62794

EPA (US Environmental Protection Agency) 1996. Ecological Screening Values. In: Supplemental Guidance to RAGS: Region 4 Bulletins-Ecological Risk Assessment, Bull. No. 2, Atlanta Georgia (http://www.epa.gov/region4/wastepgs/oftecser/otsguid.htm)

United States Environmental Protection Agency, Region 4

Waste Management Division

61 Forsyth St.

Atlanta, GA 30303

Phone: 404-562-9714

Fax: 404-562-8628

For best quality hard-copy save and print this document as a PostScript file.
Click on any HYPERTEXT link in this color to move around the document.

Index
Ecological

Region 4's Ecological Bulletins are undergoing revision. Please contact OTS personnel

1. Ecological Introduction
2. Preliminary Risk Evaluation
3. Ecological Screening Values

- Table 1 Freshwater Surface Water Screening Values
- Table 2 Saltwater Screening Values
- Table 3 Sediment Screening Values
- Endpoint Selection

MAR 0 4 1999

DRAFT

Ecological Risk Assessment

BULLETINS

1. ECOLOGICAL INTRODUCTION

The role of a Superfund Ecological Risk Assessment is to: (1) determine whether unacceptable risks are posed to ecological receptors from chemical stressors, (2) derive contaminant levels which would not pose unacceptable risks, and (3) provide the information necessary to make a risk management decision concerning the practical need and extent of remedial action.[1]

Ecological Risk Assessment is in a beginning phase of development and therefore exists in a very dynamic state. Agency guidance is limited and there is uncertainty concerning the roles and processes of Ecological Risk Assessment in the different programs within the Agency. The Office of Technical Services (OTS) should be contacted prior to applying other programmatic guidance, policies, or practices to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Ecological Risk Assessments in Region 4.

The intention of this series of ecological bulletins is to provide regional direction for implementation of the Agency's Ecological Risk Assessment Guidance for Superfund (referred to as the Process Document).[2] This guidance supersedes the previous Risk Assessment Guidance for Superfund (RAGS), Volume II, which still may be used as a primer on the basic elements of a CERCLA Ecological Risk Assessment.[3] The Risk Assessment Forum's Framework for Ecological Risk Assessment (referred to as the Framework document) provides the basic approach for conducting Ecological Risk Assessments used by all programs within the Agency.[4] Specific program guidance presented in these Region 4 Bulletins, as well as the Process document, may appear in rare cases to be at odds with the Framework document. Region 4 views these documents as being complementary with their focus directed at different organizational levels.

The CERCLA Ecological Risk Assessment process as outlined in the Process document consists of eight steps and five scientific/management decision points. These steps are: (1) Preliminary Problem Formulation and Ecological Effects Evaluation, (2) Preliminary Exposure Estimate and Risk Calculation, (3) Problem Formulation: Assessment Endpoint Selection and Formulation of Testable Hypothesis, (4) Conceptual Model Development: Conceptual Model Measurement

Endpoint Selection and Study Design, (5) Site Assessment to Confirm Ecological Sampling and Analysis Plan, (6) Site Field Investigation, (7) Risk Characterization, and (8) Risk Management. The decision points follow steps 2 - 5, and 8.

Additional resources may be found in the Bibliography of the Process Document. Included in this list are the ECO Update bulletin series issued by the Office of Emergency and Remedial Response.[5] These bulletins are focused discussions of elements and topics related to CERCLA Ecological Risk Assessments. The guidance and direction contained in these bulletins is still somewhat broad, therefore approval of the proposed approach in CERCLA Ecological Risk Assessments should be obtained from OTS.

These regional guidance bulletins will be dynamic documents. Bulletins will be updated and new ones added as questions are posed and regional practices are developed.

This guidance does not constitute rulemaking by the Agency, and may not be relied on to create a substantive or procedural right enforceable by any other person. Region 4 reserves the right to take action that is at variance with this guidance. The intent of this guidance is to aid in the development of high-quality, single draft risk assessments consistent with the criteria of the OTS in its oversight role.

References

1. Role of the Ecological Risk Assessment in the Baseline Risk Assessment, OSWER Directive Number 9285.7-17, August 12, 1994, Laws, EP.

2. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Review Draft, September 1994.

3. Risk Assessment Guidance for Superfund, Volume II-Environmental Evaluation Manual, Interim Final, March 1989, EPA/540/1-89/001.

4. Framework for Ecological Risk Assessment, February 1992, EPA 630/F-92/001.

5. ECO Update, Intermittent Bulletin, Volumes 1 and 2. Publication 9345.0-05I.

Volume 1:

- Number 1 - The Role of BTAGs in Ecological Assessment, September 1991.

- Number 2 - Ecological Assessment of Superfund Sites: An Overview, December 1991.
- Number 3 - The Role of Natural Resource Trustees in The Superfund Process, March 1992.
- Number 4 - Developing a Work Scope for Ecological Assessments, May 1992.
- Number 5 - Briefing the BTAG: Initial Description of Setting, History, and Ecology of a Site, August 1992.

Volume 2:

- Number 1 - Using Toxicity Tests in Ecological Assessments, September 1994.
- Number 2 - Catalogue of Standard Toxicity Tests for Ecological Risk Assessment, September 1994.
- Number 3 - Field Studies for Ecological Risk Assessment, September 1994.
- Number 4 - Selecting and Using Reference Information in Superfund Ecological Risk Assessments, September 1994.

---

1. Ecological Introduction
2. Preliminary Risk Evaluation
3. Ecological Screening Values

- Table 1 Freshwater Surface Water Screening Values
- Table 2 Saltwater Screening Values
- Table 3 Sediment Screening Values
- Endpoint Selection

2. PRELIMINARY RISK EVALUATION

The Preliminary Risk Evaluation (PRE) is the initial ecological risk screening assessment at a hazardous waste site. It should be conducted in advance of Remedial Investigation/Feasibility Study (RI/FS) work plan development so the results can be used in determining appropriate media and site- specific sampling to adequately characterize ecological impacts at a site. This bulletin provides an overview of the PRE, which is discussed in detail in Chapters 1 and 2 of the Process Document[1].

The primary purpose of the PRE is to compare concentrations of site related contaminants with Region 4 ecological screening values. It is also used to develop a conservative exposure scenario and risk characterization for a model ecological receptor based on contaminants which exceed screening values. The PRE consists of five steps:

- Ecological Screening Value Comparison
- Preliminary Problem Formulation
- Preliminary Ecological Effects Evaluation
- Preliminary Exposure Estimate
- Preliminary Risk Calculation

The last four steps are conducted only if comparisons of site analytical data with EPA Region 4 ecological screening values indicate a need for further ecological risk evaluation. See Bulletin 2 for a discussion of Region 4 ecological risk screening values.

Preliminary Problem Formulation

The focus of the preliminary problem formulation step is to identify categories of potential ecological receptors that may exist in the site area, to identify contaminants which may pose unacceptable risks to those receptors, and to determine contaminant fate/transport and toxicity mechanisms.

Selection of appropriate ecological receptors for the PRE is critical. A literature search should be conducted for the contaminants which exceeded Region 4 ecological screening values to determine whether ecological impacts are at lower trophic levels, or through food web contamination at higher trophic levels. The

environmental fate, transport and toxicity mechanisms of the contaminants being addressed as well as the environmental setting of the site should be considered when selecting an ecological receptor group.

To illustrate, chlorinated pesticides and PCBs are extremely persistent in the environment, tend to biomagnify in the food chain, and have been shown to exhibit ecological impacts such as egg shell thinning in birds (DDT) and reduction of steroid hormones necessary for successful reproduction in mammals (PCBs). Most inorganics do not tend to biomagnify up the food chain, with mercury being a notable exception; however, when present at high levels in sediments, soil or surface water, some metals can be toxic to plants and animals via direct contact, uptake and/or ingestion.

Potential ecological receptors should be generic. At a site where contaminated lake sediments have resulted in fish tissue contamination, the selected ecological receptor may be a piscivorous bird or mammal, depending on the site environmental setting.

Once the ecological receptor group has been chosen, a surrogate species should be identified to represent the broader receptor group. The kingfisher is an example of a surrogate species of piscivorous birds, and a river otter may be an appropriate surrogate species of piscivorous mammals.

Care should be taken in selecting surrogate species to ensure that the various life history and behavior parameters will result in a conservative estimate of risk. The habitat on or around the site should be capable of supporting the animal, although it is not necessary to document the species' occurrence. A biologist or ecologist familiar with the site area should be consulted to assist in selecting an appropriate surrogate ecological receptor species.

The chosen species' home range should be relatively small, and exposure parameters such as body weight and food and water ingestion rates should be available in the literature. The Wildlife Exposure Factors Handbook contains this type of information for a variety of birds, mammals, reptiles and amphibians, as well as an extensive reference list of additional resources2.

Preliminary Ecological Effects Evaluation

The preliminary ecological effects evaluation focuses on developing toxicity profiles and toxicity reference values (TRV) for contaminants of concern at the site, as well determining the complete exposure pathways that exist at the site. Potential exposure pathways are direct contact, inhalation/respiration, water

ingestion and food ingestion for animals, and direct contact and root absorption for plants. When conducting a PRE, emphasis is usually placed on direct contact and ingestion pathways since there is generally more species-specific TRV information available for these pathways.

Toxicity profiles and TRVs should be obtained from literature sources. Toxicity profiles describe the toxic mechanism or action of the contaminant and the dose or environmental concentration which causes a specified adverse effect for the exposure route being evaluated. TRVs are species-specific effect levels which have been derived from laboratory studies. The Process Document refers to TRVs as screening level ecotoxicity values.

The No Observed Adverse Effects Level (NOAEL) is a TRV which expresses the highest exposure level at which no adverse effects have been demonstrated. The Lowest Observed Adverse Effects Level (LOAEL) is a TRV which expresses the lowest exposure level or dose shown to produce adverse effects such as reduced growth, impaired reproduction or increased mortality.

For the ingestion exposure pathway, NOAELs and LOAELs are most often expressed in units of: grams of contaminant/kilogram body weight/day (g/kg/d). A TRV should be the most conservative available from the literature for the chemical and surrogate species under consideration. If the LOAEL is the only TRV available for a contaminant, then the NOAEL should be estimated by dividing the LOAEL by 10.

For some surrogate ecological receptor species, TRV literature values will be unavailable. Alternate values for a species in the same or closely related ecological receptor group that the site habitat could support may be used. For example, if the kingfisher is being used as a surrogate species for the broader ecological receptor group of piscivorous birds, but there are no literature TRVs for the kingfisher, available NOAELs or LOAELs for a similar sized fish eating bird could be used. This is acceptable at the preliminary evaluation point in the process, but increases the level of uncertainty in the results of the PRE.

An exposure pathway which is also commonly encountered in ecological risk assessments is direct contact with contaminated environmental media. This is particularly the case for exposure of aquatic receptors to contaminated surface water and/or sediments. TRVs for this pathway are usually developed by conducting toxicity bioassays with the contaminated medium using standard test organisms. Resultant TRVs are expressed as the contaminant concentration which causes adverse effects to a certain percentage of the test organisms. A TRV commonly derived from toxicity bioassays is the LC50, which is the contaminant

concentration that is lethal to 50 percent of the test organisms.

The U.S. Fish and Wildlife Service has published Contaminant Hazard Reviews for more than 20 organic and inorganic contaminants commonly encountered at hazardous waste sites. These reviews provide a summary of available literature on ecological and toxicological effects and TRVs of contaminants in the environment with special reference to fish and wildlife resources. To obtain copies of the Contaminant Hazard Reviews, contact the Publications Unit, U.S. Fish and Wildlife Service, 1849 C Street, N.W., Mail Stop 130, Webb Building, Washington, D.C. 20240. (703) 358-1711.

Preliminary Exposure Estimate

The preliminary exposure estimate involves the selection of exposure parameters for use in calculating a daily exposure dose for the selected receptor species. In the absence of adequate site-specific information or literature values, conservative assumptions are to be used in the preliminary exposure estimate.

Exposure parameters include bioavailability of contaminants, bioaccumulation factors (BAF) and surrogate species body weight, food and water ingestion rate, and area-use factor.

For the PRE, area use factor is assumed to be 100 percent, i.e., the surrogate species' home range is considered to be encompassed entirely by the highly contaminated areas of the site. It is therefore important to select a surrogate species with a small home range to represent the ecological receptors of concern.

The bioavailability of contaminants at the site is also assumed to be 100 percent because few chemicals have been tested for bioavailability, and because later steps in the ecological risk assessment process provide an opportunity for this issue to be specifically addressed.

Values for surrogate species body weight and food and water ingestion rates should be the most conservative available from the literature in order to maximize exposure.

Food web modeling is often necessary to predict concentrations of contaminants which would be available in food items of ecological receptors at higher trophic levels. Conservative literature values for contaminant BAFs should be used to avoid understating ecological risk in the PRE.

The preliminary exposure evaluation coupled with site specific analytical data and food web modeling will result in a daily exposure dose received by the receptor

species via consumption of contaminated food and/or water. Table A, following this bulletin, gives an example of daily exposure dose calculation based on site conditions at a Surerfund site in Region 4. In this example, the surrogate receptor species is the green heron, the contaminants are chlorinated pesticides, and the contaminated media are surface water and sediment in a small stream adjacent to the site.

Preliminary Risk Calculation

The preliminary risk calculation uses the hazard quotient (HQ) method as an indicator of the risks posed to the surrogate ecological receptor from exposure to site-related contaminants.

The HQ method compares the estimated exposure level or daily dose to literature derived TRVs for each contaminant under consideration. Once again, in order to produce the most conservative estimate of risk at the screening stage, the NOAEL (or LOAEL/10) for the contaminant and species of concern should be used as the HQ denominator.

When more than one contaminant is involved in the risk calculation, it is appropriate to sum the HQs if the compounds exhibit consistent modes of toxicity and effect endpoints. The sum of two or more HQs is referred to as a hazard index (HI).

Section 2.3 of the Process Document explains the HQ method and several points to keep in mind when interpreting the results of this calculation. A NOAEL-based HQ or HI of greater than one indicates an exposure level at which adverse ecological effects may occur. There is no implied linear relationship, however, between the magnitude of the HQ or HI and the likelihood or magnitude of adverse ecological impacts. The results of the risk calculation should only be used to aid in determining a further course of action for the ecological risk assessment.

A NOAEL-based HQ or HI of less than one indicates an exposure level at which adverse ecological effects are unlikely to occur, due to the conservative assumptions which were made throughout the PRE. If a LOAEL/10 is the only TRV available for the risk calculation, a resultant HQ or HI near to but less than 1.0 may be indicative of potential ecological impacts to the receptor species. In this case, further refinement of the assumptions used in the effects and exposure analyses would be required to determine whether to continue the ecological risk assessment.

References

1. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Review Draft, Sept. 1994.

2. Wildlife Exposure Factors Handbook, Volumes I and II, Dec. 1993, EPA/600/R-93/187a.

Table A:Daily Exposure Dose Calculations for Green Heron Based on Surface Water and Sediment Contaminated with Chlorinated Pesticides

COC	Max SC mg/g)	BAF inv	MAX IC (mg/g)	BAFf ish	MAX FC (mg/g)	IR(g/d)	IFI mg/d)	Max WC (mg/L)	IRW (L/day)	IW (mg/day)	SF F	BW (kg)	Max D (mg/kg/d)
alpha-BHC	0.00E+00							6.50E-05	0.023	1.50E-06	1	0.25	5.98E-06
beta-BHC	2.20E-05	12.9	2.84E-04	18.9	4.16E-04	48	2.00E-02	1.40E-04	0.023	3.22E-06	1	0.25	7.98E-02
delta-BHC	00.E+00							8.30E-05	0.023	1.91E-06	1	0.25	7.64E-01
4,4'-DDD	2.10E-04	12.9	2.71E-03	18.9	3.97E-03	48	1.91E-03	0.00E+00	0.023	0.00E+00	1	0.25	7.62E-01
Dieldrin	0.00E+00							1.10E-04	0.023	2.53E-06	1	0.25	1.01E-05
Endrin	0.00E+00							1.10E-04	0.023	2.53E-06	1	0.25	1.01E-05

---

1. Ecological Introduction
2. Preliminary Risk Evaluation
3. Ecological Screening Values

- Table 1 Freshwater Surface Water Screening Values
- Table 2 Saltwater Screening Values
- Table 3 Sediment Screening Values
- Endpoint Selection

---

3. ECOLOGICAL SCREENING VALUES

Ecological screening values are based on contaminant levels associated with a low probability of unacceptable risks to ecological receptors. The Office of Technical Services (OTS) has developed the attached tables for use at Region 4 hazardous waste sites. Since these numbers are based on conservative endpoints and sensitive ecological effects data, they represent a preliminary screening of site contaminant levels to determine if there is a need to conduct further investigations at the site. Ecological screening values should not be used as remediation levels.

Preliminary screening values for contaminants which lack Region 4 Waste Management Division Ecological Screening Values should be proposed and submitted to the OTS for approval. If at all possible these screening values should be based on ecotoxicological information from sources such as scientific literature, computer databases, etc. As information is submitted to this office for review or as new information becomes available, these Region 4 screening values may be modified and additional screening values added.

Exceedences of the ecological screening values may indicate the need for further evaluation of the potential ecological risks posed by the site. The decision concerning the necessity for evaluation requires the weighing of such factors as the frequency, magnitude, and pattern of these exceedences. The basis of the screening values should also be considered when making the decision for the collection of additional data. An exceedence may result in the retention of that contaminant for further evaluation even though its frequency of detection may be low. The sampling may indicate a "hot spot" which would be addressed by future investigations.

Surface Water Screening Values

The surface water screening values (which exist for both Freshwater [Table 1] and Saltwater[Table 2] surface waters) were derived from the Screening Worksheet prepared by the Region 4 Water Management Division.1 These values were obtained from Water Quality Criteria documents and represent the chronic ambient water quality criteria values for the protection of aquatic life. If there was insufficient information available to derive a criterion, the lowest reported effect level was used with the application of a safety factor of ten to protect for a more sensitive species. A safety factor of ten was also used to derive a chronic value if only acute information was available.

The ambient surface water quality criteria are intended to protect 95% of the species, 95% of the time. If there is reason to believe that a more sensitive species

is present at the site, such that surface water contaminant levels below the chronic ambient water quality values may pose unacceptable risks, more protective site-specific surface water screening values may be developed.

Sediment Screening Values

Sediment screening values (Table 3) are derived from statistical interpretation of effects databases obtained from the literature as reported in publications from the State of Florida, the National Oceanic and Atmospheric Administration, and a joint publication by Long et al.2,3,4 These values are generally based on observations of direct toxicity. When the Contract Laboratory Program's (CLP) practical quantification limit (PQL) is above the effect level the screening value defaults to the PQL. For those contaminants whose screening values are based on the PQL, data reported below the required quantification limit (e.g., J-flagged data) should be compared to the Effects Level number. Although the sediment screening values have been developed from a database containing information from studies conducted predominantly in marine environments, personal communication with the authors of the studies indicate that corresponding values being developed from a freshwater database are within a factor of three of the marine based numbers. The existing values will be used for freshwater sites until a separate freshwater screening value table is developed.

Soil Screening Values

Terrestrial assessments are one of the least developed aspects of Ecological Risk Assessment and screening values for this component have not been drafted by EPA. Site-specific soil screening values may be submitted based on information concerning potential effects for contaminants whose mode of toxicity is through direct exposure (e.g., soil invertebrates such as earthworms). For those contaminants which biomagnify, screening values may be back-calculated from acceptable tissue levels in prey items, through two trophic transfers from the abiotic medium. Screening values should be based on contaminant levels associated with ecological effects, instead of area or regional background levels.

Wildlife Screening Values

Wildlife screening values may serve to indicate if tissue residues pose potential risks to predatory ecological receptors (e.g., Toxicity Reference Values, TRVs). The contaminant exposure is generally expressed as a daily dietary exposure with the units of mg of contaminant, per kilogram body weight of the receptor per day (mg/kg/day). Currently there is limited information concerning tissue contaminant levels which would pose potential risks to predatory ecological receptors. Site-specific wildlife screening values may be submitted based on ecotoxicological information from sources such as scientific literature, computer databases, etc. These values may be refined, if necessary, in the Ecological Risk Assessment. The use of Food and Drug Administration (FDA) Action Levels may be used to suggest risks to ecological receptors if tissue residues exceed these values, but FDA Action Levels should not be considered protective of ecological receptors. FDA levels are derived using human health exposure assumptions from ingesting contaminated food items obtained from commercial sources (e.g., fish markets). Ecological receptors may show adverse effects at contaminant concentrations below the FDA level due to greater exposures. important factors include their: lower body weight, exposure to higher dose levels by more frequent ingestion of contaminated prey, and innate greater sensitivity to the contaminants.

Ground Water Screening Values

The potential impacts of contaminated ground water on ecological receptors, either directly (e.g., cave-dwelling ecological receptors) or indirectly through existing or potential discharge to sediments, seeps, and surface water must be considered.

The maximum ground water contaminant concentrations should be compared to the surface water screening values as a conservative scenario (e.g., no attenuation, dilution, etc.).

References

1. 304 (a) Screening Values and Related Information, Screening List, October 1991, USEPA Region 4 - Water Management Division.

2. MacDonald Environmental Sciences, Ltd. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Florida Department of Environmental Protection. November 1994.

3. Long, ER, and LG Morgan. 1991. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52.

4. Long, ER, DD MacDonald, SL Smith, and FD Calder. 1995. "Incidence of

Adverse Biological Effects with Ranges of Chemical Concentrations in Marine and Estuarine Sediments." Environmental Management 19(1): 81-97.

Table 1Table 2|Table 3|TOP|

Table 1. Region 4 Waste Management Division Freshwater Surface Water Screening Values for Hazardous Waste Sites[1]

Priority Pollutants

Compound	Acute Screening Values (ug/L)	Chronic Screening Values (ug/L)
Antimony	1300 (2s)	160 (2s)
Arsenic III	360*	90*
Beryllium	16 (6s)	0.53 (1s)
Cadmium2	1.79*	0.66*
Chromium (III)2	984.32*	117.32*
Chromium (VI)	16*	11*
Copper2	9.22*	6.54*
Lead2	33.78*	1.32*
Mercury	2.40*	0.012*3
Nickel2	789.00*	87.71*
Selenium	20.00*	5.00*
Silver2	1.23*	0.012(1s)

Thallium	140.00(3s)	4.00 (2s)
Zinc2	65.04*	58.91*
Cyanide	22*	5.2*
2,3,7,8-TCDD-Dioxin	0.1	0.00001[3
Acrolein	6.8(3s)	2.1 (1s)
Acrylonitrile	755 (4s)	75.5
Benzene	530 (7s)	53
Bromoform	2930 (2s)	293
Carbon Tetrachloride	3520 (3s)	352
Chlorobenzene	1950 (5s)	195
2-Chloroethylvinyl Etheru	35400 (1s)	3540
Chloroform	2890 (3s)	289
1,2-Dichloroethane	11800 (3s)	2000 (1s)
1,1-Dichloroethylene	3030 (3s)	303
1,2-Dichloropropane	5250 (3s)	525
1,3-Dichloropropylene (cis and trans)	606 (2s)	24.4 (1s)
Ethylbenzene	4530 (5s)	453
Methyl Bromide	1100 (1s)	110
Methyl Chloride	55000 (1s)	5500
Methylene Chloride	19300 (3s)	1930
1,1,2,2-Tetrachloroethane	932 (3s)	240 (1s)

Tetrachloroethylene	528 (5s)	84 (1s)
Toluene	1750 (5s)	175
1,2-Trans-Dichloroethylene	13500 (1s)	1350
1,1,1-Trichloroethane	5280 (2s)	528
1,1,2-Trichloroethane	3600(3s)	940(1s)
2-Chlorophenol	438 (5s)	43.8
2,4-Dichlorophenol	202 (3s)	36.5 (1s)
2,4-Dimethylphenol	212 (3s)	21.2
2-Methyl-4,6-Dinitrophenol (4,6-Dinitro-O-Cresol)	23 (4s)	2.3
2,4-Dinitrophenol	62 (3s)	6.2
2-Nitrophenol	-	3500
4-Nitrophenol	828 (3s)	82.8
3-Methyl-4-Chlorophenol(P-Chloro-M-Cersol)	3 (1s)	0.3
Pentachlorophenol[4] (pH 7.8)	20 *	13*
Phenol	1020(16s)	256 (1s)
2,4,6-Trichlorophenol	32 (3s)	3.2
Acenaphthene	170 (2s)	17
Benzidine	250 (4s)	25
Bis(2-Chloroethyl) Ether	23800 (1s)	2380
Bis(2-Ethylhexyl) Phthalate	1110 (2s)	<0.3 (2s)
4-BromophenylPhenyl Phthalate	36(2s)	12.2 (1s)
Butylbenzyl Phthalate	330(4s)	22 (2s)

1,2-Dichlorobenzene	158(4s)	15.8 (3s)
1,3-Dichlorobenzene	502(3s)	50.2
1,4-Dichlorobenzene	112(5s)	11.2
Diethyl Phthalate	5210(2s)	521
Dimethyl Phthalate	3300(2s)	330
Di-n-Butyl Phthalate	94(6s)	9.4
2,4-Dinitrotoluene	3100(2s)	310
1,2-Diphenylhydrazine	27(2s)	2.7
Fluoranthene	398(2s)	39.8
Hexachlorobutadiene	9(5s)	0.93(1s)
Hexachlorocyclopentadiene	0.7(4s)	0.07
Hexachloroethane	98(5s)	9.8
Isophorone	11700(2s)	1170
Naphthalene	230(4s)	62(1s)
Nitrobenzene	2700(2s)	270
N-Nitrosodiphenylamine	585(2s)	58.5
1,2,4-Trichlorobenzene	150(4s)	44.9 (1s)
Aldrin	3*	0.3
a-BHC	-	5005
b-BHC	-	50005
g-BHC (Lindane)	2*	0.08*
Chlordane	2.4*	0.0043*3
4,4'-DDT	1.1*	0.001*

4,4'-DDE	105(1s)	10.5
4,4'-DDD	0.064(8s)	0.0064
Dieldrin	2.5*	0.0019*3
a-Endosulfan	0.22*	0.056*
b-Endosulfan	0.22*	0.056*
Endrin	0.18*	0.0023*3
Heptachlor	0.52*	0.0038*3
Heptachlor Epoxide	0.52*	0.0038*3
PCB-1242	0.2(7s)	0.014*
PCB-1254	0.2(7s)	0.014*
PCB-1221	0.2(7s)	0.014*
PCB-1232	0.2(7s)	0.014*
PCB-1248	0.2(7s)	0.014*
PCB-1260	0.2(7s)	0.014*
PCB-1016	0.2(7s)	0.014*
Toxaphene	0.73*	0.0002*3

Non-Priority Pollutants

Compound	Acute Screening Values (ug/L)	Chronic Screening Values (ug/L)
Aluminum (pH 6.5 -9.0)	750*	87*
Boron	-	750 *6
Chloride	860,000*	230,000*
Chlorine (TRC)	19*	11*
Chloropyrifos	0.083*	0.041*
Demeton	-	0.1*
Guthion	-	0.01*
Iron	-	1000*
Malathion	-	0.1*
Methoxychlor	-	0.03*
Mirex	-	0.001*
Oil and Grease	-	0.01*Low LC_{50}
Parathion	0.065*	0.013*
Pentachlorobenzene	250	50
pH	-	6.5 -9.0*
Sulfide (S_2-, HS-)	-	2*
1,2,4,5-Tetrachlorobenzene	250	50
Tributyltin	-	0.026

[1] Based on Region 4 Water Management Division, Water Quality Standards Unit's Screening List.
Hardness (mg/L as CaCO3): 50.0
pH: 6

*: Criteria
s: Number of Species

[2] Hardness Dependent Based on the following equations:

Compound	Acute Screening Value	Chronic Screening Value
Cadmium	$e^{(1.128(\ln H)-3.828)}$	$e^{(0.7825(\ln H)-3.49)}$
Chromium III	$e^{(0.819(\ln H)+3.688)}$	$e^{(0.819(\ln H)+1.561)}$
Copper	$e^{(0.9422(\ln H)-1.464)}$	$e^{(0.8545(\ln H)-1.465)}$
Lead	$e^{(1.273(\ln H)-1.46)}$	$e^{(1.273(\ln H)-4.705)}$
Nickel	$e^{(0.846(\ln H)+3.3612}$	$e^{(0.846(\ln H)+1.1645)}$
Silver	$e^{(1.72(\ln H)-6.52)}$	
Zinc	$e^{(0.8473(\ln H)+0.8604)}$	$e^{(0.8473(\ln H)+0.7614)}$

[3] Based on the marketability of fish. The use of other values which may have greater ecological significance may be considered.

[4] pH Dependent. Based on the following equation:

Compound	Acute Screening Value	Chronic Screening Value
Pentachlorophenol	$e^{(1.005pH-4.83)}$	$e^{(1.005pH-5.29)}$

[5] Lowest plant value reported
[6] For long term irrigation of sensitive crops (minimum standard)

Table 1|Table 2|Table 3|TOP|

Table 2. Region 4 Waste Management Division Saltwater Surface Water Screening Values for Hazardous Waste Sites[1]

Priority Pollutants

Compound	Acute Screening Values (ug/L)	Chronic Screening Values (ug/L)
Antimony	-	-
Arsenic III	69*	36*
Beryllium	-	-
Cadmium	43*	9.3*
Chromium(III)	1030(2s)	103
Chromium(VI)	1100*	50*
Copper	2.9*	2.9*
Lead	220*	8.5*
Mercury	2.1*	0.025*2
Nickel	75*	8.3*
Selenium	300*	71*
Silver	2.3*	0.23(1s)
Thallium	213(3s)	21.3
Zinc	95*	86*
Cyanide	1*	1*
2,3,7,8-TCDD-Dioxin	-	0.00001[2]
Acrolein	5.5(1s)	0.55

Acrylonitrile	-	-
Benzene	1090(6s)	109
Bromoform	1790(2s)	640(1s)
Carbon Tetrachloride	15000(1s)	1500
Chlorobenzene	1050(2s)	105
2-Chloroethylvinyl Ether	-	-
Chloroform	8150(1s)	815
1,2-Dichloroethane	11300(1s)	1130
1,1-Dichloroethylene	22400(3s)	2240
1,2-Dichloropropane	24000(1s)	2400
1,3-Dichloropropylene(cis and trans)	79(2s)	7.9
Ethylbenzene	43(5s)	4.3
Methyl Bromide	1200(1s)	120
Methyl Chloride	27000(1s)	2700
Methylene Chloride	25600(2s)	2560
1,1,2,2-Tetrachloroethane	902(2s)	90.2
Tetrachloroethylene	1020(1s)	45(1s)
Toluene	370(5s)	37
1,2-Trans-Dichloroethylene	-	-
1,1,1-Trichloroethane	3120(2s)	312
1,1,2-Trichloroethane	-	-
2-Chlorophenol	-	-

2,4-Dichlorophenol	-	-
2,4-Dimethylphenol	-	-
2-Methyl-4,6-Dinitrophenol(4,6-Dinitro-O-Cresol)	-	-
2,4-Dinitrophenol	485(3s)	48.5
2-Nitrophenol	-	-
4-Nitrophenol	717(2s)	71.7
3-Methyl-4-Chlorophenol(P-Chloro-M-Cresol)	-	-
Pentachlorophenol[3]	13*	7.9*
Phenol	580(4s)	58
2,4,6-Trichlorophenol	-	-
Acenaphthene	97(2s)	9.7
Benzidine	-	-
Bis(2-Chloroethyl) Ether	-	-
Bis(2-Ethylhexyl) Phthalate	-	-
4-BromophenylPhenylEther	-	-
Butylbenzyl Phthalate	294.4(2s)	29.4
1,2-Dichlorobenzene	197(3s)	19.7
1,3-Dichlorobenzene	285(2s)	28.5
1,4-Dichlorobenzene	199(2s)	19.9
Diethyl Phthalate	759(2s)	75.9
Dimethyl Phthalate	5800(2s)	580
Di-n-Butyl Phthalate	-	3.4[4]

2,4-Dinitrotoluene	-	-
1,2-Diphenylhydrazine	-	-
Fluoranthene	4(2s)	1.6(1s)
Hexachlorobutadiene	3.2(4s)	0.32
Hexachlorocyclopentadiene	0.7(6s)	0.07
Hexachloroethane	94(2s)	9.4
Isophorone	1290(1s)	129
Naphthalene	235(3s)	23.5
Nitrobenzene	668(2s)	66.8
N-Nitrosodiphenylamine	330000(1s)	33000
1,2,4-Trichlorobenzene	45(2s)	4.5
Aldrin	1.3*	0.13
a-BHC	-	14004
b-BHC	-	-
g-BHC(Lindane)	0.16*	0.016
Chlordane	0.09*	0.004*2
4,4'-DDT	0.13*	0.001*
4,4'-DDE	1.4(1s)	0.14
4,4'-DDD	0.25(3s)	0.025
Dieldrin	0.71*	0.0019*2
a-Endosulfan	0.034*	0.0087*
b-Endosulfan	0.034*	0.0087*
Endrin	0.037*	0.0023*2

Heptachlor	0.053*	0.0036*2
Heptachlor Epoxide	0.053*	0.0036*2
PCB-1242	1.05(3s)	0.03*
PCB-1254	1.05(3s)	0.03*
PCB-1221	1.05(3s)	0.03*
PCB-1232	1.05(3s)	0.03*
PCB-1248	1.05(3s)	0.03*
PCB-1260	1.05(3s)	0.03*
PCB-1016	1.05(3s)	0.03*
Toxaphene	0.21*	0.0002*2

Non-Priority Pollutants

Compound	Acute Screening Values (ug/L)	Chronic Screening Values (ug/L)
Aluminum(pH 6.5 - 9.0)	-	-
Ammonia	5	5
Boron	-	-
Chloride	-	-
Chlorine(TRC)	13*	7.5*
Chloropyrifos	0.011*	0.0056*
Demeton	-	0.1*
Guthion	-	0.01*
Iron	-	-
Malathion	-	0.1*
Methoxychlor	-	0.03*
Mirex	-	0.001*
N-nitrosopyrrolidene	3300000	-
Oil and Grease	-	0.1*Low LC_{50}
Parathion	1.78(2s)	0.178
Pentachlorobenzene	160	129
Phosphorus(elemental)	-	0.1*
pH	-	6.5 - 8.5
Sulfide(S2-, HS-)	-	2
1,2,4,5-Tetrachlorobenzene	160	129

Tributyltin(Advisory)	-	0.01

[1] Based on Region IV Water Management Division, Water Quality Standards Unit's Screening List.
* : Criteria
s . Number of Species
[2] Based on the marketability of fish. The use of other values which may have greater ecological significance may be considered.

[3] pH Dependent. Based on the following equation:

Compound	Acute Screening Value	Chronic Screening Value
Pentachlorophenol	e(1.005pH-4.83)	e(1.005pH-5.29)

[4] Lowest Plant Value Reported
[5] See table-Ambient WQCrit.-Ammonia(Salt H2O)440/5-88-004

Table 1|Table 2|Table 3|TOP|

Table 3. Region 4 Waste Management Division Sediment Screening Values for Hazardous Waste Sites.

Metals (ppm)

Chemical Analyte	Effects Value	CLP PQL[1]	Screening Value
Antimony	2[2]	12	12
Arsenic	7.24[3]	2	7.24
Cadmium	0.676[3]	1	1
Chromium	52.3[3]	2	52.3
Copper	18.7[3]	5	18.7
Lead	30.2[3]	0.6	30.2

Mercury	0.13[3]	0.02	0.13
Nickel	15.9[4]	8	15.9
Silver	0.733[3]	2	2
Zinc	124[3]	4	124

Organics

Chemical Analyte	Effects Value	CLP PQL[1]	Screening Value
p,p'- DDD	1.22[3]	3.3	3.3
DDD	2[2]	3.3	3.3
p.p'- DDE	2.07[3]	3.3	3.3
DDE	2[2]	3.3	3.3
p,p'- DDT	1.19[3]	3.3	3.3
DDT	1[2]	3.3	3.3
Total DDT	1.58[4]	3.3	3.3
Chlordane	0.5[2]	1.7	1.7
Dieldrin	0.02[2]	3.3	3.3
Endrin	0.02[2]	3.3	3.3
Lindane(gamma- BHC)	0.32[3]	3.3	3.3
Total PCBs	21.6[3]	33(67for Aroclor1221)	33(67for Aroclor1221)
Bis(2-ethylhexyl)phthalate	182[3]	3.6	182
Acenaphthene	6.71[3]	330	330
Acenaphthylene	5.87[3]	330	330

Anthracene	46.9[3]	330	330
Fluorene	21.2[3]	330	330
2- Methyl Naphthalene	20.23	330	330
Naphthalene	34.6[3]	330	330
Phenanthrene	86.7[3]	330	330
Low Molecular Weight PAHs	312[3]	330	330
Benzo(a)anthracene	74.8[3]	330	330
Benzo(a)pyrene	88.8[3]	330	330
Chrysene	108[3]	330	330
Dibenzo(a,h)anthracene	6.22[3]	330	330
Fluoranthene	113[3]	330	330
Pyrene	153[3]	330	330
High Molecular Weight PAHs	655[3]	330	655
Total PAHs	1684[3]	330	1684

1. Contract Laboratory Program Practical Quantification Limit

2. Long, Edward R., and Lee G. Morgan. 1991. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52

3. MacDonald, D.D. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Florida Department of Environmental Protection.

4. Long, Edward R., Donald D. MacDonald, Sherri L. Smith, and Fred D. Calder. 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management 19(1):81-97.

1. Ecological Introduction
2. Preliminary Risk Evaluation
3. Ecological Screening Values

- Table 1 Freshwater Surface Water Screening Values
- Table 2 Saltwater Screening Values
- Table 3 Sediment Screening Values
- Endpoint Selection

An Ecological Risk Assessment (ERA) should be conducted at a hazardous waste site if the result of the Preliminary Risk Evaluation (PRE, see Ecological Risk Assessment 1) indicates that there is a likelihood of impacts to ecological receptors from exposure to site related contaminants. The first and most important step in the ERA is the selection of appropriate assessment and measurement endpoints. Assessment and measurement endpoint selection is discussed in detail in Chapters 3 and 4 of the Process Document, along with other components of the ERA planning process such as defining testable hypotheses, formulating the site conceptual model and designing the field study.1

The following definitions of assessment and measurement endpoints are contained in Risk Assessment Guidance for Superfund: Volume II, Environmental Evaluation Manual, Interim Final2. An assessment endpoint is the explicit expression of an environmental value that is to be protected. A measurement endpoint is a measurable ecological characteristic that is related to the environmental value chosen as the assessment endpoint.

An easy way to envision the difference between assessment and measurement endpoints is to consider the decline in numbers of some species of piscivorous birds such as the bald eagle (Haliaeetus leucocephalus), brown pelican (Pelicanus occidentalis) and osprey (Pandion haliaetus) which was well documented 20 years ago. This phenomenon was caused at least in part by decreased reproduction due to egg shell thinning induced by dietary exposure to DDT in forage fish.

If one were conducting an ERA at a hazardous waste site where DDT has migrated into a surface water body, an assessment endpoint could be the maintenance of reproductive success in a population of piscivorous birds which utilizes the contaminated aquatic system as a foraging area. The measurement endpoint in this case would be concentrations of DDT in forage fish tissue consumed by

piscivorous birds. Measured (not modeled, as in the PRE) concentrations of DDT residues in forage fish tissue from the contaminated area could be converted to a daily dose using life history and ingestion rate parameters for the piscivorous bird being considered. This exposure level could then be compared with a literature derived Toxicity Reference Value (TRV) for DDT related to eggshell thinning in the ecological receptor species. Resultant hazard quotients (HQ, see Ecological Risk Assessment 1) would indicate the magnitude of potential risks to receptors from consumption of contaminated fi! sh.

One problem with using fish tissue residues as a measurement endpoint is that fish are mobile and many species are migratory. Tissue residue levels could be due to site contamination, area-wide (background) contamination, or another source. It is important, therefore, to obtain tissue samples from non-migratory fish which have a small home range relative to the contaminated area.

The results of the PRE should aid in the selection of assessment and measurement endpoints, however, for the ERA, additional literature review is usually required to better define stressor characteristics (e.g., fate and transport), receptor specific effects, toxicity and the most appropriate endpoints to be evaluated.

Following assessment and measurement endpoint selection and development of a testable hypothesis and site conceptual model, a study plan is designed to ensure that adequate data are collected to support the ecological component of the Baseline Risk Assessment and Remedial Investigation and Feasibility Study (RI/FS). There are a limited number of fundamental approaches for conducting site specific investigations on ecological impacts of hazardous substances. Tissue residue studies, population or community evaluations and toxicity testing are the three methodologies most commonly used. The appropriate methodology will depend on the assessment and measurement endpoints selected in the previous steps. However, none of the methods can be successful without a full understanding of the ecotoxicological properties of the contaminants, their migration pathways, and complete exposure routes at the site.

Tissue residue studies are most useful for predicting ecological risk from contaminants which bioaccumulate or biomagnify in the food web, resulting in impacts to upper trophic level receptors via the ingestion pathway. In the DDT example above, whole body residue analysis of forage fish likely to be consumed by piscivorous birds would be the most appropriate methodology to assess the measurement endpoint.

Toxicity testing is most commonly employed to determine potential risk via direct contact with contaminated surface water, soil or sediment. Toxicity testing must be

carefully designed to ensure that the proper test species are used for the environmental medium being evaluated. For example, a benthic macroinvertebrate such as Hyalella should be used as a test subject in freshwater sediment toxicity tests rather than a free-swimming organisms such as Ceriodaphnia.

Community or population evaluations involve floral or faunal field surveys and the computation of species diversity and richness indices. Results of these studies should not be used as measurement endpoints for a hazardous waste site ERA because the various diversity and richness indices were not developed to measure ecological impacts of hazardous materials in the environment. Natural variability in population and community structure, lack of sensitivity of some species to some contaminants and impacts to population/community structure from non-chemical stressors make the interpretation of these studies difficult in the context of assessing ecological impacts of hazardous waste sites.

Conducting an ERA as presented in the Process Document involves a focus of time and work in the planning phase and the selection of assessment and measurement endpoints. This is necessary in order to design an ERA which will allow an adequate understanding of potential risks at the site and provide enough information to establish site clean up goals for protection of ecological resources.

References

1. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Review Draft. September 1994.

2. Risk Assessment Guidance for Superfund, Volume II. Environmental Evaluation Manual. Interim Final. March 1989, EPA/540/1-89/001.