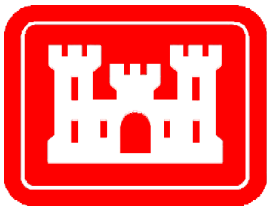
FINAL

SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT WORK PLAN FOR PHASE IV REMEDIAL INVESTIGATION/FEASIBILITY STUDY AT THE FORMER LAKE ONTARIO ORDNANCE WORKS (LOOW) NIAGARA COUNTY, NEW YORK

ADDENDUM TO THE SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT AT SELECTED EXPOSURE UNITS WITHIN THE FORMER LAKE ONTARIO ORDNANCE WORKS (LOOW) NIAGARA COUNTY, NEW YORK WORK PLAN



Prepared for

U.S. Army Corps of Engineers
Baltimore District

Contract W912DR-06-D-0002
Delivery Order 0009

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COMPLETION OF SENIOR TECHNICAL REVIEW

This document has been produced within the framework of the Earth Resources Technology, Inc. (ERT) and EA Engineering, Science, and Technology, Inc. (EA) quality management system. As such, a senior technical review, as defined in this Quality Control Plan, has been conducted. This included review of the overall design addressed within the document, proposed or utilized technologies and alternatives and their applications with respect to project objectives and framework of USACE regulatory constraints under the current DERP-FUDS No. C02NY0025 project, within which this work has been completed.

[redacted]

19 June 2009

[redacted] (EA) Date

Senior Technical Reviewer

COMPLETION OF INDEPENDENT TECHNICAL REVIEW

This document has been produced within the framework of ERT's total quality management system. As such, an independent technical review, appropriate to the level of risk and complexity inherent in the project as defined in this Quality Control Plan, has been conducted. This included review of assumptions (methods, procedures, and material used in analyses), alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the project objectives. Comments and concerns resulting from review of the document have been addressed and corrected as necessary.

[redacted]

19 June 2009

[redacted] Date

Independent Technical Reviewer

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LIST OF ACRONYMS AND ABBREVIATIONS

ATSDR	Agency for Toxic Substances and Disease Registry
BHC	Benzene Hexachloride (Hexachlorocyclohexane)
EA	EA Engineering, Science, and Technology
EcoSSL	Ecological Soil Screening Level
EU7	Exposure Unit 7
HMW PAH	High Molecular Weight Polycyclic Aromatic Hydrocarbons
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
LMW PAH	Low Molecular Weight Polycyclic Aromatic Hydrocarbons
LOAEL	Lowest Observed Adverse Effect Level
LOOW	Lake Ontario Ordnance Works
MDL	Method Detection Level
NOAEL	No Observed Adverse Effect Level
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
RI/FS	Remedial Investigation/Feasibility Study
RIVM	Rijksinstituut voor Volksgezondheid en Milieuhygiene
RL	Reporting Level
SLERA	Screening Level Ecological Risk Assessment
TOC	Total Organic Carbon
TRVs	Toxicity Reference Values
UCLM	Upper Confidence Limit on the Mean
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USEPA	United States Environmental Protection Agency
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

The earlier Screening Level Ecological Risk Assessment (SLERA) Work Plan (EA 2004) described the methods and processes for performance of the SLERA for the former Lake Ontario Ordnance Works (LOOW) in New York. As discussed in Section 3.2.3 of the earlier SLERA Work Plan (EA 2004), "It is proposed that EU6 comprise the Wastewater Treatment Plant (WWTP) Vicinity Shops and EU7 comprise the WWTP. During review of the preliminary draft of this Work Plan, a decision was made to forgo assessment of the WWTP at this time, due to the limited available analytical data (two samples) and pending remediation plans which could nullify the results of a prior risk assessment. The EU7 designation for the WWTP will be retained." Phase IV of the LOOW RI/FS for EU7 (WWTP) will address these data-gaps, and while the basic SLERA methodology remains unchanged from the original Work Plan (EA 2004), several years have passed since production of the SLERA Work Plan. The ecological habitat checklists for each of the EUs was presented in EA (2004) with the exception of EU7, however EU7 is immediately adjacent to EU6, which is included in EA (2004). The ecological habitat at EU7 is exactly the same as that found in EU6; consequently a specific EU7 ecological habitat checklist has not been included in the Addendum. This Addendum presents the modifications to the previously published Work Plan, specifically addressing:

- Updated Screening Benchmarks-Affecting Tables 5-1 and Appendix E,
- Updated Toxicity Reference Values (TRVs)-Affecting Table 6-4, and
- Updated methods for calculation of the Upper Confidence Limit on the Mean (UCLM) and performing the background comparisons.

Details related to these changes are discussed in Sections 2.0, 3.0, and 4.0 of this Addendum, respectively.

2.0 UPDATED ECOTOXICOLOGICAL SCREENING VALUES

Contaminants of potential concern are identified by screening site concentrations of chemicals against protective benchmarks. This is a conservative process that uses the maximum EU7 concentration as the exposure-point concentration. The screening benchmarks are, wherever possible, no-effect-based toxicological endpoints from the literature. Benchmarks were available primarily from three sources: USEPA, Oak Ridge National Laboratory, and the Dutch government. When available, the USEPA's Eco-SSL (ecological soil screening level) benchmarks were selected preferentially. USEPA's Eco-SSL benchmarks are updated quite often, and this addendum considers the latest available of the Eco-SSL benchmarks. These values were derived through a rigorous scientific process and are the most technically sound. If Eco-SSL values were not available, Oak Ridge National Laboratory benchmarks for the protection of plants (Efroymson et al. 1997a) and earthworms (Efroymson et al. 1997b) were selected. A number of organic compound benchmarks were based on Dutch soil guidelines (RIVM 1995). Dutch soil guidelines are determined by an agency within the Dutch Government titled the Rijksinstituut voor Volksgesondheid en Milieuhygine (RIVM) which translates to the Ministry of Housing, Spatial Planning and Environment. In cases where RIVM values are used one-half of the "intervention value" was established as the benchmark. The intervention value is the level above which represents "serious contamination." One-half of the intervention value approximates the concentration that, if exceeded, may warrant "further investigation" (RIVM 1994). Because the Dutch benchmarks are standardized to a soil organic carbon content of 10 percent, the benchmarks were adjusted to reflect the total organic carbon (TOC) content of the former LOOW surface soil of 1.5 percent (geometric mean of Phase II RI data). Finally, soil benchmarks for 2,4,6-trinitrotoluene, 2-amino-4,6-dinitrotoluene and RDX (Talmage et. al. 1999) have been added. Talmage and coauthors were associated with the Oak Ridge National Laboratory at the time of this publication. Terrestrial risk screening values were established for a number of ecological receptors, including plants, soil invertebrates, mammals, and birds. The lowest screening value for each of these receptors was chosen as the screening value in this Addendum. For example, the TNT screening value of 30 mg/kg was based on a plant endpoint.

The updated screening benchmarks are listed in Table 2-1 (this is an update to Table 5-1 of the Work Plan [EA 2004]) and are based on toxicological effects on terrestrial plants, soil invertebrates (e.g., earthworms, arthropods, etc.), avian receptors, or mammalian

receptors. If multiple benchmarks are available for a given chemical, the lowest of the benchmark values is proposed for use in the screen as a conservative approach. Derivation of the TOC-adjusted RIVM screening benchmarks is presented in Table 2-2 (updated from Appendix D of the Work Plan [EA 2004]).

In order to be sure that analytical detection limits were sufficiently low to support use of the proposed benchmarks, the benchmarks were compared to the Project Method Detection Limits (MDLs) and Reporting Limits (RLs) (Appendix E of the Work Plan [EA 2004]). Table 2-3 is an update of this table, utilizing the updated screening benchmarks presented in Table 2-1, along with most current laboratory MDLs and RLs.

As before for other EUs, bioaccumulative chemicals (e.g., pesticides, mercury) will be carried into the food-web assessment for EU7 regardless of the results of the initial screen. The nature of these chemicals is such that, even if they pose no risk to lower trophic levels, they could bioaccumulate in wildlife species and potentially pose risk.

3.0 UPDATED TOXICITY REFERENCE VALUES

Table 6-4 of the Work Plan (EA 2004) provided a listing of No Observed Adverse Effect Levels and Lowest Observed Adverse Effect Levels (NOAEL and LOAEL respectively). Since release of the Work Plan, there have been new recommended NOAEL and LOAEL values, particularly those used for derivation of EcoSSL benchmark screening values. In addition, NOAEL and LOAEL for explosive compounds such as 2,4,6-trinitrotoluene have been published. Table 3-1 contains the updated TRVs to be utilized for estimating food-web risks to ecological receptors, and replaces the values shown in Table 6-4 from the original Work Plan (EA 2004).

4.0 USE OF ProUCL TO CALCULATE UCLMs AND BACKGROUND COMPARISONS

Section 6.2 of the original Work Plan (EA 2004) provided detailed methods for the calculation of the 95 percent upper confidence limit of the mean (UCLM). Since 2004, the USEPA has released a statistical software program for the calculation of the UCLM called ProUCL, currently in Version 4.0 (USEPA, 2007a). In lieu of the procedures found in Section 6.2 of the 2004 SLERA Work Plan for calculation of exposure point concentrations, ProUCL Version 4.0 will be utilized to determine the UCLM. Outputs of the ProUCL program will be reported.

Appendix C of the original Work Plan (EA 2004) documented detailed methods for the comparison of background to site concentrations. A simplified background comparison will be used for EU7 as shown in Figure 1. ProUCL Version 4.0 will be used to calculate the appropriate background statistics, and the results of the quartile and Wilcox Rank Sum tests will be used to determine if site concentrations exceed background data set concentrations, as shown in Figure 1.

5.0 REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR). 1990a. *Toxicological Profile for Carbon Disulfide.* Draft. U.S. Public Health Service, Washington, DC.

ATSDR. 1990b. *Toxicological Profile for 2,3-Benzofuran.* Draft. U.S. Public Health Service, Washington, DC.

ATSDR. 1991. *Toxicological Profile for Tetrachloroethylene.* Draft. U.S. Public Health Service, Washington, DC.

Barnes, D., V. Sanders, K. White, Jr., G. Shopp, Jr., and A. Munson. 1985. Toxicology of trans-1,2-dichloroethylene in the mouse. *Drug Chem. Toxicol.* 8(5):373-392.

Bean, J. and R. Hudson. 1976. Acute oral toxicity and tissue residues of thallium sulfate in golden eagles, *Aquila chrysaetos. Bull. Envion. Contam. Toxicol*. 15:118-121.

Cikutovic, M., L. Fitzpatrick, B. Venables, and A. Goven. 1993. Sperm count in earthworms (Lumbricus terrestris) as a biomarker for environmental toxicology: effects of cadmium and chlordane. *Environmental Pollution* 81:123-125.

EA Engineering, Science, and Technology, Inc. (EA). 2004. *Work Plan Screening-Level Ecological Risk Assessment at Selected Exposure Units Within the Former Lake Ontario Ordnance Works (LOOW) Niagara County, New York*. Prepared for U.S. Army Corps of Engineers, Baltimore District and Buffalo District. Prepared by EA Engineering, Science, and Technology. November.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten, 1997a. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision*. Oak Ridge National Laboratory for the U.S. Department of Energy. ES/ER/TM-85/R3.

Efroymson, R.A., M.E. Will, and G.W. Suter II, 1997b. *Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997.* Oak Ridge National Laboratory for the U.S. Department of Energy. ES/ER/TM-126/R2.

Eisler, R. 1991. *Cyanide hazards to fish, wildlife, and invertebrates: a synoptic review.* U.S. Fish Wildl. Serv. Biol. Rep. 85(1.23). 55 pp.

Hall, J., U. Greichus, and K. Severson. 1971. Effects of aldrin on young pen-reared pheasants. *J. Wildl. Management* 35:429-434.

Hunt, L. and R. Sacho. 1969. Response of robins to DDT and methoxychlor. *J. Wildl. Management* 33:336-345

RIVM (Van den Berg, R. and J. Roels). 1995. *Risk Assessment to Man and the Environment in Case of Exposure to Soil Contamination: Integration of Different Aspects.* National Institute of Public Health and Environmental Protection, Bilthoven, The Netherlands. 1991 Dutch publication translated into English in 1995.

RIVM. 1994. *Intervention Values and Target Values: Soil Quality Standards.* Ministry of Housing, Spatial Planning, and Environment, Directorate-General for Environmental Protection, Department of Soil Protection. The Hague, The Netherlands.

RIVM (Denneman, C. and C. van Gestel). 1990. *Bodemverontreiniging en bodemecosystemen: voorstel voor C-(toetsings) waarden op basis van ecotoxicologische risico's.* Rijksinstituut voor Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision*. Oak Ridge National Laboratory for the U.S. Department of Energy. ES/ER/TM-86/R3.

Sax, N. 1984. *Dangerous Properties of Industrial Materials.* Sixth Edition. Van Nostrand Reinhold Co. 2641 pp.

Stickel, W., W. Didge, W. Sheldon, J. DeWitt, and L. Stickel. 1965. Body condition and response to pesticides in woodcocks. *J. Wildl. Management* 29:147-155.

Swartjes, F.A., 1999. *Risk-based assessment of soil and groundwater quality in the Netherlands: Standards and remediation urgency*. *Risk Anal*. 19:1235-1249.

Talmage S.S., D.M. Opresko, C.J. Maxwell, C.J.E. Welsh, F.M. Cretella, P.H. Reno, and F.B. Daniel.1999. Nitroaromatic munition compounds: environmental effects and screening values. *Rev. Environ. Contam. Toxicol.* 161:1-156.

U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). 2000. *Wildlife Toxicity Assessment for 2,4,6-Trinitrotoluene*. Project Number 39-EJ-1138-00. Aberdeen Proving Ground, Maryland. October.

USACHPPM. 2001a. *Wildlife Toxicity Assessment for 1,3,5-Trinitrobenzene*. Project Number 39-EJ1138-01B. Aberdeen Proving Ground, Maryland. November.

USACHPPM. 2001b. *Wildlife Toxicity Assessment for 1,3-Dinitrobenzene (m-DNB)*. Project Number 39-EJ1138-01B. Aberdeen Proving Ground, Maryland. December.

USACHPPM. 2001c. *Wildlife Toxicity Assessment for HMX*. Project Number 39-EJ-1138-01E. Aberdeen Proving Ground, Maryland. November.

USACHPPM. 2002. *Wildlife Toxicity Assessment for 1,3,5-Trinitrohexahydro-1,3,5-Triazine (RDX)*. Project Number 39-EJ1138-01B. Aberdeen Proving Ground, Maryland.

USACHPPM. 2005. *Wildlife Toxicity Assessment for 2-Amino-4,6-Dinitrotoluene and 4-Amino-2,6-Dinitrotoluene*. Project Number 39-EJ1138-01C. Aberdeen Proving Ground, Maryland. October.

USACHPPM. 2006. *Wildlife Toxicity Assessment for 2,4- and 2,6-Dinitrotoluene.* Document No. 39-EJ-1138-01D. January.

USACHPPM. 2007. *Wildlife Toxicity Assessment for Nitroglycerin*. Project Number 39-EJ-1138-01F. Aberdeen Proving Ground, Maryland. November.

United States Environmental Protection Agency (USEPA). 1987. *Health Effects Assessment for Selected Phthalic Acid Esters.* EPA/660/R-93/055. Office of Research and Development, Washington, DC.

USEPA. 1999. *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities.* Peer Review Draft. EPA530-D-99-001A. Office of Solid Waste and Emergency Response, Washington, DC.

USEPA, 2003a. *Ecological Soil Screening Levels for Aluminum.* OSWER Directive No. 9285.7-60. November.

USEPA, 2003b. *Ecological Soil Screening Levels for Iron.* OSWER Directive No. 9285.7-69. November.

USEPA, 2005a. *Ecological Soil Screening Levels for Antimony.* OSWER Directive No. 9285.7-61. February.

USEPA, 2005b. *Ecological Soil Screening Levels for Arsenic.* OSWER Directive No. 9285.7-62. March.

USEPA, 2005c. *Ecological Soil Screening Levels for Barium*. OSWER Directive No. 9285.7-63. February.

USEPA, 2005d. *Ecological Soil Screening Levels for Beryllium.* OSWER Directive No. 9285.7-64. February.

USEPA, 2005e. *Ecological Soil Screening Levels for Cadmium.* OSWER Directive No. 9285.7-65. March.

USEPA, 2005f. *Ecological Soil Screening Levels for Cobalt.* OSWER Directive No. 9285.7-67. March.

USEPA, 2005g. *Ecological Soil Screening Levels for Lead.* OSWER Directive No. 9285.7-70. March.

USEPA, 2005h. *Ecological Soil Screening Levels for Vanadium*. OSWER Directive No. 9285.7-75. April.

USEPA, 2006. *Ecological Soil Screening Levels for Silver.* OSWER Directive No. 9285.7-77. September.

USEPA, 2007a. ProUCL. Software developed by USEPA. Obtained on the Internet at http://www.epa.gov/ nerlesd1/tsc/software.htm. Las Vegas Technical Support Center for Monitoring and Site Characterization. April.

USEPA, 2007b. *Ecological Soil Screening Levels for Copper.* OSWER Directive No. 9285.7-68. February.

USEPA, 2007c. *Ecological Soil Screening Levels for Manganese.* OSWER Directive No. 9285.7-71. April.

USEPA, 2007d. *Ecological Soil Screening Levels for Nickel.* OSWER Directive No. 9285.7-76. March.

USEPA, 2007e. *Ecological Soil Screening Levels for Selenium.* OSWER Directive No. 9285.7-72. July.

USEPA, 2007f. *Ecological Soil Screening Levels for Zinc.* OSWER Directive No. 9285.7-73. June.

USEPA, 2007g. *Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs).* OSWER Directive No. 9285.7-78. June.

USEPA, 2007h. *Ecological Soil Screening Levels for DDT and Metabolites*. OSWER Directive No. 9285.7-57. April.

USEPA, 2007i. *Ecological Soil Screening Levels for Dieldrin*. OSWER Directive No. 9285.7-56. April.

USEPA, 2007j. *Ecological Soil Screening Levels for Pentachlorophenol*. OSWER Directive No. 9285.7-58. April.

USEPA, 2008. *Ecological Soil Screening Levels for Chromium.* OSWER Directive No. 9285.7-66. March.

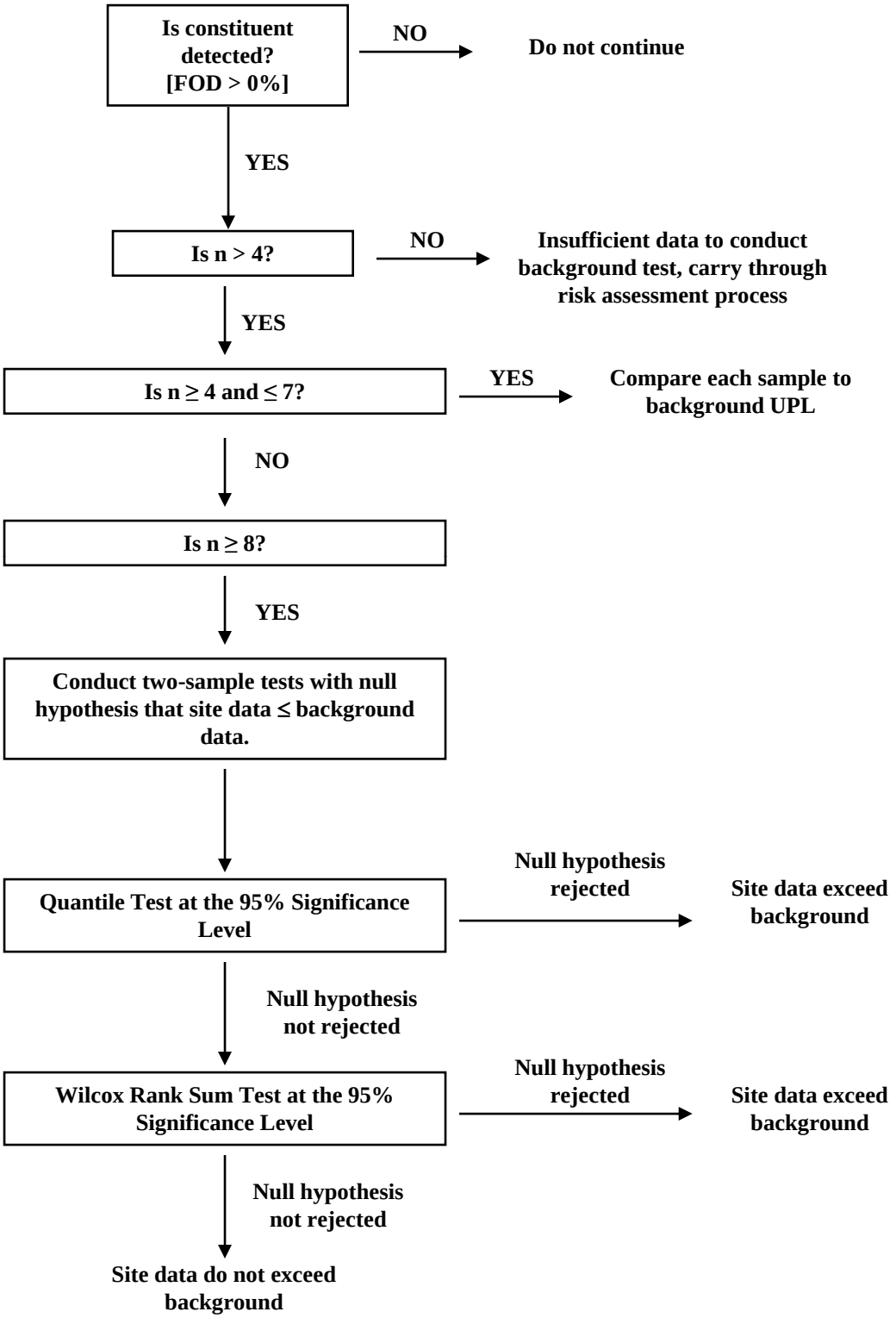

Figure 1. Decision Tree for Comparison to Background Data, EU 7 - Former LOOW Wastewater Treatment Plant

TABLE 2-1 SOIL SCREENING BENCHMARKS FOR FORMER WWTP SITE (EU7)

Analyte	Soil Screening Benchmark (mg/kg)	Benchmark Source
Inorganic Analytes		
Aluminum	NA[1]	USEPA (2003a)
Antimony	0.27	USEPA (2005a) based on mammalian receptors
Arsenic	18	USEPA (2005b) based on terrestrial plants
Barium	330	USEPA (2005c) based on soil invertebrates
Beryllium	21	USEPA (2005d) based on mammalian receptors
Boron	0.5	Efroymson et al. (1997a)
Cadmium	0.36	USEPA (2005e) based on mammalian receptors
Chromium	26	USEPA (2008) based on avian receptors
Cobalt	13	USEPA (2005f) based on terrestrial plants
Copper	28	USEPA (2007b) based on avian receptors
Cyanide	No value	Evaluate in food-web exposure assessment
Iron	NA[2]	USEPA (2003b) Eco-SSL Values
Lead	11	USEPA (2005g) based on avian receptors
Lithium	2	Efroymson et al. (1997a)
Manganese	220	USEPA (2007c) based on terrestrial plants
Mercury	0.1	Efroymson et al. (1997b)
Nickel	38	USEPA (2007d) based on terrestrial plants
Selenium	0.52	USEPA (2007e) based on terrestrial plants
Silver	4.2	USEPA (2006) based on avian receptors
Thallium	1	Efroymson et al. (1997a)
Vanadium	7.8	USEPA (2005h) based on avian receptors
Zinc	46	USEPA (2007f) based on avian receptors
Semivolatile Organic Compounds		
1,4-Dichlorobenzene	20	Efroymson et al. (1997b)
Benzyl butyl phthalate	NA	Use total phthalates
Bis(2-ethylhexyl) phthalate	NA	Use total phthalates
Di-n-butylphthalate	NA	Use total phthalates
Di-n-octyl phthalate	NA	Use total phthalates
Pentachlorophenol	2.1	USEPA (2007j) based on avian receptors
Phthalates, total	3	Swartjes (1999) assuming 1% TOC
Phenol	30	Efroymson et al. (1997b)
Polycyclic Aromatic Hydrocarbons		
Low Molecular Weight PAHs[3]	29	USEPA (2007g) based on soil invertebrates
High Molecular Weight PAHs[3]	1.1	USEPA (2007g) based on mammalian receptors
Pesticides/Polychlorinated Biphenyls		
4,4'-DDD	0.021	USEPA (2007h) based on mammalian receptors
4,4'-DDE	0.021	USEPA (2007h) based on mammalian receptors
4,4'-DDT	0.021	USEPA (2007h) based on mammalian receptors
Aldrin	0.03	RIVM 1995 (1/2 of Intervention Value)
alpha-BHC	0.15	RIVM (1995) (1/2 of Intervention Value of BHC isomers)
beta-BHC	0.15	RIVM (1995) (1/2 of Intervention Value of BHC isomers)
delta-BHC	0.15	RIVM (1995) (1/2 of Intervention Value of BHC isomers)
gamma-BHC (lindane)	0.15	RIVM (1995) (1/2 of Intervention Value of BHC isomers)
Chlordane, alpha, gamma	6.3	Cikutovic et al. (1993)
Dieldrin	0.0049	USEPA (2007i) based on mammalian receptors
Endosulfan I	3.8	RIVM (1990) (lowest NOEC value)
Endosulfan II	3.8	RIVM (1990) (lowest NOEC value)

TABLE 2-1 (Continued)

Analyte	Soil Screening Benchmark (mg/kg)	Benchmark Source
Endosulfan sulfate	3.8	RIVM (1990) (lowest NOEC value)
Endrin	0.005	RIVM 1995 (1/2 of Intervention Value)
Endrin aldehyde	0.005	Based on endrin as surrogate
Endrin ketone	0.005	Based on endrin as surrogate
Heptachlor	6.3	Based on chlordane as surrogate
Heptachlor epoxide	6.3	Based on chlordane as surrogate
Hexachlorobenzene	2.3	RIVM 1995 (1/2 of Intervention Value)
Total PCBs	2.5	USEPA (1999)
Volatile Organic Compounds		
1,1-Dichloroethane	4.5	Based on 1,2-dichloroethane as surrogate
1,2-Dichloroethane	4.5	RIVM 1995 (1/2 of Intervention Value)
1,1-Dichloroethylene	4.5	RIVM 1995 (1/2 of Intervention Value of volatile compounds)
Dichloromethane	4.5	RIVM 1995 (1/2 of Intervention Value of volatile compounds)
1,1,1-Trichloroethane	4.5	RIVM 1995 (1/2 of Intervention Value of volatile compounds)
1,1,2-Trichloroethane	4.5	RIVM 1995 (1/2 of Intervention Value of volatile compounds)
Benzene	1.9	RIVM 1995 (1/2 of Intervention Value)
Carbon disulfide	No value	Evaluate in food-web exposure assessment
Chloroform	No value	Evaluate in food-web exposure assessment
Cis-1,2-dichloroethene	4.5	RIVM 1995 (1/2 of Intervention Value of volatile compounds)
Ethylbenzene	No value	Evaluate in food-web exposure assessment
Styrene	300	Efroymson et al. (1997a)
Tetrachloroethylene	4.5	RIVM 1995 (1/2 of Intervention Value)
Toluene	200	Efroymson et al. (1997a)
Trichloroethylene	4.5	RIVM 1995 (1/2 of Intervention Value)
Xylenes, Total	No value	Evaluate in food-web exposure assessment
Explosives		
1,3,5-Trinitrobenzene	40	Efroymson et al. (1997b) (nitrobenzene as surrogate)
1,3-Dinitrobenzene	40	Efroymson et al. (1997b) (nitrobenzene as surrogate)
2-Nitrotoluene	30	TNT as surrogate
2,4-Dinitrotoluene	30	TNT as surrogate
2,4,6-Trinitrotoluene (TNT)	30	Talmage et al. (1999)
2,6-Dinitrotoluene	30	TNT as surrogate
2-amino-4,6-dinitrotoluene	80	Talmage et al. (1999)
3-Nitrotoluene	30	TNT as surrogate
4-Nitrotoluene	30	TNT as surrogate
4-amino-2,6-dinitrotoluene	80	2-amino-4,6-dinitrotoluene as surrgoate
HMX	No value	
Nitrobenzene	40	Efroymson et al. (1997b)
Nitroglycerin	No value	
RDX	100	Talmage et al. (1999)

[1]In their evaluation of potential soil-screening benchmarks for aluminum, USEPA (2003a) concluded that all available soil benchmarks for aluminum are based on the use of soluble aluminum in toxicity tests, and are therefore considered by the USEPA to be "inappropriate." USEPA declined to establish a soil concentration benchmark for aluminum; rather they directed that aluminum should only be identified as a soil COPC when the soil pH is less than 5.5. Should aluminum at any LOOW EU exceed background levels, the potential for risk will be assessed qualitatively.

[2]USEPA declined to establish a soil benchmark for iron due to the highly site-specific nature of bioavailability and toxicity to plants. They indicated that iron is not expected to be toxic to plants when soil pH is between 5 and 8. Should iron at any LOOW EU exceed background levels, the potential for risk will be assessed qualitatively.

[3]LPAH represent low molecular weight PAHs of fewer than 4 aromatic rings, HPAH represent high molecular weight PAHs of 4 or greater aromatic rings

Note: All RIVM (1995) benchmarks are adjusted for site-specific organic carbon content at LOOW (1.5%) relative to the standard Dutch soil the published benchmarks are based on (10.0%). Benchmarks for LOOW are reduced proportional to the difference in soil organic content (See Table 2-2).

TABLE 2-2 DERIVATION OF ORGANIC-CARBON CORRECTED SOIL SCREENING BENCHMARKS FROM RIVM (1995)

	RIVM Ecotox Intervention Value (mg/kg)	1/2 RIVM Ecotox Intervention Value (mg/kg)	1/2 Intervention Value Corrected for LOOW Soil Organic Carbon (TOC) Content (1.5%) (mg/kg)
Aldrin	0.35	0.175	0.03
Alpha-BHC	2	1	0.15
Beta-BHC	2	1	0.15
Delta-BHC	2	1	0.15
Gamma-BHC (lindane)	2	1	0.15
Endrin	0.06	0.03	0.005
Hexachlorobenzene	30	15	2.3
1,2-dichloroethane	60	30	4.5
1,1-dichloroethylene	60	30	4.5
Dichloromethane	60	30	4.5
1,1,1-trichloroethane	60	30	4.5
1,1,2-trichloroethane	60	30	4.5
Benzene	25	12.5	1.9
Cis-1,2-dichloroethene	60	30	4.5
Tetrachloroethylene	60	30	4.5
Trichloroethylene	60	30	4.5

RIVM soil benchmarks are standardized to a soil TOC content of 10%. The RIVM benchmarks were corrected for the LOOW TOC content (1.5%) as follows:

TOC-corrected benchmark = 1/2 RIVM benchmark X 1.5%/10%
RIVM (1994)

TABLE 2-3
COMPARISON OF PROPOSED SOIL SCREENING BENCHMARKS TO PROJECT REQUIRED METHOD DETECTION LIMITS AND REPORTING LIMITS

Analyte	Soil Screening Benchmark (mg/kg)	Method Detection Limit (MDL) (mg/kg)	Reporting Limit (RL) (mg/kg)
Inorganic Analytes			
Aluminum	Note 1	Note 1	Note 1
Antimony	0.27	0.24	2
Arsenic	18	0.26	2
Barium	330	0.01	0.5
Beryllium	21	0.01	0.2
Boron	0.5	1.77	15
Cadmium	0.36	0.02	0.6
Chromium	26	0.06	0.5
Cobalt	13	0.07	0.5
Copper	28	0.14	1
Cyanide	Note 2	Note 2	Note 2
Iron	Note 1	Note 1	Note 1
Lead	11	0.17	1
Lithium	2	0.045	2
Manganese	220	0.01	0.5
Mercury	0.1	0.01	0.03
Nickel	38	0.11	1
Selenium	0.52	0.45	2
Silver	4.2	0.03	0.5
Thallium	1	0.55	3
Vanadium	7.8	0.05	1
Zinc	46	0.21	2
Semivolatile Organic Chemicals			
1,4-Dichlorobenzene	20	0.1	0.33
Benzyl butyl phthalate	Note 3	Note 3	Note 3
Bis(2-ethylhexyl) phthalate	Note 3	Note 3	Note 3
Di-n-butylphthalate	Note 3	Note 3	Note 3
Di-n-octyl phthalate	Note 3	Note 3	Note 3
Phthalates, total	3	0.395	1.32
Phenol	30	0.066	0.33
Polycyclic Aromatic Hydrocarbons			
Total LMW PAHs (Note 4)	29	0.696	1.98
Total HMW PAHs (Note 5)	18	1.269	3.63
Pesticides/Polychlorinated Bipehnyls			
4,4’-DDD	0.021	0.00012	0.0017
4,4’-DDE	0.021	0.00013	0.0017
4,4’-DDT	0.021	0.00014	0.0017
Aldrin	0.03	0.00011	0.0017
alpha-BHC	0.15	0.00009	0.0017

TABLE 2-3 (Continued)

Analyte	Soil Screening Benchmark (mg/kg)	Method Detection Limit (MDL) (mg/kg)	Reporting Limit (RL) (mg/kg)
beta-BHC	0.15	0.00010	0.0017
delta-BHC	0.15	0.000077	0.0017
gamma-BHC (lindane)	0.15	0.00009	0.0017
Chlordane, alpha	6.3	0.00011	0.0017
Chlordane, gamma	6.3	0.00024	0.0017
Dieldrin	0.0049	0.00011	0.0017
Endosulfan I	3.8	0.00013	0.0017
Endosulfan sulfate	3.8	0.00013	0.0017
Endrin	0.005	0.00014	0.0017
Endrin aldehyde	0.005	0.000089	0.0017
Endrin ketone	0.005	0.00011	0.0017
Heptachlor	6.3	0.00010	0.0017
Heptachlor epoxide	6.3	0.00013	0.0017
Hexachlorobenzene	2.3	0.13	0.33
Total PCBs (Note 6)	2.5	0.0404	0.0017
Volatile Organic Compounds			
1,1-Dichloroethane	4.5	0.00029	0.005
1,2-Dichloroethane	4.5	0.00071	0.005
1,1-Dichloroethylene	4.5	0.00042	0.005
Dichloromethane	4.5	0.00085	0.005
1,1,1-Trichloroethane	4.5	0.00050	0.005
1,1,2-Trichloroethane	4.5	0.00082	0.005
Benzene	1.9	0.00032	0.005
Carbon disulfide	Note 2	Note 2	Note 2
Chloroform	Note 2	Note 2	Note 2
Cis-1,2-dichloroethene	4.5	0.00067	0.005
Ethylbenzene	Note 2	Note 2	Note 2
Styrene	300	0.00051	0.005
Tetrachloroethylene	4.5	0.00038	0.005
Toluene	200	0.00028	0.005
Trichloroethylene	4.5	0.00044	0.005
Xylenes, Total	Note 2	Note 2	Note 2

TABLE 2-3 (Continued)

Explosives			
1,3,5-Trinitrobenzene	40	0.005	0.040
1,3-Dinitrobenzene	40	0.0052	0.040
2-Nitrotoluene	30	0.014	0.080
2,4-Dinitrotoluene	30	0.0073	0.040
2,4,6-Trinitrotoluene (TNT)	30	0.0052	0.040
2,6-Dinitrotoluene	30	0.0025	0.040
2-amino-4,6-dinitrotoluene	80	0.051	0.040
3-Nitrotoluene	30	0.025	0.080
4-Nitrotoluene	30	0.034	0.080
4-amino-2,6-dinitrotoluene	80	0.0079	0.040
HMX	Note 2	Note 2	Note 2
Nitrobenzene	40	0.0048	0.040
Nitroglycerin	Note 2	Note 2	Note 2
RDX	100	0.012	0.080

Note 1: Neither aluminum nor iron are proposed for benchmark screening (see Table 2-1)
Note 2: Benchmarks not available; analytes carried directly to food-web assessment
Note 3: Only total phthalates screened; sum of individual phthalate MDLs and RLs shown
Note 4: Only total LMW PAH screened; sum of individual PAH MDLs and RLs shown
Note 5: Only total HMW PAH screened; sum of individual PAH MDLs and RLs shown
Note 6: Only total PCB screened; sum of individual aroclor MDLs and RLs shown
Shaded values indicate benchmarks that equal or are lower than the RL, or are lower than both the RL and MDL

TABLE 3-1 TOXICITY REFERENCE VALUES (TRVs) PROPOSED FOR FORMER LOOW SITE (EU7) FOOD-WEB EXPOSURE ASSESSMENT (mg/kg-body weight/day)

Analyte	Short-tailed shrew		Eastern cottontail		Red fox		White-tailed deer		American robin		Red-tailed hawk		Source		
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	Mammal	Avian	Notes
INORGANICS															
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	
Antimony	0.06	0.6	0.06	0.6	0.06	0.6	0.06	0.6	No TRV	No TRV	No TRV	No TRV	2	----	A
Arsenic	1.04	10.4	1.04	10.4	1.04	10.4	1.04	10.4	2.24	22.4	2.24	22.4	3	4	A, C
Barium	52	118.9	52	118.9	52	118.9	52	118.9	20.8	41.7	20.8	41.7	5	4	Z
Beryllium	0.53	0.67	0.53	0.67	0.53	0.67	0.53	0.67	No TRV	No TRV	No TRV	No TRV	6	----	Z
Boron	61.5	206	20.6	69	14.8	49	7.9	26	28.8	100	28.8	100	4	4	
Cadmium	0.77	7.7	0.77	7.7	0.77	7.7	0.77	7.7	1.47	7.8	1.47	7.8	7	7	Z
Chromium	2.4	35.1	2.4	35.1	2.4	35.1	2.4	35.1	2.6	15.6	2.6	15.6	8	8	Z
Cobalt	7.33	19	7.33	19	7.33	19	7.33	19	7.61	15.9	7.61	15.9	9	9	Z
Copper	5.6	56	5.6	56	5.6	56	5.6	56	4.05	40.5	4.05	40.5	10	10	A, C
Cyanide	141.9	1419	47.4	474	34.1	341	18.1	181	3.6	34.1	3.6	34.1	4	11	A, B
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	12	12	
Lead	4.7	47	4.7	47	4.7	47	4.7	47	1.63	16.3	1.63	16.3	13	13	A,C
Lithium	20.7	41.3	6.9	13.8	5	9.9	2.6	5.3	No TRV	No TRV	No TRV	No TRV	4	----	
Manganese	51.5	139	51.5	139	51.5	139	51.5	139	179	269	179	269	14	14	Z
Mercury	15.7	157	5.25	52.5	3.77	37.7	2	20	0.45	0.9	0.45	0.9	4	4	A
Nickel	1.7	17	1.7	17	1.7	17	1.7	17	6.71	18.6	6.71	18.6	15	15	A, Z
Selenium	0.143	1.43	0.143	1.43	0.143	1.43	0.143	1.43	0.29	2.9	0.29	2.9	16	16	A, C
Silver	6.02	60.2	6.02	60.2	6.02	60.2	6.02	60.2	2.02	20.2	2.02	20.2	17	17	D
Thallium	0.016	0.164	0.005	0.055	0.004	0.039	0.002	0.021	0.42	4.2	2.1	21	4	18	E
Vanadium	4.16	41.6	4.16	41.6	4.16	41.6	4.16	41.6	0.344	3.44	0.344	3.44	19	19	A, C
Zinc	75.4	292.1	75.4	292.1	75.4	292.1	75.4	292.1	66.1	171	66.1	171	20	20	Z
POLYCYCLIC AROMATIC HYDROCARBONS															
Low Molecular Weight PAHs	65.6	656	65.6	656	65.6	656	65.6	656	1,664	16,640	1,664	16,640	21	21	A, C
High Molecular Weight PAHs	0.615	6.15	0.615	6.15	0.615	6.15	0.615	6.15	2.0	20	2.0	20	21	21	A, C
POLYCHLORINATED BIPHENYLS															
Total PCBs	0.067	0.668	0.022	0.223	0.096	0.474	0.009	0.085	0.18	1.8	0.18	1.8	4	4	G
PESTICIDES															
DDT (and metabolites)	0.147	1.47	0.147	1.47	0.147	1.47	0.147	1.47	0.227	2.27	0.227	2.27	22	22	A, C
Aldrin	0.44	2.2	0.15	0.74	0.11	0.53	0.06	0.28	0.05	0.5	0.05	0.5	4	23	H
Alpha-BHC	0.88	4.4	0.29	1.47	0.21	1.06	0.11	0.56	0.56	2.25	0.56	2.25	4	4	Y
Beta or delta-BHC	0.88	4.4	0.29	1.47	0.21	1.06	0.11	0.56	0.56	2.25	0.56	2.25	4	4	X
Gamma-BHC (lindane)	17.58	175.8	5.88	58.8	4.22	42.2	2.24	22.4	2	20	2	20	4	4	C
Chlordane	5.5	10.9	1.8	3.7	1.3	2.6	0.7	1.4	2.1	10.7	2.1	10.7	4	4	
Dieldrin	0.015	0.15	0.015	0.15	0.015	0.15	0.015	0.15	0.071	0.71	0.071	0.71	24	24	A, C
Endosulfan I	0.33	3.3	0.11	1.1	0.08	0.8	0.04	0.4	10	100	10	100	4	4	A, C
Endosulfan II	0.33	3.3	0.11	1.1	0.08	0.8	0.04	0.4	10	100	10	100	4	4	I
Endosulfan sulfate	0.33	3.3	0.11	1.1	0.08	0.8	0.04	0.4	10	100	10	100	4	4	I

TABLE 3-1 (continued)

Analyte	Short-tailed shrew		Eastern cottontail		Red fox		White-tailed deer		American robin		Red-tailed hawk		Source		
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	Mammal	Avian	Notes
Endrin	0.109	1.094	0.037	0.366	0.026	0.263	0.014	0.14	0.01	0.1	0.01	0.1	4	4	
Endrin aldehyde	0.109	1.094	0.037	0.366	0.026	0.263	0.014	0.14	0.01	0.1	0.01	0.1	4	4	J
Endrin ketone	0.109	1.094	0.037	0.366	0.026	0.263	0.014	0.14	0.01	0.1	0.01	0.1	4	4	J
Heptachlor	0.286	2.857	0.096	0.955	0.069	0.687	0.036	0.365	1.8	18	1.8	18	4	25	K
Heptachlor epoxide	0.286	2.857	0.096	0.955	0.069	0.687	0.036	0.365	1.8	18	1.8	18	4	25	L
Methoxychlor	8.8	17.6	2.9	5.9	2.1	4.2	1.1	2.2	37.5	375	37.5	375	4	26	S, C
SEMIVOLATILE ORGANIC COMPOUNDS															
Bis(2-ethylhexyl)phthalate	21.8	218	7.3	73	5.2	52	2.8	28	1.1	11	1.1	11	4	4	C
Carbazole	5	50	5	50	5	50	5	50	No TRV	No TRV	No TRV	No TRV	27	----	A
Di-n-butyl phthalate	654	2180	219	729	157	524	83	278	0.11	1.1	0.11	1.1	4	4	
Di-n-octyl phthalate	2500	25000	2500	25000	2500	25000	2500	25000	No TRV	No TRV	No TRV	No TRV	28	----	A
Dibenzofuran	3	30	3	30	3	30	3	30	No TRV	No TRV	No TRV	No TRV	29	----	O, P
Pentachlorophenol	8.42	23.5	8.42	23.5	8.42	23.5	8.42	23.5	6.73	67.3	6.73	67.3	30	30	Z, C
Phenol	8.42	23.5	8.42	23.5	8.42	23.5	8.42	23.5	6.73	67.3	6.73	67.3+	30	30	R, Z, C
VOLATILE ORGANIC COMPOUNDS															
1,1,1-Trichloroethane	1236	12360	413	4130	297	2970	158	1580	No TRV	No TRV	No TRV	No TRV	4	----	A
1,1,2-Trichloroethane	1236	12360	413	4130	297	2970	158	1580	No TRV	No TRV	No TRV	No TRV	4	----	T
1,1-Dichloroethylene	65.9	659	22	220	3.1	31	8.4	84	No TRV	No TRV	No TRV	No TRV	4	----	A
1,1-Dichloroethane	61.8	618	20.7	207	14.8	148	7.9	79	17.2	34.4	17.2	34.4	4	4	U
1,2-Dichloroethane	61.8	618	20.7	207	14.8	148	7.9	79	17.2	34.4	17.2	34.4	4	4	A
2-Butanone	3892	10046	1301	3359	935	2414	497	1282	No TRV	No TRV	No TRV	No TRV	4	----	
Cis-1,2-Dichloroethene	387	3870	387	3870	387	3870	387	3870	No TRV	No TRV	No TRV	No TRV	31	----	M; A
4-methyl-2-pentanone	54.9	549	18.4	184	13.2	132	7	70	No TRV	No TRV	No TRV	No TRV	4	----	A
Acetone	22	109.9	7.3	36.7	5.3	26.4	2.8	14	No TRV	No TRV	No TRV	No TRV	4	----	
Benzene	31.3	313.5	10.5	104.8	7.5	75.3	4	40	No TRV	No TRV	No TRV	No TRV	4	----	
Carbon disulfide	3	30	3	30	3	30	3	30	No TRV	No TRV	No TRV	No TRV	32	----	N; A
Chloroform	33	90	11	30	7.9	22	4.2	12	No TRV	No TRV	No TRV	No TRV	4	----	
Ethyl benzene	35	350	35	350	35	350	35	350	No TRV	No TRV	No TRV	No TRV	27	----	Q; A
Methylbenzene	31.3	313.5	10.5	104.8	7.5	75.3	4	40	No TRV	No TRV	No TRV	No TRV	4	----	W
Methylene chloride	12.9	109.9	4.3	36.7	3.1	26.4	1.6	14	No TRV	No TRV	No TRV	No TRV	4	----	
Tetrachloroethene	38.6	386	38.6	386	38.6	386	38.6	386	No TRV	No TRV	No TRV	No TRV	33	----	P
Trichloroethylene	0.832	8.324	0.278	2.783	0.2	2	0.106	1.063	No TRV	No TRV	No TRV	No TRV	4	----	
Xylenes, total	2.497	3.092	0.835	1.034	0.6	0.743	0.319	0.395	No TRV	No TRV	No TRV	No TRV	4	----	
EXPLOSIVES															
1,3,5-Trinitrobenzene	2.68	13.31	2.68	13.31	2.68	13.31	2.68	13.31	No TRV	No TRV	No TRV	No TRV	34	----	
1,3-Dinitrobenzene	0.04	0.2	0.04	0.2	0.04	0.2	0.04	0.2	No TRV	No TRV	No TRV	No TRV	35	----	
2-Nitrotoluene	0.67	1.4	0.67	1.4	0.67	1.4	0.67	1.4	0.01	1.3	0.01	1.3	41	----	V
2,4-Dinitrotoluene	0.67	1.4	0.67	1.4	0.67	1.4	0.67	1.4	0.01	1.3	0.01	1.3	41	41	
2,4,6-Trinitrotoluene (TNT)	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.07	1.8	0.07	1.8	36	36	
2,6-Dinitrotoluene	0.7	7	0.7	7	0.7	7	0.7	7	No TRV	No TRV	No TRV	No TRV	41	----	
2-amino-4,6-dinitrotoluene	9.0	48.0	9.0	48.0	9.0	48.0	9.0	48.0	No TRV	No TRV	No TRV	No TRV	37	37	
3-Nitrotoluene	0.67	1.4	0.67	1.4	0.67	1.4	0.67	1.4	0.01	1.3	0.01	1.3	41	41	V
4-Nitrotoluene	0.67	1.4	0.67	1.4	0.67	1.4	0.67	1.4	0.01	1.3	0.01	1.3	41	41	V

TABLE 3-1 (continued)

Analyte	Short-tailed shrew		Eastern cottontail		Red fox		White-tailed deer		American robin		Red-tailed hawk		Source		
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	Mammal	Avian	Notes
4-amino-2,6-dinitrotoluene	9.0	48.0	9.0	48.0	9.0	48.0	9.0	48.0	No TRV	No TRV	No TRV	No TRV	37	37	
HMX	1	5	1	5	1	5	1	5	No TRV	No TRV	No TRV	No TRV	38	----	
Nitrobenzene															
Nitroglycerin	3.0	32.0	3.0	32.0	3.0	32.0	3.0	32.0	NA	NA	NA	NA	39	----	F
RDX	1.19	2.73	1.19	2.73	1.19	2.73	1.19	2.73	3.65	8.14	3.65	8.14	40	40	

Sources:

(1) USEPA (2003a)
(2) USEPA (2005a)
(3) USEPA (2005b)
(4) Sample et al. (1996)
(5) USEPA (2005c)
(6) USEPA (2005d)
(7) USEPA (2005e)
(8) USEPA (2008)
(9) USEPA (2005f)
(10) USEPA (2007b)
(11) Eisler (1991)
(12) USEPA (2003b)
(13) USEPA (2005g)
(14) USEPA (2007c)
(15) USEPA (2007d)
(16) USEPA (2007e)
(17) USEPA (2006)
(18) Bean and Hudson (1976)
(19) USEPA (2005h)
(20) USEPA (2007f)
(21) USEPA (2007g)
(22) USEPA (2007h)
(23) Hall et al. (1971)
(24) USEPA (2007i)
(25) Stickel et al. (1965)
(26) Hunt and Sacho (1969)
(27) Sax (1984)
(28) USEPA (1987)
(29) ATSDR (1990b)
(30) USEPA (2007j)
(31) Barnes et al. (1985)
(32) ATSDR (1990a)
(33) ATSDR (1991)
(34) USACHPPM (2001a)
(35) USACHPPM (2001b)
(36) USACHPPM (2000)
(37) USACHPPM (2005)
(38) USACHPPM (2001c)
(39) USACHPPM (2007)
(40) USACHPPM (2002)

Notes:

(A) Mammal LOAEL approximated as 10 X NOAEL
(B) Avian NOAEL based on 8-week study of effects on newly-hatched chickens (Eisler 1991); LOAEL approximated as 10 X NOAEL
(C) Avian LOAEL approximated as 10 X NOAEL
(D) Insufficient NOAEL data to directly calculate an NOAEL; the lowest LOAEL for reproduction or growth endpoint was divided by 10 to approximate the NOAEL.
(E) TRV for red-tailed hawk based on a single dose LOAEL (21 mg/kg/day) for golden eagle, muscle coordination; LOAEL divided by 10 to approximate NOAEL. Both values divided by 10 to account for intertaxon variability, to estimate TRVs for the robin.
(F) No adverse effects were found in Northern Bobwhite exposed to greater than 5000 ppm nitroglycerin for eight days; nitroglycerin is considered to be non-toxic in environmental settings.
(G) Based on Aroclor 1254.
(H) Avian TRV based on ring-necked pheasant NOAEL in 21-day growth study; LOAEL approximated as NOAEL X 10.
(I) Based on endosulfan as surrogate.
(J) Based on endrin as surrogate.
(K) Avian TRV based on American woodcock LD50 divided by 100 to approximate NOAEL, then multiplied by 10 to approximate LOAEL.
(L) Based on heptachlor as surrogate.
(M) Based on 90-day NOAEL for male mice for trans isomer; various pathological-hematological effects. Same value used for all mammal receptors.
(N) A 300 mg/kg/day NOAEL (1-14 day) for liver effects on mice was documented, and divided by 100 to extrapolate to a chronic NOAEL.
(O) 2,3 benzofuran used as surrogate. 103-week LOAEL for rats and mice survival.
(P) Mammal NOAEL approximated as LOAEL/10.
(Q) Based on LD50 of 3500 mg/kg/day for rats, divided by 100 to approximate chronic NOAEL.
(R) Based on pentachlorophenol as surrogate for both mammals and birds.
(S) Five-day NOAEL of 3750 mg/kg/day for robins fed earthworms, mortality endpoint. Divided by 100 to approximate chronic NOAEL of 37.5 mg/kg/day.
(T) Based on 1,1,1-trichloroethane as a surrogate.
(U) Based on 1,2-dichloroethane as a surrogate.
(V) Based on 2,4-dinitrotoluene as a surrogate.
(W) Based on benzene as a surrogate.
(X) Avian TRV based on BHC-mixed isomers.
(Y) Based on beta-BHC as a surrogate.
(Z) LOAEL calculated as geometric mean of available Eco-SSL LOAEL values.