PEER REVIEW WORKSHOP REPORT ON
ECOLOGICAL SOIL SCREENING LEVEL (ECO-SSL) GUIDANCE DOCUMENT

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1. INTRODUCTION

The purpose of this document is to present a summary of a peer review workshop that was held on July 26-27, 2000, for the U.S. Environmental Protection Agency's (EPA's) draft *Ecological Soil Screening Level (Eco-SSL) Guidance* document. The primary objective of this workshop was to obtain the comments and recommendations from nine peer reviewers on the scientific and technical aspects of the Eco-SSL *Guidance*. The *Guidance* was prepared by EPA's Office of Research and Development (ORD) National Center for Environmental Assessment (NCEA) and the Office of Emergency and Remedial Response (OERR). The *Guidance* details the procedures for developing Eco-SSLs to screen for ecological risks at Superfund sites. Versar organized and conducted the two-day scientific peer review meeting of the draft *Guidance*. This workshop report presents a summary of the recommendations and comments provided by the peer reviewers and is intended for use by EPA in revising the *Guidance*.

1.1 Background

EPA's draft Eco-SSL *Guidance* presents a set of procedures for developing scientifically-sound, ecologically-based, screening levels for contaminant concentrations in soils intended to be protective of terrestrial ecosystems. The *Guidance* also describes ways to use site-specific exposure data to modify those screening levels. EPA intends the procedures to be sufficiently specific and transparent to allow for consistent implementation by EPA and other Federal agencies, States, and private parties at all Superfund sites.

Although several different entities, including Oak Ridge National Laboratory, Canadian Council of Ministers of the Environment, Dutch National Institute of Public Health and the Environment, and Ontario Ministry of Environment and Energy, have developed sets of ecological soil screening levels, benchmarks, or preliminary remediation goals for many contaminants, EPA has not embraced any specific approach for use nationally at all Superfund sites. Although some EPA Regional Offices, Federal agencies, States and contractors use one or more of those approaches, many do not. Instead, they perform literature searches for toxicity data on each of the chemicals of potential concern (COPC) and develop site-specific soil concentrations to be used as screening levels for the site under investigation. This repetitious approach is costly and time consuming and does not foster the development and routine use of a consistent set of values to identify the chemicals that should be addressed in the baseline ecological risk assessment (ERA).

In order to improve national consistency and to conserve resources, an effort was made to form a multi-stakeholder workgroup to develop scientifically sound, ecologically-based, soil screening levels. Many entities have joined, including EPA, DOD, DOE, states, industry, and consultants. The draft *Guidance* and its associated appendices and exhibits are products of this collaborative project that, when complete, will include a look-up table of generic Eco-SSLs for up to 24 chemicals that are frequently of ecological concern at Superfund sites. These Eco-SSLs will be soil concentrations that are expected to be protective of the mammalian, avian, plant, and soil invertebrate communities that

could be exposed to these contaminants in soils. The Eco-SSLs will be conservative so that the risk assessor can be confident that contaminants that might present an unacceptable risk are not screened out early in the risk assessment process.

The multi-stakeholder workgroup has developed draft Eco-SSLs for mammals, birds, plants, and soil invertebrates for several contaminants. The plant and soil invertebrate values were developed from available plant and soil invertebrate toxicity test data. The mammal and bird benchmarks were back-calculated from a hazard quotient of 1.0 using mammalian and avian toxicity data and a small number of generic food chain models. The lowest of the four SSLs for each chemical is the Eco-SSL used to screen chemicals found at sites. These generic (i.e., not site-specific) Eco-SSLs are to be used during Steps 1 and 2 of the Superfund ERA process (*Ecological Risk Assessment Guidance for Superfund; Process for Designing and Conducting Ecological Risk Assessments*, 1997; hereafter "ERAGS"), when there often is only limited site-specific data available. Eco-SSLs represent a set of screening ecotoxicity values that can be used routinely to identify those COPCs in soil that may require further evaluation in a site-specific baseline ecological risk assessment (ERA). The Eco-SSLs **are not national cleanup standards.**

1.2 Peer Reviewers

The peer review panel of nine individuals included diverse areas of expertise and a variety of perspectives on this topic. They were selected through a rigorous process to ensure that the panel was composed of individuals representing different types of organizations and with expertise in different areas related to terrestrial ecology. They are recognized experts in ecological risk assessment and effects of toxic chemicals on terrestrial systems. Areas of expertise include ecology, wildlife exposure assessment, soil chemistry, ecotoxicology, and related disciplines. In addition to evaluating their credentials and availability for the workshop, written certification was obtained to ensure that participation in the peer review would not represent an apparent or actual conflict of interest. The nine individuals are listed below.

Gregory Biddinger, Ph.D.
Exxon/Mobil and Supply Company, Fairfax, VA

Rufus Chaney, Ph.D.
USDA - Agricultural Research Service
Beltsville, MD

Peter deFur, Ph.D.
Center for Environmental Studies
Virginia Commonwealth University, Richmond, VA

Rebecca Efroymson, Ph.D.
Environmental Sciences Division

Oak Ridge National Laboratory, Oak Ridge, TN

James Gillett, Ph.D.
Department of Ecotoxicology
Cornell University, Ithaca, NY

Gregory Linder, Ph.D.
HeronWorks Field Office
Columbia Environmental Research Center, Brooks, OR

Margaret McVey, Ph.D.
ICF Consulting, Fairfax, VA

Patrick Sheehan, Ph.D.
Exponent, Inc., Oakland, CA

Geoffrey Sunahara, Ph.D.
National Research Council-Canada, Quebec, Canada

The workshop chair was Dr. Margaret McVey of ICF Consulting. The remaining reviewers were assigned to one of two groups, based on topic area expertise and other considerations. General charge questions were posed to all reviewers. The two groups were charged with different questions specific to wildlife (mammalian/avian) and to soil chemistry/plant/invertebrate issues.

Chair - Margaret McVey

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Group 1 - Wildlife
Peter deFur
Rebecca Efroymson
James Gillett
Patrick Sheehan (Discussion Leader)

Group 2 - Soil Chemistry/Plants/ Invertebrates
Gregory Biddinger (Discussion Leader)
Rufus Chaney
Geoffrey Sunahara
Gregory Linder

The remainder of this workshop report describes the comments and suggestions provided by the peer reviewers on the draft *Guidance*. Section 2 provides summaries of the opening presentations on the first day of the meeting. Section 3 presents an overview of the written pre-meeting comments submitted by the peer reviewers. The discussions at the meeting that addressed the general charge questions are summarized in Section 4 of this report. Sections 5 and 6 provide final recommendations, as well as more in-depth descriptions of the discussions during the meeting, on wildlife and plant/invertebrate SSLs, respectively. The appendices to this workshop report include the attendee list, the agenda, slides used in EPA's introduction, and references provided by reviewers for EPA to

consider using in revising the *Guidance*.

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2. PRESENTATIONS

This section presents brief summaries of presentations that began the workshop. These short talks provided background information to help set the stage for the more in-depth discussion of the *Guidance*. These presentations included an introduction to the meeting and review of the agenda and charge questions by Mr. David Bottimore of Versar, Inc. Mr. Steve Ells of EPA's Superfund Office provided a description of the need for Eco-SSLs and the process used to develop them. These presentations are summarized below. Slides used by Mr. Ells are presented in Appendix C.

2.1 Opening Remarks

Mr. David Bottimore, from Versar, Inc., opened the workshop and welcomed the participants and observers to the two-day meeting. He described the structure and agenda for the meeting, introduced the reviewers, and asked all attendees to introduce themselves. He described the objective of the review - to provide the authors of the *Guidance* document (and its supporting appendices and exhibits) with comments and suggestions on ways to improve the *Guidance*. He added that the review would address the methods used to derive the Eco-SSLs, including assumptions, data collection, and analysis procedures. The meeting would focus on the specific methods of deriving an SSL for each of the four major types of receptors (avian, mammalian, invertebrates, and plants), on the overall guidance presentation, and on the guidance for applying the Eco-SSLs at contaminated sites. Mr. Bottimore stated that the reviewers' pre-meeting comments, which had been circulated to all reviewers and most of the attendees in the days prior to the meeting, would be the starting point for discussions during the workshop.

Mr. Bottimore described the process used to select the panel of nine experts, which included initial identification of more than 20 recognized experts in areas of terrestrial ecology and ecological risk assessment related to contaminated soils. Versar conducted an extensive recruiting effort to identify candidate experts and to screen them based on expertise, availability, and other factors. The final nine reviewers introduced themselves and provided short summaries of their areas of research and interest. Mr. Bottimore also noted that for some of the workshop, the panel would be split into two groups, to facilitate discussion of (1) the wildlife (mammalian/avian) SSLs and (2) the soil chemistry/invertebrate/plant SSLs. However, he encouraged all reviewers to participate in the open discussions. He also provided a brief review of the charge questions, which consisted of general questions on the overall *Guidance* document and two sets of questions that were specific to the wildlife and plant/invertebrates groups, respectively. The discussion at the meeting, just like the pre-meeting comments, would be organized around these charge questions. The charge questions are presented throughout this workshop report prior to presenting summaries of the comments and discussion.

During this opening presentation, it was stressed that peer reviews such as this one provide a forum for evaluating scientific products. They are, by design, intended to stimulate a wide variety of comments and suggestions. It is not a consensus building process. Mr. Bottimore stated that Versar

would be taking notes and recording the meeting to try to capture the commentary to be summarized in this workshop report. EPA will consider these comments and suggestions in revising the report and in their future efforts.

Mr. Bottimore concluded his opening remarks with a review of the agenda for the two-day workshop (Appendix B). He described the presentations to be made, suggested the use of the charge questions as the guide for commentary, and stated that direct interaction with the authors of the document would be encouraged during the workshop. His review of the agenda also pointed out that time periods had been set aside at the end of each day for public comment.

2.2 Background on Eco-SSL Development Process

Mr. Steve Ells' presentation focused on the need for Eco-SSLs in the Superfund Program and how they should be applied in the ERA process. Mr. Ells stated that Eco-SSLs are needed to avoid costly and repetitious literature searches and analyses of ecotoxicity data for contaminants found at large numbers of Superfund sites. Use of Eco-SSLs will also help to increase the level of consistency in screening ERAs at Superfund sites. Currently, there is no national consistency in the contaminant concentrations used to screen soils for ecological risks; EPA usually uses the most conservative values while other agencies and groups often use different values. The first effort to develop Eco-SSLs began in 1995 and was ultimately unsuccessful. In 1997, EPA reinitiated the effort as a result of Regional EPA Offices' requests for ecological soil screening levels. EPA established the multi-stakeholder workgroup with four separate task groups, one for each of the four types of SSL, respectively.

Mr. Ells defined Eco-SSLs as concentrations of contaminants in soil that are protective of terrestrial biota and that are used to screen out chemicals as part of the ERA process at sites or parts of sites. He stated that Eco-SSLs were developed to be conservative, but reasonable and applicable nationwide. The *Guidance* includes methods and models to use site-specific exposure data to modify the Eco-SSLs. The Eco-SSLs and methods to develop them are intended to be sufficiently specific and transparent to allow for consistent implementation by all parties at Superfund sites. Mr. Ells emphasized that the Eco-SSLs are not to be used as cleanup levels. Rather, the Eco-SSLs are to be used in Step 2 (the screening level) of the ERA process for Superfund. As stated in ERAGS, the baseline risk assessment using site-specific data would only be needed for those contaminants and receptors not screened out in Step 2.

Mr. Ells stated that EPA solicited a substantial number of reviews and consultations with experts during the early stages and throughout the development of the *Guidance* to help achieve as much consensus as possible. He noted, however, that EPA was unable to obtain consensus on how microbes could be included in the *Guidance*. He hoped that the peer review meeting would focus primarily on the Eco-SSL derivation process rather than the actual numerical Eco-SSL values derived to date. EPA would consider the peer review comments in finalizing the *Guidance* and deriving Eco-SSLs for all 24 chemicals.

In response to an inquiry from the panel regarding the anticipated timeline for the Eco-SSL *Guidance*, Mr. Ells indicated that following the peer review, he hopes to receive comments from the EPA Regions and would like to issue the *Guidance* document as interim final by the end of the calendar year or early next year. Mr. Ells indicated that the Eco-SSL *Guidance* will be assigned an EPA document number and will be distributed to the EPA Regions to use at sites. The final *Guidance* would be issued in the next year and a half with additional Eco-SSL values included. The Eco-SSL information and the ecotoxicity studies that were used to develop Eco-SSLs also will be available in EPA's ECOTOX on-line database. Mr. Ells concluded by stating that he hoped the peer review would generate continuing interest in this process.

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3. SUMMARY OF PRE-MEETING COMMENTS

The peer reviewers were charged with answering specific charge questions concerning the draft *Ecological Soil Screening Level Guidance* and were provided with the document and associated appendices and exhibits. The reviewers submitted written responses to the questions posed prior to the workshop. These pre-meeting comments were distributed prior to the workshop to the other peer reviewers and to EPA and other staff involved in developing the *Guidance*. This section provides a brief overview and highlights of the pre-meeting comments according to the charge questions (italicized below). Most of the issues raised in these comments were addressed at the workshop. Readers of this report interested primarily in the workshop conclusions and recommendations should focus on Sections 4, 5, and 6 of this report. Final copies of all written comments were provided to EPA.

3.1 General Questions for the Whole Panel

All of the peer reviewers were charged with five general questions. Highlights of the written pre-meeting responses to these questions are provided below.

Question # 1. *Are the methods and approaches used to develop these Eco-SSLs detailed clearly and understandably in the document? If not, what would be the recommendation(s) for revisions to the current documents?*

The reviewers praised many features of the *Guidance* and its supporting documentation, one stating that "the level of documentation ... is better than that incorporated in previous EPA risk assessment guidance documents." The reviewers generally considered the procedures set forth in *Guidance* appropriate to the stated uses of the *Guidance*. To use the words of one reviewer, the *Guidance* "builds on a number of EPA and other efforts which have effectively assisted resource management and environmental decision making, both as predictive and retrospective processes." The criteria and models used at each step are clear and most assumptions are transparent. The reviewers further appreciated the modular construction of the *Guidance* and its appendices and exhibits, which helped the presentation of the methods and approaches. Reviewers generally agreed that the *Guidance* provides a well defined and reproducible series of steps that are, as one reviewer put it, "surprisingly free of the extensive arbitrary parameters typifying early management of toxics". Reviewers praised the *Guidance* for the description and rigor of evaluation of toxicity studies, and recommended the same approach for bioaccumulation studies.

The reviewers were in general agreement on two points: (1) the *Guidance* document and supporting appendices and exhibits are clearly written, but (2) some of the information included in the appendices should be brought forward and summarized in the text of the *Guidance* document (e.g., a summary of the procedure to score studies on data quality). Otherwise, it is not possible to understand several aspects of the derivation of Eco-SSLs based on the *Guidance* alone.

Some reviewers identified areas where the *Guidance* (including the appendices and exhibits) does not provide sufficient information (e.g., insufficient documentation and justification of several of the default parameter values). Reviewers recommended adding several definitions to the *Guidance*:

- Ecologically Relevant Endpoints. Ecologically relevant endpoints (EREs) are variously described in the supporting materials (see Appendix 3-1, Table 1, Exhibit 3-1, Attachment J, Table 2, and Exhibit 3-2, Appendix R), but not in the *Guidance*. Moreover, the various descriptions are somewhat different.

- Acceptable Level of Protection. Risk managers need an idea of the level of protection provided by the screen (i.e., what are the chances of concluding that a site poses no risk when it in fact does/can cause harm to ecological entities and what are the chances of the opposite conclusion).

- Assessment Endpoints. The *Guidance* needs to describe the entities and their properties that the SSLs are intended to protect at the screening level.

Reviewers noted that a user of the *Guidance* would need to be an experienced risk assessor familiar with ERAGS. The level of expertise required of the user and the relationship of the Eco-SSL *Guidance* to ERAGS should be described in the introduction of the *Guidance*.

Question # 2. *Have we provided sufficient detail such that an Eco-SSL can be developed de novo for a particular chemical? If not, what would be the recommendation for accomplishing this goal?*

The reviewers agreed that the *Guidance* probably is sufficiently detailed to allow risk assessors without knowledge of the *Guidance* or chemical-specific SSLs to derive Eco-SSLs *de novo* for a chemical. The best way to answer this question would be to conduct a pilot test, e.g., task a contractor, another agency, or some other entity experienced in risk assessment with the job of developing Eco-SSLs for one or a few chemicals *de novo*. The pilot test should include documentation of any difficulties found in using the *Guidance*.

Question # 3. *Given that the number of terrestrial receptors that could be used in this process is very large, have we focused on representative and appropriate ones? If not, what would be the recommendations for change?*

The answers to these questions depended on the SSL. For SSLs for soil communities, the reviewers were concerned about the omission of soil microbial processes. The reviewers did not have the opportunity to examine EPA's rationale for the omission; Exhibit 1-2 included only a "place holder" at the time of the peer review. The reviewers felt that EPA could nonetheless proceed with the

Guidance and the Eco-SSLs that have been developed, but EPA needs to acknowledge in the *Guidance* that microbial processes are not covered by the Eco-SSLs at this time.

For avian and mammalian wildlife, the reviewers thought that the representative species included were probably adequate. They considered the species selected to represent birds and mammals to be appropriate. These included (a) species with small body size and, therefore, high food ingestion rates relative to body weight and small home range sizes; (b) species for which a single type of food that is likely to be contaminated (e.g., earthworms) comprises a large proportion of the diet; and (c) species representing herbivores, ground insectivores, and carnivores. One reviewer was concerned about the focus on small birds and mammals with high metabolic rates for chemicals that are metabolized. If the effective dose of a toxic contaminant scales between species based on metabolic rate (generally body weight raised to the 3/4 power) instead of linearly with body weight, the larger species with slower metabolic rates might be affected by lower doses of contaminants (expressed as mg/kg body weight-day) than the smaller species.

For both types of Eco-SSLs, the reviewers recommended that EPA clarify its assessment endpoints (see also Question 1 above). For example, does EPA intend to protect entire soil communities from changes in structure and/or function? Does EPA intend to protect birds and mammals at the population or individual level at this screening stage?

Question # 4. *One concern about implementation of the Eco-SSLs is that some may choose to misapply them as default cleanup values rather than screening values. We believe we have addressed this concern in the current document. Are there other potential problems in implementation that you believe should be addressed which have been overlooked?*

The reviewers agreed that *Guidance* was clear and emphatic with respect to limiting the use of Eco-SSLs to screening-level risk assessments and not using Eco-SSLs as cleanup goals. Reviewers noted that there isn't much that EPA can do to prevent the misuse of SSLs beyond what it already has said.

Some reviewers recommended that EPA elaborate on the applicability of the different types of Eco-SSLs to different environmental conditions. For example, Eco-SSLs could be used at sites with high organic content in the soil; they just would be more conservative than Eco-SSLs applied at sites with low proportions of organic material in the soil. This is because of the lower bioavailability of many contaminants in soils with higher organic content.

Question # 5. *In light of the ongoing discussions concerning endocrine effects on reptiles and amphibians, and not withstanding the lack of toxicity data on these receptors, can we appropriately claim that we feel that they are still protected by these screening levels? Or does EPA simply make this a policy call?*

The reviewers generally agreed that EPA can not claim that the Eco-SSLs are protective of reptiles and amphibians based on the analyses conducted to date. The physiology and exposure routes for those two groups are very different from birds and mammals (and plants and soil invertebrates). Reviewers recommended that EPA state in the *Guidance* that the present SSLs might not be protective of reptiles and amphibians. For Superfund sites with reptiles or amphibians of concern, a baseline risk assessment will need to be conducted for those species.

3.2 Reviewers Focusing on Derivation of Wildlife SSLs

Four of the peer reviewers were charged with the six questions related to derivation of the wildlife SSLs. The other reviewers also offered some comments.

Question # 1. *Will the proposed procedure for evaluating mammalian and avian toxicity data result in the selection and use of the most appropriate available data for generating wildlife Eco-SSLs?*

The reviewers commended EPA for the comprehensive and well documented search and review procedure for evaluating mammalian and avian toxicity data. One suggested that EPA include carcinogenicity studies because of the high quality review of other toxic endpoints. Others recommended that EPA provide a similarly rigorous approach to evaluating bioaccumulation studies.

Several reviewers expressed concern with aspects of the data evaluation and scoring algorithm. The algorithm combines "apples and oranges" by adding scores for criteria related to study adequacy/scientific validity with scores for criteria related to the relevancy of the endpoints and environmental conditions of the study to Eco-SSLs. In addition, each criterion is given equal weight, although some criteria (e.g., endpoint) are clearly more important than others (e.g., dose range). Reviewers noted that including "endpoint" as a data evaluation criterion is inconsistent with the process for generating SSLs for plants and soil invertebrates, where a study is considered either relevant or not relevant depending on the endpoint. Scoring a criterion on a scale of 1 to 10 implies that a value of 8 is twice as good as a value of 4, when in fact, the scoring is a ranking exercise. Given these attributes of

the algorithm, the total data evaluation score for a study is difficult to interpret, and there is some chance that the Agency will throw out studies with insightful data if those studies don't pass the total data evaluation score cutoff of 65. The rationale for using the total study scores to weight NOAELs before calculating the geometric mean of the NOAELs also was not clear. Reviewers generally agreed that growth, reproduction (and development), and mortality are the most relevant endpoints for deriving wildlife SSLs.

Question # 2. Will the proposed procedure for estimating toxicity reference values for birds and mammals result in ecologically relevant appropriately protective values?

Some reviewers were concerned that the proposed procedures do not result in toxicity reference values (TRVs) that are appropriately protective. Some reviewers felt strongly that taking the geometric mean of NOAEL values across studies for different species, instead of using a NOAEL for the most sensitive species tested, is simply not protective of the most sensitive species. By using the geometric mean, EPA always rejects the lowest NOAEL(s) and LOAEL(s), without examining the possible reasons for the low values. A related aspect of the procedure is the data requirement for a wildlife TRV: a minimum of three studies with two species. For data sets that just meet that criterion, it is possible that there are more sensitive species not adequately represented by the species tested. These attributes of the procedure for estimating TRVs are not protective of the more sensitive species.

The appeal of using the geometric mean of all NOAEL values for growth and reproduction is that it minimizes the impact of "outliers" on the TRV (and SSL) and appears to be a weight-of-evidence approach. However, there might be chemicals/cases for which one species really is much more sensitive than most.

Some reviewers reiterated their recommendation that EPA clearly identify its assessment endpoints, specifying whether individual animals or local populations are the entities of concern. Focusing on individual-level endpoints, which the criteria apparently do, is overprotective if the intent is to protect populations, not individuals, from adverse effects. Assuming population-level endpoints, one reviewer noted that the lack of a spatial element in the approach for developing wildlife criteria can result in over-conservatism (i.e., the contaminated area covers a tiny fraction of the population's local habitat).

One way of examining the potential for the SSLs to be overly conservative is to compare them with background concentrations (for those compounds/chemicals that naturally occur in the environment). One reviewer commented that it is not clear how close SSLs are to background concentrations nor is the relationship of TRVs to intake levels necessary for essential nutrients clear.

In summary, there are aspects of the TRV derivation process that are underprotective and other aspects that seem overprotective, and each aspect needs to be evaluated on its own.

Question # 3. Will the models and exposure factors in the wildlife food chain model, when adequately parameterized, result in reasonably conservative exposure estimates that (when used as proposed with adequately developed toxicity reference values) result in useful estimates of Eco-SSLs?

Several reviewers felt that using a default BAF of 1 when data are not available is not protective; others considered it reasonable. Some noted that use of a mean value from a regression estimate and use of field instead of laboratory data also are not conservative. Despite the non-conservative elements of the approach, most reviewers considered the models and parameters used to estimate exposures to be adequately conservative. A few reviewers questioned whether the exposure assessment was overly conservative because it focused on individual animals and assumed that all of the individual's foraging range was contaminated at the highest concentration measured or expected for the site. The last assumption, however, is stated in ERAGS and beyond the scope of this *Guidance*.

Some reviewers requested that EPA demonstrate the validity of its assumption that the inhalation and dermal exposure routes can be ignored because the bulk of exposure is through ingestion. Other reviewers noted that EPA has adequately addressed those pathways by stating that those routes might require evaluation in some cases, and should not be ignored.

Question # 4. What research areas need to be addressed to improve the process for generating soil screening levels for mammalian wildlife and avian species.

The reviewers identified research areas that need to be addressed in the near future and over the longer term to improve the process of developing SSLs for terrestrial wildlife. Several research areas need to be addressed in the near future:

- The BAF is the parameter that is perhaps the most uncertain and for which the least amount of empirical data are available.

- Bioaccumulation models for arthropods and plant seeds are needed.

- Additional data on incidental soil ingestion rates by birds and mammals are needed to characterize and reduce the uncertainty associated with the limited data on soil ingestion available to date.

- Toxicity data for reptiles and amphibians need to be identified, compiled, and reviewed, and a method needs to be devised for developing SSLs for those groups.

- The possibility of multiple exposure media and pathways needs to be considered in some way at the screening level.

Over the longer term, research in other areas would improve the process of deriving SSLs:

- An approach is needed for addressing mixtures of contaminants.
- An approach for addressing microbial processes is needed, particularly those processes related to nutrient cycling (e.g., decomposition, nitrogen fixation).
- EPA should test the hypothesis that a risk assessment for one or two species can serve to identify a contamination level protective of an entire group of species.
- Research is needed to relate individual-level toxicity to population-level effects.
- Soil quality criteria based on multiple soil attributes, including nutrient levels and interactions among nutrients and other compounds/contaminants, are needed to assess realistic values for these attributes and the Eco-SSLs in different regions of the country.

Question # 5. *Contrary to most other soil guidelines, adjustment factors were not used in the derivation of wildlife toxicity reference values (TRVs). The authors believe the TRVs are appropriately conservative through the use of conservative exposure parameters and ecologically relevant effects endpoints. Are adjustment factor warranted in this process?*

Reviewers were split on this question. Some reviewers emphasized again that the exposure assessment, and hence the wildlife SSLs, are likely to be conservative, but the TRVs are not conservative. Some reviewers suggested consideration of a species-sensitivity adjustment factor to account for variation in species sensitivity because the number of species tested is so small.

Other reviewers felt that adjustment factors are not warranted because of the high degree of conservatism already present in the SSLs and because there are no data indicating that there are more sensitive species than those typically tested in the laboratory.

Still other reviewers requested that EPA document the selection of the values for individual parameters, identifying which are upper-end versus central-tendency values, and explicitly state the level of conservatism that is sought for the final SSL. As part of that effort, some reviewers suggested that EPA conduct a sensitivity analysis to determine which parameters are most important in "driving" the final SSL.

Question # 6. *The task groups debated the use of threshold based TRVs and distributional analyses in the generation of Eco-SSLs for wildlife. The decision was made to use the more conservative threshold based TRV methods. In the future should the EPA consider using distributional analyses in the development of Eco-SSLs or should these methods be used for site specific ecological risk assessments?*

The reviewers asked what was meant by "distributional analyses." Some thought it implied a probabilistic assessment using distributions instead of point estimates (either upper end or central tendency) for the exposure/toxicity parameters. Others thought it referred to an assumed distribution of species sensitivities in order to assess the proportion of species in a taxonomic group protected by a criterion.

Reviewers who considered this question to be about using parameter distributions to conduct probabilistic assessments instead of using point estimates for parameters agreed that the use of conservative point estimates is probably the best approach for screening-level assessments. That approach helps to ensure consistency in development of the SSLs and provides transparency in how the end value was derived. Probabilistic assessments would be more appropriate in the next tier of the risk assessment process.

Reviewers considering this question to be about developing an assumed distribution of species sensitivities had other comments. EPA's Office of Water assumes a distribution of species sensitivities and targets a specified percentile on that distribution (i.e., 95th percentile) for protection to ensure protection of aquatic community structure and function. Reviewers noted that such an approach is not relevant to terrestrial birds and mammals, however, for which loss of a single species locally or regionally is not considered acceptable. One reviewer suggested that the range of sensitivities among birds or mammals might be small and that typical laboratory species might represent the more sensitive species. Another reviewer suggested that EPA examine the distribution of species sensitivities represented in the NOAELs/LOAELs from which the SSLs are derived before finalizing its approach.

3.3 Reviewers Focusing on Soil Properties and Derivation of Plant and Soil Invertebrate SSLs

Four of the peer reviewers were charged with the five charge questions on soil chemistry, plants, and invertebrate Eco-SSLs. The other reviewers also offered some comments.

Question # 1. Will the proposed procedures for evaluating soil biota toxicity data result in the selection and use of the most appropriate available literature for generating plant and invertebrate Eco-SSLs?

The reviewers who addressed this question were in general agreement that the proposed procedures and evaluation criteria are the most rigorous seen to date and should result in use of the

most appropriate literature. Reviewers considered it appropriate to use only those studies that addressed what were considered relevant endpoints. Reviewers also considered it appropriate to use a simple scoring system of 0, 1, 2, or 3, and to use the total data scores only to select studies, not to weight LOAELs before calculating the geometric mean LOAEL. The reviewers did have some suggestions for improvement:

- EPA could allow the use of biochemical responses when the population- and community-level implications of those endpoints are better understood. For example, impairment of earthworm reproduction is an important endpoint with biochemical effect precursors that can be measured.

- EPA needs to find a way to use microbial process toxicity data.

- EPA might weight different toxic responses (endpoints) based on the likelihood the response could cause a community-level effect.

Some reviewers raised the issue of giving equal weight to multiple studies from the same laboratory by taking the geometric mean of all study LOAELs. In general, the results of tests from the same laboratory are more homogenous than results from different laboratories.

One reviewer was concerned that the criteria for determining the acceptability of studies are based on older experimental methods which tended to overestimate risks to soil organisms from metals. The *Guidance* could acknowledge this limitation of the older studies and provide evaluation criteria for current and future studies based on the newer experimental methods (e.g., restoration of soil pH after addition of metal salts which tends to drop the pH). The reviewer noted further that the current *Guidance* ignores notable chemical interactions that can reduce toxicity of one or both chemicals in soils.

Question # 2. Qualitative soil chemistry parameters are used as an initial step in the Eco-SSL process to address chemical availability issues in soils. What next steps should be considered to further address soil chemistry and chemical availability issues?

The reviewers that addressed this question had several suggestions:

- Consider additional parameters that are part of standard soil analyses (e.g., cation exchange capacity, soil texture, nutrients).

- Improve guidance and requirements for field characterization of soils and their associated plant communities in preliminary assessments at sites. Some degree of characterization of soil types present at a site could improve the assessment of likely bioavailability of contaminants at that site.

- Evaluate the effectiveness of the SSLs as screening values by soliciting feedback from users. Are all, some, or none of the contaminants eliminated from concern for plants and soil invertebrates with the SSLs? If the screening process is seldom effective (i.e., seldom eliminates contaminants from concern), more regional-specific development of SSLs might be helpful (i.e., focusing on regional specific soil characteristics).

Question # 3. *Will the proposed procedure for selecting toxicity values for soil biota and plants result in ecologically relevant appropriately protective values? Should we consider using a bioavailability adjustment factor when we use toxicity data not from level A to calculate an Eco-SSL?*

The reviewers provided mixed responses to the first question. Some believed that the proposed procedure is likely to result in ecologically relevant and appropriately protective values. Others questioned the use of the geometric mean of LOAELs across different endpoints and studies of the same endpoint. For example, a database that includes many high-dose lethality studies and few studies with sublethal endpoints might result in an SSL that is less conservative (higher) than might be appropriate. Reviewers recommended that documentation of the plant and soil invertebrate SSLs include a holistic and integrated graphical presentation of all the data, as done for the wildlife NOAEL and LOAEL data.

With respect to the second question, some reviewers noted that if EPA chooses to use a bioavailability adjustment factor, the approach should be consistent with the approach used for birds and mammals. One reviewer was concerned that bioavailability adjustments can lead to eco-SSLs lower than analytical methods of detection. Another reviewer noted that tests with well-mixed and sieved soils generally decrease the effects of compaction and increase bioavailability. That and other information would be relevant to development of a bioavailability adjustment factor.

For metals, one reviewer considered the method even without a bioavailability adjustment factor to be over-conservative because of errors in the older protocols for conducting soil toxicity tests. The major errors that are now well recognized include: (1) failure to control for effects on soil pH of metal salt additions to soils; (2) failure to leach the anion which accompanied the metal addition before testing, and (3) failure to "age" soils before introducing test organisms. For example, freshly added soluble salt metals are much more bioavailable than equilibrated metals in soils because occlusion in surface oxides has not yet occurred. Another over-conservative aspect of the approach is focusing on single species/single contaminant toxicity tests. There are interactions among plants and invertebrates and among metals that can substantially reduce the bioavailability or toxicity of some metals.

Question # 4. What research topics need to be addressed to improve the process for generating soil screening levels for plants and invertebrates.

Reviewers offered several suggestions on research areas that could improve the process for generating SSLs for plants and invertebrates:

- There is a need for more data on basic ecotoxicity of soils to plants, microbes, etc. Studies to generate those data should be conducted across different soil types using different types of plant species (including woody plants). Systematic data of that type could improve the risk assessment process for soils (e.g., data on interspecies variation in sensitivity, representative species, ecotype species).

- EPA needs to develop ways to include microbial endpoints (e.g., decomposition of leaf litter).

- Ecotoxicity data are needed on additional invertebrates, particularly termites, ants, and groups in desert climates.

- Validation studies, perhaps using data from past ecological risk assessments, are needed to support the use of Eco-SSLs.

- Approaches need to be developed for handling chemical mixtures and biological interactions.

- There might be different indicators of soil community health for soils in areas with extreme (e.g., dry or cold) climates.

Question # 5. What recommendations do you have for using site-specific information in the Eco-SSL process?

The reviewers offered several recommendations in response to this question:

- EPA needs to develop and provide guidance on how to select and characterize a reference site/condition for interpreting site-specific data (e.g., background concentrations of metals).

- EPA needs to provide interim guidance on how the site risk assessor should address soil microbial endpoints and toxicity to reptiles and amphibians at the screening level.

- For any SSLs that are lower than "background" levels, it might be appropriate to develop regional SSLs based on the characteristics of soils and background concentrations of metals in that region.

3.4 Other Comments

Some reviewers made additional points outside the context of the questions posed to them:

- SSLs were not developed with input from all stakeholder parties. Groups not represented in the multi-stakeholder workgroup include the public (through citizen organizations), Tribes, and additional state agencies. The workgroup also contained few academic scientists and USGS scientists.

- The *Guidance* focuses on the "nodes" within ecosystems (i.e., "representative" plants and animals), when ecological relationships are often dominated by the interconnections among nodes. The current focus of the *Guidance* is at the organismal level of biological organization, not at the community or ecological levels of organization.

- The *Guidance* includes "technical policy". Some reviewers considered this a strength and others considered it a weakness.

- The difference between an exhibit and an appendix needs to be described in the *Guidance*.

- There are inconsistencies between the process for developing SSLs for plants and soil invertebrates and the process for developing SSLs for birds and mammals (e.g., in the data evaluation criteria and scoring, use of NOAELs for wildlife and use of LOAELs for plants and soil invertebrates, and other differences). These need to be explained (or justified), or the inconsistencies should be reduced.

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4. COMMENTS ON GENERAL QUESTIONS

This section presents a summary of the discussion and recommendations from the workshop that addressed general questions. The majority of the discussion is organized according to the charge questions. Following those is commentary on other overarching issues pertaining to the *Guidance* document. Some of this material repeats the pre-meeting comments summarized in Section 3.

4.1 Discussion, Comments, and Recommendations on General Charge Questions

Question # 1. Are the methods and approaches used to develop these Eco-SSLs detailed clearly and understandably in the document? If not, what would be the recommendation(s) for revisions to the current documents?

The reviewers were in general agreement that: (1) the *Guidance* document and supporting appendices and exhibits are clearly written, but (2) some of the information included in the appendices needs to be summarized in the text of the *Guidance*. Some additional information also needs to be added to the *Guidance*, as described in several of the paragraphs below.

As a general recommendation, EPA might review the *Guidance* document as a communication tool considering the following questions. Is it possible to understand the process in general from the *Guidance* document alone (i.e., without reading the appendices or exhibits)? What additional ERA guidance or other materials does the *Guidance* document build on or assume knowledge of? Assuming that the user is not familiar with those materials, where and how could the *Guidance* direct the user to those other sources? This theme is clear in the specific application issues identified by the reviewers that need to be addressed early in the *Guidance*:

- The *Guidance* needs to be clear about what the Eco-SSLs are intended to protect: individuals, populations, communities, and/or ecosystems.

- The *Guidance* should specify if Eco-SSLs are to be applied differently for sites with or without endangered and threatened species.

- The *Guidance* needs to define endpoints and describe which endpoints (e.g., reproduction, survivorship) can be used to infer adverse changes to the entity (entities)/attributes that the Eco-SSLs are intended to protect (e.g., the "no harm" concept for individuals or populations of highly exposed species).

- Early in the *Guidance*, the relationship of Eco-SSLs to Superfund's 1997 ERAGS needs to be described (i.e., Eco-SSLs represent screening-level soil concentrations to be applied in Step 2 of the 8-step ERA process for Superfund).

- A statement is needed about the intended users and what level of expertise they need to bring to the assessment.

- For the wildlife SSLs, are the species selected to be the most highly exposed? Would those species also be the most sensitive species (i.e., exhibit adverse effects at lower total doses)? (Probably not).

- The *Guidance* needs to describe the level of "protection" or "conservatism" targeted by the Eco-SSLs. If the Eco-SSLs are too conservative (to ensure zero false positives), and screen few chemicals out at few sites, they are not particularly useful.

Considering this last point, the reviewers strongly recommended that EPA provide tables in the *Guidance* that list all of the parameter values used in deriving each of the four SSLs. These tables should indicate how the value for each parameter was selected (e.g., median, mean, upper 95th percentile of the measured or estimated distribution). From those tables, the user should be able to understand the degree of conservatism built into the SSLs and which parameters contribute to the conservatism. If final Eco-SSLs are lower than background concentrations for naturally occurring chemicals, the Eco-SSLs are not useful. It would be helpful to express the acceptability of an Eco-SSL relative to background (e.g., there should be greater than 90 percent confidence that the SSLs are above background). TRVs should not be lower than nutritional requirements for essential nutrients.

Some reviewers suggested that the Introduction to the *Guidance* provide more information on the context in which Eco-SSLs are applied, linking them to the Superfund risk assessment process rather than assuming the user is fully versed in the ERA process outlined in ERAGS. The Introduction could reiterate, for example, that Steps 1 and 2 of the 8-step process do not involve negotiations between EPA and responsible parties; that occurs later in the process. It would be helpful if the Introduction provided perspective on what type of information generally is available at the screening stage. For example, many sites have been well characterized from the perspective of human health risks, but are just now being assessed for ecological risks. The information available for such sites tends to be extensive, although lacking data relevant to several types of ecological risks. There are other sites for which only Preliminary Assessments (PAs) have been conducted, and data for such sites are very limited. The *Guidance* could indicate how Eco-SSLs might be applied somewhat differently at data-rich and data-poor sites (e.g., some site-specific adaptation of Eco-SSLs might be possible at the screening stage for data-rich sites).

The *Guidance* can emphasize that Eco-SSLs can be used not only to identify "no harm" where that is possible, but also focus the ERA on the contaminants of concern. For example, a product of the screening exercise can be a matrix of the contaminants identified at a site compared with the four different SSLs, with the cells for which the hazard index exceeds unity identified. The matrix would then summarize those contaminant/ pathway/receptor combinations that require further evaluation in the next tier of the ERA. In other words, the result of applying the SSLs would be to identify COPCs for the soil exposure pathway.

The *Guidance* also needs to acknowledge that there are many chemical-specific factors that can influence risk, particularly for metals and their inorganic and organic compounds. For those chemicals/sites that proceed past Step 2 of the ERA process outlined in ERAGS, those considerations will become important. The peer reviewers recommended that brief descriptions of such considerations (e.g., the differing toxicities of chromium III and chromium VI; well known interactions with other elements in soil matrices; known antagonistic or synergistic toxic effects in combination with other elements/compounds) be provided in the chemical-specific writeups in Section 5 of the *Guidance*.

Reviewers noted that definitions are needed for several concepts (see the pre-meeting responses to Question # 1 in Section 3.2), including indicators of deficiencies, where applicable.

Question # 2. Have we provided sufficient detail such that an Eco-SSLS can be developed de novo for a particular chemical? If not, what would be the recommendation for accomplishing this goal?

The reviewers believed that the *Guidance* probably is sufficiently detailed to allow risk assessors without knowledge of the *Guidance* or chemical-specific SSLs to derive Eco-SSLs *de novo* for a chemical. The best way to answer this question would be to task a group (e.g., contractor, other ecological risk analyst) with developing new Eco-SSLs for one or more chemicals and documenting the questions they needed to ask. EPA might task two groups with the same chemical to see if the process is sufficiently detailed such that both groups end up with the same or very similar Eco-SSLs. Such a "pilot test" should identify any short-comings in the information provided in the draft *Guidance* as well as help to provide additional Eco-SSL values.

One important aspect of the pilot test would be to explore the consequences of the study evaluation criteria and algorithm for determining a final score for each study. Several panel members were concerned that the stringency of the data evaluation might exclude some valuable studies from consideration. Given the general data limitations to begin with, the consequences of excluding existing data should be examined in the pilot test. For example, once all studies have been evaluated and assigned a final data evaluation score, the analysts could be charged with reviewing the data that were discarded to answer several questions. What were the faults of the discarded studies? Is there any bias in the types of studies that were discarded (remembering that the different evaluation criteria were all given equal weight)? What are the consequences of working with fewer high quality studies compared with an alternative of working with more data by reducing the data quality requirements in some way (e.g., for plants/invertebrates, including both A and B data quality tiers).

The reviewers recommended the *Guidance* document indicate how the Eco-SSLs and the methods for deriving Eco-SSLs will be updated as more and better data become available.

Question # 3. Given that the number of terrestrial receptors that could be used in this process is very large, have we focused on representative and appropriate ones? If not, what would be the recommendations for change?

The answers to these questions depended on the type of SSLs (i.e., SSLs for soil communities versus SSLs for terrestrial wildlife).

For soil communities, all the reviewers were concerned about the omission of soil microbial processes, and agreed that the information in Exhibit 1-2 at the time of the review was inadequate. Steve Ells explained that the multi-agency Eco-SSL workgroup debated inclusion of microbial processes for some time. While the workgroup agreed that soil microbial processes are fundamental to the ecosystem, they found that LOAELs for various microbial endpoints and species covered a broad range of contaminant concentrations. Furthermore, the LOAELs for microbes generally were much lower than the LOAELs for other groups of organisms. Thus, the Eco-SSL workgroup felt that more work was needed to identify appropriate endpoints and levels of effect for ecologically significant changes in microbial functions in soils before microbial endpoints could be used to derive Eco-SSLs.

The peer review panel provided short-term and longer term recommendations to EPA to address microbial processes in soil communities. The panel agreed that the gap should not prevent EPA from moving forward to publish the *Guidance*, but that EPA needs to provide in Exhibit 1-2 a full description of the Eco-SSL workgroup's rationale for not including microbial processes in the initial publication of the *Guidance*. Exhibit 1-2 needs to describe the importance of microbial processes in soils and that their omission reflects current limitations on extrapolating from laboratory tests to ecologically significant changes. (That statement also needs to be clear in the *Guidance* document.) EPA also should state in the *Guidance* what its current and future plans are to address the lack of endpoints related to microbial processes in the Eco-SSLs.

For avian and mammalian wildlife, the reviewers thought that the representative species included were probably adequate. They agreed that small homeothermic animals with higher metabolic rates are likely to be more highly exposed than larger homeothermic animals with lower metabolic rates in terms of the quantity of food consumed per unit body weight. The reviewers also agreed with focusing on species that consume large quantities of a single type of food that is likely to be highly contaminated (e.g., earthworms). Some reviewers thought that the assumption that those species consume a single type of prey (e.g., shrews consume 100% earthworms) is unrealistic and overly conservative. Others agreed that such realism was not needed at the screening level; in fact, EPA could even consider using hypothetical animals to represent various groups or guilds of birds and mammals. Parameter values could be selected to represent a reasonable high-end exposure for members of such groups (e.g., otter, martin, fisher, weasel). Steve Ells of EPA noted that use of parameter values for actual species simplified the process of selecting values to use in the wildlife models for deriving SSLs.

For avian and wildlife SSLs, the peer reviewers asked what EPA intended to protect - individuals or populations of those species. Authors of the *Guidance* responded that the SSL assessment is basically at the individual level. Advantages of focusing on individuals instead of populations for the screening-level ecological risk assessment are several. First, that approach means that the SSLs are protective of threatened and endangered species and need not be modified to ensure protection of such species at the screening level. Second, that approach removes the need to consider the areal extent of contamination, the proportion of the locally suitable habitat that is contaminated, and hence what proportion of the local population of a species might be at risk. Generally, data needed to characterize areal extent of contamination, habitat suitability, and the size of local populations are not available at the screening level. Those parameters require substantial site-specific information and information on areas beyond the boundaries of the site. The peer review panel recommended that EPA make these points in the *Guidance* document.

Question # 4. One concern about implementation of the Eco-SSLs is that some may choose to misapply them as default cleanup values rather than screening values. We believe we have addressed this concern in the current document. Are there other potential problems in implementation that you believe should be addressed which have been overlooked?

The reviewers reiterated their pre-meeting comments and agreed that the *Guidance* was clear and emphatic with respect to limiting the use of Eco-SSLs to screening risk assessments and that Eco-SSLs are not to be used as cleanup goals.

Some reviewers asked about the relationship between Eco-SSLs and Natural Resource Damage Assessments (NRDAs). John Bascietto, an author from DOE, a Natural Resource Trustee, noted that Eco-SSLs are not applicable to NRDAs. Eco-SSLs are conservative and useful only for identifying situations of "no harm," not for linking contaminants with existing impacts.

Question # 5. In light of the ongoing discussions concerning endocrine effects on reptiles and amphibians, and not withstanding the lack of toxicity data on these receptors, can we appropriately claim that we feel that they are still protected by these screening levels? Or does EPA simply make this a policy call?

All of the reviewers agreed that EPA can <u>not</u> claim that the Eco-SSLs are protective of reptiles and amphibians. The physiology and exposure routes for those two groups are sufficiently different from birds and mammals (and plants and soil invertebrates) that there is no necessary relationship between them. Reviewers recommended that EPA state in the *Guidance* that the present SSLs cannot be considered protective of reptiles and amphibians. For Superfund sites with reptiles or amphibians of concern, the risk assessors will need to conduct a baseline risk assessment for those species. This issue was discussed in more detail by the group focusing on terrestrial wildlife SSLs.

4.2 Comments on Other Overarching Issues

The reviewers proved some comments and recommendations in addition to their direct responses to the charge questions, as discussed below.

Inconsistencies Between Approaches for Soil/Invertebrate and Bird/Mammal SSLs

The peer review panel commended EPA on the development of standard operating procedures (SOPs) for the derivation of Eco-SSLs. Reviewers noted, however, that there are several inconsistencies between the methods used to derive SSLs for plants/soil invertebrates and for birds/mammals which include: (a) LOAELs are used for plants/invertebrates while NOAELs are used for birds/mammals; (b) several of the criteria used to evaluate the adequacy of a study for use in deriving SSLs are different; (c) the scale for scoring the criteria ranges from 0 to 3 for plants/invertebrates and from 1 to 10 for birds/mammals; and (d) toxicity values are not weighted by the study data evaluation score for plants/invertebrates whereas the score is used to "adjust" NOAEL values for birds/mammals. EPA concurred that the task groups addressing the two different types of SSLs developed the details of their approaches independently, and the Agency is aware of the inconsistencies.

Reviewers suggested that EPA revisit this issue in two ways. First, EPA can emphasize that the two approaches are the same with respect to fundamental aspects of the approaches, such as the careful evaluation of studies from the literature, consideration of all of the relevant data identified, and the selection of parameter values to ensure that SSLs are sufficiently conservative that harmful chemicals/sites do not slip through the screen (i.e., are not eliminated from consideration at this stage). With respect to the differences between the methods, the panel had two recommendations. First, where possible, EPA could make the approaches more consistent. For example, EPA might use the endpoint evaluated in a study as a criterion for including or excluding a study for generating wildlife SSLs the same way endpoint was used to include or exclude studies for generating SSLs for plants/soil invertebrates. Second, EPA should provide an explanation of the differences that remain. In some cases, there might be important reasons (e.g., different assessment endpoints) for those differences. Other differences might simply reflect that there is no one "right" way to accomplish certain tasks.

One question raised by the differences between plant/invertebrate and bird/mammal SSLs was how the data evaluation score cutoffs were selected. For birds and mammals, how was the value of 65 out of a possible 100 points for the total data evaluation score selected as the cutoff for inclusion or exclusion of a study for the derivation of an SSL? For plants and soil invertebrates, how was the cutoff value of 10 out of a possible 18 points selected? What was the distribution of total data evaluation scores across all the studies? Was it unimodal or multi-modal with a distinct trough around the cutoff score? Answers to these questions would make the *Guidance* more transparent.

Further Review and Input to the Process

Several of the panel members suggested that the chemical-specific writeups in Section 5 of the *Guidance* be reviewed by outside experts on the specific chemical. Steve Ells observed that would require the expert to read and understand the entire *Guidance* and process of deriving Eco-SSLs. Moreover, many experts already have provided their inputs and review. The panel modified its suggestion to include two components. First, the panel suggested that experts on specific chemicals might be contacted to review two items only: (1) the list of literature reviewed in deriving the Eco-SSL and (2) the description of the chemical-specific considerations of which the risk assessor should be aware if a baseline ERA is needed (e.g., the relative toxicities of different forms of an element, interactions with other chemicals). Second, the panel suggested that EPA add a comment section to its Eco-SSL website so that users can make suggestions and offer information as they review and use the *Guidance*.

5. COMMENTS ON DERIVATION OF WILDLIFE SSLS

The peer reviewers addressed six charge questions focusing on derivation of wildlife SSLs during the workshop. The final comments and recommendations of the panel have been organized by specific charge question in Section 5.1. More extensive panel discussion regarding these questions follows in Section 5.2.

5.1 Final Comments and Recommendations

Question # 1. *Will the proposed procedure for evaluating mammalian and avian toxicity data result in the selection and use of the most appropriate available data for generating wildlife Eco-SSLs?*

The reviewers recommended that the overall process for reviewing, selecting, and scoring studies needs to be more transparent to the reader. In addition to recommending expansion of this discussion, the panel suggested that "endpoint" be removed from the criteria used to score individual studies. They felt that the document should include more text describing the logic behind focusing on growth, reproduction (and development), and mortality endpoints, both in the body of the document and in the standard operating procedures (SOPs). It was also suggested that the document explain that endocrine disruptors are captured in the reproductive endpoint.

Question # 2. *Will the proposed procedure for estimating toxicity reference values for birds and mammals result in ecologically relevant appropriately protective values?*

After lengthy discussion, the panel recommended that the data evaluation discussion be brought forward in the section of the *Guidance* document that addresses derivation of toxicity reference values (TRVs). They debated the use of the geometric mean of all NOAELs across different species and the growth and reproduction endpoints to derive a TRV, because some felt that this procedure might result in TRVs that are not protective of the most sensitive species or endpoint. The panel suggested that EPA consider changing the approach to use the highest bounded NOAEL below the lowest bounded LOAEL (considering only the selected endpoints). This should result in TRVs that are adequately protective without being overly conservative. In cases where multiple data points exist for the same species and endpoint, EPA could use the geometric mean of those values to represent that species and endpoint in deriving the TRV. The observation was made that while having data on two species was probably adequate, the *Guidance* document should encourage the scientific community to carry out testing on a broader range of mammalian, avian, and other species of concern (e.g., herps).

Question # 3. *Will the models and exposure factors in the wildlife food chain model, when adequately parameterized, result in reasonably conservative exposure estimates that (when used as proposed with adequately developed toxicity reference values) result in useful estimates of Eco-SSLs?*

While the reviewers thought that the exposure estimates were adequately conservative, suggestions were made to improve the clarity of the discussion about the exposure parameters used to derive the mammalian/avian SSLs. Included in this discussion should be text and a summary text box that present the level of conservatism in each parameter value used and the rationale for selecting that value. Several reviewers felt that the ingestion and diet information needed re-examination because the values were too conservative. Specifically, for woodcocks and shrews, the percentage of earthworms/soil in their diets should be more closely examined. The equation in Figure 4.1 needs to make clear that the quantity of soil ingested should be added to the total food intake, which is based on caloric requirements. It was also suggested that the basis for using a BAF of 1 for inorganics be clarified. To better characterize how all of these assumptions might play out, the panel suggested that EPA compare the SSLs with background concentrations and compare the TRVs with nutritional requirements. This would help to determine if the SSLs are too conservative. The review panel also suggested that sensitivity analyses be performed on the overall process to better understand which parameters most affect the results, particularly the relative contribution of the exposure parameters and the TRVs to the final SSLs. Finally, the panel recommended adding median values to Table 4.2, which describes the percentiles of BAF values greater than 1 across contaminants and receptor groups.

Question # 4. *What research areas need to be addressed to improve the process for generating soil screening levels for mammalian wildlife and avian species.*

The peer reviewers highlighted the gaps in both toxicity and exposure data as well as the overall uncertainties in derivation of SSLs from the existing data sets. Recommendations were made to encourage the scientific community to conduct research on both exposure and toxicity for a greater number of species, particularly mammals, birds, reptiles, and amphibians. The panel also felt that the limited availability of bioaccumulation data adds uncertainty to the exposure estimates. Some chemicals such as metals might have low bioaccumulation factors while certain organic chemicals have high potentials for bioaccumulation in the terrestrial food chain. The peer reviewers in the wildlife group called for more research to characterize the diets (and soil ingestion) of these species as well as the bioavailability of chemicals in soil. Reviewers also stressed the need for a better understanding of metabolism, particularly for those compounds that may be quickly metabolized and not passed on through the food chain to higher trophic levels. Finally, the reviewers stated that models are needed to better characterize below-ground ecological processes, particularly the role of arthropods and plant roots in the terrestrial ecosystem.

Question # 5. *Contrary to most other soil guidelines, adjustment factors were not used in the derivation of wildlife toxicity reference values (TRVs). The authors believe the TRVs are appropriately conservative through the use of conservative exposure parameters and ecologically relevant effects endpoints. Are adjustment factors warranted in this process?*

This question was addressed in the pre-meeting comments and reviewers did not discuss it further.

Question # 6. *The task groups debated the use of threshold based TRVs and distributional analyses in the generation of Eco-SSLs for wildlife. The decision was made to use the more conservative threshold based TRV methods. In the future should the EPA consider using distributional analyses in the development of Eco-SSLs or should these methods be used for site specific ecological risk assessments.*

This question was adequately addressed in the pre-meeting comments and reviewers agreed that no additional comments were necessary.

5.2 Discussion Summary

Question # 1. *Will the proposed procedure for evaluating mammalian and avian toxicity data result in the selection and use of the most appropriate available data for generating wildlife Eco-SSLs?*

Discussion of the procedures used by EPA to select and evaluate toxicity studies focused on the need for more clarity and explanation of the application of the study evaluation criteria. Suggestions were made to expand the discussion of the exclusion criteria (such as Figure 4-5 and Table 3.1 in the *Guidance* document) so the reader can get a better impression of the evaluation process and results. EPA was encouraged to try to retain as much data as possible in the early stages of evaluation and then exclude data later, rather than have such strict rules that many data points are never even considered. Reviewers observed that the methods used to derive wildlife SSLs varied from those used to derive the plant/invertebrate SSLs, and the group recommended that EPA more clearly explain the need for different approaches. This was particularly the case for the different scales used for scoring a criterion for the wildlife (i.e., 1 to 10) and plant/invertebrate groups (i.e., 0,1,2 and 3). Reviewers seemed to prefer the more simple ranking method used by the plant/invertebrate group.

With respect the literature evaluation, some reviewers questioned whether endpoint should be included as an evaluation criterion along with criteria related to adequacy of the study execution, or used instead as an "inclusion" or "exclusion" trigger as it is in the plant/soil invertebrate SSL derivation process. Other reviewers suggested that as much data as possible on all available endpoints be

included initially. The studies might then be weighted by endpoint in the TRV derivation process. A cogent explanation of which endpoints are appropriate and which are not needs to be brought forward into the main *Guidance* document. The weighting process for NOAELs needs to be explained clearly, and a rationale provided for each criterion receiving equal weight even though some criteria seem more important than others. One reviewer questioned why immunological data were not included and suggested that EPA revisit the data sets for possible inclusion of that endpoint. Overall the panel thought that the procedures were well developed and presented. The reviewers found the scatter plots to be a very effective means of presenting the toxicity data but questioned the use of the geometric mean of NOAELs for different species to derive the TRV (see Question # 2).

Question # 2. *Will the proposed procedure for estimating toxicity reference values for birds and mammals result in ecologically relevant appropriately protective values?*

The procedures for deriving TRVs were discussed at length by the panel. The reviewers agreed that the scoring system should put more emphasis on "better" studies, but they encouraged EPA to more carefully document the use of professional judgment in these data evaluation decisions. This was particularly true for the weighting factors. One reviewer suggested that EPA might test the influence of the weighting factors by performing the evaluation with and without them and observe the change in the TRVs. Comments also were raised on including in the scatter plots endpoints that would not be used to derive TRVs (i.e., endpoints other than growth, reproduction/development, and mortality). The reviewers suggested that a discussion of the subset of data that were actually used to derive an SSL be described in the text of the SSL documentation for each chemical in Chapter 5.

Some reviewers were concerned that the procedures used may not be adequately protective of all species. Some reviewers suggested evaluating bounded and unbounded NOAELs separately to reduce the possibility of some types of errors (e.g., including a large number of unbounded NOAELs that might actually be orders of magnitude lower than a true threshold for effect). While recognizing the preference for using bounded LOAELs and NOAELs, other reviewers felt that use of as many data points as possible was desirable, especially for chemicals for which data are scarce.

The panel also questioned using the geometric mean of NOAELs across species which could result in TRVs that are not protective of the most sensitive species or endpoints. The reviewers proposed alternate schemes that might result in TRVs that are more protective without being overly protective. If an alternate scheme results in an “outlier” driving the SSL, the analyst can review the documentation to determine if any mistakes were made or possible reasons for the outlier. If the outlier was from a valid study, and EPA did not want such a sensitive species to “drive” the wildlife SSL, EPA might recommend that a higher SSL be set based on other species, with the condition that if the sensitive species is present, the lower value must be used. The peer reviewers also suggested that EPA consider averaging NOAELs together for studies that represent the same endpoint and species to reduce the impact of variation between laboratories and test conditions. This discussion again raised the issue of whether the wildlife SSLs are intended to be protective of individuals or populations of

wildlife receptors at contaminated sites. The panel recommended that the intent or "assessment endpoints" of the wildlife SSLs be explained in the Introduction of the *Guidance*. The reviewers concluded this discussion by recommending a letter be sent to ORD to encourage testing a broader phylogenetic spectrum of species.

Question # 3. *Will the models and exposure factors in the wildlife food chain model, when adequately parameterized, result in reasonably conservative exposure estimates that (when used as proposed with adequately developed toxicity reference values) result in useful estimates of Eco-SSLs?*

Extensive discussion addressed the exposure parameters used in the wildlife food chain models, particularly with respect to values selected for various parameters that might be overly conservative or underprotective. This was particularly evident in the ingestion/diet composition and bioaccumulation areas. Reviewers questioned the particular earthworm/soil ingestion values for woodcocks and shrews and felt that they were overly conservative, which may result in Eco-SSLs that are overprotective. The diets of those species do not consist of 100 percent earthworms, even over relatively short periods of time. The diets of woodcocks and shrews are likely to contain other invertebrates that ingest only limited quantities of soil, if any. While the group did not resolve these issues, the panel suggested that EPA should re-examine the data from the literature and provide additional rationale for the selected values for the species used in the Eco-SSL derivation. Reviewers recommended that the *Guidance* explain that the same wildlife species do not need to be present at a particular site for the SSL to be applicable; just that similar types of species (with respect to their trophic level/functions/groups) be present. For reptiles and amphibians, more data are needed before they can be adequately included in this analysis.

In this discussion, reviewers observed that many of the contaminants of interest may not be bioaccumulative, and thus the predicted exposures to higher level wildlife, even assuming a BAF of 1, may be overstated. One reviewer felt that this would be the case with explosives, such as TNT which are quickly metabolized by earthworms. It is also a challenge for those chemicals with metabolites that have not been extensively tested or metabolites that work through different modes of action than the parent compounds (e.g., PCBs). In addition, the issue of chemical species was raised, particularly for metals such as chromium where the toxicity can vary widely with valence state. The reviewers stated that it would be preferable for the SSLs to be developed for the different metal species, but they recognized that site-specific chemical characterization in the screening step is often limited (and speciation data generally would not be available). They also acknowledged that because the Eco-SSLs are used as a screening tool, the values should be conservative. Chemical speciation could be addressed for those chemicals during the next tier of the risk assessment process. Agreement was reached that Eco-SSLs would be expressed as concentrations of the total metal, but the reviewers recommended that the *Guidance* explain this issue, perhaps in Section 5. This text could encourage users to perform speciation during soil sample analysis for those metals that are already of concern at a site based on previous site activities (e.g., metal plating shops, smelters, etc) where characteristics of

the site might result in the metals being in the less toxic valence state. This would be particularly important for metals such as mercury, chromium, arsenic, selenium, and manganese.

This discussion led to the group trying to determine which factors might be overly conservative (e.g., ingestion rates) and which ones might not be adequately protective (e.g., bioaccumulation factors). The reviewers felt that EPA should clearly state the assumptions used for each factor. The reviewers noted that various uncertainties in the overall process probably balance out and that the overall values are appropriate for use in a screening exercise. It was suggested that the *Guidance* present all parameter values used and characterize which values are likely overestimates and which may underestimate risks to wildlife. A table that summarizes this information would be very helpful.

Question # 4. *What research areas need to be addressed to improve the process for generating soil screening levels for mammalian wildlife and avian species.*

From both the pre-meeting comments and discussion, it was clear that the reviewers felt that data were lacking for derivation of SSLs for reptiles and amphibians. As stated in the comments to the general questions, there is little basis to expect that SSLs for other species and endpoints would be protective of the herpetological fauna. The panel suggested that the *Guidance* clearly list the research needs in areas of toxicity and exposure for reptiles and amphibians. Research is also needed to provide better data on bioavailability and food and soil ingestion rates for species of interest. Similarly, a better understanding of metabolism is needed particularly for those compounds that may be quickly metabolized and not passed on through the food chain to higher trophic levels. Finally, the peer reviewers stated that models are needed to better characterize below-ground ecological processes, particularly the role of arthropods and plant roots in the terrestrial ecosystem.

Question # 5. *Contrary to most other soil guidelines, adjustment factors were not used in the derivation of wildlife toxicity reference values (TRVs). The authors believe the TRVs are appropriately conservative through the use of conservative exposure parameters and ecologically relevant effects endpoints. Are adjustment factors warranted in this process?*

This question was addressed in the pre-meeting comments (see Section 3.2) and reviewers did not discuss it much further.

Question # 6. *The task groups debated the use of threshold based TRVs and distributional analyses in the generation of Eco-SSLs for wildlife. The decision was made to use the more conservative threshold based TRV methods. In the future should the EPA consider using distributional analyses in the development of Eco-SSLs or should these methods be used for site specific ecological risk assessments.*

This question was adequately addressed in the pre-meeting comments (see Section 3.2) and reviewers agreed that no additional comments were necessary.

6. COMMENTS ON SOIL CHEMISTRY AND DERIVATION OF INVERTEBRATE/PLANT SSLS

The peer review panel addressed five charge questions focusing on soil properties and the derivation of plant and soil invertebrate Eco-SSLs during the peer review meeting. The final comments and recommendations of the panel have been organized by specific charge question in Section 6.1. More extensive panel discussion regarding these questions follows in Section 6.2.

6.1 Final Comments and Recommendations

Question # 1. *Will the proposed procedures for evaluating soil biota toxicity data result in the selection and use of the most appropriate available literature for generating plant and invertebrate Eco SSLs?*

The panel recommended that a discussion regarding microbial functions in soil be included in Section 3 of the *Guidance* document. This discussion should emphasize the importance of microbial functions as an indicator of ambient soil conditions and their subsequent use as a receptor group in ecological risk assessments. The discussion should also provide a rationale as to why microbial functions were not used to develop SSLs along with plants and soil invertebrates.

The panel recommended that text from Appendix 3-1, describing how the criteria were used to evaluate and select studies from the published literature, and also how the data from those studies were extracted for use in the plant and soil invertebrate Eco-SSL derivation process, be pulled into Section 3 of the main *Guidance* document. This additional text will help to clarify for the reader the procedures that were used for data selection. The panel also suggested that the text in Section 3.3 of the *Guidance* (Identification of Data for Derivation of Eco-SSLs) be expanded to include a justification for the acceptance of literature studies with an evaluation score of > 10, while studies with a score of 10 or less were eliminated from consideration.

In considering whether the most appropriate available literature was used to generate the plant and soil invertebrate Eco-SSLs, the panel suggested that EPA publish a request for ecotoxicity data on the 24 chemicals to ensure that all the relevant literature studies are given appropriate consideration. The panel also suggested that the Eco-SSL document authors consider contacting the authors of literature studies that received a score somewhat lower than 10 for more details to determine if those studies could be upgraded and included in the Eco-SSL derivation process. In addition, it may be helpful to consider having experts review the list of literature cited for the chemical summaries in Section 5 for possible omissions.

The panel noted that there are several inconsistencies in the Eco-SSL derivation process between the plant/soil invertebrate group and the wildlife group. They recommended that the two groups should move toward greater consistency where appropriate (e.g., weighting) and otherwise

explain why different approaches were used for the respective groups. The panel recommended that this explanation be incorporated either in Section 1 or in a new Section 2 of the *Guidance*.

In order to give the reader some background information on the toxicity data that are used to derive the plant and soil invertebrate SSLs, the panel recommended that a discussion of the "standard" methods for both plant and soil invertebrate toxicity testing and how the data are generally used be included as an appendix to the *Guidance*.

Question # 2. Qualitative soil chemistry parameters are used as an initial step in the Eco-SSL process to address chemical availability issues in soils. What next steps should be considered to further address soil chemistry and chemical availability issues?

The Eco-SSL *Guidance* should inform the reader that past and current toxicity test methods tend to overestimate toxicity from metals in soil. Specific errors that can alter the toxicity level include the effects on soil pH from metal salt additions, failure to leach the anions which accompanied the metal before testing, and failure to "age" soils before introducing the test organisms. These issues should be addressed in Section 1 of the *Guidance* so the reader will understand that Eco-SSLs based on studies that include these types of errors are likely to be overly conservative.

The panel also suggested that the document authors modify the use of pH as a criterion for assessing bioavailability for soil invertebrates and modify the "preference" level to include bioavailability scores of "1" and possibly "0" as well as "2" for soil invertebrates. In addition, separate qualitative bioavailability matrices should be provided in Section 2 (pp. 2-9) for plants and soil invertebrates for metal cations. The matrix table for soil invertebrates should be modified for soils with high organic matter (6-10%) and low pH (between 4 and 5.5): bioavailability should be changed from "medium" to "low" (the matrix table for plants would remain unchanged).

Another recommendation for Question #2 was to consider including studies that used metal-salt-amended, biosolids/sludge additions to soil. Inclusion of those studies could be based on pre-defined rules such as requiring a relatively low organic matter content. Inclusion of such studies might greatly expand the data available for many contaminants.

Question # 3. Will the proposed procedure for selecting toxicity values for soil biota and plants result in ecologically relevant appropriately protective values? Should we consider using a bioavailability adjustment factor when we use toxicity data not from level A to calculate an Eco-SSL?

The panel suggested that text from Appendix 3-1 describing ecologically relevant endpoints (ERE) (e.g., reproduction, population dynamics, growth) should be pulled into Section 3 of the main *Guidance*. This description should also discuss why certain EREs were selected preferentially over other EREs when more than one endpoint was provided in a study.

The panel felt that the use of adjustment or safety factors in the Eco-SSL derivation process needs to be clarified in Section 3 of the *Guidance*. More information should be provided on the application factors (i.e., 2 and 5) that were used to adjust certain toxicity data. The rationale for inclusion of these particular factors may be understood by the document authors, but it is not clear to the reader. In order to provide a transparent and repeatable process, the rationale should be clearly explained in the *Guidance*. Also, the toxicity adjustment factors should be considered on a chemical-by-chemical basis based on scientific data.

Question # 4. What research topics need to be addressed to improve the process for generating soil screening levels for plants and invertebrates.

Recommendations for further research include the need to address microbial processes in soils and how this receptor group can be incorporated into the Eco-SSL process. Also, it may be helpful to validate the current plant and soil invertebrate Eco-SSL values in the field to see if they are protective. Field testing could also incorporate leaching and weathering of the soils to see how these processes can influence the resulting toxicity values. The panel also felt that more research was needed to address the effects of other contaminants (i.e., mixtures) on toxicity and that this type of information should be incorporated into the chemical summaries in Section 5 as it becomes available. One specific example given was the need to develop a stronger technical description of chromium speciation and interaction with other inorganic contaminants in soil, either in Section 5 or as the subject of a white paper.

Question # 5. What recommendations do you have for using site-specific information in the Eco-SSL process?

It may be helpful to include references in the chemical summaries of Section 5 that provide information on chemical background levels in different regions of the country. The panel recommended that the *Guidance* explain that although some literature studies may not have been included in the Eco-SSL derivation because they were not biased toward high-bioavailability, those studies still may be good sources of data for a site-specific baseline ERA.

6.2 Discussion Summary

Question # 1. Will the proposed procedures for evaluating soil biota toxicity data result in the selection and use of the most appropriate available literature for generating plant and invertebrate Eco SSLs?

There was a fairly lengthy discussion among the panel members regarding the need to address soil microbial processes in the Eco-SSL *Guidance*. The reviewers felt that it was inappropriate not to include microbial processes with plants and soil invertebrates in the derivation of Eco-SSLs or to provide an explanation of why microbial processes were not included. One peer reviewer noted that in the absence of a discussion on microbial processes, the reader may incorrectly assume that there are no issues regarding microbes.

The authors of the *Guidance* stated there was actually an extensive literature on microbial processes with toxicity data. The difficulty in incorporating the available data was the extremely large range in toxicity values for different bacterial species. As a result, microbial processes would likely become the risk driver for all chemicals. The panel then suggested that if microbial processes were not amenable to having a numeric value for screening purposes, an explanation should be provided in Section 3 of the *Guidance*. This discussion should emphasize the importance of microbial processes in ecosystems. Even though microbial processes are not presently included in the Eco-SSL derivation process, they should still be considered at least qualitatively in the screening-level assessment.

The panel felt that the information in Appendix 3-1 describing how the nine criteria were used to evaluate the applicability of the literature studies for deriving Eco-SSLs and the rules used to extract and report the most appropriate data should be included in Section 3 of the main *Guidance* document. In general, the panel felt that it would be difficult for the reader to understand the procedures followed for data selection without the supporting information in Appendix 3-1. The panel also felt that a justification should be provided in Section 3.3 (Identification of Data for Derivation of Eco-SSLs) for the acceptance of literature studies with an evaluation score greater than 10 while studies that received a total score of 10 or less were excluded. One reviewer noted that quite a few literature studies were eliminated by this particular step. It was decided that if this cut-off point of > 10 is based on professional judgment, then that should be specified in the text. Also, any supporting information for the designated cut-off point, such as a noticeable split in the quality of data that fell along those lines, should also be provided in the text.

There was considerable discussion as to whether the literature has been sufficiently reviewed and included as appropriate for the derivation of the Eco-SSLs. The panel wondered why the Eco-SSL document authors only considered studies published since 1988 (except in cases where only limited data were available), since many good older studies would have been excluded as a result. The panel also suggested that the Eco-SSL document authors consider contacting the authors of literature studies that received a score somewhat lower than 10 for more details to determine if those studies could be upgraded and included in the Eco-SSL derivation process. In addition, the panel suggested that it may be helpful to have experts review the chemical technical summaries in Section 5; not necessarily to review the derived Eco-SSLs, but to ensure that important studies have not been left out. These suggested activities may help to increase the number of studies, and therefore the number of data points, available for calculation of the SSLs, improving the overall confidence in the final four group-specific SSLs and the final one Eco-SSL.

Question # 2. Qualitative soil chemistry parameters are used as an initial step in the Eco-SSL process to address chemical availability issues in soils. What next steps should be considered to further address soil chemistry and chemical availability issues?

There was a lengthy discussion regarding current and past soil toxicity test methods and how certain procedures followed in toxicity tests in the past may result in overestimates of the level of toxicity. Three factors in particular seem to contribute to the overestimated risk; (1) anion effects, (2) pH shift, and (3) short aging or weathering period before the test organisms are introduced. If metals used in the toxicity study include a strong anion (e.g., chloride, nitrate), the metal reacts significantly with the soil and cations from the soil are dissolved. These cations compete with the metal ions for adsorption, increasing metal solubility and toxicity. The addition of metals in toxicity tests also acidifies the soil which increases metal solubility and potential toxicity relative to likely conditions in the field. Finally, failure to allow aging of soils after the addition of metal salts in toxicity tests is a significant problem, because the freshly added metals are more bioavailable than metals in soils subjected to field conditions with natural weathering. Because these types of errors are characteristic of many of the older soil toxicity tests, the derived Eco-SSLs for metals may often be based on these three artifacts. Because this issue affects SSLs for wildlife as well as SSLs for plants and soil invertebrates, it should be addressed early in the *Guidance* (e.g., Section 1). The explanation should emphasize that Eco-SSLs based primarily on older toxicity studies that include these types of errors are likely to be overly conservative.

In discussion of literature evaluation and acceptance criteria, the panel noted that for soil invertebrates, the weighting of studies based on pH range seems to have eliminated many good studies and resulted in relatively small data sets for the Eco-SSL derivation. A peer reviewer suggested that pH should not be included as a criterion for soil invertebrates because they are not influenced by pH to the same extent as plants. Another suggestion was that instead of grouping studies into specific pH ranges, an adjustment factor could be used for the different pH values. The panel concluded the discussion by recommending that the Eco-SSL document authors modify the use of pH as a criterion for assessing bioavailability for soil invertebrates and modify the "preference" level to include bioavailability scores of "1" and possibly "0" as well as "2" for soil invertebrates. In addition, separate qualitative bioavailability matrices should be provided in Section 2 (pp. 2-9) for plants and soil invertebrates for metal cations. The plant matrix would remain unchanged while the soil invertebrate matrix should be modified for soils with a low pH (4 to 5.5) and high organic matter (6 to 10%), by changing bioavailability from "medium" to "low."

There was additional discussion of soil chemistry parameters and bioavailability that included several points. One reviewer noted that including information on other soil chemistry parameters (e.g., pH, cation exchange capacity, etc.) that influence bioavailability for contaminants in soil make screening decisions more defensible. Another reviewer noted that preferentially selecting studies with relatively high bioavailability was a limiting factor in the total number of studies included for derivation of the Eco-SSLs. It was recommended that the Eco-SSL document authors consider including toxicity studies that

used metal salt amended, biosolids/sludge additions to soil. It was noted that the inclusion of these studies could be subject to pre-defined rules such as a requirement for relatively low organic matter content.

Question # 3. Will the proposed procedure for selecting toxicity values for soil biota and plants result in ecologically relevant appropriately protective values? Should we consider using a bioavailability adjustment factor when we use toxicity data not from level A to calculate an Eco-SSL?

The panel felt that based on the current information provided in Section 3 of the *Guidance*, it was difficult to determine whether the procedure for selecting toxicity values for plants/soil invertebrates result in ecologically relevant and appropriately protective values. Supporting information in Appendix 3-1 should be brought into Section 3 of the main *Guidance* document to give the reader a better understanding of how endpoints were selected for use in the Eco-SSL derivation process. The text taken from Appendix 3-1 should include a description of the ecologically relevant endpoints (ERE) including reproduction, population dynamics, growth, and physiological endpoints (for plants only) and their associated definitions in Table 1. The text should also mention that certain EREs were selected over other EREs when more than one endpoint was provided in a study using the following hierarchy: reproduction > population dynamics > growth > physiological endpoints.

There was a fairly lengthy discussion on the grouping of selected studies into levels (e.g., A, B, C, D) for preferential use in calculating Eco-SSLs as described in Section 3.3 and Tables 3.1 and 3.2. It was noted that it may be preferable to include B-level studies after some sort of adjustment, as well as A level studies in deriving SSLs for plants and soil invertebrates. This approach would increase the total number of studies included in the SSL derivation rather than basing the SSLs on a relatively small number of data points in the A-level studies.

The panel felt that the use of safety factors to adjust D-level toxicity data should be thoroughly explained in Section 3.3 of the *Guidance*. In particular, some sort of justification should be provided for the application factors (i.e., 2 and 5) that were used. The panel was uncomfortable with the inclusion of these safety factors unless some type of rationale was provided. For the Eco-SSL derivation process to be transferable, such that others can apply it to other chemicals, the rationale should be clearly explained to the reader. It was mentioned that it may be desirable to coordinate with the EPA group that oversees the Integrated Risk Information System (IRIS) database to let them review the suggested safety factors and make a determination as to whether they are appropriate.

Although the question of whether safety factors should be used for all toxicity data (with the exception of A-level data) was posed to the panel, there was not a strong consensus during the discussion. One reviewer stated that the safety factors should just be used with the D-level studies and not applied to the other levels. The panel did recommend that the toxicity adjustment factors be considered on a chemical-by-chemical basis, with all adjustment decisions based on scientific data.

Question # 4. What research topics need to be addressed to improve the process for generating soil screening levels for plants and invertebrates.

The panel suggested several research topics that they felt could help improve the process for generating SSLs for plants and soil invertebrates. One topic they felt must be addressed is the need to incorporate microbial functions into the Eco-SSL derivation process. If the problem is that the available literature is extensive and the range of sensitivity between species is extreme, perhaps the scientific community can help to identify key species and define parameters to narrow the types of studies and endpoints considered, and therefore narrow the range of LOAELs to one that would be amenable to deriving SSLs for microbial processes. The panel also discussed the need to conduct field testing, such as a 3 to 5 year ecological study, to validate the current Eco-SSL values to see if they are protective. Field testing can also incorporate certain procedures such as leaching and weathering of the test soils to determine if these procedures have an influence on the toxicity values (i.e., are they significantly different from the current Eco-SSL values).

Another important research need is to develop methods to address chemical mixtures at hazardous waste sites. The current Eco-SSL *Guidance* only discusses the effects of single contaminants on ecological receptors; chemical mixtures are not addressed. One reviewer explained that the chromic form of chromium can exist in soils at relatively high concentrations in conjunction with other ions and not result in adverse effects to ecological receptors. It was suggested that the current technical description of chromium in Section 5 be strengthened to discuss the behavior of this compound with other ions and the subsequent range(s) of toxicity. This issue could also be addressed as the subject of a white paper.

Another suggestion for research was further investigation of biochemical processes in plants for which the data are more sparse than similar data for soil invertebrates. The panel expressed hope that the Eco-SSL *Guidance* would be flexible enough to accommodate new data on biochemical endpoints that can be related to growth, reproduction, and survival in plants as such data become available.

Question # 5. What recommendations do you have for using site-specific information in the Eco-SSL process?

The panel stated that it may be helpful to include in the individual chemical summaries (Section 5) references that provide information on chemical background levels in different regions of the country. The reader can than review those studies to identify appropriate chemical background data for use in the baseline ERA. One reviewer also suggested that any available information on atypical soil profiles that occur in the western United States (e.g., Great Basin soils), which often have different characteristics from the soils discussed in Section 2, be included in the *Guidance* to help the user evaluate those soils.

The panel recommended that the Eco-SSL *Guidance* explain that although many of the literature studies reviewed may not have been included in the Eco-SSL derivation process, some still may be appropriate for use in the baseline ERA. For example, many studies evaluating the effects of metals in soil may have been excluded from the Eco-SSL derivation because they were not conducted in conditions favoring high bioavailability. These same studies, however, may be appropriate to use in the development of site-specific toxicity reference values if the experimental conditions of these studies are similar to the conditions that occur at the site of interest. The panel felt that it was important for the reader to understand that these studies are potentially valuable as resources even if they are not appropriate for national-level Eco-SSL values.

Appendix A

List of Peer Reviewers, Participants, and Attendees

PEER REVIEW WORKSHOP ON
EPA's ECOLOGICAL SOIL SCREENING LEVEL (SSL) GUIDANCE DOCUMENT

PEER REVIEWERS SIGN-IN SHEET

Wednesday, July 26 - Thursday, July 27, 2000
Crystal City Marriott Hotel, Arlington, VA

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PEER REVIEW WORKSHOP ON
EPA's ECOLOGICAL SOIL SCREENING LEVEL (SSL) GUIDANCE DOCUMENT

STEERING COMMITTEE SIGN-IN SHEET

Wednesday, July 26 - Thursday, July 27, 2000
Crystal City Marriott Hotel, Arlington, VA

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PEER REVIEW WORKSHOP ON
EPA's ECOLOGICAL SOIL SCREENING LEVEL (SSL) GUIDANCE DOCUMENT

ATTENDEE REGISTRATION LIST

Wednesday, July 26 - Thursday, July 27, 2000
Crystal City Marriott Hotel, Arlington, VA

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