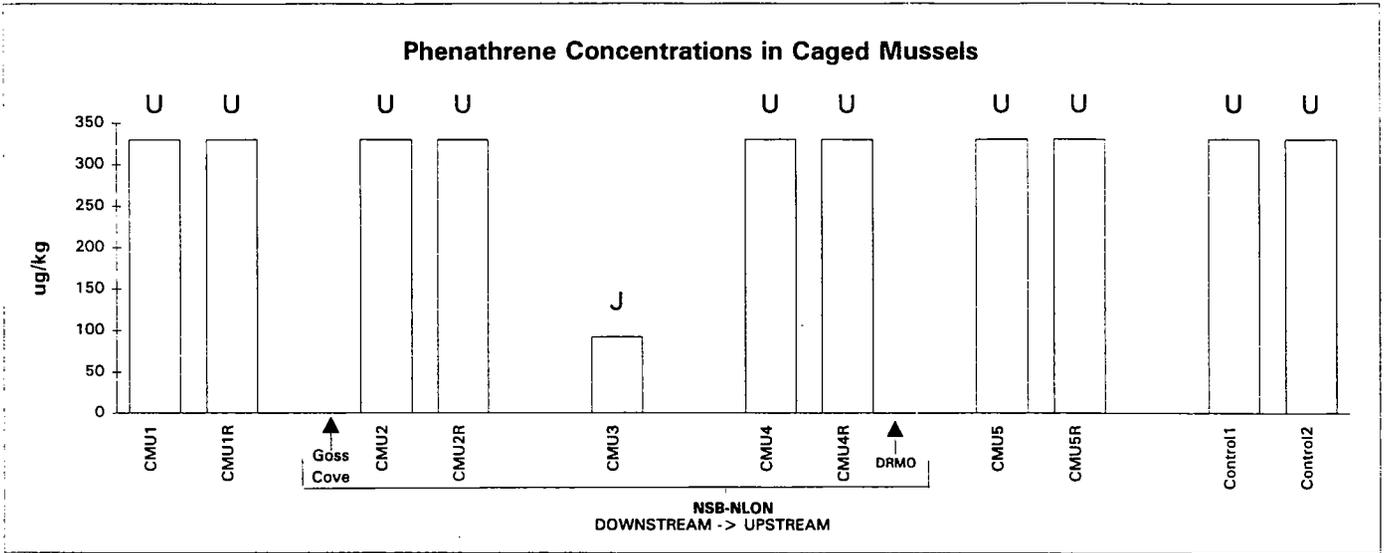
Heptachlor Concentrations in Caged Mussels



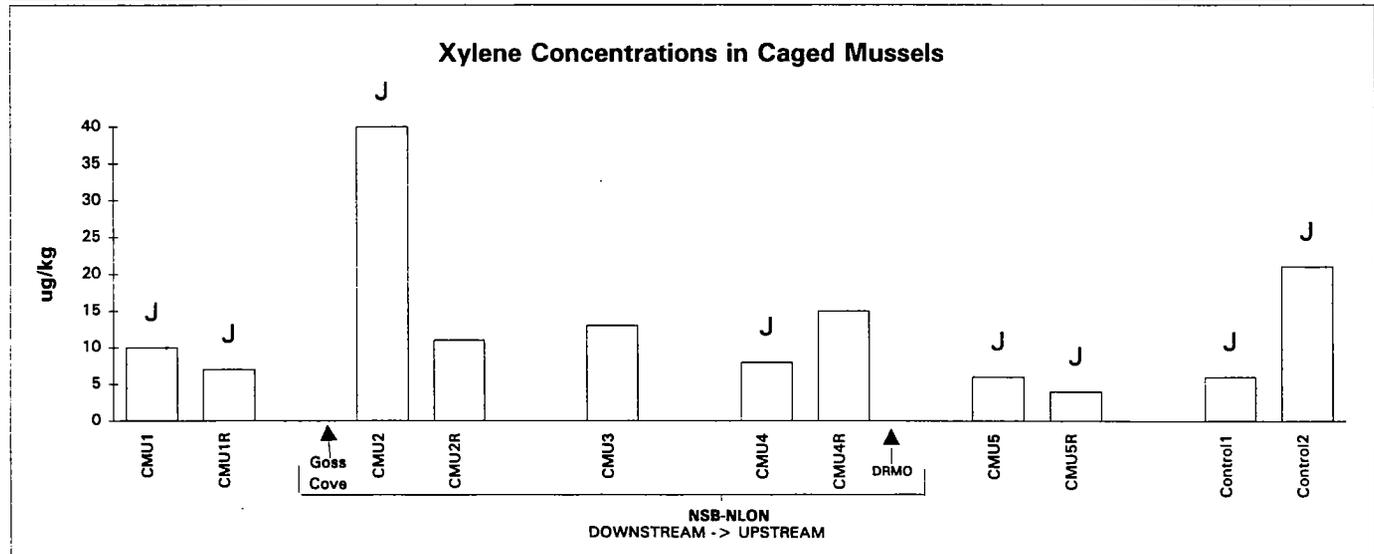
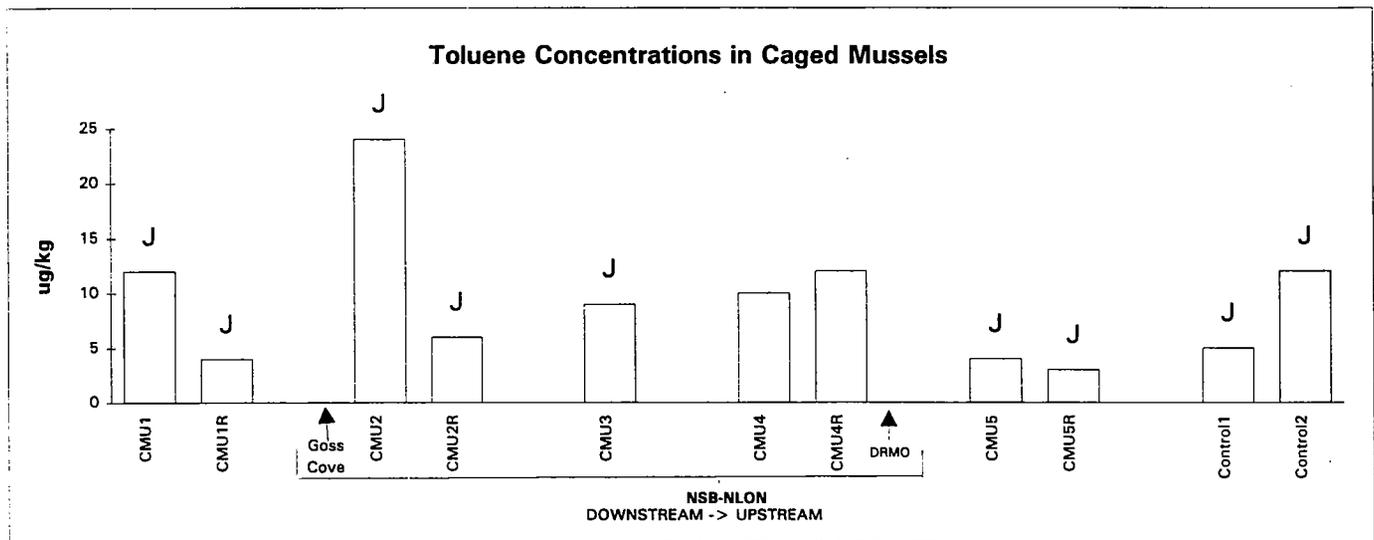
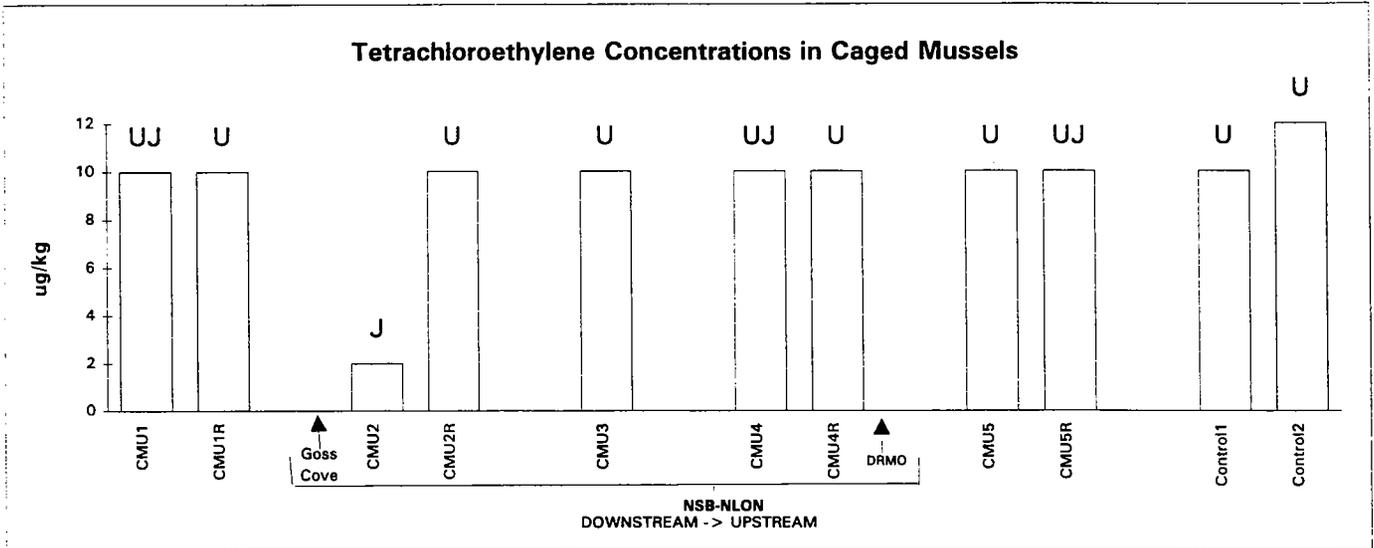
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THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**



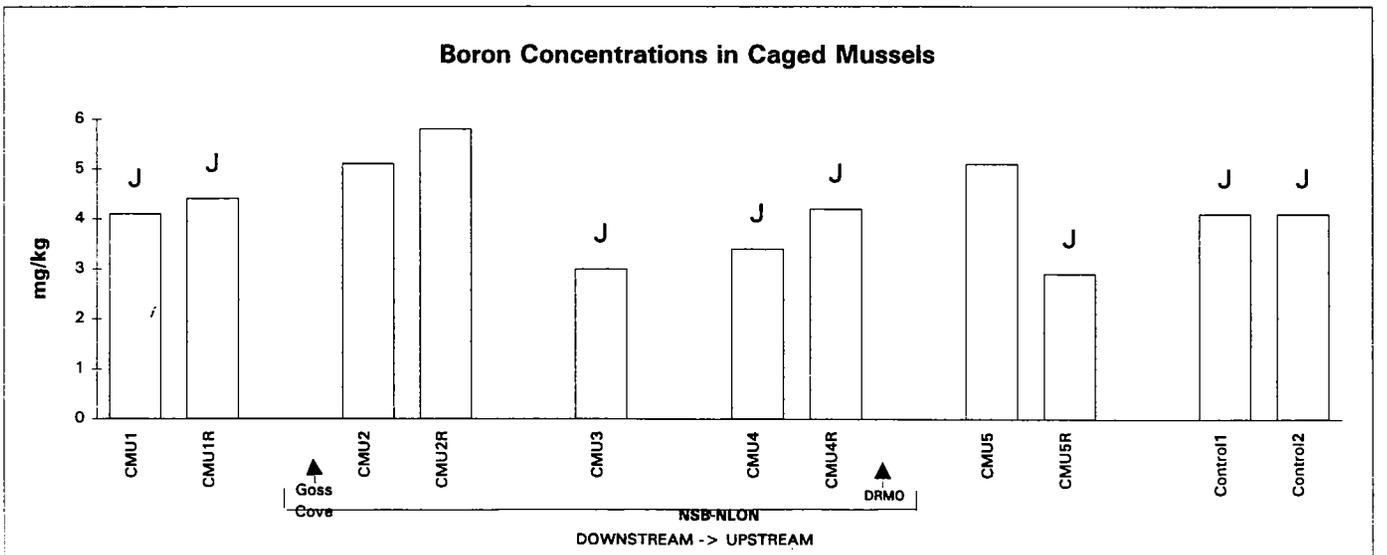
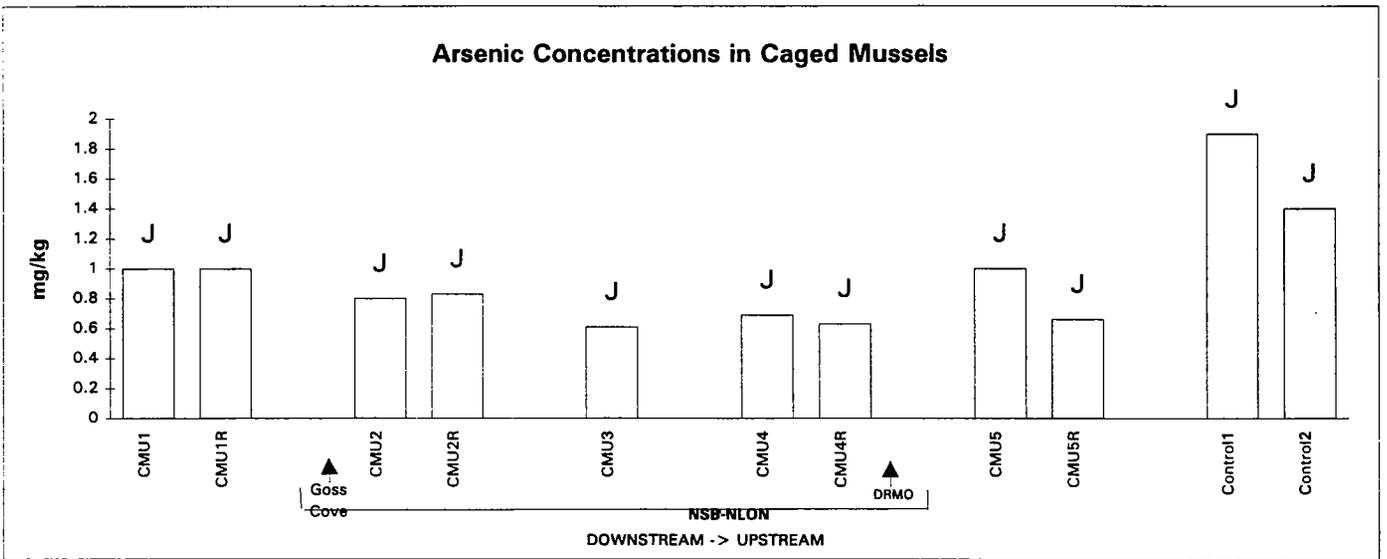
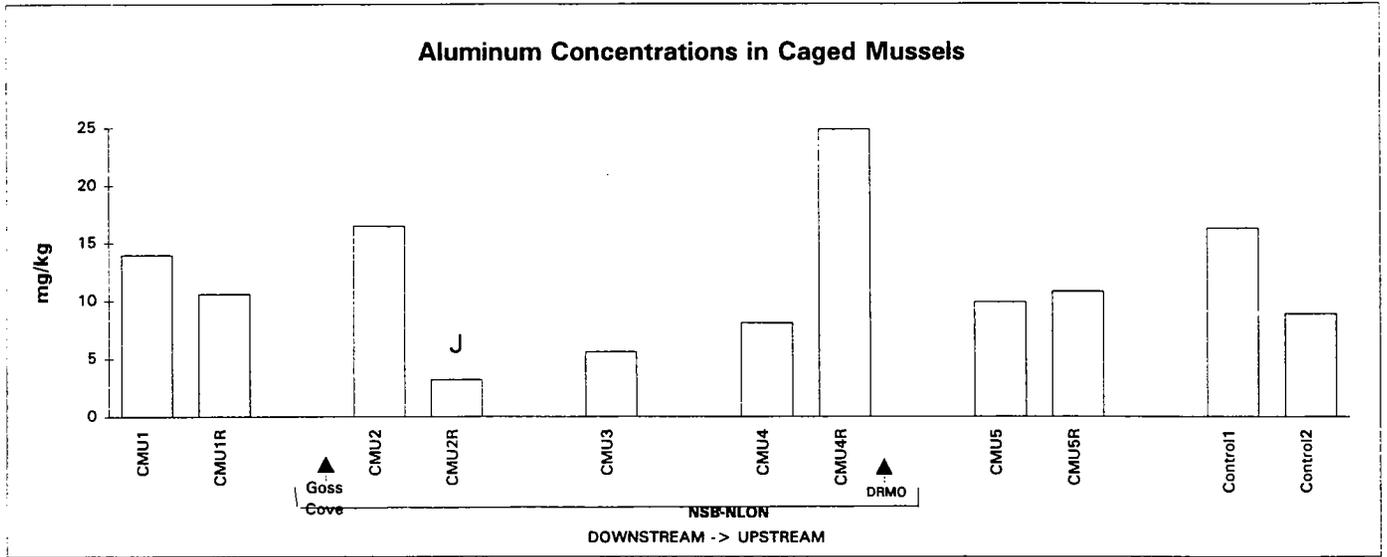
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THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**



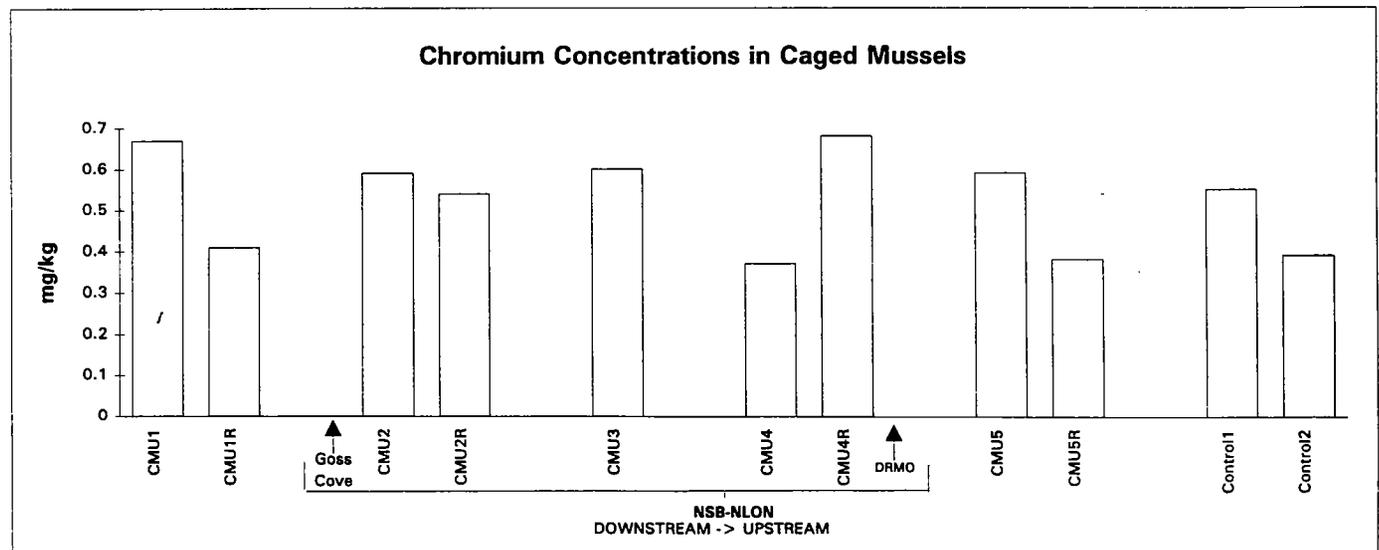
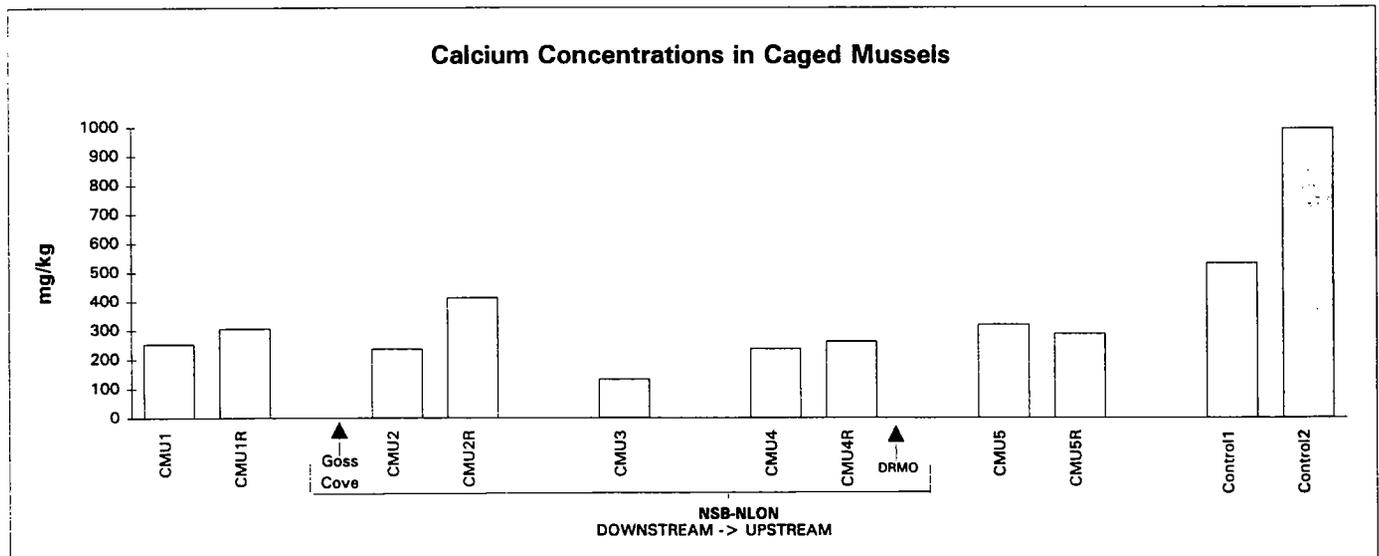
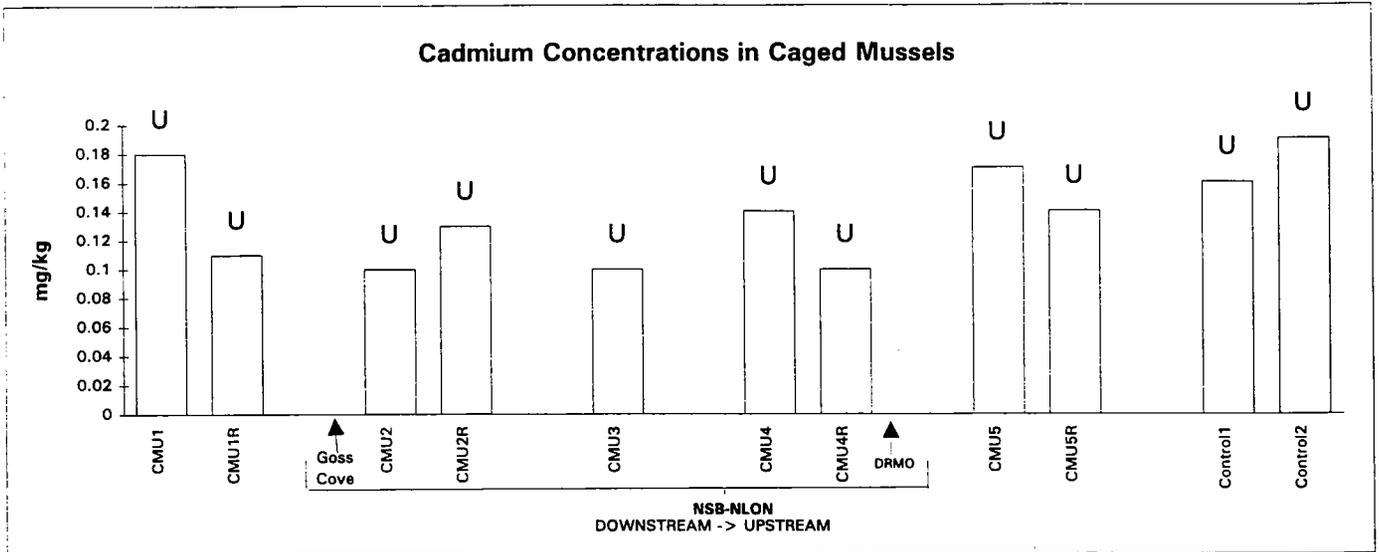
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THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**



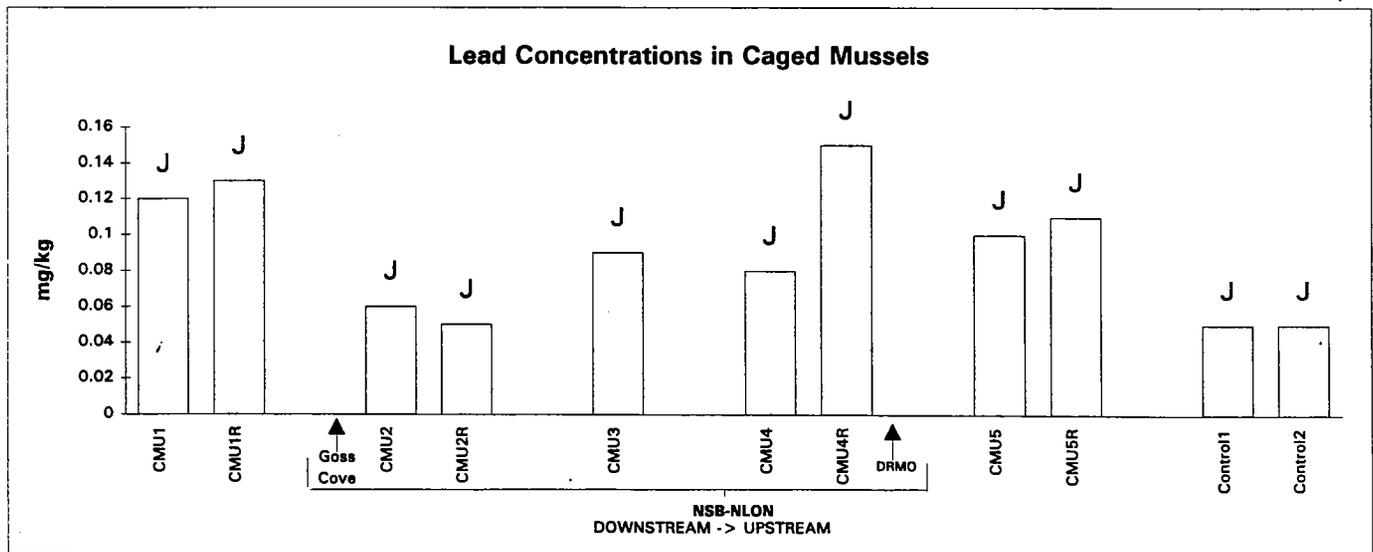
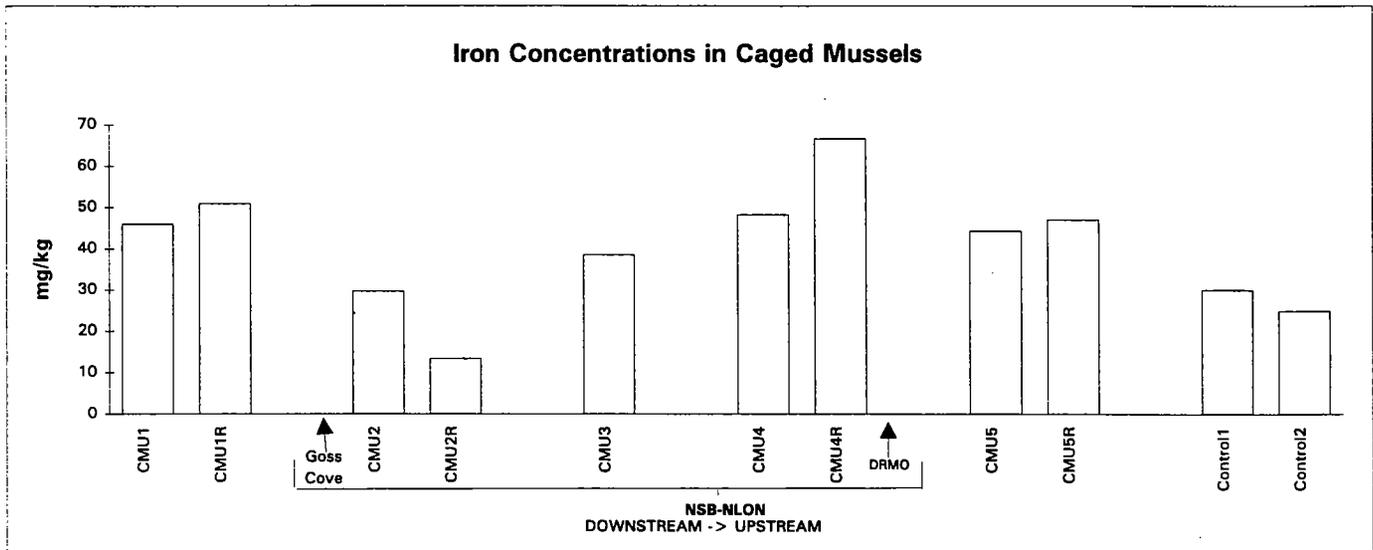
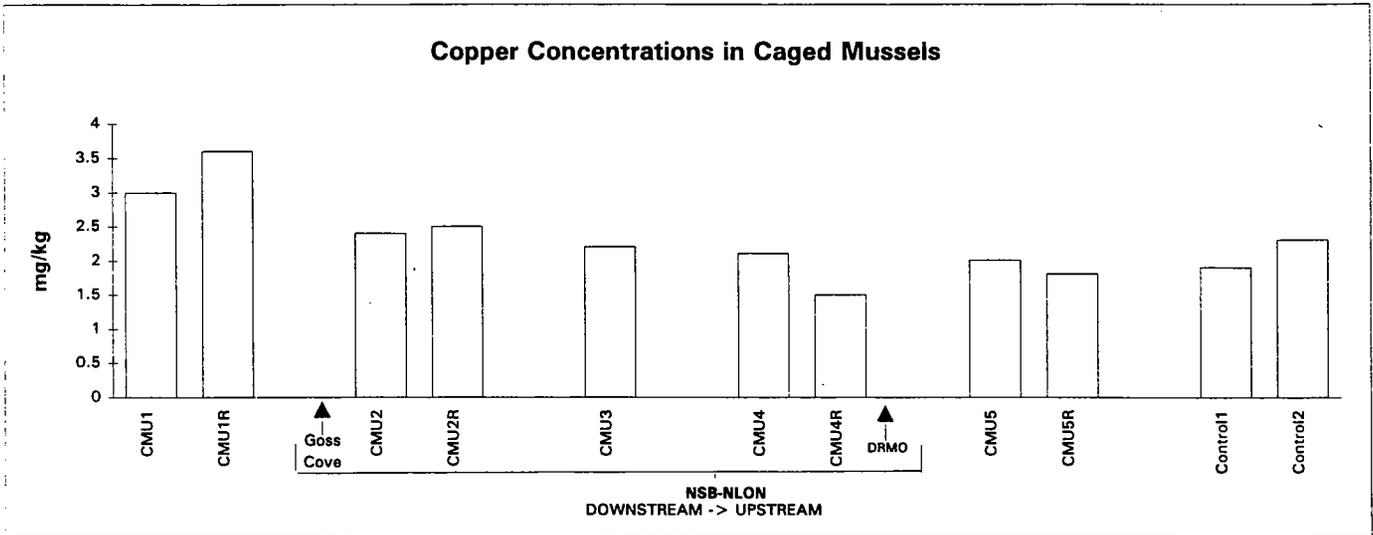
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THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**



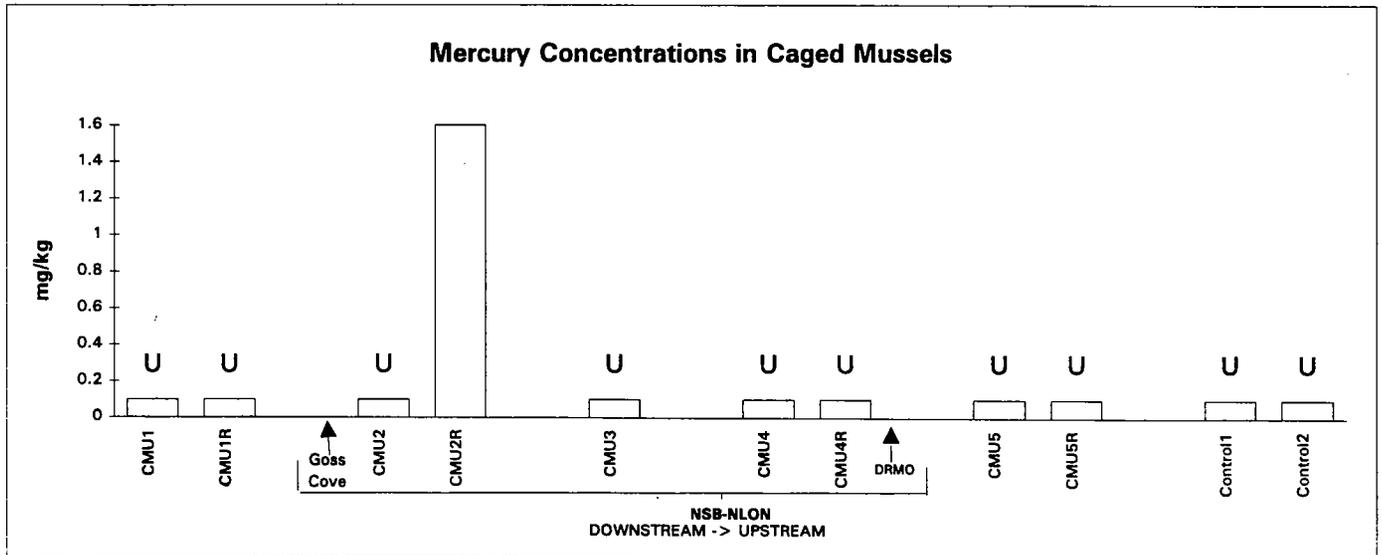
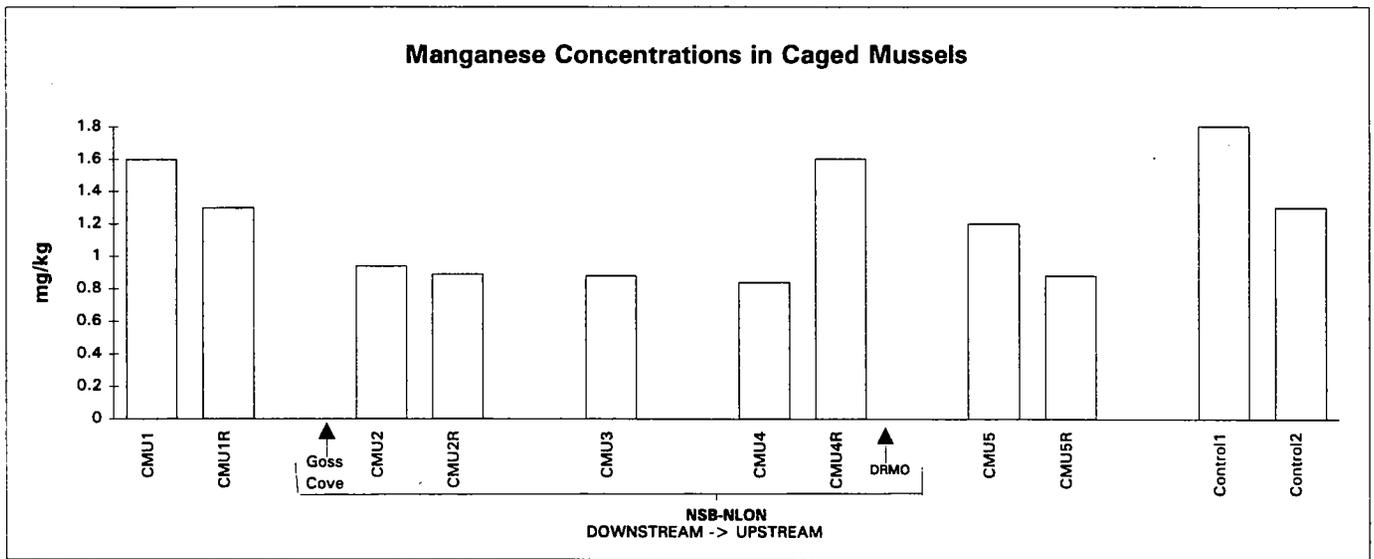
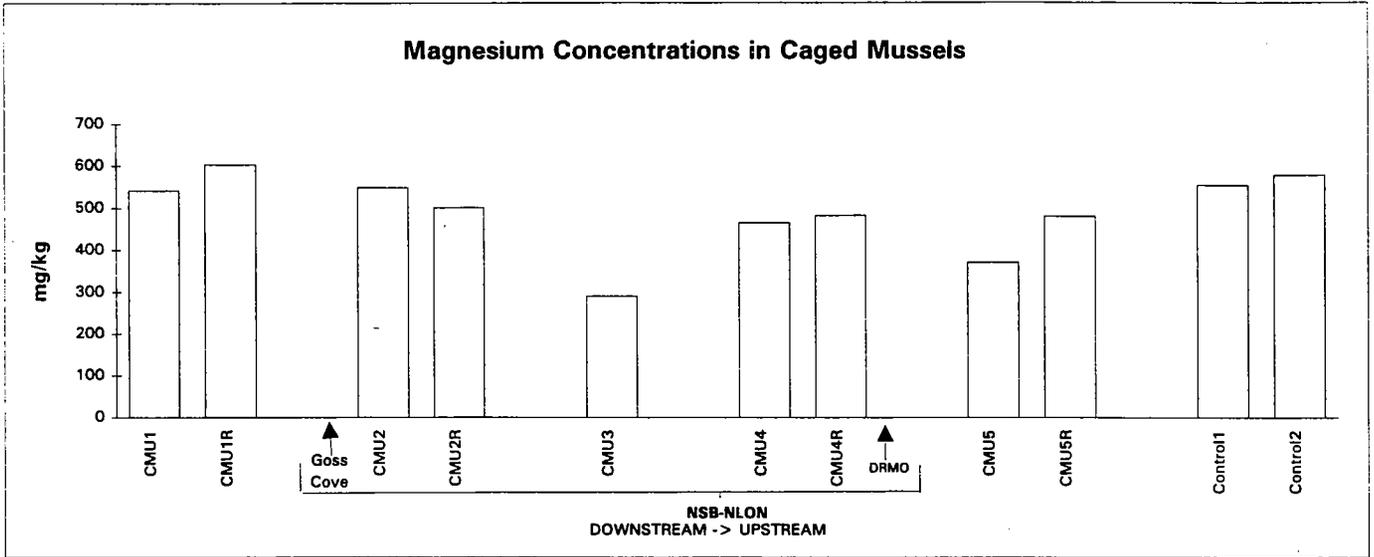
**CONTAMINANT CONCENTRATIONS IN CAGED MUSSELS
THAMES RIVER
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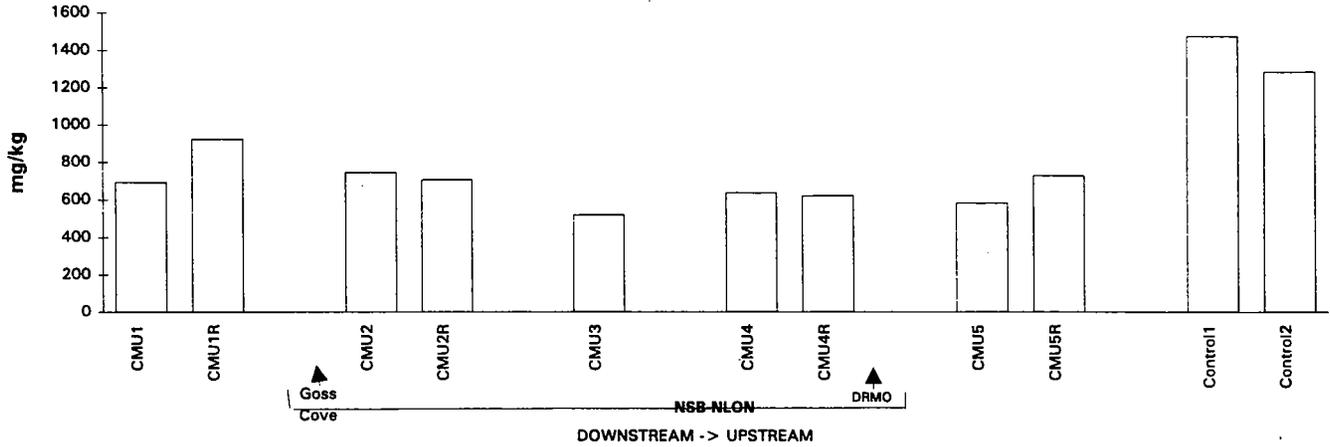


**CONTAMINANT CONCENTRATIONS IN CAGED MUSSELS
THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**

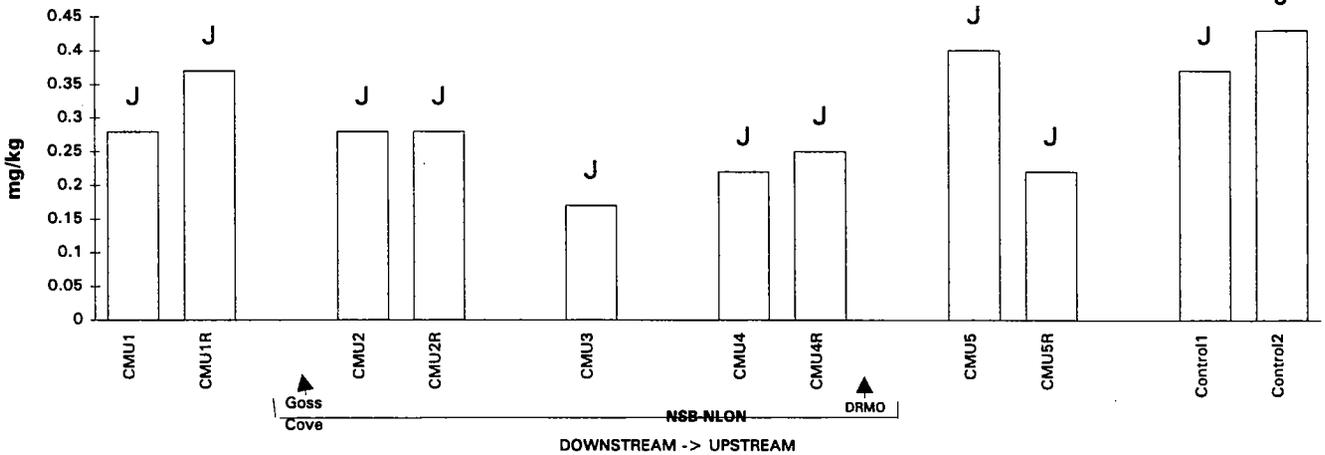


**CONTAMINANT CONCENTRATIONS IN CAGED MUSSELS
THAMES RIVER
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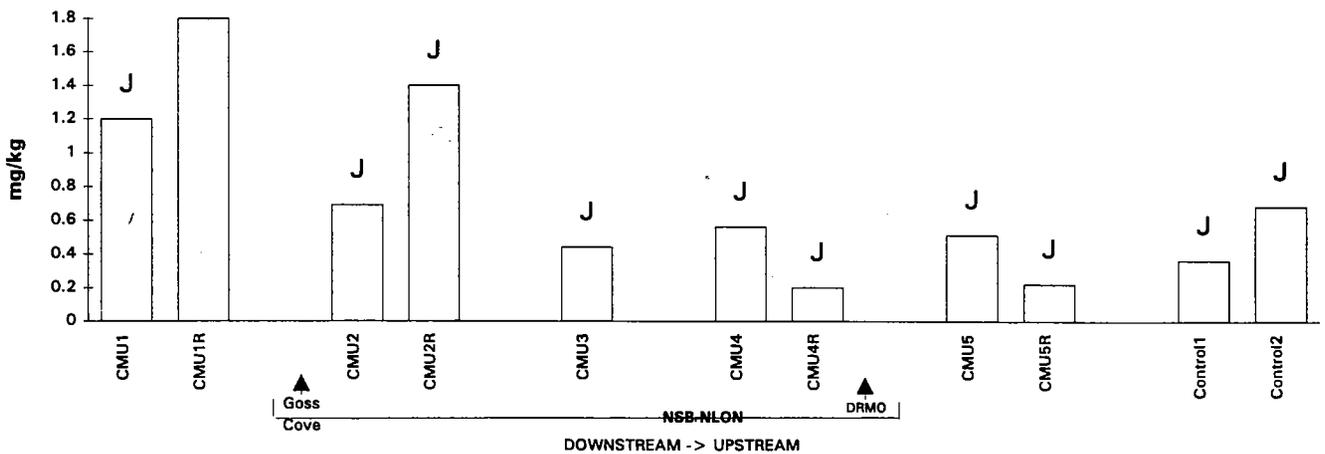
Potassium Concentrations in Caged Mussels



Selenium Concentrations in Caged Mussels



Silver Concentrations in Caged Mussels



**CONTAMINANT CONCENTRATIONS IN CAGED MUSSELS
THAMES RIVER
NSB-NLON, GROTON, CONNECTICUT**

