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Standard Guide for Data and Information Options for Conducting an Ecological Risk Assessment at Contaminated Sites[1]

This standard is issued under the fixed designation E2020; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide is intended to assist remedial project teams, specifically ecological risk assessors, in identifying data and information options that may be used to perform a screening or complex ecological risk assessment (ERA) at a contaminated site.

1.2 The identification of data and information options for human health risk assessment is outside the scope of this guide.

1.3 This guide is intended to provide a list for identifying data and information options and does not recommend a specific course of action for ERA activities.

1.4 This guide addresses data and information options for the ecological risk assessment, not verification or long-term monitoring studies.

1.5 This guide lists many of the common data and information options for ERA, but there may be others relevant for any particular site.

1.6 This guide considers one component of an ERA, that is, identification of data and information options. Other ASTM guides have been developed, for example, Guides E1689 and E1848, and are being developed to cover other components of the risk assessment process.

1.7 This guide does not provide information on how to perform any of the analytical procedures used to perform a risk assessment once data collection options are defined.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D5730 Guide for Site Characterization for Environmental Purposes With Emphasis on Soil, Rock, the Vadose Zone and Groundwater (Withdrawn 2013)[3]

E1391 Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing and for Selection of Samplers Used to Collect Benthic Invertebrates

E1525 Guide for Designing Biological Tests with Sediments

E1689 Guide for Developing Conceptual Site Models for Contaminated Sites

E1848 Guide for Selecting and Using Ecological Endpoints for Contaminated Sites

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *assessment endpoint, n*—an explicit expression of the environmental value to be protected.

3.1.2 *chemical stressor, n*—a chemical, chemical mixture, or radionuclide present in an environmental medium that is known or suspected to induce an adverse biological, toxicological, or ecological response in an exposed ecological receptor.

3.1.3 *complex ecological risk assessment, n*—an ecological risk assessment completed using quantitative methods, which relies on site-specific data and may include toxicity testing, field biological surveys, and probabilistic analysis.

3.1.4 *data quality objective, n*—a specification of the amount and quality of data required to adequately complete the risk assessment such that a risk management decision can be made.

3.1.5 *ecological receptor, n*—ecosystems, communities, populations, and individual organisms (except humans), that can be exposed directly or indirectly to site stressors.

3.1.6 *measurement endpoint, n*—a measurable response to a stressor that is quantifiably related to the valued characteristic chosen as the assessment endpoint.

3.1.7 *non-chemical stressor, n*—a biological agent, physical disturbance, condition, or nonchemical characteristic of a

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

waste material, substrate, or source associated with a contaminated site and corrective actions that is known or suspected to interfere with the normal functioning of an ecological receptor.

3.1.8 *screening ecological risk assessment, n*—an ecological risk assessment completed using qualitative or simple quantitative methods, which relies on literature information and is unlikely to include toxicity testing, field biological surveys, or probabilistic analysis.

3.1.9 *site, n*—the terms "site," "on-site," and "off-site," have not been defined in this guide. They will need to be defined on a case-by-case basis. They could be defined by regulatory needs, natural boundaries, or property boundaries.

4. Summary of Guide

4.1 This guide provides a series of lists of data and information options for conducting an ecological risk assessment at a contaminated site and is organized in accordance with the major components of the risk assessment process: problem formulation, exposure characterization, effects characterization, and risk characterization (**1-4**).[4] Lists are provided for screening and complex ERAs.

5. Significance and Use

5.1 This guide is significant in that it addresses the data and information options of each component of the ecological risk assessment process, for both a screening and complex ERA. It outlines the data and information options while recognizing that an ecological risk assessment may be focused to achieve a particular stated goal. This guide is not intended to represent the views of the U.S. Environmental Protection Agency (USEPA), or any other regulatory agency, on data collection for ecological risk assessment.

5.2 This guide is to be used by managers, scientists, and technical staff of contractors, industry, government agencies, and universities responsible for conducting ecological risk assessments at contaminated sites. It is to be used to guide data collection phases of the ecological risk assessment. It will assist in the development of the conceptual site model (see Guide E1689) and the identification of potential assessment and measurement endpoints (see Guide E1848). While it was written to assist in planning an ERA, the list also may be used in the review of a completed ERA.

6. General Guidance on Determining Data Collection Options for Ecological Risk Assessment

6.1 It is imperative that the goals of the ERA are outlined at the beginning of the ERA process. Data collection efforts may then be focused to ensure a sound scientific approach and cost-effective use of resources, for example, time and money.

6.2 The lists are not meant to be exhaustive. Neither are they intended to be lists of data required for all ERAs. The amount and type of data required for a screening or complex ERA will depend upon the size and location of the site, the future intended use of the site, the complexity of the site, and the outcome of the data quality objectives (DQO) process (**5**). A typical site may utilize only a small percentage of these data and information options. These lists are intended to serve as a general index to data collection efforts.

7. Lists

7.1 Not all of the components within the following lists will be relevant at every contaminated site. In addition, some information may be site-specific and other information may be obtained from the literature. Literature data are more prevalent in screening ERAs and site-specific data are more prevalent in complex ERAs. Whenever practicable, site-specific data are preferred over literature data.

7.2 The options in the lists are not in any particular order. Risk assessment often is an iterative process, and it may be more scientifically sound and cost-effective to complete certain options before others. The order for the completion of options will need to be determined on a case-by-case basis.

8. Data Options for Problem Formulation

8.1 Most of the data and information options in problem formulation are applicable to both screening and complex ERAs and are outlined below; however, the information will be more detailed in a complex ERA. Additional data and information options typically found only in complex ERAs are listed in Section 9.

8.2 Clearly define the goals of the ERA (**6**).

8.3 Define data quality objectives (DQOs) for the assessment see Ref.(**5**).

8.3.1 State the problem that the risk assessment should address.

8.3.2 Identify the decision(s) that require new environmental data to address the contamination problem.

8.3.3 Identify the inputs (data or information) needed to support the decision.

8.3.4 Define the scale (spatial and temporal) of the assessment.

8.3.5 Develop a decision rule that defines choice among alternative solutions.

8.3.6 Specify acceptable limits on decision errors used to establish performance goals for limiting uncertainty.

8.3.7 Optimize the design for obtaining data, by identifying the most resource-effective sampling and analysis plan.

8.4 Complete the conceptual site model (see Guide E1689)

8.4.1 Identify the current and historical sources of potential chemical stressors, such as the following:

8.4.1.1 Process areas;

8.4.1.2 Landfill;

8.4.1.3 Burial ground;

8.4.1.4 Underground or aboveground storage tanks, or both;

8.4.1.5 Lagoons;

8.4.1.6 Holding ponds;

8.4.1.7 Air stacks or other air emission sources;

8.4.1.8 Effluent pipes; or,

8.4.1.9 Historical spills or accidental releases.

8.4.2 Identify nonchemical, for example, physical and biological stressors, such as the following:

[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.

8.4.2.1 Nonnative or exotic species;
8.4.2.2 Pathogens;
8.4.2.3 Temperature;
8.4.2.4 Suspended solids;
8.4.2.5 Change in water levels;
8.4.2.6 Oxygen depletion;
8.4.2.7 pH;
8.4.2.8 Predators;
8.4.2.9 Habitat alteration, degradation or destruction; or,
8.4.2.10 Non-site-related stressors, for example, local releases from municipal or industrial development.

8.4.3 Identify potential constituent migration pathways.

8.4.4 Identify geological features that control movement of constituents and dictate exposure pathways. In particular, note any features which would cause unpredictable movement of constituents, for example, karst formations in limestone often cause difficulties in tracing ground water movement.

8.4.5 Identify all relevant constituent-bearing media, such as the following:
8.4.5.1 Soil;
8.4.5.2 Ground water;
8.4.5.3 Surface water;
8.4.5.4 Sediment;
8.4.5.5 Air; or,
8.4.5.6 Biota.

8.4.6 Identify direct and indirect complete exposure pathways. Ensure that exposure pathways are identified appropriately, for example, PCBs may not be detected in surface water, but may be detected in fish tissues, and therefore, food web exposure pathways are appropriate to consider. Exposure pathways may include the following:
8.4.6.1 Inhalation;
8.4.6.2 Ingestion;
8.4.6.3 Dermal uptake;
8.4.6.4 Root uptake; or,
8.4.6.5 Food web.

8.4.7 Identify normal and atypical weather patterns for the site location, such as the following:
8.4.7.1 Excessive dry periods with high winds may lead to increased levels of constituents in air from fugitive dusts, and destruction of habitat;
8.4.7.2 Storm events, for example, hurricanes, that may mobilize constituents, for example, suspension of sediments may increase the bioavailability of constituents;
8.4.7.3 Periodic flooding may result in certain exposure pathways that may otherwise not exist, for example, contamination of the floodplain community from a stream; or,
8.4.7.4 Fluctuations in salinity.

8.4.8 Define the assessment endpoints and include rationale for their selection (see Guide E1848).
8.4.8.1 Ensure the assessment endpoints are relevant to decision-making. **(7)**
8.4.8.2 Consider whether endpoints are ecologically relevant.
8.4.8.3 Consider whether endpoints have societal importance.
8.4.8.4 Determine whether endpoint species are or could be at the site.
8.4.8.5 Consider whether endpoint species are sensitive to site constituents.
8.4.8.6 Consider whether endpoint species are likely to receive high exposures.

8.4.9 Identify any threatened, or endangered species (plant or animal), or both, known to inhabit, or that could potentially inhabit, the vicinity of the site. Also, identify the presence of habitat that could be utilized by threatened and endangered species. Consider using state or federal listings of threatened, rare and endangered species, for example, Natural Heritage Program. Consider local laws and regulations to identify any protected species or species of local concern.

8.4.10 Identify any commercially or recreationally important species in the area of the site.

8.4.11 Describe the food web. Identify multiple food sources, where appropriate, in the foraging area of each receptor species. Consider consulting with local naturalists, for example, Department of Natural Resources, Fish and Wildlife Service, Department of Environmental Protection, Natural Heritage Program, to obtain information on local species.

8.4.12 Define measurement endpoints and include rationale for their selection. Also, describe relation between assessment endpoints and measurement endpoints.

8.4.13 Present both current and future exposure scenarios. Future exposures should be based on reasonably anticipated future land use. Describe how future exposures may change, as a result of the following scenarios, for example:
8.4.13.1 Increased release from a ground water plume to a stream;
8.4.13.2 Increased habitat from forest succession causes additional ecological receptor species to be in contact with constituents;
8.4.13.3 Decreased exposure because of scouring of sediments out of a stream, but increased exposure downstream where sediments settle;
8.4.13.4 Weather-related seasonal or periodic changes; or,
8.4.13.5 Continued physical degradation or biodegradation of constituents.

8.5 Environmental Description of Site **(8)**:

8.5.1 Describe and map current and potential future land use scenarios of the site and surrounding area, to ensure assessment endpoints and ecological receptor species are selected that are appropriate for current and future land uses. Land uses may include the following:
8.5.1.1 Residential;
8.5.1.2 Park land/recreational;
8.5.1.3 Industrial;
8.5.1.4 Commercial;
8.5.1.5 Agricultural;
8.5.1.6 Forested;
8.5.1.7 Wetlands;
8.5.1.8 Wildlife preservation area; or,
8.5.1.9 Aquatic habitat.

8.5.2 Describe and map the aquatic habitat.
8.5.2.1 Describe and map features as follows:
(a) Type and area of habitat;
(b) Function of habitat;
(c) Water and sediment quality parameters;

(d) Pattern of ground water and surface water flow;
(e) Ground water discharge and recharge points; or,
(f) Flora and fauna historically present, currently present, or expected to be present.

8.5.2.2 Consider photographing relevant features.

8.5.2.3 Consider utilizing geographic information systems (GIS) or similar visualization tools.

8.5.3 Describe and map the terrestrial habitat.

8.5.3.1 Describe and map features as follows:
(a) Type and area of habitat;
(b) Function of habitat;
(c) Topography;
(d) Soil types;
(e) Flora and fauna (including avifauna) historically present, currently present, or expected to be present; or,
(f) Fragmentation of terrestrial habitat, for example, by roads.

8.5.3.2 Consider photographing relevant features.

8.5.3.3 Consider utilizing geographic information systems (GIS) or similar visualization tools.

8.5.4 Describe magnitude and extent of constituents in media, for example, area, depth, volume, using available preliminary data. This information will be used to determine appropriate endpoints and to estimate exposures.

8.5.5 Detail the proximity of any potentially sensitive ecological areas or areas of local ecological or social importance.

8.5.6 Describe field conditions and physical parameters that may be relevant to sample integrity, as follows:

8.5.6.1 Potential background sources/contamination;

8.5.6.2 Nearby spraying of pesticides, for example, farmer, groundskeeper, homes;

8.5.6.3 Use of fertilizers; or,

8.5.6.4 Location of aquifers.

8.5.7 Identify wetlands and floodplains. Define relevant seasonal changes that may influence the wetlands. Surveys may be required (see 13.3.1).

8.6 *Identification of Constituents of Concern*—The identification of constituents of concern should be based on ecological and not human health considerations. Screen constituents and other stressors to determine those that are likely to contribute to significant ecological risk.

8.6.1 Water analyses required may include the following:

8.6.1.1 Filtered water samples for aquatic biota endpoints (to determine soluble, bioavailable fraction);

8.6.1.2 Total water analyses;

8.6.1.3 Dissolved organic carbon (DOC) and total organic carbon (TOC) analyses;

8.6.1.4 Total dissolved solids (TDS) and total suspended solids (TSS);

8.6.1.5 Analytical detection limits below regulatory concentrations, where technically and economically feasible;

8.6.1.6 Hardness or salinity;

8.6.1.7 pH;

8.6.1.8 Dissolved oxygen; or,

8.6.1.9 Background or reference site concentrations.

8.6.2 Sediment analyses (see Guide E1391) required may include the following:

8.6.2.1 Whole sediment chemical analysis;

8.6.2.2 TOC analyses;

8.6.2.3 Cation exchange capacity (CEC) measurements;

8.6.2.4 Pore water analysis;

8.6.2.5 DOC analysis of pore water;

8.6.2.6 Acid volatile sulfides (AVS) and simultaneously extracted metals (SEM);

8.6.2.7 Particle/grain size; or,

8.6.2.8 Background or reference site concentrations.

8.6.3 Soil analyses required may include the following:

8.6.3.1 Soil type and classification;

8.6.3.2 Organic carbon;

8.6.3.3 Moisture content;

8.6.3.4 Grain size distribution;

8.6.3.5 pH;

8.6.3.6 Oxidation reduction potential (Eh);

8.6.3.7 Cation exchange capacity; or,

8.6.3.8 Background or reference site concentrations.

8.6.4 Air analyses may include the following:

8.6.4.1 Volatile constituent concentrations;

8.6.4.2 Constituent concentrations of particulates; or,

8.6.4.3 Background or reference site concentrations.

9. Additional Data Options for a Complex ERA Problem Formulation

9.1 In addition to the data and information options listed in Section 8, the following may be considered in a complex ERA problem formulation.

9.2 *Ecological Receptor Species Information:*

9.2.1 Collect appropriate ecological receptor species information for the ERA, such as the following:

9.2.1.1 Habitat preferences or needs;

9.2.1.2 Home range size;

9.2.1.3 Population densities;

9.2.1.4 Food, water, sediment, air, and soil intake rates;

9.2.1.5 Diet composition;

9.2.1.6 Body weight;

9.2.1.7 Sensitivity to specific constituents;

9.2.1.8 Reproductive status;

9.2.1.9 Migratory potential;

9.2.1.10 Sex and age; or,

9.2.1.11 Lifespan.

9.2.2 Obtain chemical and toxicological information for the completion of a toxicity profile for selected constituents of concern. Necessary information may include the following: (**7**)

9.2.2.1 Chemical speciation;

9.2.2.2 Chemical mobility;

9.2.2.3 Persistence;

9.2.2.4 Biodegradation;

9.2.2.5 Bioconcentration, bioaccumulation, biomagnification;

9.2.2.6 Partitioning, for example, K_{ow};

9.2.2.7 Interactions with other constituents, for example, additive, synergistic;

9.2.2.8 Biological effects; or,

9.2.2.9 Mechanism of action.

9.3 *Biota Analyses*—Biotic samples should be collected and co-located with environmental abiotic/biotic media so that site

specific exposure levels can be determined. Biota analyses may include the following:

9.3.1 Fish whole body;

9.3.2 Lipid content;

9.3.3 Purged invertebrate, for example, earthworm or whole invertebrate;

9.3.4 Whole animal body burden;

9.3.5 Specific animal tissues;

9.3.6 Edible plant matter; or,

9.3.7 Background or reference site concentrations.

10. Data Options for Exposure Characterization

10.1 Most of the data and information options in exposure characterization are applicable to both screening and complex ERAs and are outlined below. The information will be more detailed in a complex ERA, however. Additional data and information typically found only in complex ERAs are listed in Section 11.

10.2 *Characterization of Exposure Environment*—Ensure that exposure scenarios and exposure routes that are defined in the site-conceptual model are characterized. This includes both the on-site and off-site exposure environments. Describe the physical relationship of the endpoint biota and the sources of exposure as follows:

10.2.1 Identify and sample the media in which the exposure is occurring, as follows:

10.2.1.1 Soil;

10.2.1.2 Sediment;

10.2.1.3 Surface water;

10.2.1.4 Air; or,

10.2.1.5 Shallow ground water.

10.2.2 Consider the environmental fate and transport of the chemicals, including degradation products.

10.2.3 Consider the bioavailability of constituents, for example, dissolved metal concentrations in water for exposure evaluation of aquatic species.

10.2.4 Consider seasonal influences on exposure, in terms of biotic responses, for example, increased sensitivity during reproductive season, diet composition changes, types of species present, for example, species that migrate or hibernate, and media fluctuations, for example, groundwater discharges to surface water during different seasons.

10.2.5 For media in which constituent concentrations are expected to increase or decrease in the future, estimate the future exposure levels, if relevant and feasible.

10.3 Ensure that analytical detection limits are below toxicological thresholds, if practicable.

10.4 Apply appropriate statistical approaches for the calculation of exposure concentrations.

11. Additional Data Options for Complex ERA Exposure Characterization

11.1 In addition to the data and information options listed in Section 10, the following may be considered for a complex ERA exposure characterization.

11.2 Obtain information on potential nonchemical stressors, and identify any expected seasonal changes in these stressors.

11.3 *Modes of Exposure:*

11.3.1 Describe direct exposures for chemical and nonchemical stressors, including factors as follows:

11.3.1.1 Exposure time; or,

11.3.1.2 Modifying factors.

11.3.2 Describe indirect exposures for chemical and nonchemical stressors, including factors as follows:

11.3.2.1 Diet;

11.3.2.2 Depuration rate;

11.3.2.3 Life stage variations; or,

11.3.2.4 Organism activity or behavioral changes.

11.3.3 Consider providing a description of the toxicokinetics of chemical stressors, including factors, such as the following:

11.3.3.1 Uptake rate;

11.3.3.2 Depuration rate; or,

11.3.3.3 Assimilation efficiency.

11.4 Consider information on the forms of the constituents as follows:

11.4.1 Chemical speciation;

11.4.2 Physical state, for example, dissolved, particulate;

11.4.3 Chemical transformation by physical or biotic processes, or both.

11.5 Identify appropriate constituent intake equations for ecological receptor species.

11.6 Identify and describe any exposure models used, their parameters, assumptions, limitations and the values selected for each parameter.

11.7 Decide whether the assessment will be deterministic or probabilistic.

12. Data Options for Effects Characterization

12.1 Some of the data and information options in effects characterization are applicable to both screening and complex ERAs and are outlined below. Additional data and information typically found only in complex ERAs are listed in Section 13.

NOTE 1—Some EPA regions and states have developed species-specific threshold levels.

12.2 *Toxicological Benchmarks:*

12.2.1 Obtain relevant federal, state, and other applicable criteria and guideline values that may be used as toxicological benchmarks, such as the following:

12.2.1.1 National/state ambient water quality criteria (USA);

12.2.1.2 National/provincial sediment and water quality guidelines (Canada);

12.2.1.3 Guidelines published in peer-reviewed journals, for example, Ref (**9**); or,

12.2.1.4 National/state soil standards.

12.2.2 Describe the method used to develop toxicity benchmarks that are not criteria or guidelines as described previously, for example, weight of evidence, see Ref. (**2**), or from literature data, Refs. (**7**) and (**10-18**).

12.3 Consider development of toxicological profile for each constituent of concern and endpoint species.

12.3.1 Consider dose-response information, including both no-effect and low-effect levels, when available.

12.3.2 Consider lethal and sublethal toxicity endpoints.

12.3.3 Consider information on bioaccumulation in endpoint species and their food.

12.3.4 Consider information, such as persistence, degradation half-life, octanol-water partition coefficient (K_{ow}), and other relevant chemical information.

12.3.5 Consider information on any known interactions between the constituent of concern and any other constituents at the site.

12.3.6 Consider the seasonality of potential effects, for example, life stage or physiological state.

12.3.7 Consider structure activity relationship information.

12.4 Identify and sample reference site(s), when feasible and appropriate as follows:

12.4.1 Reference site should be as similar to the site under investigation as possible, in terms of substrate/soil type, habitat, etc, but should not be influenced substantially by constituents from the site under investigation.

12.4.2 Abiotic or biotic media constituent concentrations, or both.

12.4.3 Toxicity testing of media tested at the site under investigation.

12.4.4 Field biological surveys for the same parameters as collected at the site under investigation.

12.4.5 Other data, as appropriate, depending on which data are collected for the site under investigation.

13. Additional Data Options for Complex ERA Effects Characterization

13.1 In addition to the data and information options listed in Section 12, the following may be considered in a complex ERA effects characterization.

13.2 *Toxicity Tests*—Selection of appropriate toxicity tests will depend on the conceptual model and DQOs developed for the site.

13.2.1 Select appropriate toxicity test species and test methods (see Guide E1525, USEPA, OECD standards and test methods) with adequate quality assurance/quality control (QA/QC) requirements. An index of ASTM toxicity test methods is provided in Guide D5730, Appendix X2. Appropriate test methods should be selected for the following:

13.2.1.1 Water, sediment or soil media;

13.2.1.2 Acute or chronic exposure, or both;

13.2.1.3 Lethal or sublethal endpoints, or both; or,

13.2.1.4 Bioaccumulation or bioconcentration.

13.2.2 Coordinate (spatially or temporally) sampling of media with chemical analysis sampling, or field biological surveys, or both.

13.2.3 Collect samples at appropriate times of the year, for example, may need to avoid sprawning periods for endangered species.

13.2.4 Select appropriate statistical methods for analyzing the data.

13.3 *Field Biological Surveys*—Selection of appropriate field biological surveys will depend on the conceptual model and DQOs developed for the site.

13.3.1 Conduct a wetlands survey, to identify, and possibly delineate, wetlands.

13.3.2 Conduct a survey of threatened, rare, and endangered species, as well as species of special concern, and their habitat, at an appropriate time of year.

13.3.3 Aquatic community/habitat surveys, which may include the following:

13.3.3.1 Fish community;

13.3.3.2 Amphibian community;

13.3.3.3 Benthic macroinvertebrate community;

13.3.3.4 Aquatic plant community;

13.3.3.5 Zooplankton and phytoplankton communities;

13.3.3.6 Population structure; or,

13.3.3.7 Habitat quality assessment.

13.3.4 Terrestrial community/habitat surveys, which may include the following:

13.3.4.1 Plants;

13.3.4.2 Small mammal population or community;

13.3.4.3 Soil invertebrate community;

13.3.4.4 Insect community;

13.3.4.5 Large herbivore presence at or near site;

13.3.4.6 Large predator presence at or near site;

13.3.4.7 Birds (resident and migratory);

13.3.4.8 Bats;

13.3.4.9 Reptiles and amphibians; or,

13.3.4.10 Habitat quality assessment.

13.4 Identify biomarkers to be used in risk assessment, if any, justify the selection, and collect appropriate data. Biomarkers may include the following:

13.4.1 Body burden;

13.4.2 Gross pathology;

13.4.3 Histopathology;

13.4.4 Enzyme induction; or,

13.4.5 Biochemical changes.

14. Information Options for Risk Characterization

14.1 While not exclusively a list for data options, the following information is provided for completeness, should this guide be used as an ERA review list.

14.2 Identify whether all DQOs have been met.

14.3 Identify whether data are of sufficient quality and quantity to complete the assessment.

14.4 Calculate hazard quotients or indices, or complete probabilistic analyses for each assessment endpoint species, population, or community.

14.5 In a complex ERA, evaluate site chemistry, toxicity testing, field survey and other relevant data using the weight-of-evidence approach.

14.6 Conduct a qualitative or quantitative uncertainty or sensitivity analysis as follows:

14.6.1 Describe uncertainty inherent in data gathering, for example, inability to complete surveys due to migratory or nesting season.

14.6.2 List parameters believed to significantly contribute to the uncertainty.

14.6.3 Present possible range in values for these parameters.

14.6.4 Provide rationale for selection of parameter values and probability distribution function.

14.6.5 Describe model or method used for uncertainty analysis.

14.6.6 Clearly present and interpret results.

14.7 Compare site data to literature-derived results, when relevant.

14.8 Consider the incorporation of existing literature concerning constituent exposure or effects relationships into the evaluation of site data.

14.9 Identify any data gaps in the ERA that could increase confidence in the ERA results if additional analyses were completed.

14.10 When required after a complex ERA, develop or recommend a remediation objective for each medium for which unacceptable risks were estimated, or recommend additional ERA activities.

15. Keywords

15.1 contaminated site; data options; ecological risk assessment; list

REFERENCES

(1) "Risk Assessment Guidance for Superfund, Vol II, Environmental Evaluation Manual," EPA/540/1–89/001, Washington, DC, 1989.

(2) "Framework for Ecological Risk Assessment," EPA/630/R-92/001, Washington, DC, 1992a.

(3) "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments," USEPA Environmental Response Team, Washington DC, 1997 (Interim Final).

(4) "Guidelines for Ecological Risk Assessment," EPA/630/R-95/002F, Risk Assessment Forum, Washington, DC, 1998.

(5) "Guidance for the Data Quality Objectives Process," EPA/600/R-96/055, Office of Research and Development, Washington DC, 1994.

(6) "ECO Update-Developing a Work Scope for Ecological Assessments," EPA Publication 9345.0–05I, *Intermittent Bulletin*, Vol 1 No. 4, Washington, DC, 1992b.

(7) Integrated Risk Information System, National Library of Medicine, www.nlm.nih.gov/iris.

(8) "ECO Update-Briefing the BTAG: Initial Description of Setting, History, and Ecology of a Site," EPA Publication 9345.0–05I, *Intermittent Bulletin*, Vol 1 No. 5, Washington DC 1992c.

(9) MacDonald, D.D., Carr, R.S., Calder, F.D., Long, E.R., and Ingersoll, C.G., "Development and Evaluation of Sediment Quality Guidelines for Florida Coastal Waters," *Ecotoxicology* 5:253–278, 1996.

(10) Sample, B.E., Opresko, D.M. and Suter II, G.W., 1996, "Toxicological Benchmarks for Wildlife, (1996 revision) ES/ER/TM-86/R3, Oak Ridge National Laboratory, Oak Ridge, TN.

(11) Suter, G.W., II and Tsao, C.L., 1996, "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota," ES/ER/TM-96/R2, Oak Ridge National Laboratory, Oak Ridge, TN.

(12) Efroymson, R.A., Will, M.E., Suter II, G.W., and Wooten, A.C., 1997a,"Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1997 revision. ES/ER/TM-85/R3, Oak Ridge National Laboratory, Oak Ridge, TN.

(13) Efroymson, R.A., Will, M.E. and Suter II, G.W. 1997b," Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Microbial Processes," 1997 revision, ES/ER/TM-126/R2, Oak Ridge National Laboratory, Oak Ridge, TN.

(14) Jones, D.S., Suter II, G.W., and Hull, R.N., 1997, Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Sediment-Associated Biota," 1997 revision. ES/ER/TM-95/R4, Oak Ridge National Laboratory, Oak Ridge, TN.

(15) "Development and Application of Benchmarks in Ecological Risk Assessment," American Industrial Health Council(AIHC) Issue Brief, 10/20/1997.

(16) Generic Ecological Assessment Endpoints, (630-P-02-004F)USEPA, October 2003

(17) Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Site, EPA-540-R-01-03, September 2002

(18) USEPA Ecotox database; https://cfpub.epa.gov/ecotox