Report on the Peer Review of the U.S. Environmental Protection Agency's "Draft Engineering Performance Standards—Peer Review Copy" for the Hudson River PCBs Superfund Site

—Final Report—

Prepared for:

U.S. Environmental Protection Agency, Region 2
Emergency and Remedial Response Division
290 Broadway, 19th Floor
New York, NY 10007-1866

EPA Contract No. 68-C-02-060
Task Order No. 0002

Prepared by:

Eastern Research Group, Inc.
110 Hartwell Avenue
Lexington, MA 02421

March 26, 2004

Note

This report was prepared by Eastern Research Group, Inc. (ERG) under contract to the U.S. Environmental Protection Agency (EPA) (Contract No. 68-C-02-060, Task Order No. 0002). As a general record of discussion for the peer review meeting, this report captures the main points of scheduled presentations, highlights discussions among the peer reviewers, and documents observer comments provided at the peer review meeting. This report does not contain a verbatim transcript of all issues discussed during the peer review meeting, and it does not embellish, interpret, or enlarge upon matters that were incomplete or unclear. EPA will evaluate the peer reviewers' recommendations and determine what, if any, modifications are necessary to the Engineering Performance Standards for the Hudson River PCBs Superfund site. Except as specifically noted, no statements in this report represent analyses by or positions of EPA or ERG.

Table of Contents

Table of Contents (Continued)

List of Abbreviations

BMP	best management practices
DO	dissolved oxygen
EPA	U.S. Environmental Protection Agency
EPS	Engineering Performance Standards
ERG	Eastern Research Group, Inc.
GE	General Electric Company
MCL	Maximum Contaminant Level
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NYSDEC	New York State Department of Environmental Conservation
PCB	polychlorinated biphenyl
ROD	Record of Decision
SPI	sub-bottom profile imaging
SPT	Standard Penetration Test
TSS	total suspended solids

Executive Summary

This report summarizes a peer review of the U.S. Environmental Protection Agency's (EPA's) "Draft Engineering Performance Standards—Peer Review Copy" (Malcolm Pirnie and TAMS 2003) for the sediment remediation activities to occur at the Hudson River PCBs Superfund site. Nine independent peer reviewers with various affiliations and from relevant scientific disciplines thoroughly discussed and evaluated the Draft Engineering Performance Standards (EPS). During the 3-day meeting, the peer reviewers answered 15 charge questions that addressed the proposed Resuspension Standard, Residuals Standard, and Productivity Standard, as well as issues that pertain to all three standards.

Overall, the peer reviewers commended EPA and its contractors on the efforts that went into preparing the Draft EPS. The reviewers had favorable feedback on many issues. For instance, they supported the development of the EPS to maximize the benefits of the two-phase approach to the remedy, which makes it possible to incorporate site-specific data collected during Phase 1 into the final performance standards prior to full-scale production. In addition, they offered constructive criticism on many topics. They indicated, for example, that some standards are overly complex and can be simplified in various ways without their objectives being compromised; they also proposed, for EPA's consideration, an alternate framework for the Residuals Standard. Following are the reviewers' key findings, organized by topic. The remainder of this report documents both the extensive discussions that led up to these findings and the deliberations on additional topics not listed below.

Key Findings for the Resuspension Standard

Charge Question 1: Framework (see Section 2.1 of this report)

- The general framework is logical and well-thought out, however, this standard may have too many levels. EPA should consider simplifying or reducing the number of action levels, primarily to reflect those necessary to evaluate compliance.

- The panel recommends that the Resuspension Standard consider and address all relevant Water Quality Standards. This would include the assimilative capacity for PCBs in the Hudson River.

- For the long-term protection of the river, the dredging-related export should not exceed 650 kg of total PCBs over the life of project as the upper bound limit. This objective should be clearly identified in the framework, as should the means by which it will be achieved.

Charge Question 2: Near-Field Analyses (see Section 2.2 of this report)

- The panel supports the use of near-field analysis during Phase 1 with the goal of acquiring sufficient information to simplify and streamline objectives for Phase 2.

- The panel recommends that, during Phase 1, total PCB data be collected in the near-field. If data collected in Phase 1 demonstrate a relationship between turbidity, TSS, and total PCB, then the Phase 2 standard would be modified accordingly.

- Some of the panel recommends adding best management practices (BMP) guidelines for controlling solids losses during remediation and including near-field turbidity monitoring with an upstream comparison.

- Some of the panel feels that unacceptable downstream turbidity levels should initiate a response other than monitoring, preferably an action by the remedial operation to address the high turbidity level.

- In general, there was consensus that the models were well formulated and applied and made good use of existing data. Monitoring will help clarify future direction.

Charge Question 3: Evaluation Level (see Section 2.3 of this report)

- The panel is split on elimination of the Evaluation Level but overall recommends consideration of blending levels in Phase 2.

Charge Question 4: Resuspension Threshold (see Section 2.4 of this report)

- In general, there is agreement on the reasonableness of the 500 ng/L standard.

- The concern and control levels for total PCBs should be based on the lower 95% confidence interval estimated around the 500 ng/L standard.

Charge Question 5: Monitoring Program (see Section 2.5 of this report)

- The panel recommends a special study during Phase 1 to assess non-target area impacts.

- The panel recommends consideration be given to reducing the number of monitoring stations if not needed for compliance determinations. This would especially apply to the near-field monitoring stations around each piece of equipment and the furthest downstream stations.

- The panel recommends that data should be taken only to answer specific questions. The onus will be on the standard writer to make an explicit statement of what question is to be answered. This would include analyses for each location, data type, and frequency at each action level.

- The panel recommends consideration be given to using the "homolog method."

- The panel recommends that a special study of split phase PCBs be conducted in the near-field and that split phase sampling be dropped from the far-field.

- EPA should use temporal composite whole water samples for PCBs in the far-field.

- If the collected monitoring data in near-field and far-field are meeting or exceeding necessary levels for protection of human health and the environment, EPA may, at its discretion, reduce the level of monitoring in the program.

- EPA should adopt a goal to develop and implement a potential Phase 2 monitoring program before the end of Phase 1.

- The New York State Department of Environmental Conservation (NYSDEC) needs to provide documentation regarding the 401 Water Quality Certification requirements and in particular they need to address dissolved oxygen (DO), pH, and how they view non-target contaminants of concern (e.g., metals). The state also needs to address the PCB assimilation capacity issue. Once that is written, the standard needs to consider associated impacts.

- Cost-benefit and implementability analysis of the monitoring program needs to be documented.

- There is a suggestion that a relationship between turbidity, suspended solids, and PCBs is not needed to control solids losses.

Key Findings for the Residuals Standard

Charge Question 6: Framework (see Section 3.1 of this report)

- The peer review panel is in general agreement that the framework is reasonable and based on sound scientific principles, as stated.

- The goals of the Residuals Standard need to be articulated better. The standards focus solely on confirmation of removal of all PCBs with an anticipated post-dredging (pre-backfill) residual PCB concentrations of 1.0 mg/kg Tri+PCBs. The standard also appears to have an unstated goal that after backfill, an expected surface sediment concentration of $\leq$0.25 mg/kg (assuming 1-ft backfill) will be achieved. That level is necessary to support levels of risk reduction to human health and the environment that were used in the ROD, as predicted by the HUDTOX model.

  The specific objectives of the standard need to be articulated better at the beginning of the performance standards, to include the following goals:

  - Inventory removal (standards for inventory removal are not included; rather, the standards assume inventory removal is achieved).

  - Post-dredging pre-backfill residual concentrations [Tri+ PCBs] = 1.0 mg/kg.

  - Post-backfill surface sediment target concentration based on risk reduction of 0.25 mg/kg.

  The standard needs to address how these goals will be met; that is, how the monitoring program will be used to meet these goals.

- The proposed framework can be used to meet the objectives (as the panel understands them) of the standard. However, the panel believes that the framework is complex and directly impacts the potential success of the Productivity Standard. As crafted, the standard requires dredging, followed by up to two additional dredge passes, followed by either a mandatory 1-ft backfill or cap. The alternate framework described below may provide greater potential for success in the field. The cost of the potentially increased amount of dredging has to be balanced with the possible reduction in re-dredging and testing.

  The alternative framework is as follows:

  - The design needs to specify the dredge prisms such that the inventory removes Tri+ PCBs in excess of 1.0 mg/kg; bottom elevations should be based on the lower confidence of the mean of the 1.0 mg/kg Tri+ PCB target concentration;

restated, the dredge prisms should be designed with sufficient certainty that no more than 5% of the target areas would be expected to exceed the 1.0 mg/kg Tri+ PCB goal.

- Confirmation of inventory removal (e.g., using bathymetry or similar measurements) should be incorporated into the standard.

- No re-dredging would be required unless the target elevation is not achieved.

- Once dredging is complete, and design elevations verified, the contractor will have two alternatives:

  - Backfill without further testing.

  - Avoid backfilling by verifying that dredging achieved an average surface sediment concentration ≤0.25 mg/kg Tri+ PCB; this will be done through confirmatory sampling similar to the sampling requirements stipulated in the draft Residuals Standard.

- During Phase 1, pre-backfill and post-backfill investigative sampling may be required to validate this approach. Post-backfill sampling would be necessary to confirm the degree of mixing that occurs.

Charge Question 7: Statistical Analyses (see Section 3.2)

- Within the context of the draft framework, the statistical analysis was technically adequate and properly documented.

Charge Question 8: Post-Dredging Confirmatory Sampling Program (see Section 3.3)

- The 20-acre evaluation area is intended to provide flexibility to the contractor to achieve the 1.0 mg/kg Tri+ PCB treatment goal. If the alternative framework is employed, the concept of the 20-acre evaluation area may not be relevant. Otherwise, within the existing framework, the 20-acre area concept is reasonable. The concept should be re-evaluated for Phase 2 based on the final surface area concentrations measured during Phase 1.

- Some peer reviewers felt the 40 samples per certification unit could be composited. Others felt that compositing should not be permitted during Phase 1, but that it could be considered during Phase 2. If compositing is employed, the following restrictions should be included in the sampling program:

  - Composited samples should be analyzed in duplicate or triplicate.

  - Aliquots of each of the 40 samples should be saved for individual analyses, in the event that the sample does not meet the 1.0 mg/kg Tri+ PCB goal.

Charge Question 9: Re-dredging and Engineering Contingencies (see Section 3.4)

- The document did not adequately discuss cap and backfill material placement and performance metrics.

- The sub-bottom profile imaging (SPI) requirement should be revisited or removed.

- There is general consensus to limit the number of re-dredging attempts. Currently, the Residuals Standard requires no more than two re-dredging attempts. Under the alternative framework, re-dredging requirements will be based on achieving design elevations. However, if the alternative framework is not implemented, the existing framework should evaluate the efficacy of multiple dredging attempts during Phase 1. This evaluation should consider (a) whether re-dredging results in lower surface sediment concentrations and achieves the surface sediment concentration goals, and (b) whether re-dredging negatively impacts resuspension. If re-dredging negatively impacts resuspension, the impacts on resuspension should be weighted against the potential benefits of re-dredging. The Phase 2 Residuals Standard should reflect the results of this evaluation in the interest of further reducing re-dredging requirements.

- The Residuals Standard needs to more clearly articulate where backfill is required. As the panel understands it, backfilling is required in all dredged areas except within the navigation channel, if specific habitat (deep water) is desired, or if a cap is deemed necessary.

- The panel believes that the design criteria for sediment caps and backfill need to be better documented.

Key Findings for the Productivity Standard

Charge Question 10: Framework (see Section 4.1 of this report)

- The concept of cumulative volumes and monthly targets is considered to be a reasonable approach.

- During Phase 1, volume is less important than the information gained, but we recommend that the target in Phase 1 be at least 150,000 cubic yards.

- Consider establishing a lower target production volume for year 2 to make full use of the new data gathered during Phase 1.

- Phase 1 dredge sites should be chosen carefully to provide specific data on dredge and disposal production under different conditions anticipated during Phase 2 dredging.

Charge Question 11: Example Production Schedule (see Section 4.2)

The panel recommends that EPA strengthen the documentation on the following underlying assumptions that need to go into the Example Production Schedule:

- Present better documentation of the utilization of the equipment to explain the dredging rates, capping rates, sheet piling installation rates, and other required work items.
- Present a complete description of the river transportation cycle, including barge capacity, locking time, interference from river traffic, and mooring facilities at the transfer facility.
- Present a complete description of the transfer facility, including the layout and the process.
- Present a complete geotechnical description of material to be dredged, including soil borings, Standard Penetration Test (SPT) blowcounts, water contents, grain size distribution, and plasticity.
- Complete a sensitivity analysis of the re-dredging effort on overall schedule.
- Present typical information on river velocities (feet per second) in addition to flow rates (cubic feet per second) by month and location.
- Review the effect the Quality of Life Standards for noise and lights might have on production rates. For example, a clamshell bucket offloading backfill or cap material from a deck scow could produce noise levels that exceed the Quality of Life Standard.
- Develop an operations plan that describes and shows the working relationships between the different equipment. Specifically, show relative equipment locations, especially for the multiple dredging and backfilling events.
- Describe the assumed impacts of the Water Quality Certification on production rates.
- Conduct a critical path analysis.

Charge Question 12: Action Levels (see Section 4.3)

For Phase 2, the actual target cumulative volume must be based on an orderly progression of the dredging from upstream to downstream. This may mean that some intermediate years will have cumulative volumes that reflect either significantly slower or significantly faster production for the year than the average. The actual cumulative volume should be confirmed in a complete dredging schedule that shows the entire quantity of remedial activities completed in accordance with the ROD. Specific information that should be collected, in addition to that presented in the report, includes:

- Number of hours of actual dredging time to determine and monitor efficiency and net and gross production rates.

- Monitoring of offloading rates.

- Monitoring of capping and backfilling production rates.

- Monitoring of shoreline work.

- Note of other delays associated with river flow conditions, weather, traffic, Quality of Life Standards, equipment problems, sampling work, or other activities. It is important to be able to see if there are trends with delays.

The U.S. Army Corps of Engineers has a standard "Dredge Daily Report" that may be used as a guide.

Key Findings for Issues Relevant to All Three Standards

Charge Questions 13 and 14: Interactions Among the Standards and Plans for Refining the Standards (see Section 5.1 and 5.2 of this report)

- The panel recommends that there be a summary capturing interactions between standards.

- There needs to be a balance between the standards and a decision process that allows the parties to achieve that balance.

- Risk reduction at the end of the project is the goal of the balancing process.

- Data gathering to refine all standards should be stressed in Phase 1 and an attempt should be made to revise the approach by the end of the first year.

- The peer reviewers recommend that EPA develop a process to evaluate data as they are generated and modify the implementation process in Phase 1. The proposed Phase 2 peer reviewers should be involved during Phase 1.

Charge Question 15: Other Issues (see Section 5.3)

- Some members recommend performance criteria for re-contamination that acknowledge that non-target areas will equilibrate with areas of remediation.
- Individual members recommended that design criteria be included for the final dredge

surface such that sediment entrapment and re-contamination is minimized and that habitat goals are met.

- Some members suggest that the actions as defined in Tables 1-1 and 1-2 (of the Resuspension Standard volume) should be more directly related to controlling resuspension.

- The standards should include a discussion of how the analytical methods and data management are to be applied and communicated. Clear guidelines on data interpretation need to be developed.

- A special study should be conducted during Phase 1 to assess the release of other contaminants (e.g., metals) during dredging.

- Some panel members recommended that during Phase 1, the standards be considered goals or alternatively draft standards until reformulation for Phase 2.

1.0 Introduction

This report summarizes nine experts' independent peer review of the four-volume report, "Draft Engineering Performance Standards—Peer Review Copy" (Malcolm Pirnie and TAMS 2003). The Engineering Performance Standards (EPS) address resuspension, residuals, and productivity associated with the planned environmental dredging of sediments contaminated with polychlorinated biphenyls (PCBs) in the Upper Hudson River, New York. The purpose of the peer review was to determine whether the EPS are "based on sound and credible science" and are "technically adequate, competently performed, properly documented, and satisfy established quality requirements" (EPA 2000).

The peer review took place in a meeting open to the public on January 27–29, 2004, in Saratoga Springs, New York. Eastern Research Group, Inc. (ERG), under contract to the U.S. Environmental Protection Agency (EPA), organized and implemented the peer review according to procedures outlined in EPA's "Peer Review Handbook" (EPA 2000). ERG prepared this report, which summarizes the independent peer review. This introductory section provides background information on the Hudson River PCBs site (Section 1.1), describes the scope of this peer review (Section 1.2), and outlines the organization of this report (Section 1.3).

1.1 Background

In 1984, EPA classified approximately 200 miles of the Hudson River in the state of New York—from Hudson Falls to New York City—as a Superfund site, because the river sediments were contaminated with PCBs. This site traditionally has been divided into the "Upper Hudson River," which flows from Hudson Falls downstream to the Federal Dam at Troy, and the "Lower Hudson River," which flows from the Federal Dam downstream to New York City. The sediments were contaminated with PCBs predominantly by discharges from two capacitor manufacturing facilities owned by General Electric Company (GE). In 1984, EPA issued a Record of Decision (ROD) for the Hudson River PCBs Site, which included, among other things, an interim No Action decision regarding the contaminated sediments.

Between 1990 and 2000, EPA reassessed its earlier decision with respect to the contaminated sediments of the Upper Hudson River to determine whether a different course of action was needed. The reassessment involved compiling and analyzing existing data, collecting additional data, using models to evaluate human health and ecological risks, and studying the feasibility of various remedial alternatives. In 2002, after completing the reassessment studies, EPA issued a ROD that calls for, among other actions, targeted environmental dredging of approximately 2.65 million cubic yards of contaminated sediments from the Hudson River PCB site (EPA 2002). Readers should refer to the ROD for further details on the site history, the remedial action objectives, and other aspects of the proposed remedy.

In addition to specifying the selected remedy, the ROD requires EPA to develop enforceable performance standards that "promote accountability and ensure that the cleanup meets the human health and environmental protection objectives of the ROD" (EPA 2002). The ROD also specifies that these performance standards must be subject to independent external peer review. Through these requirements, EPA prepared the Draft EPS and hired ERG to conduct the current peer review. The remainder of this report documents the peer review of the Draft EPS.

1.2 Scope of the Peer Review

ERG managed every aspect of the peer review, including selecting reviewers (see Section 1.2.1) and coordinating activities before, during, and after the peer review meeting (see Sections 1.2.2, 1.2.3, and 1.2.4, respectively). The following sections of the report describe what each of these tasks entailed.

1.2.1 Selecting the Peer Reviewers

ERG followed its long-standing procedures for conducting peer reviews to select nine highly qualified and independent reviewers. The selection process involved the following steps:

- *Establishing peer review selection criteria.* After reading the Draft EPS (Public Review Copy), ERG determined that the peer review panel should contain individuals who have managed sediment dredging projects, studied water quality impacts from dredging, researched engineering controls to reduce resuspension, assessed sediment residuals, or evaluated sediment processing and transfer facilities. Accordingly, ERG sought scientists, engineers, and other experts who have extensive experience and related publications in one or more of the following areas: sediment remediation projects, sediment dredging technologies, PCB-contaminated sediments, statistical and spatial analysis of data, geochemistry, hydrology, and sediment sampling techniques. The candidate peer reviewers should have published in scientific journals, conference proceedings, or project summary reports on the aforementioned topics.

  ERG did not consider candidates with conflicts of interest. For this peer review, a conflict of interest was defined as a situation in which an individual's activities, interests, or relationships create a situation where the candidate may benefit from the outcome of the review. In selecting reviewers, ERG did not consider individuals who were associated in any way with preparing the Draft EPS or individuals associated with GE or any other specifically identified stakeholder. ERG sought only reviewers who could provide an objective and fair critique of EPA's work.

- *Identifying candidates.* Several months before selecting reviewers, ERG developed a list of highly qualified candidates for this peer review. The search for candidate reviewers began with EPA giving ERG a list of individuals who had been nominated by stakeholders and the public. The list ERG received was in alphabetical order and did not specify which parties made the nominations. ERG attempted to contact everyone on the list, but the contact information for some individuals was outdated or incorrect. ERG also identified candidate peer reviewers through its own search of subject matter experts. Overall, ERG contacted more than 100 highly qualified candidate peer reviewers.

- *Selecting the final peer reviewers.* After carefully reviewing the candidates' expertise and credentials, ERG selected nine peer reviewers who, as a group, met the selection criteria. Appendix A lists their names and affiliations. Recognizing that few individuals truly specialize in every technical area in the reviewer selection criteria, ERG ensured that the collective expertise of the selected peer reviewers covers the required areas (i.e., at least one reviewer has managed dredging projects, at least one reviewer has studied water quality impacts of dredging, and so on). Moreover, ERG selected peer reviewers of varying affiliations (e.g., academia, consulting, state agencies), in hope that the expert panel would offer a balanced perspective on the Draft EPS. Copies of the peer reviewers' resumes and conflict of interest disclosure forms are now part of the "peer review record," which the public can access from EPA Region 2. ERG believes the nine peer reviewers were able to provide a fair, independent, and scientifically rigorous peer review of the Draft EPS.

1.2.2 Activities Prior to the Peer Review Meeting

ERG took several steps to ensure that the peer reviewers had the information necessary to conduct thorough, informed, and unbiased reviews of the Draft EPS. This section describes the major activities that ERG and the peer reviewers conducted prior to the peer review meeting:

- *Organize a briefing and site tour.* Given the large volume of site-specific information in the Draft EPS and the fact that most reviewers do not have extensive experience with the Hudson River PCBs Superfund site, ERG organized a 2-day meeting in October 2003, during which the reviewers toured the Upper Hudson River and received background information on the site and the Draft EPS from EPA and selected stakeholders. The reviewers did not provide technical comments on the Draft EPS during this briefing. Refer to Appendix F for minutes from the briefing and site tour.

- *Distribute peer review documents and background information.* At the end of the briefing and site tour, ERG gave the peer reviewers copies of the four-volume Draft EPS. ERG also distributed written guidelines for the peer review. These guidelines (commonly called a "charge") were presented during the briefing. The charge includes 15 questions that address various aspects of the Draft EPS, including one open-ended question that invites peer reviewers to comment on any topics not explicitly addressed by the other questions. A copy of this charge is included in this report as part of Appendix B.

  For additional background information on the site, its history, and stakeholder interest, ERG provided the peer reviewers with multiple background documents (see Table 1). Copies of all background documents were available to observers at the peer review meeting. The peer reviewers were asked to focus their evaluations primarily on the Draft EPS, and use the background documents to supplement their evaluations, as necessary. Though they were not required to do so, some reviewers might also have researched site-specific reports they obtained from other sources.

- *Facilitate questions of clarification.* ERG instructed the reviewers to remain independent throughout the peer review process, and therefore refrain from discussing the scientific merit of the Draft EPS with EPA or any stakeholder. However, ERG recognized that peer reviewers, while reading the Draft EPS and the background documents, might have questions of clarification for these parties. The peer reviewers were asked to forward all such questions in writing to ERG, and ERG, in turn, sent the questions to the appropriate parties for written responses. By this approach, all questions of clarification that the peer reviewers asked and responses that EPA and stakeholders provided would be documented and available for review by the peer reviewers, stakeholders, and the public. Copies of the questions and responses were available at the peer review meeting and are included in the peer review record.

- *Obtain and compile the peer reviewers' pre-meeting comments.* After the briefing and site tour, ERG asked the peer reviewers to prepare their initial evaluations of the Draft EPS. The peer reviewers had 3 months to submit their written preliminary comments. One week before the meeting, ERG compiled and bound the reviewers' pre-meeting comments, distributed the comments to the peer reviewers, and made the comments available to observers. Specifically, observers who pre-registered for the peer review meeting had the opportunity to receive the peer reviewers' pre-meeting comments before the peer review took place. The peer reviewers' pre-meeting comments are included in this report, without modification, as Appendix B. It should be noted that the pre-meeting comments are preliminary in nature and some reviewers' technical findings might have changed based on discussions during the meeting. The pre-meeting comments should therefore not be considered the reviewers' final opinions.

1.2.3 Activities at the Peer Review Meeting

The nine peer reviewers and approximately 30 observers attended the peer review meeting, which was held at the Gideon Putnam Hotel and Conference Center in Saratoga Springs, New York, on January 27–29, 2004. The peer review meeting was open to the public, and the meeting dates and times were announced both on EPA's project Web site and in a public notice that appeared on January 13, 2004, in *The Post-Star*, a local newspaper. Appendix C lists the observers who confirmed their attendance at the meeting registration desk. The schedule of the peer review meeting generally followed the agenda, presented here as Appendix D.

The peer review began with introductory comments and opening remarks by the meeting's facilitator (Jan Connery of ERG), stakeholders, and EPA:

- *Welcome and introductions.* Ms. Connery welcomed the peer reviewers and observers to the meeting, stated the purpose of the peer review, and identified the document under review. Ms. Connery briefly explained the peer review process and reviewed several logistical details for the meeting, including the procedures observers should follow to make comments. To ensure that the peer review remained independent, Ms. Connery asked the reviewers to discuss technical issues during the meeting and to consult with EPA and stakeholders only for necessary clarifications. The peer reviewers then introduced themselves by stating their names, affiliations, and areas of expertise; all peer reviewers stated that they have no conflicts of interest in working on this project.

- *Observer comments.* The agenda included three time slots for observer comments, during which stakeholders and the public were invited to give their impressions of the Draft EPS.

Appendix E of this report documents all observer comments given during the meeting. On the first day of the meeting, the only observer who presented comments was John Haggard (GE).

- *EPA introduction.* After the first observer comment period ended, Alison Hess (EPA) provided opening remarks. Ms. Hess thanked the peer reviewers and observers for participating in the meeting. She welcomed the peer reviewers and noted that their conclusions and recommendations would help EPA strengthen and improve the Draft EPS.

Following these opening presentations, Dr. Ken Reimer, a peer reviewer and the designated chair of the meeting, opened the technical discussions among the peer reviewers. Dr. Reimer and the peer reviewers first presented brief general comments on the Draft EPS, after which the peer reviewers engaged in free-flowing discussions to answer the charge questions. The technical discussions were strictly among the peer reviewers. The only instances in which individuals other than ERG or the peer reviewers spoke were when the reviewers asked EPA or stakeholders questions of clarification, which were facilitated by either Ms. Connery or Dr. Reimer. The remainder of this report summarizes the peer reviewers' discussions, observations, and comments and documents the reviewers' major findings and recommendations. Unless specified otherwise, the discussions at the meeting (and not the pre-meeting comments) should be viewed as the peer reviewers' final opinions on the Draft EPS.

1.2.4 Activities Following the Peer Review Meeting

Following the peer review meeting, an ERG technical writer who attended the peer review prepared this summary report. ERG distributed a draft of this report to the nine peer reviewers and asked them to verify that it accurately reflects the tone and content of the discussions at the peer review meeting. After every peer reviewer confirmed that the draft summary report was a faithful account of the peer review meeting, ERG submitted the final peer review report (i.e., this report) to EPA, and EPA made the report available to the public and stakeholders.

1.3 Report Organization

The structure of this report reflects the main topic areas identified in the agenda. Sections 2, 3, and 4 of this report document the reviewers' responses to charge questions pertaining to the Resuspension Standard, Residuals Standard, and Productivity Standard, respectively. Section 5 summarizes the reviewers' evaluation of issues relevant to all three standards, and Section 6 documents the discussion that led up to the peer reviewers' conclusions and recommendations. Finally, Section 7 provides references for all citations in the text. The appendices to this report contains the following:

- A list of the peer reviewers (Appendix A).
- The peer reviewers' pre-meeting comments and the charge to the reviewers (Appendix B).
- A list of registered observers of the peer review meeting (Appendix C).
- The agenda for the peer review meeting (Appendix D).
- Observer comments given during the peer review meeting (Appendix E).
- Minutes from the October 2003 Briefing and Site Tour (Appendix F).

In addition to the information documented in this summary report, ERG will submit a peer review record to EPA. The peer review record will not only include this report, but will also contain copies of background documents provided to the reviewers (see Table 1), responses to questions of clarification during the peer review, and other relevant items. Stakeholders and the public will be able to access the peer review record from EPA Region 2.

Table 1
Background Information Provided to Peer Reviewers

1. EPA's October 10, 2003, responses to public comments received during the public comment period (May 14–July 14, 2003) for the Draft EPA Public Review Copy, as well as the comments themselves.
2. Suggested charge questions submitted to EPA from GE, the National Oceanic and Atmospheric Administration, Saratoga County Environmental Management Council, and Scenic Hudson, Inc.
3. The following excerpts from the Responsiveness Summary (Part 3 of the ROD): White Paper—Resuspension of PCBs During Dredging White Paper—Relationship Between PCB Concentrations in Surface Sediments and Upstream Sources White Paper—Metals Contamination White Paper—Dredging Productivity and Schedule White Paper—Delays and Downtime White Paper—Model Forecasts for Additional Simulations in the Upper Hudson River White Paper—Rail Operations White Paper—Post-Dredging PCB Residuals White Paper—Example Sediment Processing/Transfer Facilities White Paper—Relationship Between Tri+ and Total PCBs
4. GE's "Supplement to Comments of General Electric Company on EPA's Draft Engineering Performance Standards for the Hudson River PCBs Superfund Site, November 19, 2003."
5. EPA's response to "Supplemental Comments From General Electric Company on Draft Engineering Performance Standards—Peer Review Copy; Hudson River PCBs Superfund Site, November, 19, 2003."
6. Four documents that Tim Thompson (a peer reviewer) distributed to the panel: "A Mass-Balance Approach for Assessing PCB Movement During Remediation of a PCB-Contaminated Deposit on the Fox River, Wisconsin." United States Geological Survey, December 2000. "Evaluation of the Effectiveness of Remediation Dredging: The Fox River Deposit N Demonstration Project, November 1998–January 1999." Water Resources Institute, University of Wisconsin, June 2000. "Sample Size, Spatial Allocation of Samples, and Statistical Methods for Detection of the Boundary of 1 ppm PCB Concentration in Sediment of the Lower Fox River, Wisconsin." Nayak Polissar, Derek Stanford, and Blazej Neradilek, June 2003. "Sampling Sediment in the Lower Fox River: How Many Samples?" Nayak Polissar and Derek Stanford, June 2003.

Note: ERG provided the peer reviewers items 1–3 at the briefing and site tour. Items 4–6 were sent to the peer reviewers after the briefing and site tour, but before the peer review meeting.

2.0 Peer Review of the Resuspension Standard

This section summarizes the peer reviewers' comments on the Resuspension Standard. These comments focused on five general topics, as outlined in the charge to the reviewers. The peer reviewers' comments on the Resuspension Standard were generally favorable, but they made several recommendations for improving it. The main recommendations pertained to simplifying the standards and more clearly articulating the rationale behind specific requirements. A record of the reviewers' discussions on the Resuspension Standard follows, and the Executive Summary lists the most important conclusions and recommendations.

2.1 Charge Question 1: Framework

The first charge question addressed the framework of the Resuspension Standard. The question asked the peer reviewers:

> The Resuspension Standard was developed with a routine (i.e., baseline condition) water quality monitoring plan and three tiered action levels (Evaluation, Concern, and Control) leading up to a maximum allowable concentration of PCBs in river water. Exceedence of an action level would trigger additional monitoring requirements beyond the routine monitoring, as well as operational or engineering steps (studies and operational or engineering improvements and, if necessary, temporary halting of operations). The Resuspension Standard was developed with this framework to accommodate the project need for both protection and production (i.e. upon an exceedance of an action level, appropriate steps can be taken to identify and address remediation-related problems before dredging operations would need to be halted temporarily) (see, for example, Section 2.3 [in the Draft EPS]: Rationale for the Standard). Please comment on whether this framework provides a reasonable approach for developing the Resuspension Standard.

The peer reviewers generally agreed that the overall framework with tiered action levels and corresponding monitoring and engineering contingencies is logical and appropriate for protecting public water supplies and reducing downstream transport of PCBs. They noted that EPA can reduce the number of action levels and still achieve the project's environmental and human health protection objectives. Given that EPA based the Resuspension Standard in part on a theoretical model of conditions in the Hudson River, the reviewers stressed the importance of

EPA revisiting and revising this standard after careful review of the sampling data collected during Phase 1. Specific comments on the framework for the Resuspension Standard follow:

- *Assimilative capacity for PCBs released during dredging.* Noting that engineering controls to minimize resuspension are not required until the Control Level is triggered, one reviewer was concerned that the Draft EPS implies that the Hudson River has the capacity to assimilate PCBs released from the dredging sites. Given that PCB concentrations in the Upper Hudson River currently exceed Water Quality Standards, this reviewer suggested that the Resuspension Standard should place a higher priority on minimizing PCB loads from dredging operations, rather than implying that it is acceptable to degrade water quality well beyond baseline conditions before engineering contingencies or other interventions must be implemented.

  As a suggested improvement, this reviewer recommended that the Resuspension Standard's framework be more consistent conceptually with approaches supporting other EPA programs, such as the National Pollutant Discharge Elimination System (NPDES). Specifically, he suggested that the Draft EPS more prominently acknowledge that several Water Quality Standards for PCBs are not being met in the Upper Hudson River and, as a result, further degradation of water quality must be minimized. Consistent with this conceptual approach, engineering contingencies would be required at lower action levels than currently proposed. The reviewers revisited this topic when responding to Charge Question 3 (see Section 2.3).

  Other reviewers briefly discussed these comments. One reviewer agreed that the Draft EPS should address the issue of assimilative capacity, relating PCB loads to the remedial goal of reducing downstream transport of PCBs. Regarding the applicability of NPDES to releases from dredging operations, another reviewer agreed that NPDES requirements would probably apply to point source discharges, such as those from the de-watering operations, but he was not convinced that this regulatory framework would directly apply to releases occurring within the river, such as resuspension of PCBs from dredging operations. The reviewers eventually asked EPA to clarify whether it had considered using an NPDES approach when developing the Resuspension Standard. In response, Ms. Hess (EPA) said EPA had considered this possibility. She referred the reviewers to a written response the Agency presented on this matter. This response is included among the background materials that are part of the peer review record available from EPA Region 2; a copy of this response appears at the end of this section (see Attachment 2-1). Finally, regarding other water quality standards for PCBs, a reviewer agreed that the Draft EPS should acknowledge that certain standards are not being met; however, the reviewer noted that achieving these other water quality standards should not necessarily be viewed as a goal of the project, because some standards likely will not be met, no matter how aggressive the remediation project is.

- *Significance of PCB loads from dredging operations.* One reviewer found the framework of the Resuspension Standard acceptable for ensuring that PCB concentrations do not exceed acceptable levels, but he was less convinced that the standard ensures that PCB loads are adequately addressed. This concern is based on the estimated PCB load that EPA found to be associated with long-term environmental protection goals. Specifically, the increase of total PCB load due to dredging must not be greater than 650 kg over the course of the 6-year project (which translates to approximately 600 g/day) in order to meet the remedial objectives. This peer reviewer recommended that the Resuspension Standard emphasize the basis for the PCB load requirements and the means by which the PCB load limits will be achieved. Other reviewers agreed that these are important points, and added that the Resuspension Standard should be very clear in stating the proposed load limits, whether they apply to PCBs or "Tri+ PCBs,"[1] over what time frames the load limits apply, and whether the loads refer to actual measurements or increases over baseline conditions. The peer reviewers revisited the issue of PCB loads and the Resuspension Standard when responding to Charge Question 4 (see Section 2.4).

- *Other comments.* During this discussion, the reviewers began raising several detailed issues concerning the number of action levels, the proposed concentration and PCB load triggers, the required responses, and the baseline monitoring program. Sections 2.2 through 2.5 document these comments.

2.2 Charge Question 2: Near-Field Analyses

The second charge question asked the peer reviewers to comment on the near-field analyses conducted to support the Resuspension Standard. This question asks:

> Development of the Resuspension Standard considered the potential effects of resuspension in the near-field and in the far-field (see, Section 2.1.2 [in the Draft EPS]: Definitions). The near-field work was performed to help identify the locations of the near-field water column monitoring stations, to estimate the loss from the dredge, to estimate the nature of the release (i.e., dissolved vs. suspended) to provide an estimate of the solids transported into the far-field, and to estimate the effects of settled material on PCB concentrations in near-field sediment. Relevant sections of the document [Draft EPS] include, but are not limited to, Section 2.2.7: Near-Field Modeling, Section 2.2.8: Relationship Among the Resuspension Production, Release and Export Rates, and Attachment D: Modeling Analysis.

[1] "Tri+ PCBs" refers to the PCB congeners that have at least three chlorine atoms, not the mono- and di-chlorinated congeners. Tri+ PCBs, therefore, constitute a subset of total PCBs.

> Please comment on the technical adequacy of the near-field analyses, in particular the linkage from the resuspension production rate (at the site of dredging), to the resuspension release rate (reflecting PCB transport in the water column in the immediate vicinity of the dredging operations) and finally to the resuspension export rate (essentially equilibrium conditions reflecting long-distance transport of PCBs in the water column).

The peer reviewers generally agreed that the near-field analyses using theoretical models was technically adequate, was appropriate, and made good use of existing data. However, several peer reviewers questioned some findings from the modeling analysis, particularly the expectation that releases of dissolved-phase PCBs from dredging sites will be minimal. Given these and other concerns regarding the models, the peer reviewers supported the approach of proceeding with Phase 1 based on the existing near-field analyses and using the data collected during Phase 1 to verify the modeling predictions and to streamline and simplify the data collection needs during Phase 2. A more detailed summary of the peer reviewers' specific comments regarding the near-field analyses follows:

- *Relationship between PCBs, total suspended solids (TSS), and turbidity.* The peer reviewers cited several reasons why they do not believe a reliable relationship will be found between near-field TSS and turbidity measurements during sediment remediation activities and far-field PCB concentrations for the Hudson River, especially because the near-field and far-field stations will be at least 1 mile apart. For example, capping, backfilling, debris removal, and other remediation activities that do not involve dredging likely will significantly increase turbidity levels, even though PCB releases from these activities may be minimal. Further, due to the variability of PCB concentrations in the sediments and the possibility of dissolved-phase releases, turbidity and TSS measurements downstream from dredging sites might not be consistently correlated or would correlate poorly.

  The reviewers further noted that correlations between PCBs, TSS, and turbidity have not been observed at other environmental dredging projects. Citing recent findings published by the United States Geological Survey (USGS 2000) and the University of Wisconsin (Water Resources Institute 2000), one reviewer noted that neither TSS nor turbidity measurements were reliable indicators of total PCB concentrations at locations approximately 100 yards downstream from hydraulic dredging operations in the Fox River. Though not disagreeing with these comments, another reviewer cautioned against assuming that dredging-related PCB resuspension will be similar in the Fox and Hudson Rivers. As an example of his concern, this reviewer indicated that a special PCB analytical method was developed and applied in the Fox River studies—a method that may have influenced the final results. Further, he noted that the sediments in the two river systems do not contain the same type of PCBs: the Fox River contains “micro-encapsulated” PCBs released largely from paper manufacturing facilities, while the Hudson River contains “pure” PCBs from capacitor manufacturing facilities.

Despite these reservations and others about the probability of relating near-field and far-field sampling data, the reviewers ultimately recognized that EPA cannot currently determine whether a reliable relationship exists between the different metrics because no data are available to characterize dredging-related resuspension in the Upper Hudson River. Most reviewers ultimately agreed that EPA should evaluate the Phase 1 sampling data to determine more conclusively whether a qualitative or quantitative relationship linking the different metrics can be developed and applied in Phase 2. Establishing such a relationship, even if it is conservative and overstates far-field effects, could greatly streamline sampling requirements and therefore facilitate implementation of the performance standards during Phase 2. However, the peer reviewers concluded that a relationship between turbidity, suspended solids, and PCBs is not needed to control solids losses.

- *Need for PCB sampling in the near-field.* Several reviewers recommended that, during Phase 1, EPA require collection of whole water PCB samples at near-field locations downstream from dredging sites and specify how this information will be used to inform dredging operations. The reviewers noted that, after Phase 1 is completed, EPA could review the data collected to determine if such near-field sampling needs to continue during Phase 2.

  To justify this recommendation, one reviewer explained, and others agreed, that near-field PCB sampling is the only positive, confirmatory metric for characterizing the export of PCBs from dredging sites, and this metric does not involve the inherent uncertainties of theoretical models or empirical relationships. Further, because near-field PCB sampling provides a direct measure of downstream PCB transport, the sampling results will best enable EPA to evaluate the environmental protection objectives stated in the ROD. Another reviewer agreed with these comments, adding that it is more likely that EPA will observe a relationship between near-field PCB levels and far-field PCB levels, rather than between near-field turbidity or TSS measurements and far-field PCB levels. A reviewer indicated that having near-field PCB sampling results—along with data on sediment type, sediment contamination levels, and dredging operational details—will allow EPA to better understand and identify the conditions that cause far-field PCB levels to approach the Resuspension Threshold. The reviewers also noted that PCB samples need not be collected at all near-field stations around dredging sites, but they should at least be collected at near-field stations that are at least 100 meters downstream from the sites.

Though the reviewers agreed that near-field PCB sampling should occur, they expressed different opinions on what form of PCBs should be measured. Some reviewers initially advocated congener analysis of split-phase samples (i.e., samples that differentiate particulate-bound PCBs from dissolved-phase PCBs), because these detailed results would provide greater insight on the nature of PCB releases from dredging sites and what engineering contingencies would be most effective at minimizing these releases. On the other hand, other reviewers recommended that only whole water PCB samples be collected in the near-field, because the action levels and Resuspension Threshold are based on PCB concentrations and loads, and not on the phase in which the PCBs are found. These reviewers also were concerned that requiring congener-specific analysis of split-phase samples in the near-field would increase the costs and laboratory turnaround time of the sampling unnecessarily, without providing any unique insights on potential exceedances of action levels. The peer reviewers revisited this issue when evaluating the baseline monitoring program in the Resuspension Standard (see the bulleted item "parameters selected for monitoring," in Section 2.5, for the reviewers' further discussions on this matter).

The only shortcoming identified for the proposed near-field PCB sampling is that measurement results would not be immediately available; however, some reviewers noted that results from continuous near-field turbidity monitoring (see the next bulleted item) would at least provide qualitative insights on downstream transport of contaminants until the PCB analytical data become available.

- *Role of turbidity monitoring in the near-field.* Recognizing that continuous turbidity monitoring is the best opportunity for providing real-time feedback to dredge operators regarding release and downstream transport of solids, several reviewers agreed that continuous near-field turbidity monitoring should be required during remediation activities, regardless of whether a relationship between PCBs and suspended solids can be developed. However, the reviewers expressed different opinions on potential uses of turbidity data. One reviewer, for instance, noted that turbidity monitoring can help characterize the effectiveness of containment and other engineering contingencies. Another reviewer agreed, adding that comparing simultaneous turbidity measurements from locations immediately upstream and downstream from dredging sites would provide critical information on exactly how dredging operations at specific locations affect resuspension. This reviewer noted that comparing upstream-downstream continuous turbidity measurements has been an important component of evaluating resuspension at other environmental dredging projects.

  Some peer reviewers suggested that the continuous turbidity measurements could be used to develop BMP guidelines for controlling releases of solids during dredging operations. These reviewers noted that EPA could establish an allowable percent increase in turbidity across dredging sites and require the dredge operator to implement actions to reduce resuspension from the dredging site when this percentage is exceeded. They advocated using this requirement to minimize solids losses, rather than allowing dredging to proceed at PCB resuspension rates up to the Control Level without requiring any engineering contingencies, thus implying that the Hudson River has the capacity to assimilate PCBs released to the water column. After Phase 1 dredging is completed, EPA could revisit and revise the proposed action levels based on continuous turbidity monitoring data. Though he agreed that BMPs for dredging eventually need to be developed, one reviewer did not agree that BMPs need to be included in the Draft EPS, because critical information to support the BMPs (e.g., the type of dredging equipment to be used) is not currently available. This reviewer suggested that EPA proceed only with the Resuspension Standard as proposed, with the addition of near-field PCB sampling.

The peer reviewers eventually agreed that EPA should still examine trends among near-field turbidity monitoring data collected during Phase 1 for two reasons: to determine if the near-field measures provide any qualitative or quantitative insights on downstream transport of PCBs and to provide real-time feedback to the dredge operators regarding solids losses. None of the reviewers indicated that near-field turbidity monitoring should be dropped from the Resuspension Standard.

2.3 Charge Question 3: Evaluation Level

The third charge question asked the reviewers to consider the appropriateness of the Evaluation Level in the Resuspension Standard:

> The Evaluation Level of the Resuspension Standard can be reached by exceeding criteria for net (i.e., over baseline) PCB load (mass loss) measured at far-field locations or criteria for net suspended solids concentrations measured at either near-field or far-field locations (see, Table 1-1 [in the Draft EPS]). The Evaluation Level was specifically developed for Phase 1 to provide the site-specific information necessary to understand the mechanisms of PCBs release from dredging in the Upper Hudson, which in turn is needed to guide the selection of appropriate engineering controls, as necessary. As stated in the Resuspension Standard, EPA anticipates that sufficient data may be collected in Phase 1 to justify eliminating the Evaluation Level in Phase 2. Also, the Evaluation Level is well above the best estimate of dredging release alone. Some of the public comments that EPA received suggested that the dredging operations should not be allowed to increase PCB concentrations in the water column above baseline conditions (i.e., that the Evaluation Level should be the threshold level that results in the temporary halting of dredging). Other comments suggested that the requirements of the Evaluation Level and Concern Level should be reduced and combined into one level prior to the Phase 1 dredging. Relevant sections of the document [Draft EPS] include, but are not limited to Section 3.1.1: Evaluation Level). Please comment on the appropriateness of the Evaluation Level as a component of the standard applied to for Phase 1.

Although the peer reviewers had different opinions on the appropriateness of the Evaluation Level, they unanimously agreed that the Resuspension Standard—with three action levels and the Resuspension Threshold—is overly complex and involves redundancies that should be removed from the program. The peer reviewers concluded that EPA could remove or blend some action levels without compromising the integrity of the standard. Accordingly, the peer reviewers recommended that EPA consider eliminating, or blending features from, one or more action levels before Phase 2 dredging begins. The peer reviewers' specific comments addressed two general topics:

- *Suggestions for eliminating action levels.* Several peer reviewers commented on the utility of specific action levels and whether they should remain in the Resuspension Standard. One peer reviewer, for instance, suggested that EPA should remove the Evaluation Level, especially considering that the triggers for this level are barely distinguishable from baseline conditions in the Upper Hudson River. Other peer reviewers concurred, noting that sampling requirements once the Evaluation Level is exceeded do not differ considerably from those under the baseline monitoring program, especially if EPA adopts the recommendation for conducting near-field PCB sampling.

  On the other hand, several peer reviewers saw benefits in retaining the Evaluation Level. One reviewer argued that the Evaluation Level is critical, because it provides early warnings for when dredging operations first cause PCB loads to exceed baseline conditions. For this reason, the reviewer suggested that the Evaluation Level not only should remain part of the Resuspension Standard, but should have more aggressive actions required (beyond increased monitoring) to minimize releases of PCBs to the river. These reviewers suggested that EPA should consider eliminating the Concern Level, rather than eliminating the Evaluation Level.

  Although the peer reviewers did not agree on exactly what revisions to make, they agreed that EPA should investigate restructuring the action levels before Phase 2 begins. Some peer reviewers recommended that EPA restructure the action levels before Phase 1 begins, but others suggested that the revisions could be made between Phases 1 and 2.

- *Required actions when action levels are exceeded.* The peer reviewers suggested that EPA consider the required actions (i.e., increased monitoring, engineering evaluations, engineering controls) that accompany each action level when revising the Resuspension Standard. Several peer reviewers were concerned that the standard currently does not require engineering controls until the Control Level is reached. Noting that sustained operations at the Concern Level could cause the total PCB loads over the project to approach the 650 kg limit for long-term protection of the river, one of these reviewers suggested that EPA should carefully examine whether more aggressive responses at the Evaluation or Concern Levels are needed. Another reviewer agreed, adding that actions beyond increased monitoring should be required at the Evaluation Level to minimize downstream transport of PCBs—one of the five remedial objectives stated in the ROD. Additionally, two reviewers commented that the Resuspension Standard should not have action levels that, when exceeded, simply require increased monitoring and no engineering controls. These reviewers saw no clear benefit to having such action levels, especially considering the large volume of data that the routine monitoring program will generate. The general theme in these discussions was that EPA should consider implementing more aggressive responses at lower action levels, regardless of how the action levels and their triggers are revised.

2.4 Charge Question 4: Resuspension Threshold

The fourth charge question asked the peer reviewers to consider the Resuspension Threshold:

> Under the Resuspension Standard, the maximum allowable concentration (i.e, threshold) in the water column is 500 ng/L Total PCBs, which is the maximum contaminant level (MCL) for potable water under the federal Safe Drinking Water Act. This threshold concentration was selected in consideration of the goals of the cleanup, which include protecting downstream public water supplies that draw from the river, and minimizing the long-term transport of PCBs in the river, both from one section of the Upper Hudson to another and from the Upper Hudson to the Lower Hudson. Relevant sections of the document [Draft EPS] include, but are not limited to, Section 2.2.9: Review of Applicable or Relevant and Appropriate Requirements, Section 2.3.1: Development of Basic Goals and Resuspension Criteria. The threshold addresses the *resuspension export rate*, which describes the rate of PCB mass transported in the water column when particle settling is unlikely to further reduce the level of PCBs in the water column (see, Section 2.1.2: Definitions). The Resuspension Standard requires that the threshold be applied to the nearest far-field sampling station that is at least 1 mile away. Moreover, to reduce the possibility that a short-duration anomalous "spike" or laboratory error could temporarily halt the dredging operations, the standard requires that the concentration be confirmed by an average of four samples collected the next day with 24-hour laboratory turnaround time. Please comment on the reasonableness of the 500 ng/L Total PCBs threshold concentration developed for the Resuspension Standard.

The peer reviewers unanimously agreed that it is appropriate for EPA to use the Maximum Contaminant Level (MCL) for PCBs as the Resuspension Threshold for the dredging program, and some reviewers suggested that EPA should use data collected during Phase 1 to determine whether a more restrictive Resuspension Threshold that would further limit PCB export is practicable. Discussions leading up to this conclusion addressed the following topics:

- *Analytical variability.* A main concern regarding the Resuspension Threshold was the lack of information in the Draft EPS on how field operators should consider analytical variability when interpreting sampling results. As an example of this concern, one reviewer wondered how field operators would interpret a split sample in which one laboratory reports a concentration of 500 ng/L and another laboratory reports a concentration of 350 ng/L. Moreover, assuming an analytical variability of 20%, a reviewer noted the Resuspension Threshold may be exceeded even though the analytical laboratory might be reporting PCB concentrations of only 400 ng/L. To avoid the possibility of analytical variability causing "false negative" conclusions regarding the Resuspension Threshold (i.e., concluding the threshold was not exceeded when it actually was), a reviewer wondered if the Resuspension Threshold should be set at a lower value.

  Other reviewers did not support this suggestion, for several reasons. First, one reviewer noted that environmental scientists routinely operate with the realities of analytical variability when comparing measurements to standards. He saw no reason for driving the Resuspension Threshold to artificially low values to account for the variability. Further, based on levels of PCBs historically measured in the Hudson River, this reviewer feared that setting the Resuspension Threshold too low would cause unnecessarily frequent halts in dredging. Second, the reviewers learned from EPA during this discussion that GE's laboratory typically measures total PCB concentrations with excellent analytical precision, achieving relative percent differences lower than 15% for split samples. This high level of measurement precision, combined with the fact that the standard currently requires one to analyze four 6-hour composite confirmation samples before one may conclude that the Resuspension Threshold has indeed been exceeded, caused some reviewers to be less concerned that analytical variability would cause "false positive" conclusions regarding the Resuspension Threshold.

  The reviewers did not make specific conclusions or recommendations regarding analytical variability, other than that EPA ensure that the final Resuspension Standard provide clear instruction as to how field operators should interpret measurements.

- *Consideration of PCB loads.* While still supporting use of the MCL as the Resuspension Threshold, several peer reviewers expressed concern that continued operation with PCB concentrations approaching this threshold might lead to unacceptable PCB loads delivered to the Lower Hudson River. As an example of this concern, one peer reviewer noted that a PCB concentration of 500 ng/L corresponds to a PCB load of approximately 5,700 g/day when the river flow is 8,000 cubic feet per second (see page 93 in Appendix B). If operations persist at or near this level, another reviewer commented, then the total export of PCBs during the dredging project might exceed the 650 kg limit for ensuring long-term protection of the environment. These reviewers suggested that EPA should give greater consideration in the Resuspension Standard to ensuring that the PCB load limit for the entire project is not exceeded.

One reviewer cautioned about using conversions between PCB concentrations and PCB loads to evaluate the different action levels in the Resuspension Standard. This reviewer explained that the Resuspension Standard requires that PCB concentrations be lower than certain levels, regardless of the source of the PCBs. However, the PCB load criterion in the standard—including the 650 kg cutoff for long-term recovery of the river—reflects an increase in PCB loads above baseline conditions.[2] Once EPA confirmed that this clarification was correct, the peer reviewers recommended that EPA clarify the text in the Resuspension Standard to explain the different interpretations of PCB concentrations and PCB loads. They also recommended that EPA clarify in the standards exactly how PCB loads over the course of the project will factor into the decision-making process.

- *Derivation of concentration limits for the Concern and Control Levels.* When discussing the Resuspension Threshold, the reviewers asked EPA to clarify how the agency derived the concentration limit (350 ng/L total PCBs) used for the Concern and Control Levels. An EPA contractor explained that this limit was selected as 70% of the Resuspension Threshold as a warning that PCBs in the water column are approaching the maximum amounts allowed. One peer reviewer suggested that the concentration limits for the Concern and Control Levels should instead be based on the lower 95% confidence interval estimated around the 500 ng/L standard.

- *Other comments.* Peer reviewers offered two additional comments related to the Resuspension Threshold. First, one reviewer recommended that the Draft EPS state the threshold very clearly and explicitly. The statement would specify not only the PCB concentration corresponding to the threshold, but also the sample averaging time, the sampling locations, and the statistical confidence limits that will be used in evaluating whether the standard is being met. This reviewer referred to his pre-meeting comments for an example statement of the Resuspension Threshold (see page 4 of Tim Thompson's supplemental comments in Appendix B). Second, a reviewer recommended that the Draft EPS more prominently acknowledge that several Water Quality Standards are not being met in the Hudson River, even though PCB levels may not be reaching the Resuspension

[2] During this discussion, an EPA contractor confirmed that the PCB load requirements in the Resuspension Standard indeed reflect net increases in loads above baseline conditions, which vary with river flow rate, location, and month.

Threshold. Another reviewer, however, noted that the Draft EPS (see pages 39–40 of Volume 1) already identify selected standards that may apply to the Hudson River.

2.5 Charge Question 5: Monitoring Program

The final charge question related to the Resuspension Standard asked the peer reviewers to comment on the proposed monitoring program. This charge question asks:

> The 2002 ROD states (see, p. iii), "Beginning in phase 1 and continuing throughout the life of the project, EPA will conduct an extensive monitoring program." Section 3.3 [of the Draft EPS]: Monitoring Plan and Attachment G (and related tables and figures) describe the attendant monitoring program for the Resuspension Standard.
>
> Please comment on whether the monitoring program reasonably can be expected to provide adequate data in Phase 1 that will allow EPA to evaluate necessary adjustments to dredging operations in Phase 2 or to the Resuspension Standard. Also, please identify any necessary improvements to the monitoring program.

The peer reviewers commented on several aspects of the proposed baseline monitoring program. Most peer reviewers supported the general approach of collecting more intensive sampling data during Phase 1, with the understanding that EPA would streamline monitoring requirements before Phase 2 begins. The peer reviewers also made several recommendations on how EPA can improve the monitoring program before Phase 1 begins. The reviewers' main comments follow, organized by subject matter:

- *Monitoring objectives.* Several peer reviewers said the Draft EPS should be more transparent with respect to monitoring objectives and should clearly indicate why every required sampling parameter is being collected. One of these reviewers recommended that the final EPS document include a table that lists the sampling objectives for each parameter. Such a table would explicitly indicate whether a given parameter is being collected to validate assumptions or models, to protect human health, to test compliance with the standard, to inform dredge operators of river conditions, or for other reasons. Further, the table would explain why sampling is proposed at certain locations, such as the furthest downstream locations—locations that the peer reviewers felt EPA should remove from the monitoring program (as discussed further below). Such a table would also specify whether EPA intends to have the parameter sampled only during Phase 1 or for the duration of the project. The peer reviewers noted that clear statements of monitoring objectives are needed in all three engineering performance standards, not only in Attachment G of Volume 1 of the standards.

During this discussion, one reviewer noted that much of the information the reviewers requested on monitoring objectives is already documented in Appendix G of the Resuspension Standard document. This reviewer suggested that EPA could address most of the reviewers' concerns about monitoring objectives by making better reference to, and use of, the data quality objective tables and other information in Appendix G.

- *Protection of sediments not targeted for dredging.* One peer reviewer was concerned that the proposed performance standards have no action levels or triggers that protect against the possibility of resuspended PCBs from dredging sites settling out and contaminating areas that are not targeted for dredging. The reviewer was particularly concerned about non-target sediments adjacent to dredging sites. Another reviewer indicated that non-target sediments also might be contaminated if dredging in a given river section occurs at multiple sites, some upstream from others. The reviewers acknowledged that the draft Resuspension Standard addresses this issue (see page 89 of Volume 1 of the Draft EPS), but not with proposed action levels.

  The peer reviewers agreed that it is important to protect non-target areas, but had different opinions on how best to do so. One peer reviewer recommended near-field water quality monitoring to protect non-target areas downstream. Another indicated that use of containment structures likely would minimize contamination of non-target areas, though EPA has not determined the extent to which containment will be used. On the other hand, other peer reviewers said water quality monitoring alone would not allow EPA to determine definitively whether contamination of non-target areas is occurring. Accordingly, another peer reviewer suggested that EPA require sediment sampling in non-target areas as the most direct metric for studying potential re-contamination. A peer reviewer recommended that EPA then evaluate whether the downstream sediment contamination is related to other parameters, such as the production rate or the near-field PCB water concentrations. In their final summary statements, the peer reviewers eventually recommended that EPA require a special study in Phase 1 to assess non-target area impacts, but they did not specify the details of what this study would entail.

- *Far-field monitoring locations.* The peer reviewers had several comments on the monitoring locations, primarily on reducing the number of proposed far-field stations. One peer reviewer questioned the need for sampling at multiple far-field stations in cases when PCB levels at the nearest far-field station to a dredging site comply with the Resuspension Standard. To illustrate this concern, this reviewer noted that the routine monitoring program currently calls for sampling at two locations more than 40 miles downstream from the Thompson Island Pool and at one location in the Mohawk River. Though he appreciated the scientific value of monitoring results at these far-field locations (e.g., to compare PCB levels during the remediation project to those observed historically), this reviewer did not think sampling there is necessary for evaluating compliance with the Resuspension Standard. Another reviewer agreed, noting that the Draft EPS should not include monitoring stations not related to compliance. Based on these comments, the peer reviewers recommended that EPA consider reducing the number of far-field monitoring stations listed in Tables 1-2 and 1-3 of Part 1 of the Draft EPS. Some peer reviewers also recommended that EPA consider reducing to less than 1 mile the distance between dredging sites and far-field stations.

- *Parameters selected for monitoring.* The peer reviewers offered several comments on the monitoring parameters. First, two peer reviewers indicated that the Draft EPS does not explain why EPA will require monitoring of several parameters, such as dissolved oxygen and temperature. Though they recognized the potential need for collecting such data, the peer reviewers recommended that the Draft EPS clearly articulate why the parameters will be measured and what actions, if any, will be implemented based on the values measured.

  Second, the peer reviewers revisited the issue of whether the baseline monitoring program should require measurement of total PCB concentrations or measurement of the individual PCB congeners. The peer reviewers had previously suggested that the only PCB measurement needed in this program is total PCBs. An EPA contractor presented two reasons EPA considered before requiring congener-specific analyses: (1) total PCB analytical methods typically have poorer measurement sensitivity, especially for the lower homolog PCBs, than do the congener-specific analytical methods; and (2) the Resuspension Standard has requirements for Tri+ PCBs, which would not be characterized if only total PCB measurements were used.

  Upon hearing these remarks, the peer reviewers offered one recommendation for considering an alternate analytical method for PCBs. One reviewer noted that use of a "homolog-specific" analytical method might meet EPA's needs for high measurement sensitivity and separate characterization of mono- and di-substituted congeners, perhaps with lower analytical costs and faster laboratory turnaround times. (Refer to pages 97–98 of Appendix C for more information on this proposed method.) The peer reviewers recommended that EPA and GE investigate whether using this "homolog-specific method" would be appropriate for the baseline monitoring program, considering, among other factors, whether data collected using this method would be comparable to data collected historically in the Hudson River using other PCB analytical methods.

  At the end of this discussion, the peer reviewers concluded that routine split-phase PCB sampling is not necessary for purposes of evaluating compliance with the Resuspension Standard, assuming that total PCB measurements will be collected at both near-field and far-field locations and that these measurements will be compared against appropriate action levels. Recognizing the need to know if dissolved-phase PCBs are being released from dredging sites, however, the peer reviewers recommended that split-phase sampling occur as a special study at near-field monitoring locations during Phase 1. This recommendation for a special study relates back to the issue of TSS as a surrogate for PCB releases. The split-phase special study would help EPA understand if all PCB releases are particulate bound (i.e., with the TSS) or if some PCB releases are in the dissolved phase that would not be captured by TSS measurements.

On a separate matter related to monitoring parameters, two peer reviewers questioned the utility of TSS sampling at far-field monitoring locations. The reviewers doubted that EPA would be able to relate the measured solids concentrations to dredging or other remediation activities, given the distances that will separate dredging sites from far-field stations and the various sources of uncontaminated solids that will likely be present over these distances. Backfilling and capping, these reviewers noted, will cause considerable increases in TSS levels—even at distances more than 1 mile from the dredging sites. The reviewers feared that such increases in TSS concentrations may be high enough to trigger various action levels, even though the increases from backfilling and capping will likely not be accompanied by considerable increases in PCB levels.

Finally, several peer reviewers noted that the final baseline monitoring program may need to include sampling requirements for other parameters, depending on what NYSDEC publishes in its 401 Water Quality Certification requirements.

- *Monitoring frequency.* The Draft EPS includes a baseline monitoring program, which requires that certain samples be collected more frequently if action levels are triggered. The peer reviewers generally found this framework to be sensible, because more frequent sampling at higher action levels would likely provide more accurate and precise accounts of PCB concentrations if river conditions worsen. Two peer reviewers, however, suggested that EPA consider, even during Phase 1, allowing less frequent sampling than currently proposed in the baseline monitoring program in cases when solids loadings, PCB concentrations, and PCB loads are consistently lower than the Evaluation Level. Noting that some sampling frequencies at higher action levels seem excessive, another peer reviewer recommended that the Draft EPS more explicitly describe why EPA proposes the different sampling frequencies and what the Agency hopes to achieve with these increased sampling frequencies. A general theme expressed during this discussion was that EPA should consider reducing sampling requirements in the interest of enhancing productivity, but avoid compromising remedial objectives.

  Summarizing, a peer reviewer said that the Draft EPS needs to clearly justify the proposed sample collection frequencies, and EPA should consider revising these frequencies after reviewing the monitoring data collected during Phase 1. Additionally, he noted that EPA should consider reducing the level of monitoring required during Phase 1, if the near-field and far-field data consistently meet levels that would be protective of human health and the environment.

As a final comment on monitoring frequency, three peer reviewers said the various action levels in the Resuspension Standard should require responses at the dredging sites, beyond simply increasing the frequency of monitoring.

- *Collection of temporal composite samples.* The peer reviewers debated whether the Resuspension Standard should allow composite sampling for PCBs, rather than requiring collection of multiple discrete samples. To open this discussion, the peer reviewers asked EPA why collection of composite PCB samples was not part of the baseline monitoring program. An EPA contractor explained that composite sampling was not proposed for several reasons: PCBs in composite samples will partition between suspended and dissolved phases between when samples are collected and when they are analyzed in the laboratory, so split-phase results from composite samples will not represent river conditions; composite sampling results from fixed locations may be biased due to the known cross-channel variability in PCB water column concentrations (as was demonstrated in a plot of cross-channel PCB concentrations that GE collected in the Thompson Island Pool); and logistical constraints, such as those that may be imposed by the canal corporation, might limit where composite sampling is allowed or feasible.

  The peer reviewers then commented on these reasons. First, two peer reviewers noted that split-phase sampling is not necessary for evaluating compliance with the Resuspension Standard. Therefore, the fact that split-phase analyses of composite samples may not represent actual river conditions should not affect the decision on whether to allow composite sampling. Moreover, another reviewer commented that the concern about PCBs partitioning between suspended and dissolved phases should not apply to most far-field sampling stations, given that the PCBs in the water column likely equilibrated between the dredging sites and the sampling points. This reviewer added that EPA could still use composite sampling techniques to achieve the goal of split-phase sampling by operating two composite samplers at each station: one to collect a dissolved-phase sample and the other to collect a whole water sample. Finally, another reviewer added that conducting split-phase PCB sampling both at near-field and far-field monitoring stations appears to be excessive, especially because PCBs in the water column will partition between the dissolved and suspended phases as water moves downstream. Consequently, this reviewer suggested that split-phase sampling should be conducted only at near-field sampling stations, where the amounts of PCBs in the dissolved and suspended phases more closely represent what is released from the dredging sites, while composite sampling for total PCBs at far-field stations would be appropriate.

Attachment 2-1
EPA Response to a Peer Reviewer's Question Regarding Whether the Agency Considered Basing the Resuspension Standard on NPDES Requirements

Note: The following response was distributed at the peer review meeting. Copies of this response were handed to the peer reviewers and available to all observers.

USEPA Response. Yes, the EPA team considered the use of NPDES-based requirements in its development of the Resuspension Performance Standard. However, several important distinctions make a NPDES-type approach unworkable for the Hudson River dredging project.

NPDES is intended to control new discharges to a water body so as to prevent further deterioration of the water quality. It is based on the premise that the discharger is an industrial-type user and is not acting to improve water quality for the water body. For the Hudson, dredging resuspension does not represent a long-term new "discharge" that is being added to the existing burden. Rather, as a direct result of the remedial activities, the water quality is expected to improve locally as the operation moves downstream. Moreover, as noted in the 2002 Record of Decision, "[a]lthough precautions to minimize resuspension will be taken, it is likely that there will be a localized temporary increase in suspended PCB concentrations in the water column and possibly in fish PCB body burdens." (ROD, p. 85).

EPA recognized the need to balance impact and cost in specifying the standard. While little or no resuspension is the ideal goal, attainment of this goal is not practical for the dredging project. Additionally, the dredge release estimates derived from the "best practices" analysis do not consider the impacts of many other aspects of the dredging operation (*e.g.*, boat traffic, barrier deployment, debris removal, etc.). Thus, it is not possible to determine a "best practices" estimate for the entire remedial operation.

Because both controlling the PCB releases and meeting the project schedule are goals of the remediation, it is important that a requirement to limit the dredging-related releases be justified by a substantive improvement in the anticipated recovery of the river, since these controls will also add to the project's cost and schedule. To this end, EPA's peer-reviewed models, HUDTOX and FISHRAND, were used to demonstrate that the PCB releases allowed by the standard do not appreciably affect the river's recovery. For this reason, the Resuspension Standard does not require further controls of PCB release and their associated expense, as well as additional schedule impacts, given that they would do little to further speed the river's recovery.

Specification of a minimal release standard as well as engineering controls would require the completion of substantial portions of the design prior to finalizing the Resuspension Standard. The ROD, however, calls for the performance standards to be completed first to guide and constrain the design process (see ROD, p. v). Therefore, it is not appropriate to specify design details before developing the standard. Rather, the Resuspension Standard places the burden of compliance on the contractor implementing the remedy, not on EPA design requirements.

Measuring far-field PCB concentrations is essential to demonstrating that the project does not significantly impair downstream water quality and does not adversely affect downstream water use. PCB export has always been a significant issue for the project's stakeholders. Downstream measurements also allow time for mixing to dampen episodic releases associated with dredging operations, and support the estimation of a net daily increase in PCB load due to the entire dredging operation.

3.0 Peer Review of the Residuals Standards

This section summarizes the peer reviewers' discussions on charge questions relevant to the Residuals Standard. A central issue in this discussion was whether EPA should proceed with its proposed framework for the standard or with an alternate framework to be proposed by the peer reviewers. A key feature of the alternate framework the reviewers devised is that it incorporates an engineering design component to ensure that PCB inventory is removed with statistical confidence, thus eliminating the need for extensive sampling and re-dredging requirements. The peer reviewers noted that either framework would likely help ensure that the dredge operation meets the goals of the Residuals Standard. This section presents the peer reviewers' feedback on both frameworks.

3.1 Charge Question 6: Framework

This first charge question addressed the framework of the Residuals Standard. The question asked the peer reviewers:

> EPA's 2002 ROD calls for removal of all PCB-contaminated sediments (i.e., to non-detection levels) in areas targeted for dredging, with an anticipated residual of approximately 1 mg/kg Tri+ PCBs prior to backfilling (Tri+ PCBs are the subset of PCBs with 3 or more chlorine atoms). The Residuals Standard builds on the requirements in EPA's 2002 ROD as well as case studies and regulatory guidance (see, Section 2.1 [in the Draft EPS]: Background and Approach). It requires comparison of PCB concentrations in post-dredging sediment samples within a given area (i.e., ~ 5-acre certification unit) to statistically-based PCB concentrations (i.e., action levels), which then guide appropriate actions (see, for example, Figure 1-1 [in the Draft EPS]). The Residuals Standard was developed with this framework to accommodate the project need for both protection and production, in that post-dredging sampling can proceed directly upon EPA verification that the design cutlines have been attained and the options for appropriate next steps are known and, to the extent possible, pre-approved during design. Please comment on whether this framework provides a reasonable approach for developing the Residuals Standard.

The peer reviewers extensively discussed the framework of the Residuals Standard. While they generally agreed that EPA's proposed framework would likely suffice for addressing dredged residuals and missed PCB inventory, the peer reviewers also developed an alternate framework with streamlined requirements for EPA to consider when developing the final Residuals Standard. Some peer reviewers felt the alternate framework should be applied to the project, while others were comfortable proceeding with EPA's proposed framework. One of the peer reviewers noted that EPA could re-examine the benefits of the two frameworks after evaluating sampling data collected during Phase 1. The following paragraphs summarize the reviewers' discussions regarding EPA's proposed framework and the alternate framework for the Residuals Standard:

- *Comments supporting EPA's proposed framework.* The peer reviewers found the overall framework for EPA's proposed Residuals Standard to be reasonable, protective, and based on sound scientific principles. They noted that EPA's proposed framework should enable the agency to meet the objectives of the Residuals Standard. However, several peer reviewers had concerns regarding EPA's proposed framework. Those concerns are listed in the next bulleted item.

- *Concerns regarding EPA's proposed framework.* Some peer reviewers said the many requirements in EPA's proposed Residuals Standard—extensive post-dredging confirmatory sampling, up to two re-dredging attempts, and backfilling or capping—may unnecessarily slow dredging productivity. The peer reviewers discussed several ways that the Residuals Standard could be restructured to achieve the same goals, but with less extensive sampling and other requirements. Another primary concern was that EPA's proposed Residuals Standard seems to imply that PCB inventory will be removed but does not explicitly list removal as a priority.

  A central issue in this discussion was the fact that dredge cut lines were not specified. A peer reviewer explained that the approach taken to set dredge cut lines will likely determine the amount of re-dredging required. Two reviewers agreed: setting dredge cut lines too high will have the benefit of requiring less extensive initial dredging, but at the expense of more re-dredging and capping if the PCB inventory is not removed; conversely, setting dredge cut lines much lower would greatly reduce, if not eliminate entirely, the need for re-dredging and capping, but likely at the expense of having far greater dredge volumes. In short, decisions on dredge cut lines affect the number of re-dredging attempts and whether the Residuals Standard can be achieved.

  Recognizing that the approach for setting dredge cut lines is closely linked to the PCB surface concentrations that might remain after initial dredging, the peer reviewers asked EPA and GE to clarify how dredge cut lines will be set. An EPA contractor said the Feasibility Study prepared during the Site Reassessment estimates dredging volumes assuming that a nominal 6 inches of over-dredge depth will be removed, but the remedial design may propose a different approach. A GE contractor noted that the proposed dredge prisms have not been identified, though their intent is to dredge down to the elevation where 1.0 mg/kg Tri+ PCB concentration is found. Additionally, Ms. Hess (EPA) said the ROD requires removal of all PCBs in dredged areas, effectively meaning that PCBs would be removed down to detection limits. Despite these clarifications, several peer reviewers noted that the final approach for setting dredge cut lines will be established in the final remedial design, which will not be completed until well after the peer review meeting.

Given the relationship between dredge cut lines, the Residuals Standard, and the Productivity Standard, some peer reviewers commented on factors EPA and GE should consider when establishing dredge cut lines, but they did not agree upon the best way to address this matter. One peer reviewer advocated using statistical analysis of GE's sediment coring data to set dredge cut lines that ensure, to a certain level of confidence, inventory removal to 1.0 mg/kg Tri+ PCBs. He noted that a similar approach was used to set dredge cut lines in the Fox River (Polissar, Stanford, Neradilek 2003). This approach, he noted, effectively establishes a lower cleanup criterion (e.g., a surface concentration before backfill lower than 1.0 mg/kg Tri+ PCBs), thus providing confidence that the entire inventory has been removed and accounting for the uncertainties among the sediment coring data. Another reviewer did not support lowering the cleanup criterion for several reasons. He noted, for example, that other approaches (such as requiring over-dredge depths, using different statistical approaches, or collecting additional sediment cores) can achieve the same inventory removal goals, but without effectively lowering the cleanup criterion. Additionally, he noted, dredge operations can create PCB residuals of varying thicknesses even if dredge cut lines are set to aggressively target inventory removal. Finally, a third reviewer commented that the issue of dredge cut lines will be resolved in the engineering design, which is outside the scope of the peer review of the Draft EPS. This reviewer said it would be sensible to emphasize inventory removal, regardless of what approach is taken to do so. Though they did not reach consensus on the best approach for setting dredge cut lines, these reviewers agreed that it would be desirable for the final Residuals Standard to be linked more closely to the engineering design, once it is developed. They also agreed that EPA and GE should place a priority on inventory removal when completing the design.

The peer reviewers eventually developed an alternate framework for the Residuals Standard (see the next bulleted item) that would streamline sampling, re-dredging, and backfilling requirements. The impacts of the alternate framework on total dredge volumes could not be assessed.

- *Reviewers' alternate framework for the Residuals Standard.* After completing their discussions, the peer reviewers eventually developed an alternate framework that EPA should consider when developing the Residuals Standard. As the Executive Summary of this report indicates, this alternate framework focuses on removing PCB inventory with statistical certainty, which would require bottom elevations of dredge prisms to be set at elevations based on the lower confidence of the mean of the 1.0 mg/kg Tri+ PCB target concentration. Other elements of this alternate framework include confirmation of inventory removal using bathymetry or similar measurements, re-dredging only when dredge cut lines are not achieved, and post-dredging confirmatory sampling only when backfilling is not used. The peer reviewers acknowledged that some post-dredging confirmatory sampling should occur during Phase 1 to confirm that the assumptions inherent to the alternate framework are valid, even if dredge cut lines have been achieved. The peer reviewers provided additional detail on the alternate framework for the Residuals Standard when discussing re-dredging and engineering contingencies (see Section 3.4).

Several peer reviewers recognized that this alternate framework not only is simpler than EPA's proposed Residuals Standard, but also has many desirable features. For instance, the alternate framework focuses on PCB inventory removal and can include confirmation of removal using bathymetry, without the need for exhaustive re-dredging and post-dredging confirmatory sampling. Some reviewers pointed out potential shortcomings with the alternate approach, though. First, two peer reviewers noted that, by requiring a high level of confidence of inventory removal, the alternate framework may lead to considerably greater dredge volumes than currently anticipated, which may increase project costs and further compromise the ability to meet the Productivity Standard. These reviewers acknowledged that the actual increases in dredged volume under the alternate framework would not be known until EPA and GE examine the sediment coring data. Second, another reviewer indicated that aggressive efforts to address PCB inventory still do not address the issue of re-suspended PCBs depositing on clean surfaces, creating a contaminated layer of residuals. This reviewer explained that inventory removal and contaminated residuals should be viewed as two separate issues. To illustrate this concern, he and another peer reviewer referred to past project experiences in which highly contaminated residuals were observed, even though dredge cut lines were set to capture all of the contaminated sediment. Based on these experiences, a reviewer feared re-dredging might be needed to address contaminated residuals that deposit back onto clean surfaces, even with a framework designed to target inventory removal with a high level of confidence (though reviewers acknowledged that re-deposition as a result of dredging might not be important, given that backfilling will occur).[3]

---

[3] One reviewer offered several post-meeting comments regarding the alternative framework. The reviewer was concerned that the coring database will not adequately support identification of a concentration that provides statistical certainty without extensive over-dredging (due to problems with detection limits, inherent variability of the chemical data, inadequate sample size to calculate such a number, etc.). In addition, this reviewer noted that EPA stated in the meeting that where removal occurs, PCBs will be removed to the equivalent of the detection limit. However, historical subsurface data were often reported as non-detects at 1 ppm Tri+ PCBs, which complicates the certainty with which a dredge elevation can be identified. Ultimately, the design elevation for dredging needs to balance the amount of over-dredging with the likelihood that inventory with high concentrations of PCBs will be missed, using statistical tools, best professional judgement, and the physical constraints of each dredging unit.

As is stated in this document, achieving design elevations while dredging does not ensure that residual contamination is not a problem. In addition, it is this reviewer's opinion that some inventory will be missed due to

- *Questions regarding backfilling.* One peer reviewer said EPA should clarify the backfilling requirements in the Residuals Standard. Noting that EPA's proposed standard typically refers to "backfilling, where appropriate," this reviewer recommended that the standard specify under what conditions backfilling will be required and who will decide when backfilling is not necessary. The issue of backfilling requirements, this reviewer explained, is particularly relevant to the framework of the Residuals Standard: residuals become less important if nearly all river sections are to be covered with 1 foot of backfill material; on the other hand, the need for intensive sampling becomes more important if there will be areas where backfilling or capping is not required. During this discussion, EPA clarified that backfilling will likely be required everywhere but in navigational channels and in other situations where it might be preferable to leave deeper water, such as for habitat recovery considerations or for hydrological concerns. A peer reviewer recommended that the revised Residuals Standard more clearly state these backfilling requirements.

  This reviewer suggested two revisions to the backfill requirements in the draft Residuals Standard. First, he recommended that EPA consider not requiring post-dredging confirmatory sampling in cases when dredge cut lines have been met and backfilling will be used. Second, he suggested that backfilling should not be required in cases where post-dredging confirmatory sampling confirms that PCB residual concentrations meet the remedial objective. Another reviewer did not think the first recommendation was appropriate for Phase 1 of the dredging project. Rather, the reviewer suggested that post-dredging confirmatory sampling should occur during Phase 1 to confirm inventory removal and to verify other assumptions in the Residuals Standard. If the data collected during Phase 1 demonstrate that reaching dredge cut depths is sufficient for inventory removal, this reviewer noted, then there may be no need for post-dredging confirmatory sampling during Phase 2 for those locations where backfill will be used.

---

the (unavoidable) uncertainty in setting the design elevation. The reliance on achieving this physical goal in lieu of extensive post-dredge confirmation sampling needs to be tested in Phase I. As a potential alternative approach, this reviewer recommended that in Phase I each unit be dredged to its design elevation (set using statistics and other methods), and then inventory removal be confirmed via shallow subsurface sampling (rather than just surface samples). The shallow cores should be sub-sampled to represent the unconsolidated surface material (i.e., residuals), if present, versus the consolidated underlying material (which may be contaminated inventory or clean material). If the post-dredge contamination proves to be inventory that was missed, then re-dredging can occur. If the post-dredge contamination is from residual material, then the decision to backfill or cap should be made (based on thickness and concentration). No re-dredging would occur if the contamination was solely due to residual material. If meeting the design elevation is shown to have a high degree of certainty in achieving the inherent mass removal objectives, Phase II post-dredging activities could be simplified, such that one either backfills (without testing) or tests to show that no backfill is necessary.

Finally, this reviewer noted that EPA needs to clarify if the performance criterion in the confirmational samples will be the detection limit (0.2 ppm Tri+ PCB) or the remediation goal of 1 ppm Tri+, given their comment in the meeting.

- *The need for a clear statement of the standard's goals.* When discussing the framework of the Residuals Standard, the peer reviewers generally agreed that Volume 2 of the Draft EPS does not clearly articulate the goals of the standard. While the peer reviewers recognized that the standard focuses on ensuring that post-dredging pre-backfill residual concentrations are less than 1.0 mg/kg Tri+ PCBs, they identified two other goals of the standard that are not prominently stated: ensuring that the PCB inventory is removed and ensuring that the post-backfill surface sediment concentration is less than 0.25 mg/kg Tri+ PCBs to achieve the risk reduction goals. The peer reviewers agreed that EPA should revise the Residuals Standard to include a clear statement of these goals and how they will be achieved.

3.2 Charge Question 7: Statistical Analyses

This question asked the peer reviewers to comment on the statistical analyses conducted in support of the Residuals Standard. This question asked:

> The supporting analyses for the Residuals Standard, in particular the statistical analyses of sites-specific sediment data collected in the Upper Hudson and the sediment data from case studies of environmental dredging projects, are presented in Section 2.2 (and associated tables and figures) and in Attachment A of the Residuals Standard [in the Draft EPS]. Please comment on whether the statistical analyses are technically adequate and properly documented.

The peer reviewers who commented on the statistical analysis supporting the Residuals Standard found the analysis to be technically adequate and properly documented. They identified only two follow-up actions for EPA to consider. First, one reviewer recommended that EPA address the reviewers' detailed pre-meeting comments on Charge Question 7 when revising the Residuals Standard. Second, another reviewer recommended that EPA update the statistical analysis before Phase 2 begins using the site-specific data collected during Phase 1, rather than relying upon existing data from other sites.

3.3 Charge Question 8: Post-Dredging Confirmatory Sampling Program

This charge question asked the peer reviewers to comment on the post-dredging confirmatory sampling program:

> Section 2.2.9 and Section 3.0 of the Residuals Standard [in the Draft EPS] present an evaluation of available sampling techniques and describe the procedures for establishing the post-dredging confirmatory sampling grid, collecting and managing the samples, and evaluating the sample data and required actions. In certain circumstances identified in the Residuals Standard, a certification unit can be evaluated by considering the sediment data in three previously dredged certification units within 2 miles (i.e., a 20-acre evaluation). Please comment on the adequacy of these aspects of the Residuals Standard, in particular the concept of a 20-acre evaluation area for Phase 1.

The peer reviewers had differing opinions on the most appropriate approach for conducting post-dredging confirmatory sampling, but they supported the use of 20-acre evaluation areas in cases where smaller certification units may not achieve the target level of PCB residuals. The following paragraphs summarize their comments on these topics:

- *Use of composite sampling before backfilling.* The peer reviewers' comments regarding post-dredging confirmatory sampling apply to EPA's proposed framework for the Residuals Standard. As the previous section indicates, the need for post-dredging confirmatory sampling will be greatly reduced, if not completely eliminated in Phase 2, if EPA adopts the reviewers' alternate framework for the Residuals Standard.

  The main issue discussed regarding the post-dredging confirmatory sampling was whether EPA should allow for analysis of composite samples or require analysis of multiple, discrete samples within a certification unit. Recognizing that one goal of the Residuals Standard is for the dredging to achieve a surface-weighted average concentration of 1.0 mg/kg Tri+ PCBs over a certification unit, one peer reviewer said that analysis of composite samples should be allowed to evaluate compliance with the standard. Specifically, this reviewer advocated collection of individual sediment cores throughout the certification unit, with aliquots drawn from these cores to make the composite sample. He further recommended analyzing a subset of the individual cores to check for PCB contamination outliers. Finally, retaining all discrete samples would make it possible to analyze the cores (or a subset of them) individually if the composite sample does not meet the 1.0 mg/kg Tri+ PCB goal. Such an approach, this reviewer noted, would reduce costs of laboratory analytical work without compromising the intent of the standard. Another reviewer agreed with these comments and added that composite samples should be analyzed either in duplicate or triplicate.

  On the other hand, one reviewer did not support conducting composite sampling during Phase 1 of the dredging project. This reviewer explained that the statistical analysis used to determine the number of discrete samples per certification unit is based on an assumed variability in residual concentrations. (The reviewers actually noted that the statistical analysis found that more than 300 individual discrete samples would be needed to evaluate the residuals with a high level of confidence, but EPA scaled this number down to 40 discrete samples as a more reasonable, practical approach.) Unless discrete samples are analyzed during Phase 1, this reviewer argued, EPA will not be able to verify whether an adequate number of discrete samples are being collected for each certification unit. Moreover, this reviewer noted that evaluating results from individual samples will allow EPA to determine the specific areas within a certification unit that contribute to non-compliance and that might require further sampling, re-dredging, or capping. Therefore, this reviewer recommended that EPA require analysis of the individual, discrete samples during Phase 1; if the data collected during Phase 1 demonstrate that analyzing composite samples would be acceptable and would not mask notable outliers, EPA could then consider allowing analysis of composite samples during Phase 2. Other reviewers agreed that, within EPA's proposed framework for the Residuals Standard, analyzing discrete samples is necessary during Phase 1. One reviewer stated that analyzing discrete sampling should be carried forward into Phase 2 if EPA proceeds using its proposed framework for the Residuals Standard.

- *Should sampling be conducted after backfilling?* The Residuals Standard currently does not require any sampling of sediments after backfill is put in place. One peer reviewer recommended some post-backfill sampling during Phase 1 to confirm that the remediation project meets risk reduction goals, which are based in part on an assumed post-backfill surface concentration of 0.25 mg/kg Tri+ PCBs. Other reviewers agreed it would be appropriate to require some limited sampling after backfilling during Phase 1 to verify the assumptions regarding how dredging residuals will mix with backfill material (see page 7 of Volume 2 of the Draft EPS). Another reviewer supported this recommendation, but clarified that sampling after backfilling would not replace the requirement of sampling before backfilling. (A peer reviewer noted that page 54 of the Residuals Standard states that backfill will have "testing to certify that the upper 6 inches of placed backfill contains less than 0.25 mg/kg Tri+ PCBs.")

- *Appropriateness of the 20-acre evaluation area.* The peer reviewers who commented on this topic found the allowance for 20-acre evaluation areas to be appropriate, though they cited different reasons for reaching this conclusion. One peer reviewer liked the idea of examining residuals over 20 acres, given that the models supporting EPA's human health risk assessment calculations simulated PCB fate and transport in 20-acre regions. This reviewer noted that EPA should consider using the 20-acre evaluation areas to test risk reduction hypotheses for the dredging project. Though he did not disagree with these remarks, another peer reviewer commented that the Draft EPS allows for 20-acre evaluation areas primarily to account for the difficulties in achieving the required 1.0 mg/kg Tri+ PCB residual concentrations in every 5-acre certification unit. Allowing for the larger evaluation area gives the dredging contractor flexibility in ensuring that the Residuals Standard is met, particularly for areas that might be difficult to dredge.

- *Other comments.* The peer reviewers commented on two topics that do not fit into the categories above. First, one peer reviewer recommended that EPA clarify the rules proposed for designating certification units and evaluation areas. He was particularly concerned about the clarity of the bulleted items listed on page 34 in Volume 2 of the Draft EPS. Some of the rules, as written, appear to conflict. Second, citing past experiences in which he found sub-bottom profile imaging (SPI) to be not particularly useful for examining post-dredging conditions in freshwater environments, another peer reviewer recommended that the Draft EPS not require use of SPI in achieving the Residuals Standard. Another reviewer agreed that the Residuals Standard need not prescribe the use of SPI.

3.4 Charge Question 9: Re-Dredging and Engineering Contingencies

The final charge question related to the Residuals Standard addressed re-dredging and engineering contingencies:

> Consistent with the 2002 ROD, the Residuals Standard is clear in describing EPA's preference for dredging over capping as a means of sequestering PCB inventory (mass). The standard also addresses the expectation that some targeted areas of the Upper Hudson river bottom may be difficult to dredge effectively, such as rocky areas. For these special circumstances, the standard addresses re-dredging and the number of additional re-dredging attempts, how the extent of the non-compliant area is to be determined, and the use of engineering contingencies to address recalcitrant residuals (e.g., alternative dredge, cap). Relevant sections of the document [the Draft EPS] include Section 2.3.5: Determining the Number of Re-Dredging Attempts, Section 2.3.6: Engineering Contingencies for the Residuals Standard, Section 3.5.1: Re-dredging and Required Number of Re-dredging Attempts, Section 3.5.2: Determining the Extent of the Non-Compliant Area, and Section 3.6: Engineering Contingencies. Please comment on the reasonableness of the Residuals Standard with respect to re-dredging and engineering contingencies.

The peer reviewers' comments on re-dredging and engineering contingencies focused largely on streamlining requirements in the Residuals Standard, possibly by adopting the reviewers' alternate framework for the standard:

- *Re-dredging requirements.* Under EPA's proposed framework for the Residuals Standard, no more than two re-dredging attempts are required in areas with surface sediment concentrations that do not meet the 1 mg/kg Tri+ PCB target. The following paragraphs present the peer reviewers' comments on how re-dredging fits into EPA's proposed framework. Under the peer reviewers' alternate framework for the standard (see Section 3.1), re-dredging would be required only when initial dredging attempts do not achieve the corresponding design elevations.

The peer reviewers first made general comments on the advantages and disadvantages of re-dredging. Several peer reviewers, for instance, said or implied that re-dredging could be effective in cases where first dredging attempts do not achieve PCB inventory removal. A peer reviewer explained that a re-dredging requirement is an important facet of the Residuals Standard: without such a requirement, the dredging contractor would have no incentive to achieve inventory removal on the initial dredging pass. However, the peer reviewers questioned whether re-dredging would be effective at addressing areas where elevated PCB concentrations remain in surficial residuals or areas that are otherwise difficult to dredge. In fact, some peer reviewers feared that using re-dredging to address residuals (and not inventory removal) would have little benefit, and would instead result in elevated resuspension rates and potential contamination of non-target areas downstream from the dredging site.

The peer reviewers then made specific comments on the current requirement for having no more than two re-dredging attempts. One peer reviewer, for example, said it is difficult to comment on the appropriate maximum number of re-dredging attempts without knowing how dredge cut lines will be set. Requiring no more than two re-dredging attempts seemed sensible to this reviewer, until information on dredge cut lines is available. Another reviewer added that the current approach of requiring re-dredging in certain instances but limiting the number of re-dredging attempts to two, is reasonable for Phase 1, though he was concerned that extensive re-dredging during the project could compromise meeting the Productivity Standard. A reviewer added that the experience gained and data gathered during Phase 1 would help EPA determine whether the re-dredging requirements are effective and how these requirements should be modified.

The peer reviewers eventually agreed that EPA should limit the number of re-dredging attempts: some reviewers found a maximum of two re-dredging attempts acceptable, others supported reducing the number to one or zero, but none recommended that EPA increase the number. The panel agreed that EPA should evaluate the efficacy of multiple dredging attempts during Phase 1 by balancing the benefits of re-dredging against the impacts of the increased resuspension that re-dredging causes.

- *Capping and backfilling.* The Residuals Standard has capping and backfilling requirements that apply under different circumstances. Though the Draft EPS currently presents general performance criteria for isolation caps, the document states that "the specific design details of the capping contingency are to be addressed in the design phase" (page 54, Section 3.6, Volume 2). The peer reviewers found the discussion on capping and backfilling lacked clarity, particularly with respect to performance criteria. One peer reviewer, for instance, said the Residuals Standard does not clearly describe the differences between backfill and caps. Another reviewer found the discussion of cap design in Section 2.3.6.2 of the Residuals Standard not adequately reflected in the performance criteria outlined in Section 3.6. Further, it was not clear to this peer reviewer and others whether the text in Section 3.6 was intended to be cap design requirements or merely suggested design considerations.

Two peer reviewers eventually commented that EPA should have an engineering design standard for capping. Such a standard would specify, among other requirements, the point of compliance within the cap, the time period over which caps are expected to perform, and what type of armoring is needed to protect against scour during flood events. However, another reviewer was not convinced that the Draft EPS needs to include an engineering design standard for caps; this reviewer was satisfied knowing that EPA would approve all cap designs for the project, whether as part of the remedial design or through the Draft EPS. Overall, the reviewers concluded that there is ambiguity as to whether performance standards for the engineering contingencies are, or are not, part of the Residuals Standard.

- *Further comment on the reviewers' alternate framework for the Residuals Standard.* After discussing the re-dredging and engineering contingencies, the peer reviewers revisited and elaborated upon the alternate framework for the Residuals Standard that they had discussed earlier (see the third bulleted item in Section 3.1). The following paragraphs summarize the reviewers' additional comments on the alternate framework, and the Executive Summary of this report presents their final findings on this topic.

  One reviewer summarized how he would envision a revised Residuals Standard. First, under this alternate framework, EPA would develop an engineering design standard to address the goal of removing PCB inventory. The design criteria would specify the dredge cut lines and would include contractual best management practices to ensure, with rigid statistical confidence limits, that the initial dredging attempts achieve mass removal. Bathymetric observations would be used to confirm that dredge cut lines (and presumably PCB inventory removal) have been achieved. After dredging, EPA would verify that the surface concentration for a 20-acre modeling cell meets the value set for risk reduction goals, whether it be 1.0 mg/kg Tri+ PCBs before backfill or 0.25 mg/kg Tri+ PCBs after backfill. Overall, the main difference between the two frameworks is that the reviewers' alternate framework places a greater emphasis on the engineering design needed to ensure inventory removal, thus greatly reducing the complexity of the post-dredging decision tree (see Figure 1-1 in Volume 2) that is currently part of EPA's proposed framework. A main underlying assumption in the alternate framework, however, is that PCB inventory will be removed when the conservatively derived dredge cut lines are met.

The reviewers debated whether pre-backfill sampling would be required under this alternate framework. One peer reviewer said pre-backfill sampling results would help EPA and the dredge operators identify specific locations within certification units that might require further dredging or capping; however, another reviewer suggested that, if one is truly confident that the PCB inventory has been removed, then sampling appears to be unnecessary and skipping directly to backfill would be acceptable. As another option, a reviewer commented that backfilling should not be required in cases when pre-backfill sampling reveals an average surface concentration less than 0.25 mg/kg Tri+ PCBs. Reviewers noted that factors other than sampling results will influence the decision on whether to backfill; these factors include navigational needs, hydrological concerns, and a desire to preserve certain habitats.

An issue the reviewers debated was how to interpret scenarios, in the alternate framework for the Residuals Standard, in which one finds notably elevated post-dredging pre-backfill PCB concentrations in the sediments (e.g., would re-dredging be required? could the field operator proceed directly to backfill?). A reviewer noted that EPA and the dredge contractor would first need to use best professional judgment to determine if the elevated concentrations result from missed PCB inventory or from dredging residuals. But given that nearly all dredged areas will be backfilled, and if one again assumes that the dredge cut lines achieve inventory removal, consideration of engineering contingencies (other than backfill) would not be necessary for the areas found to be non-compliant with the 1.0 mg/kg Tri+ PCB residual concentration target.

After specifying these further details of their alternative framework to the Residuals Standards, the peer reviewers indicated that EPA could at least test the alternative framework during Phase 1, before deciding whether the approach is appropriate for the Phase 2 dredging. One reviewer recommended that EPA, when evaluating the framework for the Residuals Standard, consider the potential costs and ease of implementation of the two different approaches.

- *Other comments.* Noting that the significant health and safety risks of diver-assisted dredging would outweigh any benefits of this technique, one peer reviewer recommended that EPA remove references to diver-assisted dredging from the Draft EPS.

4.0 Peer Review of the Productivity Standard

This section presents a record of discussion of the peer reviewers' comments on the framework, example production schedule, and action levels in the Productivity Standard. The peer reviewers discussed the Productivity Standard further when addressing potential interactions among the three performance standards (see Section 5.1 of this report).

4.1 Charge Question 10: Framework

The first charge question for the Productivity Standard addresses the proposed framework. The charge question asked:

> The requirements of the 2002 ROD inform the overall parameters of the Productivity Standard (e.g., dredging of an estimated 2.65 million cubic yards in 6 years, with the first dredging season [Phase 1] at a reduced rate of dredging) (see [in the Draft EPS], Section 2.1: Background and Approach and Section 2.3: Rationale for the Development of the Performance Standard). Within this context, the Productivity Standard requires compliance with minimum cumulative volumes of sediment for each dredging season and targets larger cumulative volumes for the first five dredging seasons. In requiring cumulative annual volumes, the standard accounts for the expectation that some areas will be faster to dredge than others, and thus provides an opportunity to carry over the benefit of this faster dredging from one year to the next as a "cushion" against when dredging more difficult areas. In setting targeted cumulative annual volumes, the standard provides for the dredging to be designed to attain a somewhat faster rate of dredging, so that a reduced volume remains in the sixth (final) dredging season and additional time is available to address any unexpected difficulties. The Productivity Standard was developed with this framework to ensure that the dredging design and implementation meets the schedule called for in the ROD. Please comment on whether this framework provides a reasonable approach for developing the Productivity Standard.

The peer reviewers found the general framework for the Productivity Standard to be reasonable, and made the following comments:

- *General framework.* The peer reviewers concluded that the framework for the Productivity Standard is reasonable and consistent with the ROD. Some peer reviewers added that specifying required and target cumulative volumes, requiring record keeping and periodic reporting, and implementing tiered action levels is a reasonable approach for setting the standard.

The reviewers agreed that EPA should consider making at least two revisions to the framework. First, one reviewer was concerned that the target dredging volume EPA set for Year 1 (Phase 1) was too high. Suspecting that the dredge operators will encounter various unforeseen circumstances during the first dredging season, this reviewer suggested that EPA set the minimum required dredged volume for Phase 1 at 150,000 cubic yards—the lowest value allowed in the ROD. Second, this reviewer was also concerned that the proposed target dredging volume for Year 2 (the first year in Phase 2) was also too high. This concern stemmed from the fact that, between Year 1 and Year 2, EPA is supposed to evaluate the Phase 1 data, revise the performance standards, conduct another independent peer review, and possibly perform additional activities. With such a schedule, the reviewer feared that dredging operations likely will not occur for the entire season in Year 2. Given these concerns, this reviewer recommended that EPA reduce the target dredged volumes for Years 1 and 2, and increase the target volumes for years toward the end of the project (e.g., Year 6), when the dredging operation would presumably be most productive and efficient.

Another reviewer emphasized that EPA should view Phase 1 as an opportunity to collect information that will best inform what production rates can be achieved during Phase 2. Accordingly, this reviewer strongly recommended that EPA strategically select a wide range of dredging site characteristics in Phase 1: some sites in cohesive sediments, others in non-cohesive sediments; some sites requiring in-river transport through locks, others near the de-watering facility; some sites with highly contaminated sediments at depth, others with lower contamination levels near the surface; and so on (see pages 70–71 in Appendix B). He noted that the Phase 1 dredging need not necessarily occur from upstream to downstream, but other reviewers had concerns about re-contamination issues if dredging were not to proceed sequentially down the river.

A peer reviewer agreed that selection of dredging sites in Phase 1 is critical, emphasizing the importance of gathering quality information rather than trying to achieve as high a production rate as possible. Another reviewer supported this recommendation, adding that very detailed records must be kept in Phase 1 and frequently submitted to EPA to track the different factors (e.g., sediment type, river location) that could affect dredging productivity. A reviewer agreed, but expected the dredging contractor would already be keeping such detailed records.

- *Should EPA set a minimum dredged volume for Phase 1?* At the beginning of the discussion on Charge Question 10, some peer reviewers commented that EPA should not set a minimum dredged volume for the Phase 1 dredging. These reviewers explained that the role of Phase 1 should be to determine what dredging production rates are feasible, and those rates could then be carried forward into Phase 2. One of these reviewers said that Phase 1 should be viewed as a pilot project or demonstration project, with a greater emphasis on working out the details for the Resuspension and Residuals Standards.

Another reviewer agreed that the dredged volume achieved in Phase 1 is less important than the need to gather useful site-specific information for revising the Productivity Standard, but he recognized that the ROD has constraints on the minimum amount of material to be removed.

The peer reviewers eventually agreed, however, that setting dredging target volumes for Phase 1 is sensible. One peer reviewer, for instance, was concerned that if the production volumes during Phase 1 are allowed to be very low, then the data collected during Phase 1 will not provide meaningful insights into Phase 2 production demands. In short, he feared that setting dredge volumes too low in the first year would essentially defeat the purpose of conducting Phase 1, at least in terms of gathering information on dredging productivity. Other reviewers agreed, adding that having a minimum production rate is reasonable. The peer reviewers eventually agreed that the dredging target volume for Phase 1 be at least 150,000 yards.

4.2 Charge Question 11: Example Production Schedule

The second charge question asked the peer reviewers to comment on the example production schedule that EPA developed in support of the Productivity Standard:

> As part of the development of the Productivity Standard, an Example Production Schedule was developed based on site-specific information and case studies of other environmental dredging projects to demonstrate that the Productivity Standard can be met. Relevant sections of the document [the Draft EPS] include Section 2.2: Supporting Analyses, Attachment 1: Productivity Schedule, Attachment 2: Productivity Schedule Backup, and Attachment 3: Evaluation of Applicable Dredge Equipment for the Upper Hudson River. Please comment on the Example Production Schedule, including the reasonableness of the underlying assumptions for equipment selection and efficacy, as well as the time necessary to deploy, use, and move equipment.

The peer reviewers commented on various aspects of the example production schedule. Though they identified several assumptions that EPA should better justify, most peer reviewers eventually recommended that EPA not spend considerable time updating the example production schedule. Rather, they suggested that EPA allow GE's design effort to proceed. A summary of the discussion that led to these findings follows:

- *Overall impressions of the example production schedule.* The peer reviewers had different opinions on how detailed the example production schedule should be. Some reviewers, for instance, noted that the schedule is basically a hypothetical exercise. Further, peer reviewers questioned the utility of the schedule, given that it does not incorporate information on the remedial design, the Quality of Life Standards, the Water Quality Certification requirements, and other considerations.

  On the other hand, another reviewer recognized that EPA had no choice but to develop the current example production schedule without information on some important topics. Accepting this, the reviewer said that EPA made good use of available information (e.g., from case studies), though he listed several factors the Agency should consider when revising the example production schedule (see the next bulleted item).

  Noting that the example production schedule was only intended to be a conceptual schedule, another reviewer saw little benefit in having EPA invest considerable effort to revise the schedule, given that the remedial design presumably will resolve many of the key scheduling and productivity issues. Other peer reviewers agreed with this statement, adding that further work on scheduling is of limited utility until critical design issues—such as the type of dredging equipment to be used and the location and capacity of de-watering facilities—are specified.

- *Suggested improvements to the example production schedule.* Section 2.2 of the Productivity Standard presents supporting analyses that are intended to demonstrate that the standard is achievable. One peer reviewer commented that these supporting analyses lacked clarity, and another said that they lacked specifics on certain topics. Particularly, he noted, the schedule focuses largely on dredging schedules, with little emphasis on in-river transport of dredged material and the capacity and design of de-watering facilities. Accordingly, both reviewers noted that the supporting analyses do not adequately demonstrate that the required production rates can be achieved. Meaning, the required production rate might be feasible, but the supporting analyses in the Productivity Standard did not convince some peer reviewers that this is the case.

  Two peer reviewers raised concerns about the example production schedule and questioned some assumptions EPA made when developing it. One peer reviewer, for instance, questioned a potentially critical assumption: that the de-watering and transfer facility will have the storage capacity to handle peak dredging production rates. This reviewer also was concerned about assumptions made regarding fish windows, cooperation from the canal corporation, and the number of dredges and ancillary equipment that will operate simultaneously in the Upper Hudson River. Another peer reviewer was not convinced that the example production schedule adequately accounted for re-dredging to address residuals, downtime due to inclement weather, icing, and high flow events (i.e., river flow velocities greater than 3 or 4 feet per second), navigational restrictions due to barge traffic and river locks, potential incompatibility with noise requirements outlined in the Quality of Life Standards, and reliability of rail operations. For a more complete list of these reviewers' concerns, readers should refer to pages 71–78 and 173–177 of Appendix B.

Several peer reviewers eventually recommended that EPA strengthen the documentation of these and other underlying assumptions in the example production schedule—to the extent that these improvements can be made without the final remedial design—to better demonstrate that the desired production rate is feasible. The Executive Summary of this report lists the specific recommendations that the peer reviewers identified as being most important.

During this discussion, a peer reviewer emphasized that the dredging production rate will ultimately depend on a sequence of events, each of which must link seamlessly to ensure that high production rates can be sustained. Because bottlenecks anywhere in this sequence can cause project delays, some peer reviewers recommended that EPA conduct a sensitivity analysis of critical potential bottlenecks in the dredging, transporting, and handling of contaminated sediments.

4.3 Charge Question 12: Action Levels

The final charge question related to the Productivity Standard asked peer reviewers to evaluate the appropriateness of the proposed action levels:

> The Productivity Standard includes two tiered action levels (Concern and Control) prior to any determination of non-compliance with the standard, as well as their respective required actions and monitoring and recordkeeping requirements. Relevant sections of the document [the Draft EPS] are Section 1.1: Implementation and Section 3.3: Monitoring, Record Keeping and Reporting Requirements. Please comment on appropriateness of the action levels and the required actions, as well as the reasonableness of the monitoring and record keeping requirements.

Several peer reviewers commented that it is reasonable to apply action levels to the Productivity Standard and require responses from the dredging contractor when these levels are not met. Two of these reviewers cautioned that the dredging contractor must not compromise meeting the Resuspension or Residuals Standards when attempting to address lagging productivity.

The peer reviewers suggested several ways to help ensure that action levels are met. First, two reviewers said EPA will need to work collaboratively with the dredging contractor to identify causes of lagging productivity and to develop acceptable approaches for addressing slow production rates. Second, a reviewer recommended that innovative contracting procedures with appropriate bonuses and penalties will likely be necessary to ensure that the dredging contractor has meaningful incentives to meet the Productivity Standard, but not at the expense of failing to comply with the two other standards. Third, a reviewer noted that productivity rates will inevitably vary with river conditions, and EPA should expect fluctuations in productivity during the project. Accordingly, failure to meet monthly targets might simply result from the project reaching areas that are difficult to dredge, and not due to inadequate performance on behalf of the dredge contractor. Finally, a reviewer recommended that EPA revise the final action levels for the Productivity Standard, as appropriate, after reviewing the dredging productivity data collected during Phase 1.

The peer reviewers' main recommendation for this charge question was that EPA require the dredge contractor to record additional information in the daily logs than is currently required by the standard. The dredge operator should be required to keep daily records of number of hours of actual dredging time, off-loading rates, capping and backfilling production rates, and observations of any conditions that contribute to delays (e.g., river flow, weather, barge traffic, compliance with Quality of Life Standards, and so on). The reviewers explained that requiring this data collection should not place an undue burden on the dredging contractor, as most experienced dredging contractors should be accustomed to maintaining detailed daily logs and meeting recordkeeping requirements. EPA, these reviewers noted, will find this information very helpful when revising the Productivity Standard before Phase 2 dredging begins.

5.0 Peer Review of Issues Relevant to All Three Standards

This section presents a record of discussion of the peer reviewers' responses to three charge questions related to all three engineering performance standards.

5.1 Charge Question 13: Interactions Among Standards

The following charge question asked the peer reviewers to evaluate how the Draft EPS addresses potential interactions among standards:

> Because the Engineering Performance Standards for Resuspension, Residuals and Productivity be applied in conjunction with one another, the standards must be considered as a whole as well as individually. In developing the standards, their points of interaction were balanced to allow flexibility during design and implementation, while ensuring that human health and the environment are adequately protected. Thus, the standards contain self-correcting features (e.g., the requirements for additional re-dredging attempts in the Residuals Standard must consider the requirements for dredging production in the Productivity Standard). The interactions among the standards are discussed in the Executive Summary, Introduction, and Section 3.2 of the Productivity Standard [in the Draft EPS]. Please comment on whether the main interactions among the standards are properly documented and taken into account.

The peer reviewers discussed potential interactions among and conflicts between the three engineering performance standards. During this discussion, they revisited many of the topics that were raised when debating the Productivity Standard. The reviewers' specific comments on these matters follow:

- *Articulation of potential interactions in the Draft EPS.* The peer reviewers unanimously agreed that the three performance standards have inherent conflicts, the chief conflict being that increasing dredging productivity may come at the expense of increased resuspension and residuals contamination. Additionally, compliance with the standards could be affected by other requirements, such as the Quality of Life Standards and the Water Quality Certification.

  One reviewer indicated that the Draft EPS includes little documentation of potential interactions and how they might be resolved; however, other peer reviewers noted that the full spectrum of potential interactions cannot be known in advance, and can only be speculated before Phase 1 begins. The reviewers agreed that Phase 1 presents the best opportunity for understanding how the three engineering performance standards will interact. Accordingly, a peer reviewer recommended that EPA track potential interactions during Phase 1, such that they can be addressed and avoided in Phase 2. Ultimately, the peer reviewers recommended that the Draft EPS include summaries of potential interactions and how they might be addressed.

- *Should the performance standards be prioritized?* The peer reviewers debated whether EPA should assign higher priorities to individual standards. Initially, several peer reviewers recommended that EPA place higher priority on complying with the Resuspension and Residuals Standard and a lower priority on complying with the Productivity Standard. Otherwise stated, these reviewers initially suggested that the Resuspension and Residuals Standards should not be compromised in attempt to comply with the Productivity Standard. One reviewer suggested that EPA use Phase 1 as an opportunity to refine the Resuspension and Residuals Standards, but place far lesser emphasis on achieving minimum production rates—perhaps by not requiring a target dredge volume for Phase 1. This reviewer also commented that EPA may need to revise the ROD, if Years 1 or 2 of dredging prove that the Productivity Standard cannot be met.

  As discussions continued, other peer reviewers identified reasons why all three performance standards may need to be given equal priority and why the Productivity Standard should not be viewed as lower priority. One reviewer explained, for instance, that if the dredging project were to continue much longer than anticipated, the risk reduction goals could be compromised due to the PCB resuspension caused by prolonged dredging operations. Moreover, this reviewer envisioned scenarios in which the Productivity Standard actually might take precedence over the Resuspension and Residuals Standards. For example, EPA might appropriately decide to allow dredging productivity to increase in order to avoid the need for additional dredging seasons, even if this increased productivity comes at the expense of elevated resuspension rates over the short term. Whether such decisions are implemented, this reviewer noted, should be based on evaluations of risk reduction goals. Another reviewer added, as another example, that compliance with the Productivity Standard might also help mitigate undesirable quality-of-life concerns that would be associated with an unnecessarily prolonged dredging project. Finally, one reviewer noted that EPA could address the perception of the Productivity Standard being less important by clarifying in Volume 3 that failure to meet the required dredging production rates could actually increase risks to health and the environment, as a result of prolonged dredging.

  Based on these discussions, a peer reviewer recommended that EPA needs to strike a *balance* between the standards, and not necessarily place priorities on the individual standards. The greatest priority in meeting the standards, this reviewer noted, is risk reduction, which is very closely tied to the time frame over which PCB inventory is removed. Other peer reviewers eventually agreed that balancing the standards is more reasonable than prioritizing among them. The peer reviewers' final recommendation on this matter (see the Executive Summary) was that the standards should be balanced.

- *Approach for resolving interactions.* Several peer reviewers observed that the Draft EPS does not specify how EPA will work with GE and the dredging contractor to resolve unforeseen conflicts between the three engineering performance standards. These peer reviewers recommended that EPA outline the decision-making process that EPA, GE, and the dredging contractor will follow to quickly resolve conflicts among the standards. The reviewers generally agreed that decisions regarding conflicts between standards should be based, where possible, on considerations of long-term risk reduction goals.

  One reviewer identified ways that EPA could ease the potential tensions between the standards before the dredging begins. For instance, by setting the Phase 1 target production rate at the lowest value (150,000 cubic yards) and requiring higher production rates near the end of the 6-year project (see Section 4.1), EPA could better test the Resuspension and Residuals Standards during Phase 1, without worrying as much about achieving what may be an overly optimistic production rate for the initial dredging.

5.2 Charge Question 14: Refinement of the Standards

This charge question, which addresses EPA's plan to refine the Draft EPS, asked:

> Section 4.0 [in the Draft EPS] presents the plans for refinement of each standard. Please comment on whether there are any additional aspects to effectively accomplish the refinement that EPA should consider in evaluating the Phase 1 data.

Noting that the Draft EPS does not specify exactly how EPA will refine the engineering performance standards, the peer reviewers offered several considerations for when and how the standards should be refined.

- *Refining the standards during Phase 1.* The peer reviewers discussed whether it is reasonable for EPA to refine the performance standards during Phase 1. First, some peer reviewers were not convinced that changes need to be made during Phase 1. One reviewer, for example, questioned the feasibility of making major changes during Phase 1, given the level of activity that will be occurring, the volume of data that will be generated, the approvals that may be needed, and the limited duration of the first dredging season. This reviewer noted that the best opportunity for refining the standards will be between Phases 1 and 2. Another reviewer agreed, but for a different reason: multiple revisions to the standards during Phase 1 ultimately would complicate efforts to interpret the data that will be generated.

Though not disagreeing with these points, other reviewers recommended that EPA consider refining the standards during Phase 1, particularly in cases where it becomes immediately apparent that certain dredging, sampling, or other requirements are unnecessary. The panel as a whole eventually recommended that EPA gather and interpret data as soon as they are reported in order to implement changes and streamline requirements during Phase 1, with an attempt to revise the overall approach by the end of the first year of dredging. The peer reviewers noted that EPA, GE, and the dredging contractor will need to collaborate with deciding what changes are warranted.

- *Process for developing the final standards.* The peer reviewers recommended that the Draft EPS clearly indicate the approach EPA plans to take to refine the standards. Recognizing the large volume of data that Phase 1 will generate, three peer reviewers indicated that EPA cannot wait until Phase 1 is over to begin refining the standards, because doing so would likely lead to a shortened dredging season for Year 2. Rather, the peer reviewers said, EPA needs to collect and evaluate the data as it is reported such that the Agency has time to draft revisions to the standard, have them peer-reviewed, and publish the final standards, all before the Phase 2 dredging begins.

  The peer reviewers offered several recommendations on how EPA can refine the standards in a timely manner. First, a peer reviewer noted that EPA should develop a data reporting and management system, such that all parties can access information on the performance standards during the Phase 1 dredging. Second, another reviewer recommended that, before Phase 1 begins, EPA establish a process by which data will be managed and evaluated. Finally, noting that the ROD requires an independent peer review of the Phase 1 dredging results, a peer reviewer suggested that EPA give the independent peer reviewers ample time to examine and evaluate the data collected during Phase 1, rather than giving the reviewers a limited time frame to comment on the initial dredging. He also recommended that the independent peer reviewers be allowed to tour dredging sites, observe dredging and transportation operations, and visit the de-watering and transfer facilities for a better perspective on the Phase 1 progress. Such activities would enable the peer reviewers to conduct more meaningful evaluations of the initial dredging.

5.3 Charge Question 15: General Comments

The final charge question invited the peer reviewers to discuss any issues not specifically addressed by the other charge questions. Specifically, this question asked:

> Please provide any other comments, concerns or suggestions, involving both strengths and weaknesses, with respect to the October 2003 "Draft Engineering Performance Standards—Peer Review Copy" that may not be fully covered by the above charge questions.

When responding to this charge question, the peer reviewers were encouraged to raise any issues relevant to the Draft EPS that the other charge questions did not cover. Following are the reviewers' responses, in the order they were given:

- On the issue of post-dredging confirmatory sampling, one reviewer recommended that EPA require analysis both of a composite sample for the dredging certification unit and of a certain subset—perhaps 10% or 20%—of aliquots from the individual discrete samples used to make the composite.

- One reviewer recommended that, before Phase 1, EPA perform and document a cost-benefit and implementability analysis for the baseline monitoring program. He noted that the Draft EPS should identify the total number of samples that are expected to be collected for different parameters, alongside the corresponding monitoring objectives. Such information could then be used to weigh the costs of sampling against the benefits and assess whether the proposed number of samples is adequate (e.g., is the investment in the sampling worth the return of having the monitoring results?). Two other reviewers agreed with this recommendation, encouraging EPA to assess the benefits of the required sampling as well as the costs associated with a less extensive baseline monitoring program. Another reviewer supported this recommendation, and added that EPA should evaluate whether field sampling crews and the analytical laboratory can realistically implement the baseline monitoring program while meeting required turnaround times and data quality objectives.

  While not disagreeing with these comments, another reviewer noted that the benefits of having certain samples collected might not be fully understood until Phase 1 is complete. This reviewer added that EPA presented estimated costs for the monitoring program in one of the background documents provided to the peer reviewers, though not in the Draft EPS.

- One reviewer emphasized the importance of the transfer facility to meeting the Productivity Standard. The reviewer explained that this facility must be capable of handling 5,700 cubic yards of material per day. Should peak dredge volumes exceed this amount or the transfer facility otherwise be shut down, this peer reviewer noted, the entire remedial operation—from dredging to transport of material by rail—would need to be temporarily suspended. As a result, design considerations for the transfer facility will be critical.

- Citing a theme expressed earlier in the discussions, a peer reviewer noted that the contracting mechanism with the dredging operator should allow for ample flexibility when conducting daily activities and for working collaboratively with GE and EPA.

- One peer reviewer suggested that a relationship between turbidity, suspended solids, and PCB concentrations is not needed to control solids losses from dredging sites, because other approaches (e.g., application of best management practices to real-time turbidity data) can inform the dredge operator when elevated solids losses are occurring.

- One peer reviewer recommended that a design criterion be developed for the final dredge surface, such that sediment entrapment and any subsequent re-contamination is minimized. This peer reviewer suggested that separate performance criteria be developed to address the issue of sediment re-contamination (both short-term and long-term).[4]

- A peer reviewer recommended that, in the Resuspension Standard, actions required at the different trigger levels address solids losses at the dredging operation, rather than simply requiring increased monitoring frequency. Otherwise stated: when action levels are triggered, the reviewer prefers requiring more aggressive responses (e.g., engineering contingencies) that are more directly related to production and resuspension, rather than simply allowing dredging operations to continue to export PCBs, albeit with increased monitoring frequency.

- A peer reviewer recommended that data collection should be targeted toward addressing compliance with the performance standards, not toward validating models. Other reviewers disagreed, noting that data collection to test modeling assumptions is appropriate, at least during the Phase 1 dredging.

- Two peer reviewers recommended that the engineering performance standards give more attention to laboratory analytical methods and provide clear guidance to field operators on how laboratory analytical data should be interpreted. These reviewers referred EPA to the pre-meeting comments for more detailed suggestions on consideration of analytical methods (see Victor Magar's comments in Appendix B).

---

[4]A reviewer explained this point further in a post-meeting comment: Re-suspended material (either from dredging or other transport processes) may potentially contaminate both remediated areas and non-target areas in the Upper Hudson River. Re-contamination goals need to assume that the remediated sediments will equilibrate with sediments in adjacent areas that were not addressed by this action (i.e., at some point the surface sediment concentration in a given reach of the river is going to reflect the areal average for that reach). Depending on the quality of the non-target sediments, remediated areas may either increase or decrease in surface concentrations. Development of re-contamination goals may address the issue of impacts to adjacent non-target areas, such that extensive sampling is not needed to prevent further degradation of these areas (i.e., non-target sediment concentrations remain below the short-term re-contamination goal, even with resuspension and transport of contaminated material during remediation).

- A peer reviewer said that NYSDEC needs to provide EPA with the proposed Water Quality Certification requirements and identify non-target contaminants of concern. Another reviewer agreed, and suggested that EPA consider conducting a special study during Phase 1 to assess dredging-related releases of contaminants other than PCBs, particularly metals.

- Two peer reviewers recommended that, during Phase 1 of the project, the proposed standards should not be enforceable, nor should they carry legal or regulatory consequences. Rather, these reviewers suggested that the engineering performance standards be considered as “goals” or “draft standards” during Phase 1, until the final performance standards are established before Phase 2 begins. On the other hand, two reviewers were comfortable with the standards being labeled as such, given that the Draft EPS allows for flexibility in meeting the standards and responding to non-compliance.

6.0 Peer Reviewers' Conclusions and Recommendations

After responding to the 15 charge questions, the panel worked together to draft their key findings for the peer review. Every peer reviewer was asked to reflect upon the discussions during the first 2 days of the meeting and to draft preliminary conclusions and recommendations on specific topics. These draft statements were displayed at the meeting to the entire panel and observers, edited by the panelists, and then compiled into final summary statements, which included both conclusions and recommendations. The reviewers' final summary statements, with minor editorial revisions, appear in the Executive Summary of this report.

7.0 References

EPA. 2000. Peer Review Handbook, Second Edition. U.S. Environmental Protection Agency, Office of Science Policy. EPA 100-B-00-001. December 2000.

EPA. 2002. Hudson River PCBs Site, New York: Record of Decision. U.S. Environmental Protection Agency. February 2002.

Malcolm Pirnie and TAMS. 2003. Draft Engineering Performance Standards—Peer Review Copy. Parts 1–3 and Appendix. Prepared by Malcolm Pirnie, Inc., and TAMS Consultants, Inc. Prepared for U.S. Army Corps of Engineers, on behalf of the U.S. Environmental Protection Agency, Region 2. October 2003.

Nayak Polissar, Derek Stanford, and Blazej Neradilek, 2003. Sample Size, Spatial Allocation of Samples, and Statistical Methods for Detection of the Boundary of 1 ppm PCB Concentration in Sediment of the Lower Fox River, Wisconsin. June 2003.

USGS. 2000. A Mass-Balance Approach for Assessing PCB Movement During Remediation of a PCB-Contaminated Deposit on the Fox River, Wisconsin. United States Geological Survey. December 2000.

Water Resources Institute. 2000. Evaluation of the Effectiveness of Remediation Dredging: The Fox River Deposit N Demonstration Project, November 1998–January 1999. Water Resources Institute, University of Wisconsin, June 2000.