UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4

61 Forsyth Street
Atlanta, Georgia 30303-3104

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4WD-OTS

MEMORANDUM

SUBJECT: Amended Guidance on Ecological Risk Assessment at Military Bases: Process Considerations, Timing of Activities, and Inclusion of Stakeholders

FROM: Ted W. Simon, PhD, DABT
Toxicologist
Office of Technical Services

TO: Jon D.Johnston, Chief, FFB
Earl Bozeman, Chief, DOD Section, FFB
FFB Remedial Project Managers

CC: Elmer W. Akin,
Chief, OTS

The purpose of this memorandum is to clarify and expand a previous memorandum dated December 22, 1998. This memorandum supersedes the previous one. The reason for an amended version of this memorandum is to provide and emphasize flexibility in implementing the ecological risk assessment process at DOD facilities in Region 4. Acknowledgments are given to Robert Pope, Lynn Wellman, Sharon Thoms, Elmer Akin and David Charters who helped with the development of this memorandum. The information in this memorandum should be interpreted as suggestions to improve the outcome of the process.

Both this memo and the previous memo provided information regarding EPA's June 1997 program guidance, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* and the implementation of this guidance at Department of Defense (DOD) facilities in Region 4. The program guidance will henceforth be referred to as the "Process Document." The Process Document is complementary to the DOD guidance, *Tri-Services Procedural Guidelines for Ecological Risk Assessment.*

The Process Document outlines the eight steps that make up the Ecological Risk Assessment (ERA) process. This eight-step process is meant to provide a rational, science-based

approach for evaluating ecological risks for remedial decision-making and the site administrative record. When the eight-step process is understood and followed, greater efficiency can be achieved in conducting and documenting the assessment of ecological concerns at hazardous waste sites. The process provides a means of balancing the scope of the risk assessment against the hazards posed by the site conditions. Under appropriate circumstances, the process has provisions for early exit and for minimal expenditure of effort and resources.

This memorandum presents the timing and requirements for each step in the process, including suggested submission of interim deliverables. Appropriate stakeholders should be included at all stages of the process, and a discussion of coordination with stakeholders is included in this memo. Finally, a description of the ERA process is included, and suggestions for each step are presented.

Questions regarding the process and timing of ERA or about technical issues in ERA should be directed to Sharon Thoms at thoms.sharon@epa.gov or Lynn Wellman at wellman.lynn@epa.gov. In addition, please inform Ted W. Simon at simon.ted@epa.gov of these requests or other issues at DOD sites in Region 4.

Stages of the Ecological Risk Assessment Process

Ecological risk assessment consists of an eight step process with five Scientific/Management Decision Points. The process is described in detail in the Agency's program guidance, the Process Document. Exhibit 1-2 from the Process Document provides a flow chart for the process and is attached to this memorandum. The Process Document supersedes previous program guidance, *Risk Assessment Guidance for Superfund, Volume 2: Environmental Evaluation Manual.*

The Risk Assessment Forum's *Guidelines for Ecological Risk Assessment* provides broad guidelines for all Agency programs but is not specific to any program. In contrast, the Process Document is specific to the Office of Solid Waste and Emergency Response (OSWER) and the Superfund program. The Process Document has been determined to be consistent with the Risk Assessment Forum's Guidelines.

☞ *The Process Document is the appropriate guidance for Superfund risk assessments and supersedes previous guidance.*

The Process Document may be downloaded from the Environmental Response Team Center Homepage at http://204.46.140.12/media_resrcs/media_resrcs.asp.

This memorandum suggests that steps one through five of the process occur as soon as possible after some site chemical data is available as discussed below. Steps one through five generally occur prior to the performance of the data collection effort for the baseline ecological risk assessment that is part of the Remedial Investigation (RI) or RCRA Facility Investigation

(RFI). Because the first five steps are expected to precede data collection activities supporting the remedial investigation and the baseline ecological risk assessment, there is a chance that sufficient resources will not be devoted to these initial steps of the ecological risk assessment process.

☞ *Successful completion of steps one through five prior to data collection for the ecological risk assessment are suggested to minimize problems in steps six through eight.*

If data collection (both biotic and abiotic data) to support the ecological risk assessment occurs as part of the overall RI/RFI effort, it is important to ensure that steps one through five are completed prior to actual data collection. Hence, the sampling effort may occur as part of a single phase RI or RFI data collection. Alternatively, at sites with more complex ecological risk issues, data collection may occur in several phases or tiers.

☞ *Waiting until RI or RFI data is available will result in additional data collection. This additional data collection may be costly and potentially redundant.*

Communication among stakeholders early in the process is important to achieve consensus and understanding about future ecological risk assessment activities. The five Scientific/Management Decision Points (SMDP) provide an opportunity to reach agreement between the risk manager for the site (e.g. the remedial project manager), the risk assessment review team and any other stakeholders in the process.

Timing of Ecological Risk Assessment Activities

A major portion of the thought process in designing and conducting a technically defensible ERA occurs in the early steps of the process, particularly steps three and four. ERA activities should commence as soon as ecological concerns are identified and any chemical analytical data are available for a given site. Often, environmental samples and chemical data are available prior to the development of a formal sampling and analysis plan (SAP). Samples may be available during the Preliminary Assessment/Site Investigation (PA/SI) in the CERCLA process, a RCRA Facility Assessment (RFA) or Confirmation Sampling (CS) in the RCRA process or the Environmental Baseline Survey (EBS), which may be the earliest available information. At this early stage, a limited number of environmental samples are available.

☞ *The first three steps of the ERA process are performed prior to the development of the work plan for the RFI or RI. After Step 3, an SMDP must occur to determine whether or not to move forward with the ERA. Steps Four and Five should take place as part of the development of the RI/RFI work plan.*

The albeit limited early sampling can be used to conduct a first iteration of steps one through three, and possibly step four, of the ERA process, assuming site conditions such as habitat, site setting, etc. indicate that ecological risk will be a concern. This information may be valuable in the development of the work plan for the next investigative phase.

Coordination with Stakeholders

Stakeholders in the ERA process include state and Federal regulatory and scientific personnel, their DOD counterparts, and natural resource trustees. Trustees may include other federal agencies such as the Department of Interior (DOI), the National Oceanic and Atmospheric Administration (NOAA), state and/or tribal officials designated by the governor of the state, as well as private and non-profit conservation organizations. The public is also a stakeholder, and members of the public should also be included in the decision process during those times normally arranged for public input, such as the public comment period of the CERCLA proposed plan or the RCRA statement of basis.

☞ *Communication among all stakeholders is a necessary and integral part of a successful ecological risk assessment effort.*

Should ecological concerns exist at the site, notification of the trustees is required early in the ERA process. Natural resource trustees and their representatives may supply technical expertise and support during the ERA process in addition to their specific roles as trustees. Federal and state trustees are listed in *Supplemental Guidance to RAGS: Region 4 Bulletins. Ecological Risk Assessment, Bulletin No. 4 - Natural Resource Trustees*. This guidance is available at http://www.epa.gov/region4/wastepgs/oftecser/otsguid.htm.

It is suggested that all stakeholders be provided with copies of the interim deliverables at each of the SMDPs. Stakeholders should be informed of the SDMPs so they can participate in the planning of future ecological risk assessment activities.

The Ecological Risk Assessment Process

Step 1: Screening Level Problem Formulation and Ecological Effects Evaluation

Step one activities can commence once any preliminary data is in hand and ecological concerns exist at the site. Documentation of the activities in steps one and two should be provided to all stakeholders prior to discussions associated with the step two Scientific/Management Decision Point. The failure of an identified trustee to participate should not delay completion of these steps.

☞ *Risk management considerations are considered only minimally, if at all, in the screening level ERA.*

The screening level problem formulation considers aspects such as:

- ecological setting
- chemicals or classes of chemicals
- contaminant fate and transport processes
- mechanisms of ecotoxicity of the contaminants for the probable categories of receptors
- potentially complete exposure pathways
- preliminary endpoints

The screening level problem formulation should contain maps, figures and color photographs of the site and surrounding area, if available. Site visits by review personnel are strongly encouraged, and the risk manager may wish to plan a site visit.

Step 2: Screening-Level Preliminary Exposure Estimate and Risk Calculation

The screening-level exposure estimate and risk calculation is conducted with assumptions that maximize the risk estimate to ensure that sites with unacceptable risk will not be dropped at this screening step. The maximum concentrations of chemicals in each medium are compared to ecological screening values to determine chemicals of potential concern (COPCs).[1] Screening levels for sediment and surface water, both freshwater and saltwater, are attached to this memo. Screening levels for soil have been compiled by Region 4 and are also attached.

To perform the screening level risk calculation, the maximum detected concentration of a given chemical is divided by the ecological screening value. The result is the Screening Hazard Quotient. Contaminants with a Screening Hazard Quotient of one or greater are carried through to step three, Problem Formulation. Chemicals without screening values are also carried through to Problem Formulation.

The first Scientific/Management Decision Point occurs after step two. The Screening-Level ERA should be submitted to Region 4 as a technical memorandum or as part of a Site Investigation (SI) report or a similar level report. Review personnel include both EPA staff and EPA contractors.

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[1]COPC screening for ecological risk assessments is performed differently than that for human health risk assessments. In ecological risk assessments, exceedance of screening values is the sole criterion for COPC inclusion after step two. Comparison to background, frequency of detection and other considerations not related to risk or toxicity are not considered until step three of the ecological risk assessment process. For details of COPC screening for human health, *Supplemental Guidance to RAGS: Region 4 Bulletins, Bulletin #1* should be consulted. These bulletins are available at http://www.epa.gov/region4/waste/oftecser/oftecser.htm.

☞ *It is very important to involve a qualified ecological risk assessor from the regulatory agency during this first SMDP.*

The purpose of this SMDP is to determine whether a site will continue into step three. Generally, sites with Screening-Level Hazard Quotients greater than one or with chemicals present that have no screening values are carried into step three. Even if the ERA stops at this step, the results of the Screening-Level assessment must be summarized for the final RI or RFI report.

At the majority of sites, the ERA will proceed into step 3 and the process will stop at that step. As such, facilities are encouraged to submit the results of steps one through three as a single deliverable document.

Step 3: Problem Formulation

Problem formulation begins with the refinement of the COPCs. This step is an opportunity for facilities to present a reasoned toxicological approach for the elimination of one or more COPCs from future consideration. At this step, negotiations are undertaken to alter assumptions associated with the Screening Level ERA. These assumptions include but are not limited to area use factors (e.g. home ranges), incidental soil/sediment intakes, background/reference location comparisons and the nature of the contaminants.

Contaminants generally fall into two classes: 1) chemicals for which the exposure route of concern is direct contact; and 2) chemicals for which the exposure route of concern is the food chain. Most non-bioaccumulative chemicals, such as chromium, occur in the first class. Bioaccumulative and biomagnifiable chemicals comprise the second class. DDT, polychlorinated biphenyls (PCBs), and lead are examples. A few chemicals, such as toxaphene, possess characteristics of both classes.

Considering chemicals for which the major concern is direct toxicity, the assessment endpoint will generally be developed based on a common habitat among potentially affected species. Terrestrial invertebrates are an example. For chemicals in class two, for which the major concern is food chain exposure, the assessment endpoint will generally be developed based on a common feeding strategy among potentially affected species. Avian piscivores or fish-eating birds are an example.

Initial food chain modeling should occur as part of step three and the results be submitted as part of the deliverable associated with the Problem Formulation deliverable. It is not necessary to perform food chain modeling for all COPCs. Rather, food chain models should be limited to those chemicals that are bioaccumulative. Region 4 OTS should be consulted when questions arise about the inclusion of a particular chemical in a modeling effort.

Problem formulation is a refinement of the issues addressed in the Screening-Level ERA. Problem formulation includes the designation of assessment endpoints and the development of the ERA conceptual model.

☞ *The ERA conceptual site model supplies working hypotheses or scientific questions that site investigation and sampling will address.*

Risk management issues such as background comparison, are introduced for discussion among stakeholders at this stage. Problem Formulation is commonly thought of in two parts: step 3a and step 3b. For those sites at which there exist minimal ecological concerns, step 3a serves to introduce information to refine the risk estimates from steps one and two. For the majority of sites, ecological risk assessment activities will cease after completion of step 3a. At many sites, a single deliverable document consisting of the reporting of results from steps 1, 2 and 3a may be submitted.

At those sites with greater ecological concerns, the additional problem formulation is called step 3b. At such sites, it is preferred that the Problem Formulation deliverable be submitted as a technical memorandum, a separate document or part of an SI Report or similar level report. At such sites, in some cases, it may be more appropriate to present the Problem Formulation in briefing packages for discussion during a meeting.

Following the review of the step 3 deliverable, the second Scientific/Management Decision Point occurs. This SMDP is an opportunity for stakeholders to provide input to the process prior to data collection. Failure of an identified trustee to participate should not delay progress toward completion of the ERA; however, EPA should make a concerted effort to include stakeholders in the process.

It is very important at this stage to perform a "reality check." Sites that do not warrant further study should not be carried forward. Consideration of the site setting, COPCs, results of the food chain models and other information may be sufficient to decide that the area needs no further study and no remediation.

☞ *Only those sites that warrant further study should be carried forward into steps four through eight.*

The results of steps one through three for those sites which exit the ERA process at this point should be presented in the RI or RFI report.

Step 4: Study Design and Data Quality Objectives Process

The Study Design seeks to prove or refute the hypotheses in the ERA conceptual site model developed in step three. The study design should provide all procedures used for sampling and all methods, models or techniques used for data analysis.

Generally, ERA data collection involves sampling along a chemical concentration gradient. Biotic and abiotic samples should be collected at a common location. Data of this nature enables the risk assessment team to understand the relationship between concentrations in abiotic media and biological effects measured either by tissue residues or toxicity testing. Failure to collect colocated biotic and abiotic samples during the same sampling event will defeat the purpose of gradient sampling.

The Data Quality Objectives Process should be followed to set limits on decision errors and to obtain samples most likely to provide answers to the questions posed in Problem Formulation. The Guidance for Data Quality Objective QA/G-4 should be consulted. This guidance is available at http://es.epa.gov/ncerqa/qa/qa_docs.html.

The DQO process is applicable for obtaining samples from both biotic and abiotic sources. The study design should discuss methods of data analysis and identify criteria for acceptable risks.

A Scientific/Management Decision Point occurs at this stage for stakeholders to provide input to and approve the Study Design. However, the failure of an identified trustee to participate should not delay progress.

Step 5: Verification of Field Sampling Design

Step five confirms that the proposed data collection is possible and feasible in the field. Step five ensures that the work plan and the various Sampling and Analysis Plans (SAPs) will meet the needs of the assessment outlined in Problem Formulation.

Involvement of review personnel is critical. Field screening methods or rapid analytical are techniques to establish a concentration gradient and guide further sampling efforts.

An SMDP occurs at this stage to permit stakeholder input on any changes to the Study Design. However, the failure of an identified trustee to participate should not delay progress.

Step 6: Site Investigation

Step six is the performance of the RI/RFI data collection. Any deviation from the Study Design and associated SAP for the ERA requires agreement among the stakeholders. Hence, the process flow chart shows a possible SMDP at this stage.

Step 7: Risk Characterization

The data collected in step six is analyzed using the methods developed in step four.

☞ *If additional data suggest that the ecological risk assessment should be re-evaluated, then this re-evaluation may be necessary at this step, even if the ERA process was stopped at step three.*

Step 8: Risk Management

Step eight is risk management and includes the selection of a preferred remedial alternative. The selection procedure evaluates the ecological impacts of the various remedial alternatives. These alternatives are presented in the Feasibility Study (FS) under CERCLA or the Corrective Measures Study (CMS) under RCRA. The preferred remedial alternative is selected in the Proposed Plan and documented in the Record of Decision or Statement of Basis.

Selection of a remedial alternative is the quintessence of the risk management decision and will necessarily involve discussions with all stakeholders.

☞ *The determination of actual cleanup goals take into account mant factors in addition to the results of the risk assessment. Ecological screening levels may not be appropriate to use as final remediation goals.*

An SMDP also occurs at this last step.

Attachments

1) Exhibit 1-2 from Ecological Risk Assessment Guidance for Superfund. Process for Designing and Conducting Ecological risk Assessments
2) Draft Ecological Screening Levels for Soil taken from Friday, GP, (1998) ECOLOGICAL SCREENING VALUES FOR SURFACE WATER, SEDIMENT, AND SOIL, prepared for the Savannah River site
3) Ecological Screening Levels for Fresh Water
4) Ecological Screening Values for Salt Water
5) Ecological Screening Values for Sediment

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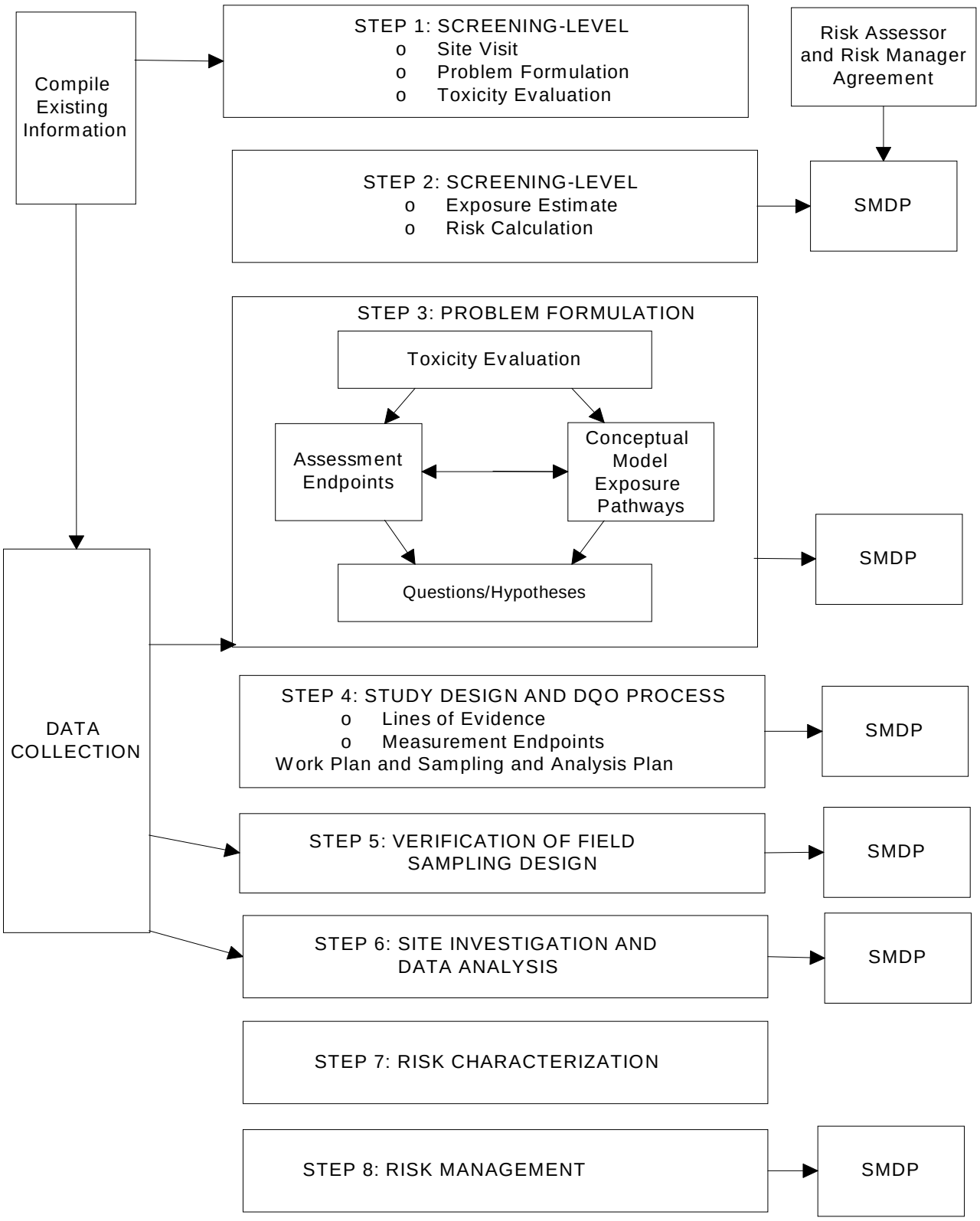
Attachment 1

EXHIBIT 1-2
Eight-step Ecological Risk Assessment Process for Superfund



Attachment 2
Recommended Ecological Screening Values (mg/kg) for Soil

Chemical	Screening Value	Source
Inorganics		
Aluminum	50	2
Antimony	3.5	5
Arsenic	10	2
Barium	165	5
Beryllium	1.1	5
Boron	0.5	2
Cadmium	1.6	5
Chromium	0.4	2, 3
Cobalt	20	1, 2, 4
Copper	40	5
Iron	200	2
Lanthanum	50	2
Lead	50	1, 2
Lithium	2.0	2
Manganese	100	2
Mercury (Inorganic)	0.1	2
Methylmercury	0.67	5
Molybdenum	2.0	2
Nickel	30	2
Selenium	0.81	5
Silver	2.0	2
Technetium	0.2	2
Thallium	1.0	2
Tin	53	5
Titanium	1000	2
Tungsten	400	2
Uranium	5.0	2
Vanadium	2.0	2
Zinc	50	2

Attachment 2 - Recommended Ecological Screening Values (mg/kg) for Soil (Continued)

Chemical	Screening Value	Source
Mineral Pollutants		
Bromine	10	2
Cyanide, free (total)	0.9	3
Cyanide, complex (total)	5.0	1
Thiocyanates	2.0	4
Fluorine	30	2
Iodine	4.0	2
Sulfur	2.0	1
Cyclic Aromatic Hydrocarbons		
Benzene	0.05	4
Biphenyl	60	2
Ethylbenzene	0.05	1, 4
Toluene	0.05	1, 4
Xylene	0.05	1, 4
Total Cyclic AHs	0.1	1
Phenolic Compounds		
Phenol	0.05	4
3-Chlorophenol	7.0	2
Chlorophenols (each)	0.01	1
Chlorophenols (total)	0.01	1
3,4-Dichlorophenol	20	2
Dichlorophenols (total)	0.003	4
2,4-Dinitrophenol	20	2
Monochlorophenols (total)	0.0025	4
4-Nitrophenol	7.0	2
Pentachlorophenol	0.002	4
2,3,4,5-Tetrachlorophenol	20	2
Tetrachlorophenols (total)	0.001	4
2,4,5-Trichlorophenol	4.0	2

Attachment 2 - Recommended Ecological Screening Values (mg/kg) for Soil (Continued)

Chemical	Screening Value	Source
Phenolic Compounds (continued)		
2,4,6-Trichlorophenol	10	2
Trichlorophenols (total)	0.001	4
Polycyclic Aromatic Hydrocarbons		
Acenaphthene	20	2
Anthracene	0.1	1
Benzo(a)Pyrene	0.1	1
Chloronaphthalene	1.0	4
Fluoranthene	0.1	1
Naphthalene	0.1	1
Phenanthrene	0.1	1
Pyrene	0.1	1
Total PAHs	1.0	1, 4
Substituted Hydrocarbons		
Aliphatic chlorinated hydrocarbons (each)	0.1	1
Aliphatic chlorinated hydrocarbons (total)	0.1	1
Carbon tetrachloride	1000	2
Chlorinated hydrocarbons (total)	0.1	1
Chloroacetamide	2.0	2
3-Chloroaniline	20	2
Chlorobenzene (each)	0.05	1
Chlorobenzene (total)	0.05	1
Cis-1,4-dichloro-2-butene	1000	2
2,4-Dichloroaniline	100	2
3,4-Dichloroaniline	20	2
Dichlorobenzene	0.01	4
1,2-Dichloroethane	0.4	4
Dichloromethane	2.0	4
1,2-Dichloropropane	700	2
Hexachlorobenzene	0.0025	4

Attachment 2 - Recommended Ecological Screening Values (mg/kg) for Soil (Continued)

Chemical	Screening Value	Source
Substituted Hydrocarbons (cont.)		
Hexachlorocyclopentadiene	10	2
Nitrobenzene	40	2
N-Nitrosodiphenylamine	20	2
Pentachloroaniline	100	2
Pentachlorobenzene	0.0025	4
PCBs (total)	0.02	4
Polycyclic chlorinated hydrocarbons (total)	0.1	1
2,3,5,6-Tetrachloroaniline	20	2
Tetrachlorobenzene	0.01	4
Tetrachloroethylene	0.01	4
Trans-1,4–dichloro-2-butene	1000	2
2,4,5-Trichloroaniline	20	2
Trichlorobenzene	0.01	4
Trichloroethylene	0.001	4
Chloroform	0.001	4
Vinyl chloride	0.01	4
Pesticides		
Aldrin	0.0025	4
Atrazine	0.00005	4
DDT/DDE/DDD	0.0025	4
Dieldrin	0.0005	4
Endrin	0.001	4
Carbaryl	0.5	4
Carbofuran	0.2	4
HCH-α	0.0025	4
HCH-β	0.001	4
HCH-γ (Lindane)	0.00005	4
Maneb	3.5	4
Organochlorinated (each)	0.1	1

Attachment 2 - Recommended Ecological Screening Values (mg/kg) for Soil (Continued)

Chemical	Screening Value	Source
Pesticides (cont.)		
Organochlorinated (total)	0.1	1
Total Pesticides	0.1	1
Other Pollutants		
Acrylonitrile	1000	2
Catechol	20	4
Cresols	0.5	4
Cyclohexane	0.1	1
Cyclohexanone	0.1	4
Diethylphthalate	100	2
Dimethylphthalate	200	2
Di-n-butylphthalate	200	2
Total Phthalates	0.1	4
Ethylene glycol	97	3
Furan	600	2
Gasoline	20	1
Hydrochinon	1.0	4
Mineral oils	50	4
Pyridine	0.1	1, 4
Resorcinol	1.0	4
Styrene	0.1	1, 4
Tetrahydrofuran	0.1	1, 4
Tetrahydrothiophene	0.1	1, 4

Attachment 2 - Sources:

1: Beyer,WN. 1990 Evaluating Soil Contamination. United States Fish and Wildlife Service. Biological Report 90(2).

2: Efroymson, R.A., M.E. Will, G.W. Suter. 1997a Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN ES/ER/TM-126/R2 (http://www.hsrd.ornl.gov/ecorisk/reports.html.
Efroymson, R.A., M.E. Will, G.W. Suter. 1997b Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN ES/ER/TM-85/R3 (http://www.hsrd.ornl.gov/ecorisk/reports.html.

3. Canadian Council of Ministers of the Environment (CCME). March 1997. Recommended Canadian Soil Quality Guidelines. Canadian Council of Ministers of the Environment (CCME), Winnipeg, Manitoba.

4. Ministry of Housing, Spatial Planning and Environment (MHSPE) 9 May 1994 Intervention Values and Target Values - Soil Quality Standards. Directorate-General for Environmental Protection, Department of Soil Protection, The Hague, The Netherlands.

5. Crommenttuijn, T., M.D. Polder, and E.J. van de Plassche. 1997. Maximum Permissible Concentrations and Negligible Concentrations for metals, taking background concentrations into account. RIVM Report No. 601501002.

Attachment 3
Region 4 Waste Management Division
Freshwater Surface Water Screening Values
for
Hazardous Waste Sites[1]

Compound	Acute Screening Values (ug/L)	Chronic Screening Values (ug/L)
Priority Pollutants		
Antimony	1300 (2s)	160 (2s)
Arsenic III	360*	190*
Beryllium	16 (6s)	0.53 (1s)
Cadmium[2]	1.79*	0.66*
Chromium (III)[2]	984.32*	117.32*
Chromium (VI)	16*	11*
Copper[2]	9.22*	6.54*
Lead[2]	33.78*	1.32*
Mercury	2.40*	0.012*[3]
Nickel[2]	789.00*	87.71*
Selenium	20.00*	5.00*
Silver[2]	1.23*	0.012(1s)
Thallium	140.00(3s)	4.00 (2s)
Zinc[2]	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

Compound	Acute Screening Value (ug/L)	Chronic Screening Values (ug/L)
2-Chloroethylvinyl Ether	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

Compound	**Acute Screening Value (ug/L)**	**Chronic Screening Values (ug/L)**
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

Compound	Acute Screening Value (ug/L)	Chronic Screening Values (ug/L)
N-Nitrosodiphenylamine	585(2s)	58.5
1,2,4-Trichlorobenzene	150(4s)	44.9 (1s)
Aldrin	3*	0.3
a-BHC	-	500[5]
b-BHC	-	5000[5]
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]

Compound	**Acute Screening Value (ug/L)**	**Chronic Screening Values (ug/L)**
Non-priority Pollutants		
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 IV Water Management Division, Water Quality Standards Unit's Screening List.
Hardness (mg/L as $CaCO_3$): 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	$e^{(1.128(\ln H)-3.828)}$	$e^{(0.7852(\ln H)-3.49)}$
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)

Attachment 4
Region 4 Saltwater Water Quality Screening Values for Hazardous Waste Sites[1]

Compound	Acute Screening Value (ug/L)	Chronic Screening Values (ug/L)
Priority Pollutants		
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

Compound	Acute Screening Value (ug/L)	Chronic Screening Values (ug/L)
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

Compound	Acute Screening Value (ug/L)	Chronic Screening Values (ug/L)
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-BromophenylPhenyl Ether	-	-
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

Compound	**Acute Screening Value (ug/L)**	**Chronic Screening Values (ug/L)**
N-Nitrosodiphenylamine	330000(1s)	33000
1,2,4-Trichlorobenzene	45(2s)	4.5
Aldrin	1.3*	0.13
a-BHC	-	1400[4]
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

Compound	**Acute Screening Value (ug/L)**	**Chronic Screening Values (ug/L)**
Non-priority Pollutants		
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 (S_2-, 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 H_2O) 440/5-88-004

Attachment 5 - Region 4 Waste Management Division
Sediment Screening Values

Chemical Analyte	Effects Value	CLP PQL[1]	Screening Value
Metals (ppm)			
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 (ppb)			
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 (67 for Aroclor 1221)	33 (67 for Aroclor 1221)

Chemical Analyte	Effects Value	CLP PQL	Screening Value
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	20.2[3]	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.