REPORT ON THE PEER REVIEW OF THE DATA EVALUATION AND INTERPRETATION REPORT AND LOW RESOLUTION SEDIMENT CORING REPORT FOR THE HUDSON RIVER PCBs SUPERFUND SITE

—Final Report—

Prepared for:

U.S. Environmental Protection Agency, Region II
Emergency and Remedial Response Division
290 Broadway, 18th Floor
New York City, NY 10007-1866

EPA Contract No. 68-W6-0022
Work Assignment No. 3-12

Prepared by:

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

June 3, 1999

NOTE

This report was prepared by Eastern Research Group, Inc. (ERG), an EPA contractor, as a general record of discussion for the peer review meeting. This report captures the main points of scheduled presentations and highlights discussions among the reviewers. This report does not contain a verbatim transcript of all issues discussed during the peer review. Additionally, the report does not embellish, interpret, or enlarge upon matters that were incomplete or unclear. EPA will evaluate the recommendations developed by the reviewers and determine what, if any, modifications are necessary to the current modeling approach. Except as specifically noted, no statements in this report represent analyses or positions of EPA or of ERG.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF ABBREVIATIONS

DEIR	Data Evaluation and Interpretation Report
DNAPL	dense, nonaqueous phase liquid
DOC	dissolved organic carbon
EPA	U.S. Environmental Protection Agency
ERG	Eastern Research Group, Inc.
GE	General Electric Company
HRC	high-resolution sediment coring
LRC	Low Resolution Sediment Coring Report or low-resolution sediment coring
MDPR	molar dechlorination product ratio
MW	molecular weight
NYSDEC	New York State Department of Environmental Conservation
PCA	principal component analysis
PCB	polychlorinated biphenyl
ppm	parts per million
RPD	relative percent difference
TID	Thompson Island Dam
TIP	Thompson Island Pool

EXECUTIVE SUMMARY

Six independent peer reviewers critiqued the following reports prepared as part of the U.S. Environmental Protection Agency's (EPA's) reassessment of the Hudson River PCBs Superfund site: the "Data Evaluation and Interpretation Report," the "Low Resolution Sediment Coring Report," and Responsiveness Summaries for both documents. After thoroughly discussing and debating the scientific rigor of the main conclusions of these reports, the reviewers unanimously agreed that the reports were acceptable. Four of the six reviewers found the reports "acceptable with minor revisions;" the other two reviewers found the reports acceptable, but they were unsure if their recommended revisions were "minor" or "major."

When answering the questions in the charge, the reviewers generally agreed with the major conclusions of the DEIR and LRC (e.g., the sediments in the Thompson Island Pool act as a source of PCBs to the water, the data suggest that most hot spots have lost PCBs, widespread burial of PCBs is not occurring, and so on), but they suggested that some conclusions should be modified to more accurately reflect the supporting data. At the close of the peer review meeting, every reviewer listed his major findings and recommendations. Following is a list of specific recommendations that at least two reviewers made during their closing statements. Specific examples of other suggested revisions and recommendations made by the reviewers can be found throughout this report.

- The reviewers unanimously agreed that the reports should have included multivariate statistical analyses to identify and quantify trends and patterns among the data, but especially for evaluating the large volume of congener-specific data.

- Every reviewer thought the reports should have more prominently acknowledged the uncertainty associated with some major findings. The reviewers were particularly concerned with reporting estimated PCB mass losses from hot spots as firm numbers. The reviewers suggested that reporting a range of estimated mass losses might have been more appropriate.

- The reviewers agreed that the DEIR's original finding on anaerobic dechlorination of PCBs was not supported by the data. The reviewers thought a more accurate conclusion

would indicate that dechlorination is predictable at higher PCB concentrations, but this should not be taken as evidence of lack of dechlorination at lower concentrations.

- Several reviewers recommended that EPA publish a concise summary of the main findings of the DEIR, the LRC, and the Responsiveness Summaries.

- Several reviewers recommended that EPA validate selected conclusions in the DEIR with the results from more recent water column sampling data.

- Several reviewers agreed that the DEIR and LRC did not fully characterize the fate of PCBs in the Hudson River. Two reviewers indicated that EPA should have considered evaporative losses, photochemical degradation, and aerobic degradation in the reports.

1.0 INTRODUCTION

This report summarizes an independent peer review by six experts of the following documents the U.S. Environmental Protection Agency (EPA) released as part of its reassessment of the Hudson River PCBs Superfund site:

- The February 1997 "Data Evaluation and Interpretation Report" (DEIR) (TAMS et al., 1997)
- The December 1998 "Responsiveness Summary" for the DEIR (TAMS et al., 1998a)
- The July 1998 "Low Resolution Sediment Coring Report" (LRC) (TAMS et al., 1998b)
- The February 1999 "Responsiveness Summary" for the LRC (TAMS et al., 1999)

To facilitate their evaluations of these reports, the reviewers also were given copies of the "Hudson River Reassessment Database," which contains all of the sampling data used to prepare the above reports.

The six reviewers attended two meetings, which were both open to the public. The first meeting, which took place in Albany, New York, on January 11–12, 1999, included several presentations and a tour of the Upper Hudson River to familiarize the reviewers with the site and its environmental history. The second meeting, which took place in Albany on March 16–18, 1999, was the forum in which the reviewers critiqued the above documents. Eastern Research Group, Inc. (ERG), a contractor to EPA, organized the expert peer review and prepared this summary report.

This introductory section provides background information on the Hudson River PCBs Superfund site, the scope of the peer review of the DEIR and LRC, and the organization of the report.

1.1 Background

In 1983, EPA classified approximately 200 miles of the Hudson River in the state of New York as a Superfund site, due to elevated concentrations of polychlorinated biphenyls (PCBs) in sediments. The sediments are believed to have been contaminated by discharges of PCBs over approximately 30 years from two General Electric (GE) capacitor manufacturing plants, one in Hudson Falls and the other in Fort Edward. The superfund site runs from Hudson Falls to New York City. After an initial site assessment, EPA issued an "interim No Action decision" in 1984 for the contaminated sediments of the Hudson River PCBs site.

Since 1990, EPA has been reassessing its earlier decision to determine whether a different course of action is needed for the contaminated sediments in the Hudson River. EPA is conducting this reassessment in three phases: compiling and analyzing existing data for the site ("Phase I"), collecting additional data and using models to evaluate human health and ecological risks ("Phase II"), and studying the feasibility of remedial alternatives ("Phase III"). As part of Phase II, EPA's contractors conducted field studies to characterize levels of PCBs in the water and sediments of the Hudson River to better understand the factors that affect the fate and transport of PCBs in this system. The original findings of these studies are documented in the DEIR and LRC. Since EPA released these reports, several parties submitted comments during the designated public comment periods, after which EPA's contractors prepared Responsiveness Summaries to address the comments.

To ensure that the assumptions, methods, and conclusions of the DEIR, the LRC, and their Responsiveness Summaries are based on sound scientific principles, EPA decided as per policy to obtain an expert peer review of the documents. The remainder of this report describes the scope and findings of this independent peer review.

1.2 Scope of the Peer Review

ERG managed every aspect of the peer review, including selecting reviewers, briefing the reviewers on the site, and organizing the peer review meeting. The following subsections describe what each of these tasks entailed.

1.2.1 Selecting the Reviewers

To organize a comprehensive peer review, ERG selected six independent peer reviewers who are engineers or senior scientists with demonstrated expertise in any combination of the following technical fields:

- River sedimentology
- Low and high resolution sediment coring
- Hydrology and water column fate and transport
- Geochemistry
- Analytical chemistry of PCBs
- Anaerobic dechlorination of PCBs

Appendix A lists the six reviewers ERG selected for the peer review meeting; brief bios that summarize each reviewer's areas of expertise can be found in Appendix C. Recognizing that few individuals specialize in every technical area listed above, ERG ensured that the collective expertise of the selected peer reviewers covers the six technical areas (i.e., at least one reviewer has expertise in analytical chemistry of PCBs, at least one reviewer has experience in river sedimentology, and so on).

To ensure the peer review's independence, ERG considered only individuals who could provide an objective and fair critique of EPA's work. As a result, ERG did not consider in the reviewer selection process individuals who were associated in any way with preparing the DEIR or the LRC or individuals associated with GE or any other specifically identified stakeholder.

1.2.2 Briefing the Reviewers

Given the large volume of site-specific information in the DEIR and LRC and the fact that none of the reviewers had extensive experience with the Hudson River PCBs site, ERG organized a 2-day meeting prior to the actual peer review to provide the reviewers with background information on the reports and to tour the Upper Hudson River. The purpose of the meeting was to familiarize the reviewers with the site; the reviewers did not provide technical comments on EPA's reports during this briefing. A copy of the minutes from this briefing can be found in Appendix G.

To focus the reviewers' evaluations of the documents, ERG worked with EPA to develop written guidelines for the technical review. These guidelines (commonly called a "charge") were presented during the briefing meeting and asked the reviewers to address at least the following topics: whether the main conclusions of the DEIR and LRC are well supported by the data; if the data presented in these reports is sufficient for understanding fate and transport mechanisms in the Upper Hudson River; and if additional analyses should be performed to verify certain findings of the reports. A copy of this charge, which includes many additional topics and questions, is included in this report as Appendix B.

In the weeks following the briefing meeting, ERG requested that the reviewers prepare their initial evaluations of the DEIR, the LRC, and the Responsiveness Summaries. ERG compiled these "premeeting comments," distributed them to the reviewers, and made copies available to observers during the peer review meeting. These initial comments are included in this report, without modification, as Appendix C. It should be noted that the premeeting comments are preliminary in nature and some reviewers' technical findings might have changed based on discussions during the meeting. As a result, the premeeting comments should not be considered the reviewers' final opinions.

The peer reviewers were asked to base their premeeting comments on the written materials distributed by ERG: the DEIR, the LRC, and the Responsiveness Summaries. Though

not required for this review, some reviewers might also have researched site-specific reports they obtained from other sources.

1.2.3 The Peer Review Meeting

The peer review meeting, which was held at the Albany Marriott Hotel in Albany, New York, on March 16–18, 1999, was attended by the six expert reviewers and at least 30 observers. Appendix D 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 E. As the agenda indicates, the meeting began with introductory comments both by the designated facilitator and by the designated chair of the peer review meeting. (These and other introductory comments are summarized below.) For the remainder of the meeting, the reviewers discussed and debated several technical issues when answering the questions in the charge. During the technical discussions, the reviewers provided many comments, observations, and recommendations. The agenda included two time slots for observer comments, which are summarized in Appendix F of this report. An ERG writer attended the meeting and prepared this summary report.

On the first day of the meeting, Jan Connery of ERG—the designated facilitator of the peer review—welcomed the six reviewers and the observers to the 3-day meeting. In her opening remarks, Ms. Connery introduced Dr. Ken Reimer (a peer reviewer and the technical chair of the meeting), stated the purpose of the peer review meeting, and identified the documents under review. To ensure the peer review remained independent, Ms. Connery asked the reviewers to discuss technical issues among themselves during the meeting and to consult with EPA only for necessary clarifications. Ms. Connery explained the procedure observers should follow to make comments. Finally, she reviewed the meeting agenda.

Following Ms. Connery's opening remarks, the peer reviewers introduced themselves, noted their affiliations, identified their areas of expertise, and stated that they had no conflicts of interest in conducting the peer review. Selected representatives from EPA and from EPA's

contractors then introduced themselves and identified their roles in the site reassessment. To orient the peer reviewers and observers to EPA's ongoing site reassessment efforts, Mr. Doug Tomchuk (EPA) then gave a presentation describing the history, current status, and planned future activities for the Hudson River PCBs site. Mr. Tomchuk also discussed the importance of peer review in the ongoing site reassessment efforts. Mr. Tomchuk then reviewed the four major conclusions of the DEIR and the LRC, but he did not interpret, or expand on, the assumptions and findings documented in the reports.

As a transition into technical discussions, Dr. Ed Garvey of TAMS Consultants gave a presentation on the main findings of the Responsiveness Summary for the LRC—the only report that was not available prior to the January briefing meeting. Dr. Garvey clarified several findings documented in this Responsiveness Summary, but he focused on several topics: the precision of the data; the use of radioactive isotopes to "date" the sediments; approaches used to quantify the extent of anaerobic dechlorination; the significance of wood chips in the sediment cores; and the general findings of the appendices to the LRC.

Following Dr. Garvey's presentation, Dr. Reimer began to chair the technical discussions of the peer review meeting. Dr. Reimer first identified several common themes among the reviewers' premeeting comments, and then worked with the peer reviewers to answer the questions in the charge, following the agenda. The remainder of this report summarizes the peer reviewers' discussions and documents their major findings and recommendations.

1.3 Report Organization

The structure of this report reflects the order of questions in the charge to the reviewers: Section 2 of this report summarizes the reviewers' discussions on specific questions regarding the DEIR; Section 3 summarizes the discussions on specific questions regarding the LRC; Section 4 summarizes the discussions on general questions that apply to both documents; and Section 5 highlights the discussions that led to the reviewers' final recommendations. Section 6

of this report lists all references cited in the text. In these sections, the initials of the reviewers are used to attribute technical comments and findings to the persons who made them.[1]

As mentioned earlier, the appendices to this report include a list of the peer reviewers (Appendix A), the charge to the reviewers (Appendix B), the premeeting comments organized by author (Appendix C), a list of the observers who confirmed their attendance at the meeting registration desk (Appendix D), the meeting agenda (Appendix E), summaries of the observers' comments (Appendix F), and minutes from the January briefing meeting for the reviewers (Appendix G).

[1] The initials of the reviewers are: RB (Dr. Reinhard Bierl), PL (Dr. Per Larsson), KM (Dr. Keith Maruya), RM (Dr. Ron Mitchum), KR (Dr. Ken Reimer), and BR (Dr. J. Bruno Risatti).

2.0 RESPONSES TO SPECIFIC QUESTIONS REGARDING THE DEIR

The peer reviewers opened their discussions by addressing the seven questions in the charge that related to the DEIR. In answering these questions, each reviewer presented his initial thoughts and comments, which the reviewers as a group then further discussed. At the end of the discussion on a given question, the chair summarized the common themes expressed by the reviewers and indicated areas where reviewers had differing opinions. A general record of the peer reviewers' discussions on the DEIR, organized by question, follows. The reviewers' final conclusions and recommendations for the DEIR are presented in Section 5.0.

Note: Throughout this section, the initials of the reviewers are used to attribute comments to the individuals who made them: RB=Dr. Reinhard Bierl, PL=Dr. Per Larsson, KM=Dr. Keith Maruya, RM=Dr. Ron Mitchum, KR=Dr. Ken Reimer, and BR=Dr. J. Bruno Risatti.

2.1 Responses to Question 1

The first question in the charge relating to the DEIR asked the reviewers: "Is the documented PCB load, which originated from the TI Pool [the Thompson Island Pool], consistent with a source consisting of historically deposited PCB-contaminated sediments?" The reviewers made the following comments and observations when responding to this question:

- *The Thompson Island Pool (TIP) sediments act as a source of PCBs.* The six reviewers unanimously agreed the data reported in the DEIR indicate sediments in the TIP act as a source of PCBs to the water column in the Hudson River, but the reviewers made several caveats in reaching this conclusion. Two reviewers, for example, noted that some of the water column transect data presented in the DEIR provide evidence of other PCB sources, particularly upstream sources, in addition to sediments of the TIP (RM,KM). Two reviewers emphasized, however, that changes in PCB loads and congener profiles during the summer low-flow conditions quite clearly indicated that the TIP sediments act as a source of PCBs (KM,KR). To put this finding into perspective, one reviewer commented that sediments downstream of the Thompson Island Dam (TID) likely also act as a source of PCBs, though he still agreed that sediments in the TIP are a source as well (KM).

- *Questions regarding whether "historically deposited" sediments act as a source.* Though the reviewers agreed that the TIP sediments acted as a source of PCBs, several reviewers did not think the water column transect data were sufficient for determining the

extent to which recently deposited sediments and sediments buried at depth contributed to the PCB loading (KM,KR,PL). One reviewer noted that this distinction was particularly difficult to resolve because the terminology is vague (i.e., exactly what should be considered as "historically deposited" sediments?) and because he did not think the PCB congener profiles differed enough with depth to determine conclusively which sediment layers act as the predominant sources (KM). One reviewer modified his earlier findings by noting that the TIP sediments clearly act as a source of PCBs, despite the uncertainties as to when these PCBs were originally deposited (PL). In short, one reviewer thought, and others agreed, conclusions on exactly what layers of sediments contributed to the PCB loading were speculative (RM).

The reviewers revisited this finding towards the end of the meeting, but they did not modify their original finding: the TIP sediments act as a source of PCBs, but the relative contributions of recently deposited and historically deposited sediments is not known.

C *Questions regarding the mechanisms by which PCBs enter the water column.* Two reviewers indicated that many physical, chemical, and biological mechanisms (e.g., resuspension, partitioning, bioturbation) might contribute to the source of PCBs (RB,PL). One reviewer indicated that laboratory studies, rather than strict data collection and analysis, are ultimately needed to understand these mechanisms in the Hudson River; he also noted that the peer reviewers were not asked to determine the extent to which different mechanisms affect PCB transport in the Upper Hudson River (PL). After brief discussions, the reviewers agreed that the data collected for the DEIR did not determine exactly how PCBs move from the sediments to the water column, but this shortcoming did not modify their primary conclusion: regardless of what mechanisms are most important, the sediments in the TIP act as a source of PCBs to the water column.

C *Discussions of upstream sources of PCBs.* Two reviewers discussed at length the extent to which releases of PCBs as dense, nonaqueous phase liquids (DNAPL) from GE's upstream facilities might act as a source in the Upper Hudson River (RM,BR). These reviewers indicated that locating and quantifying releases from DNAPL upstream sources would be extremely difficult. All six reviewers considered whether partitioning of PCBs in the form of oil droplets might explain trends in the water column transect data, and one reviewer indicated that the congener profiles of the PCBs, particularly the presence of relatively large amounts of mono- and di- substituted PCBs, were inconsistent with an oil droplet source of PCBs in the TIP (KM). After a lengthy discussion on upstream sources, the reviewers agreed that DNAPL sources of PCBs at upstream locations, if any, do not change their general response to the original question (i.e., that the sediments in the TIP act as a source of PCBs to the water column).

C *Recommendations that this conclusion be verified by analyzing additional monitoring data.* Noting that the conclusions in the DEIR are based primarily on 1 year of water column transect data, one reviewer thought the role of TIP sediments should be further

investigated by analyzing water column monitoring data from more recent years (KM). The reviewer thought this verification was particularly important for evaluating river conditions during the winter months, because the DEIR data that was collected during the winter was confounded by an upstream release (the Allan Mill event) (KM). Two reviewers thought GE might have more recent water column data available for verifying this conclusion (KM,KR).

- *An improved statistical approach would have strengthened this conclusion.* Several reviewers found the statistical analyses in the DEIR difficult to follow and overly simplistic. One reviewer felt strongly that the DEIR should have included a clear framework that outlined the statistical analyses in the report (PL). This reviewer clarified that he thought the statistical tests used in the report were properly applied, but he found the analyses difficult to follow since a clear framework was not presented.

  Commenting further on the statistical approach, several reviewers thought the DEIR relied too heavily on qualitative comparisons (e.g., similarity between diagrams of congener profiles) in reaching its conclusions. These reviewers thought conclusions would have been more convincing had they been better supported with quantitative, multivariate statistical tests (RB,RM,KR). One reviewer was largely unconvinced by simple plots showing that certain parameters might have "increased" or "decreased," without any comments on whether changes were statistically significant (KR). Another reviewer thought EPA's contractors should have adopted statistical approaches to identify outliers among the sampling data (RM).

- *Other comments regarding the treatment of analytical data.* When commenting on the role of TIP sediments, several reviewers offered general comments on the presentation of data in the DEIR. One reviewer noted that the DEIR included very little information, quantitative or qualitative, on analytical variability of the PCB measurements (KR). This reviewer indicated that EPA should have more prominently acknowledged in the DEIR the analytical variability of the water column transect data and sediment coring data. Noting that the analytical laboratory had quality assurance criteria that automatically excluded from consideration any samples that did not meet certain precision criteria, one reviewer thought the report should have clearly stated these criteria and the number of samples that were excluded as a result (RM).

- *Comments on data quality.* Since the quality of the water column transect and sediment coring data were relevant to every question in the charge, the reviewers decided to state their general findings on data quality when responding to Question 1. Two reviewers commented that the quality of the monitoring data, as a whole, appeared to be acceptable (KM,RM). Another reviewer agreed with this general statement, but he again suggested that the DEIR should have clearly documented measurement precision for each PCB congener (KR).

2.2 Responses to Question 2

The second question asked the reviewers: "Are the two-phase and three-phase partitioning coefficients, derived in the DEIR, appropriate and do they properly address the physical parameters of the system (e.g., temperature)?" The reviewers made the following comments and observations in response:

- *Comments on the two-phase partition coefficients.* The reviewers unanimously agreed that the derivation and calculation of two-phase partition coefficients, including their corrections for temperature, were scientifically sound. As a qualitative check on the calculated values, one reviewer noted that the calculated two-phase partition coefficients generally increased with reported values of octanol-water partition coefficients, as is to be expected (KM). Another reviewer indicated that estimated partition coefficients for many congeners had widely variable values (RB), but a reviewer indicated that such variability is typical for deriving PCB partition coefficients from field measurements (KM).

- *Comments on the three-phase partition coefficients.* Several reviewers thought the water column transect data were insufficient for calculating reliable three-phase partition coefficients (RB,KM,RM). As evidence of this finding, one reviewer mentioned that three-phase partition coefficients for some congeners appeared to have unrealistic values, when compared to the coefficients for other congeners (KM). This reviewer thought the three-phase partition coefficients might include errors of an order of magnitude or greater and should not have been reported to two decimal places, as was done in the DEIR. The reviewers did not take exception with how mathematical expressions for the three-phase partition coefficients were derived (RM), but they thought additional data that characterize concentrations of dissolved organic carbon (DOC), including colloids, in the water column are needed for more accurate estimates of the three-phase partition coefficients (RB).

- *Use of partition coefficients in future modeling studies.* Two reviewers thought the partition coefficients should be used to develop empirical models of PCB transport mechanisms (RB,PL). These reviewers indicated that such modeling could quantify how temperature and other relevant parameters affect partitioning of PCBs in the Hudson River, which, in turn, would be useful for understanding underlying mechanisms of PCB transport (RB,PL).

- *Consideration of nonequilibrium partitioning and other "compartments" for equilibrium.* Noting that sorption and desorption kinetics affect partitioning of PCBs in the water column, one reviewer suggested that nonequilibrium effects might need to be

considered in future modeling exercises (RB); other reviewers did not comment further on this topic.

Regarding other "compartments" to consider for partitioning, one reviewer noted several times that volatilization and photolysis of PCBs should have been addressed in the reports (RM). Other reviewers, however, were not convinced of the need to address these compartments in the analysis of equilibrium partitioning: one reviewer explained that photolysis is a nonequilibrium process (KR) and another reviewer acknowledged that EPA should eventually address volatilization in its reassessment, but not necessarily in these partitioning models (PL).

2.3 Responses to Question 3

The reviewers discussed at length the third question on the DEIR: "Are the conceptual models based on the transect sampling consistent with the data?" A summary of these discussions follows:

- *General agreement that the conceptual models were supported by the data and illustrated important aspects of PCB transport in the Hudson River.* Though the reviewers expressed several concerns about the conceptual models used to interpret the water column transect sampling data (these concerns are summarized below), they agreed that the models were generally consistent with the data and provided useful insight into PCB transport in the Hudson River. One reviewer felt, and other reviewers agreed, that the conceptual models presented in the Responsiveness Summary offered a much more defensible account of the water column transect data than did the models presented in the DEIR (KR).

  Some reviewers identified what they considered to be particularly useful findings of the conceptual models. Two reviewers, for example, indicated that the conceptual models helped depict seasonal changes in PCB levels in the water column (KM,BR). They noted that the models clearly illustrated how PCBs in the water column, particularly those bound to suspended solids, increased during high-flow events and how levels of lower molecular weight PCBs tended to decrease with downstream distance during the warmer summer months, whether by volatilization, photolysis, or degradation. Another reviewer indicated that the models were useful for illustrating congener-specific trends (BR).

- *Models should have been supported by more sophisticated statistical analyses.* Almost every reviewer indicated that a more rigorous statistical analysis would have provided more compelling evidence of the models' findings than did the simple visual comparisons of congener profiles in the DEIR. One reviewer noted that he had conducted a principal component analysis (PCA) on a subset of the water column transect data to verify the

conclusions drawn in the conceptual models (KR). This reviewer thought PCA or similar multivariate statistical analyses should have been conducted to quantify notable, but possibly subtle, trends among the large volume of monitoring data. Several reviewers agreed and indicated that multivariate statistics would have particular utility in interpreting the large volume of congener-specific data (RM,BR,KR).

- *Concern about corrections made to the river flow data.* Several reviewers thought the conceptual models were consistent with the data, but were concerned about corrections that were made to the river flow data originally presented in the DEIR (RB,RM,BR). More specifically, river flow data for some stations presented in the Responsiveness Summaries were roughly 40 percent higher than the corresponding data presented in the DEIR. One reviewer found it difficult to verify whether this correction was made correctly and noted that the magnitude of the flow correction has a notable impact on the calculated PCB loads to the water column (RB). Another reviewer, however, explained that the magnitude of the flow correction has no bearing on the relative changes in PCB concentrations from one sampling station to the next (KM). This reviewer thought the conceptual models of the water column transect data provided insight into PCB transport, regardless of whether the flow corrections were correctly or incorrectly applied.

- *Consideration of parameters other than PCB concentrations in the conceptual models.* Several reviewers thought applying the conceptual models to pollutants other than PCBs might lead to a greater understanding of fate and transport of chemicals in the Upper Hudson River. For instance, one reviewer thought the models should be applied to measured levels of metals and chlorophyll, if such data are available (RB). In support of this recommendation, another reviewer noted that the U.S. Geological Survey has used metals and other contaminants to gain greater insight into physical processes in other rivers (BR). Another reviewer indicated that examining levels of chlorophyll might be worthwhile because in-situ production might be an important factor to consider in the relatively quiescent TIP (KM). Though these three reviewers recommended evaluating data trends and patterns for other parameters as part of the ongoing reassessment efforts on the Hudson River, none of these reviewers listed this recommendation among their major findings for the peer review meeting.

- *Miscellaneous comments.* When discussing the conceptual models, the reviewers made several comments that do not fall under the categories listed above. One reviewer, for example, noted that the database of sampling results was extremely difficult, and almost impossible, to use (KR). Further, some reviewers thought the conceptual models should have more prominently acknowledged the analytical variability of the laboratory measurements (KR) and the difficulties associated with quantifying congeners of lower PCB homologues in environmental samples (BR). Another reviewer thought the term “model” applies more to a mathematical construct that has predictive capabilities, and that the “conceptual models” in the DEIR were more simply “conceptual reasoning” (PL).

2.4 Responses to Question 4

The fourth question in the charge asked the reviewers: "Does the sampling at the TI Dam-West location impact EPA's conclusion that the sediments of the TI Pool are the major source of PCBs to the freshwater Hudson during low flow conditions considering the analytical corrections made to GE's PCB data? What are the other implications of finding higher concentrations along the shoreline than in the center channel?" The reviewers discussed these two questions at length and offered several general responses:

- *Cancellation of sampling and analytical biases.* The reviewers understood that corrections made for a sampling bias altered the quantitative findings of the DEIR, but they did not think these corrections affected the general conclusion that the TIP sediments are a primary source of PCBs to the Hudson River (RB,PL,RM,KR). More specifically, a reviewer noted that the corrections made for the sampling bias were almost entirely offset by other corrections made to laboratory analytical data (KM). Assuming both corrections were made correctly, this reviewer thought the sampling bias had little impact on the DEIR's findings. Two reviewers commented that the algorithm, or "box model," EPA used to derive the corrections appeared to be valid (PL,KM).

- *Comments on the clarity of the question.* Several reviewers thought the first part of Question 4 did not clearly indicate which water column sampling data was corrected and how this correction was made (KM,BR,KR). At the reviewers' request, EPA's contractors identified the three sampling locations in the vicinity of the TID—GE's "west wing wall" location, GE's "center channel" location, and EPA's location about ¼ mile upstream from the dam—and explained the sampling bias and the corresponding data corrections. An observer offered to present additional data to clarify this issue, but the meeting facilitator noted that presenting such information would be more appropriate during the observer comments.

- *Other comments regarding potential sampling biases.* One reviewer thought the use of a different sampling technology, such as one that pumps water from different depths of the river, might have provided a more accurate account of concentrations of PCBs in the water column (PL). Nonetheless, this reviewer believed EPA's corrections for the sampling bias were appropriate.

- *Implications of PCB concentrations in near-shore areas being higher than those in the center channel.* The reviewers raised and discussed several implications of the spatial variations of PCB concentrations: they agreed that the greatest implications pertain to calculating PCB load to the water column and estimating the inventory of PCBs in the sediments. Regarding PCB loads, one reviewer explained, and the others agreed, that load

estimates would be biased if water column samples were collected in a channel with artificially high or low PCB concentrations (KM). More specifically, they thought uncorrected sampling results from a near-shore "hot spot" location might lead to a different estimate of PCB loads than sampling results from the center channel. Regarding PCB inventories, two reviewers indicated that the inventory might be understated if relatively high concentrations of PCBs in near-shore sediments have not been adequately characterized (KM,RM). The reviewers agreed to revisit the issue of PCB inventories during their discussions on the LRC, summarized in Section 3 of this report.

The reviewers briefly discussed several other implications of the spatial variations in PCB concentrations. These implications include, but are not limited to, a hypothesis that PCB loads to the water column might actually be lower than expected if near-shore contaminated sediments are not submerged during seasonal low-flow conditions (KM) and an observation that local river flow patterns, which affect sediment deposition and resuspension, also change considerably from the center channel to the shoreline (BR).

After answering the specific questions in the charge, the reviewers revisited their response to this question later in the meeting. One reviewer expanded on his earlier discussions about the implication of higher PCB concentrations in near-shore sediments: he noted that an undersampling of near-shore sediments might have biased the geostatistical analysis of the 1994 PCB inventory to lower levels (KM). He explained that, in cases where near-shore cores were not collected, the kriging and polygonal declustering analyses would use PCB concentrations measured in deeper sections of the river to estimate PCB concentrations in near-shore sediments. Other reviewers did not comment on this observation and indicated that their earlier summary statements were sufficient.

2.5 Responses to Question 5

The reviewers answered the fifth question: "Are the geostatistical techniques (polygonal declustering and kriging) correctly applied?" as follows:

- *General agreement that the geostatistical techniques were correctly applied.* The reviewers agreed that the findings from the geostatistical analyses gave a reasonable approximation of the PCB inventory and that EPA's contractors appeared to have applied the techniques correctly. Since most of the reviewers did not have extensive experience using these geostatistical techniques, however, they did not comment in detail on this topic.

- *Concerns about the selected geostatistical techniques.* Though he agreed that EPA's contractors had applied kriging and polygonal declustering analyses correctly, one reviewer thought the spatial heterogeneity of PCBs in the sediments necessitated the use of more sophisticated analyses of the PCB inventory (RB). This reviewer recommended nonlinear statistical techniques for this purpose, but he did not specify a particular test or method that

would be best suited for such analyses.[2] He also recommended gathering more data to characterize the spatial variations in PCB concentrations more thoroughly, but another reviewer commented that the results of EPA's side-scan sonar study already offered insight into the spatial heterogeneity of the river sediments (PL).

- *Concerns about presenting inventory estimates without addressing uncertainty.* Though the reviewers thought the geostatistical analyses were valid, one reviewer noted, and several reviewers agreed, that EPA's reports did not acknowledge the uncertainty associated with estimating PCB inventories from a finite number of sediment cores (KR). Given the uncertainty in making this estimate, this reviewer recommended the reports acknowledge that the calculated PCB inventory is only an estimate of the actual inventory. He also suggested that EPA consider presenting a range of inventory estimates, rather than presenting a single value.

2.6 Responses to Question 6

The sixth question on the charge asked the reviewers: "Are the methods applied in the DEIR (change in molecular weight (MW) and evaluating concentrations of BZ#s 1, 4, 8, 10 and 19 (MDPR)) appropriate standards for determining extent of dechlorination? Are there any significant problems with this approach, or more appropriate approaches?" The reviewers discussed these two questions at length and offered several general responses:

- *Agreement that the MDPR is an approximate measure of the extent of anaerobic dechlorination.* The reviewers agreed the MDPR provides a useful characterization of dechlorination, though they identified several potential shortcomings with the MDPR. These shortcomings relate to the fact that the MDPR is calculated from concentrations of several PCB congeners from the lower homologues. Noting that the lower homologues are the most difficult to measure, one reviewer thought the MDPR might be biased by the analytical method (BR). Furthermore, because lower homologue PCBs are more likely to be removed from sediments than higher homologue PCBs (whether by pore water diffusion, aerobic degradation, or some other mechanism), several reviewers indicated that the sediment coring data do not characterize the amounts of dechlorination products that have actually been formed (KM,BR,KR). The reviewers noted that the DEIR did acknowledge these potential shortcomings of the MDPR.

---

[2] When reviewing the draft peer review report, this reviewer indicated that EPA could have used "disjunctive kriging" or "kriging in terms of projections." The reviewer indicated that these more complex approaches may help gain accuracy in non-linear estimators. The reviewer recommended that EPA consult the following software library: "Glayton V. Deutsch and Andre G. Journel: GSLIB: Geostatistical Software Library and User's Guide. Oxford University Press, 1997.

The reviewers also discussed the implications of the MDPR being calculated from concentrations of both "near final" and "terminal" dechlorination products. The reviewers thought this calculation was defensible, provided that ortho dechlorination of PCBs in the Hudson River does not occur (as is stated in the DEIR). During this discussion, two reviewers indicated that their own research has observed ortho dechlorination in sediments (BR,KR); however, another reviewer noted that several research projects on Hudson River sediments have not provided much evidence of ortho dechlorination (KM). The reviewers did not comment further on this topic.

- *Alternative measures for quantifying the extent of dechlorination.* The reviewers identified alternative measures for characterizing dechlorination in the Hudson River sediments, but they were not certain whether these alternative measures would provide any greater insight into the issue. One reviewer suggested that EPA could have examined "parent-daughter" dechlorination pairs to characterize overall levels of dechlorination, but this reviewer noted that this approach would suffer from some of the same shortcomings as the MDPR (KM). Another reviewer suggested that EPA quantify dechlorination strictly from data trends for heavier PCB congeners, which are not as difficult to measure and are not as likely to partition to the water column (BR). When discussing these alternatives, a reviewer asked whether EPA's contractors had considered variations of the MDPR to estimate the extent of dechlorination. As a point of clarification, EPA's contractor indicated that the Responsiveness Summary for the LRC contains such an analysis.

- *Other comments on estimating the extent of dechlorination.* Two reviewers offered other insights when discussing the appropriateness of the MDPR. One reviewer did not think the DEIR acknowledged the uncertainty associated with estimating the extent of dechlorination: he thought presenting point estimates of dechlorination ratios without including error bounds or appropriate caveats did not reflect the associated uncertainties (KR). Another reviewer emphasized that dechlorination has no bearing on the total mass of PCBs in the river sediments, since dechlorination merely transforms PCBs and does not remove them entirely from the system (PL). This reviewer thought the transformation of PCBs was notable since dechlorination products are generally more mobile than the higher-chlorinated PCBs (PL).

2.7 Responses to Question 7

The reviewers discussed at length the final question in the charge related to the DEIR, which asked: "The DEIR finds that the degree of anaerobic dechlorination is primarily a function of original concentration rather than time, and accordingly that there is not significant predictable dechlorination in sediments containing less than approximately 30 mg/kg PCB. Is this reasonable?" The reviewers addressed the following topics when answering this question:

- *Comments on the wording of the question.* Two reviewers commented that this question in the charge was open to several interpretations. One reviewer, for instance, explained that he addressed simply whether dechlorination could occur at PCB concentrations below 30 mg/kg (30 parts per million [ppm]) while other reviewers might have answered a different question: whether *predictable* dechlorination occurs at these levels (KM). Another reviewer noted that people might have differing opinions on what constitutes *significant* predictable dechlorination (KR). Despite the ambiguities in the question, the reviewers focused their discussions on whether thresholds for anaerobic dechlorination, in a general sense, are scientifically plausible and whether the 30 ppm threshold reported for the Hudson River is supported by the available data. The following bullets summarize these, and other, discussions relevant to Question 7.

- *Discussion on whether concentration thresholds for dechlorination are plausible.* The reviewers talked at length about whether concentration thresholds for dechlorination are consistent with fundamental physical and biological mechanisms. One reviewer noted that he has observed concentration thresholds for dechlorination and other biological phenomena in his own research (BR), but another reviewer indicated that other studies have observed dechlorination occurring at levels considerably lower than 30 ppm (KR). Two reviewers were not surprised by this discrepancy, noting that conditions that affect biological activity in river sediments are different from those in controlled laboratory conditions (BR) and real-life river conditions often vary notably from river to river (PL). Several reviewers confirmed these comments by identifying the many parameters affecting biological processes (e.g., temperature, nutrients, inhibitors, organic carbon) that might have unique levels in the Upper Hudson River.

  The reviewers then identified fundamental biological and physical processes that might explain thresholds. One reviewer commented that, under certain conditions (e.g., severely limited diffusion or unavailable nutrients), dechlorination kinetics can conceivably become imperceptibly slow, so as to give the appearance of a concentration threshold for dechlorination (KM). Another reviewer agreed, but had difficulty believing the findings in the DEIR because the report failed to offer a mechanistic explanation for the apparent concentration threshold (PL). The remainder of the reviewers' discussion on thresholds focused specifically on the likelihood that they apply for dechlorination in the Upper Hudson River.

- *Discussion on whether the DEIR and LRC data support a concentration threshold for dechlorination.* The reviewers unanimously agreed that the sediment coring data from the DEIR and the LRC do not support the reported 30 ppm threshold for dechlorination, and one reviewer went further in stating that the data do not support a threshold occurring at *any* concentration (RM). The reviewers gave several reasons for rejecting this finding. Noting that a large subset of the sediment cores were not considered in the dechlorination calculations, for example, one reviewer wondered whether this selective use of data might have masked more general trends (KM). Another reviewer did not think enough samples

with PCB concentrations lower than 30 ppm were available to reach a firm conclusion that dechlorination does not occur below this threshold (KR).

Other reviewers offered different perspectives on this topic: one reviewer thought EPA's sediment coring data supported a predictive empirical relationship between the extent of dechlorination and PCB concentrations greater than 30 ppm; however, he did not think this data implied that dechlorination ceases at lower concentrations (PL). Agreeing with this sentiment, another reviewer emphasized that no conclusion should be drawn about dechlorination in sediments with PCB concentrations below 30 ppm (KR). Finally, one other reviewer highlighted some exceptions to the basic trend reported in the DEIR, for example, a small subset of sediment cores with relatively high PCB concentrations had very little evidence of dechlorination (BR). Later in the meeting, this same reviewer listed three sediment cores with PCB concentrations lower than 30 ppm that showed evidence of dechlorination. After thoroughly reviewing these arguments, the reviewers all agreed the data provided in the DEIR and LRC do not support the 30 ppm dechlorination threshold. Based on this finding, one reviewer thought a summary statement in the DEIR ("PCBs in sediments with less than 30 ppm are largely left unaffected by the dechlorination process") should be qualified (KR).

- *Agreement that dechlorination is predictable at "higher" PCB concentrations.* After answering the specific questions in the charge, the reviewers revisited Question 7 to further debate whether the extent of dechlorination is predictable. Several reviewers commented that the figures in the DEIR clearly demonstrate a relationship between the extent of dechlorination and PCB concentration, at least among the sediment cores with relatively high PCB levels (PL,BR,KR). The reviewers did not specify the lowest PCB concentration at which the extent of dechlorination appears to be predictable, but one reviewer did not think predictable dechlorination occurred at levels near 30 ppm (KR). Based on these discussions, the reviewers unanimously agreed with the summary statement: "There is predictability of dechlorination at higher PCB concentrations, but this should not be taken as evidence of lack of dechlorination at lower concentrations."

- *Comments on whether dechlorination might be a function of time (i.e., age of sediments).* The reviewers briefly discussed the possibility that the extent of PCB dechlorination varies as a function of time. They indicated that available data provide conflicting answers to this question: some studies by other researchers have reported considerable dechlorination in freshly deposited sediments (KM), yet many of the Hudson River cores showed little evidence of dechlorination in some of the older sediments (BR). Focusing on the Hudson River sediments, another reviewer commented that the coring data clearly show that the extent of dechlorination is more dependent on PCB concentration than it is on time (KR). This reviewer cautioned, however, that the greater dependence on PCB concentration does not imply that dechlorination is totally independent of time, as he documented in his premeeting comments. The reviewers did not discuss this topic further.

- *Comments on the presentation of data.* One reviewer thought presenting dechlorination data on a logarithmic scale, as was done in the DEIR, was inconsistent with the mathematical derivation of the MDPR (RM). This reviewer asked EPA's contractors to clarify several issues related to the presentation of the data, after which he still concluded there was no scientific basis for using logarithmic scales to depict the dechlorination results. He thought EPA's contractors chose to use logarithmic scales simply to fit the data to a trend.

3.0 RESPONSES TO SPECIFIC QUESTIONS REGARDING THE LRC

The peer reviewers continued their discussions by addressing the seven questions in the charge that related to the LRC. The scientific chair followed the same format as used in the previous discussion about the DEIR in facilitating these discussions: individual reviewers were asked to present initial thoughts on the questions; the reviewers as a group then further discussed and debated these initial comments; and finally the chair summarized the common themes expressed by the reviewers and indicated areas where reviewers had differing opinions. A general record of the peer reviewers' discussions on the LRC, organized by question, follows. The reviewers' final conclusions and recommendations for the LRC are presented in Section 5.0.

Note: Throughout this section, the initials of the reviewers are used to attribute comments to the individuals who made them: RB=Dr. Reinhard Bierl, PL=Dr. Per Larsson, KM=Dr. Keith Maruya, RM=Dr. Ron Mitchum, KR=Dr. Ken Reimer, and BR=Dr. J. Bruno Risatti.

3.1 Responses to Question 1

As the charge in Appendix B shows, the first question specific to the LRC asked: "In the LRC, EPA compared sediment data from cores taken in 1977, 1984 and 1994, which had the PCB analysis conducted by different laboratory methods. How valid are the methods used to establish a consistent basis for comparison?" The reviewers' comments and main findings on this topic follow:

- *Comments on comparing cores collected in 1984 to those collected in 1994.* The reviewers unanimously agreed that EPA's contractors used a reasonable method to compare sediment coring results between 1984 and 1994. Several reviewers thought no other defensible methods could have been used, given the difficulties laboratories had measuring levels of mono- and di-substituted PCBs (PL,KM,BR). Individual reviewers made several other observations regarding the data comparisons. For instance, one reviewer felt confident in the data comparison, partly because the majority of PCB releases to the Hudson River were reportedly Aroclor 1242, which likely produced consistent peaks among the chromatograms; he said he would have been less confident in comparisons involving complex mixtures of Aroclors (KM). Two reviewers thought the comparison between the 1984 and 1994 data had greater uncertainty than the LRC acknowledged. As a result, they thought the comparison should have been presented as

an approximation of a trend, rather than as a concrete estimate (RM,KM). Finally, one reviewer added, and several other reviewers agreed, that the data comparison would be better supported by a detailed review of the 1984 sampling effort (e.g., analyzing archived samples and extracts, inspecting chromatograms) (RB).

- *Comments on comparing cores collected in 1977 to those collected in 1994.* The reviewers had no confidence in quantitative comparisons between the 1977 and 1994 sediment coring data sets. Moreover, two reviewers thought the LRC did not describe the 1977 sampling effort in detail nor did it propose a method for comparing the 1977 and 1994 data (KM,KR). Based on the lack of confidence in the quality of the 1977 data, one reviewer concluded that any comparison between the 1977 and 1994 data sets would be speculative (KM). Two reviewers indicated they would be more confident in the 1977 data set if samples could be reanalyzed and chromatograms examined (RB,KM).

- *Discussion on the quality of the 1977 and 1984 data.* While reviewing the methods used to compare the data sets, the reviewers expressed several concerns about data quality for the previous coring studies. The main concern was that very little information was provided on the extraction procedures, precision estimates, use of internal standards, and other quality assurance measures that were used in the 1977 and 1984 sampling and analytical programs (RB,PL,RM). On the other hand, some reviewers offered reasons to believe the data quality from the past sampling efforts, particularly from 1984, was acceptable. Based on his experience with EPA's oversight of laboratory quality assurance in the 1980s, for example, one reviewer was satisfied that the 1984 data were likely of a reasonable quality, though he was less confident in the quality of the 1977 data (RM). Agreeing with this sentiment, another reviewer noted that he did not think analytical variability for PCB measurements had changed dramatically between 1984 and 1994 (PL). As noted above, several reviewers suggested that the best way to gain greater confidence in the past data is by carefully reviewing chromatograms and reanalyzing archived samples or extracts, if such information is available.

3.2 Responses to Question 2

The reviewers discussed at length the second question in the charge on the LRC, which asked: "In the Upper Hudson River system, it has been well established that there is significant lateral heterogeneity in sediment concentrations. While it was attempted to reoccupy previous locations, some uncertainty is added with respect to the actual sampling location. While the statistical techniques help compensate for this, how does the sediment heterogeneity affect the comparison of cores from two different years? Given the spatial variability, is the finding that

there is loss from most of the locations supported by the data?" The reviewers addressed the following topics when answering this question:

- *Evaluation of the techniques used to compare sediment concentrations from two different years.* The reviewers agreed the combined "point-to-point" and "area-to-area" comparison was a reasonable approach for examining changes in PCB mass loading between two different years, but they had several comments on how these approaches were applied. First, given the heterogeneity of the sediments, several reviewers indicated that the "area-to-area" comparisons presented in the Responsiveness Summary are much more defensible than the "point-to-point" comparisons originally reported in the LRC (KM,BR). Second, several reviewers emphasized that statistical techniques alone cannot compensate for heterogeneous sediments, as implied by the question in the charge; these reviewers explained that only larger sample sizes can effectively reduce uncertainty in the sediment core comparisons (PL,KM,BR). Third, two reviewers noted that EPA used acoustical techniques to characterize sediment properties and heterogeneity in areas where cores had not been collected—an issue that was discussed in greater detail later in the meeting (see Section 3.7 of this report) (PL,KM). Finally, one reviewer thought the LRC should have included more information on the factors that contribute to the spatial heterogeneity of PCB concentrations (e.g., is the heterogeneity caused by historical deposition areas, differing sediment characteristics, or other factors?) (RB).

- *Comments on the reported loss of PCBs from sediments in most sampling locations.* The reviewers agreed the sediment coring data indicate a general trend of PCB loss from sediments in most locations. Several reviewers added, however, that estimated amounts of PCB loss should be interpreted with caution due to the uncertainty inherent in comparing sediment cores collected in different years (RB,PL,KM). Another reviewer noted that the analytical variability in the measurements alone complicates efforts to quantify PCB losses (RM). The reviewers discussed the implication of uncertainty further when answering Question 3, as summarized in the next section.

3.3 Responses to Question 3

The reviewers continued their discussion on the estimates of PCB loss from river sediments when answering the third question in the charge: "What is the impact of the difference between replicate samples in the 1994 sampling effort (36 percent average variability) on the finding that there was a 40 percent loss of PCB inventory from the highly contaminated sediments in the TI Pool?" The reviewers' responses to this question focused on the following issues:

- *Recommendations for acknowledging the uncertainty in the reported PCB loss.* The reviewers unanimously recommended that EPA's reports not present discrete estimates of the PCB inventory loss without caveats about the uncertainty associated with the calculation. More specifically, one reviewer suggested that point estimates of PCB loss could be bracketed by estimates of uncertainty (KM), while other reviewers thought the loss estimate should simply be reported as a range of values without a point estimate (RB). The reviewers noted that the estimate of 40 percent loss of PCBs has considerable uncertainty, but they added that the sediment coring data do support a loss of PCBs from most areas of the TIP (see response to Question 3, above).

- *Comments on how the analytical variability affects the PCB loss estimates.* To focus their discussions on analytical variability, the reviewers asked EPA's contractors to clarify how they calculated relative percent difference (RPD) and whether the RPD accounts for sampling variability. The contractors responded that they calculated RPDs from "true splits," which, in theory, strictly characterize analytical variability. Some reviewers were surprised that the average analytical variability was as high as 36 percent (RM,BR,KR): one reviewer noted that his laboratory routinely generates data with better precision (KR). Other reviewers found it difficult to comment on analytical variability, because little information was provided on the RPDs for the 1984 data set (KM,RM).

  Despite these concerns about data variability, the reviewers agreed that the sediment cores provide a basis for evaluating changes in PCB inventory from 1984 to 1994. As noted above, however, the reviewers emphasized that quantitative comparisons are highly uncertain. Citing a figure in the LRC that presented congener-specific RPDs, one reviewer noted that the analytical variability among the 1994 data seemed to be random and not systematic (KM). This reviewer felt more comfortable with the PCB inventory comparisons due to the apparent absence of a systematic bias in the analytical data, but he emphasized that the reports should more prominently acknowledge the uncertainty associated with the estimated inventory loss.

3.4 Responses to Question 4

The reviewers then discussed the fourth question in the charge: "In the LRC, it was found that Hot Spot 28 contained much more mass than previous estimates. Is the conclusion that this 'gain' is primarily due to incomplete characterization in 1977 valid?" A summary of their responses follows:

- *Agreement that the apparent gain in PCB mass for Hot Spot 28 was not a valid finding.* The reviewers unanimously agreed that the apparent increase in PCB mass for Hot Spot 28 did not represent a true gain in mass, but merely resulted from the 1977 coring study failing to characterize Hot Spot 28 completely. One reviewer offered two reasons for

questioning the validity of the 1977 mass loading estimates (KM). First, noting that the 1977 study did not sample an area of Hot Spot 28 that the 1994 study found to have relatively high PCB concentrations, this reviewer indicated that the 1977 study might have underestimated the spatial extent, and hence the mass loading, of the hot spot. Second, the reviewer explained that the cores used in the 1977 study were not long enough to characterize the depth of the hot spot—a shortcoming that also caused an underestimation of the mass loading. For these and other reasons, the reviewers concluded that the quality of the 1977 data was unknown, but they thought the 1994 characterization of Hot Spot 28 seemed adequate.

- *Lack of other logical explanations for the apparent gain in PCBs.* Several reviewers could not envision any other logical reason (except for the incomplete characterization during the 1977 study) that could adequately explain the considerable increase in PCB mass in just one hot spot, while the PCB mass in other hot spots apparently decreased (RB,KM,RM).

3.5 Responses to Question 5

Continuing their discussion on losses in PCB inventory, the reviewers answered the fifth question in the charge, which asked: "Does the data set and its interpretation support the conclusion that significant losses have occurred from hot spots below TI Dam?" The reviewers addressed the following issues in their response:

- *Comments on the wording of the question.* Two reviewers thought this question was open to several interpretations, due to ambiguity in the term, "significant losses" (PL,KR). For instance, one reviewer indicated that he could answer whether a loss of PCBs is *significant* from the perspective of downstream ecosystems, from the perspective of total inventory, or from the perspective of statistics (PL). This reviewer explained further that a 1 percent loss of PCBs from the sediments might be *significant* in terms of the implication on downstream ecosystems, but such a loss might not be *significant* when compared to the total PCB inventory in the sediments. Given these concerns, the reviewers decided to answer a more direct question: "Does the data set support the conclusion that losses have occurred from hot spots below the TID?" Responses to this question, which omits the word *significant*, are summarized below.

- *Agreement that PCB losses seem reasonable, but the amounts are difficult to quantify.* The reviewers unanimously agreed that the data presented in the LRC support the conclusion that sediments downstream from the TID have lost PCBs, but they thought estimates of the actual mass loss would be difficult, if not impossible, to quantify. The reviewers thought PCB losses seemed reasonable based on data reported in the LRC:

noting that approximately 50 percent of the PCB inventory in the downstream hot spots appeared to lie within the top 9 inches of sediments, one reviewer thought it was conceivable that losses could have occurred (KM). Another reviewer agreed, stating that PCBs in the top 9 inches of sediment are probably available for transport to the water column in some manner, though the exact mechanism might not be known (KR). Yet another reviewer argued against this reasoning, because he thought sediment cores collected by GE provided evidence that maximum PCB levels typically occurred at depths between 5 and 9 inches (BR). Nonetheless, this reviewer agreed with the basic summary finding: PCB losses have likely occurred from sediments downstream from the TID. (The reviewers decided to address the issue of how PCB concentrations vary with sediment depth when responding to the sixth question in the charge [see Section 3.6].)

The reviewers were concerned about attempts to quantify PCB losses from this stretch of the river since many of the hot spots were characterized only by the 1977 and 1994 sampling efforts. As summarized in Section 3.4, the reviewers questioned the quality of the data from the 1977 sampling.

C *Comments on the mechanisms contributing to PCB losses.* Two reviewers indicated mechanistic explanations for the loss of PCBs from sediments downstream of the TID (RB,PL). They agreed that particle transport (sediment resuspension) could have accounted for the PCB losses in this stretch of the Hudson River, but they were skeptical that either pore water diffusion or bioturbation were the primary mechanism of PCB transport to the water column (RB,PL). One of these reviewers recommended that future work on the site focus more on mechanistic explanations for observed data trends (RB).

3.6 Responses to Question 6

The reviewers debated several issues pertaining to the sixth question in the charge: "The LRC found that the historically contaminated sediments in the TI Pool were not universally being buried and sequestered from the environment. How much confidence would you place in the LRC evidence against widespread burial?" A summary of their discussion follows:

C *Comments on the wording of the question.* Several reviewers thought Question 6 was open to several interpretations, largely due to the terms "widespread" and "burial." More specifically, one reviewer noted that different people might have different conceptions of what "widespread" actually means (KM). On a similar note, another reviewer indicated that he had difficulty answering this question because he was not sure how to interpret "burial" (i.e., exactly how many inches of sediment must deposit for "burial" to occur?) (RB). Due to these concerns, the reviewers carefully worded their responses to the question, which are summarized below.

- *Agreement that widespread burial of PCBs is not occuring.* The reviewers offered many different opinions on whether PCBs are being buried in the TIP, after which they agreed that the data in the LRC suggest that widespread burial does not appear to occur. One reviewer based this finding on how PCB concentrations varied with depth in the low resolution sediment cores: for the hot spots in the TIP, he calculated that approximately 60 percent of the PCB inventory lies within the upper 9 inches of sediments (KM). This reviewer used this evidence to argue against burial of PCBs to depths of 9 inches or deeper. Another reviewer added that the water column transect data are inconsistent with widespread burial (RB). He explained that the water column data from the DEIR, which indicated that PCBs enter the water column from the TIP sediments (see Section 2.1), suggest that PCBs likely remain in the upper layers of the sediments and that widespread burial probably does not occur. Yet another reviewer agreed with both of these arguments and concluded that the weight of the evidence from EPA's reports is against deep burial of PCBs (KR).

  During these discussions, one reviewer stressed that PCBs are likely being buried in certain parts of the Upper Hudson River (BR). Other reviewers agreed with this statement, but noted that "deep" burial does not appear to be widespread (PL,KM). All six reviewers eventually agreed that burial might occur in some places, but it does not appear to be widespread.

  After answering the specific questions in the charge, the reviewers revisited Question 6, focusing primarily on whether "deep" burial of PCBs occurs. One reviewer explained that the depth of burial can have significant implications on the bioavailability of PCBs (KM). Another reviewer agreed, but noted that future modeling exercises will have to determine whether or not the PCBs are, in fact, bioavailable (KR). The reviewers then discussed basic data trends of the LRC, as summarized in one reviewer's premeeting comments (KM), and eventually agreed with their original summary statement: "There does not appear to be widespread burial."

- *Caveats on drawing conclusions from data collected over a 10-year period.* Though he agreed that widespread burial of PCBs does not appear to occur, one reviewer thought debating the evidence of burial from 1984 to 1994 might be a moot point, particularly because sediment deposition trends might easily be reversed during flood events (PL). Another reviewer agreed, citing his personal experience working with other rivers where flood events considerably alter the river sediments (BR). These reviewers asked EPA to clarify how flood events have historically affected the Hudson River. Representatives from EPA explained that the Hudson River has a relatively controlled flow, due in part to upstream reservoirs, and 100-year floods might not have as great an impact on sediment transport as one might expect. The reviewers did not discuss issues pertaining to flood events further.

On a related topic, however, another reviewer suggested that the conclusion of no widespread burial should be revisited in later years (KM). Noting that much of EPA's sampling data was collected during a release of PCBs from an upstream source, which might not be characteristic of PCB sources over the long term, this reviewer recommended that EPA verify the finding of "no widespread PCB burial" during times when upstream sources of PCBs have been considerably reduced.

- *Comments on the importance of future modeling efforts.* One reviewer commented several times that modeling sediment deposition and resuspension might be the best approach for determining whether widespread burial of PCBs likely occurs (RB). Another reviewer agreed, but explained that such modeling was not included in the scope of the DEIR or the LRC (KM).

3.7 Responses to Question 7

The reviewers answered the seventh question, "Is the interpretation of the sidescansonar data appropriate and supported by the analysis of the associated sediment properties?", as follows:

- *Agreement that interpretations of the sidescansonar data seem appropriate.* The reviewers unanimously agreed that the interpretation of the sidescansonar data seemed reasonable. One reviewer based this finding on his personal experiences with this acoustical technique (KR), and others based the finding on consultations with colleagues who have used the technique (KM,BR). Two reviewers commented that the sidescansonar data seemed to complement many other findings presented in EPA's reports (KM,RM).

- *Miscellaneous comments.* The reviewers made several miscellaneous comments when discussing this topic. For instance, one reviewer indicated that sidescansonar studies were particularly useful for differentiating fine-grained and coarse-grained sediments (BR). This reviewer thought the sidescansonar data might help researchers identify sediments that *likely* contain PCBs, but he cautioned that the data cannot be used as an absolute indicator of where PCB-contaminated sediments occur. Another reviewer suggested "ground penetrating radar" data, which might be available from the U.S. Geological Survey, also could be useful for understanding the properties of the bedrock that underlies the river bed (RM). Finally, yet another reviewer thought the reports should have documented the operative details of the sidescansonar study more extensively (e.g., describing how the geometry of the river bed might have affected the sonar reflectivity) (KR).

4.0 RESPONSES TO GENERAL QUESTIONS REGARDING THE DEIR AND LRC

After answering the 14 questions in the charge that were specific to the DEIR and LRC, the reviewers then discussed two general questions that addressed issues documented in both documents and their Responsiveness Summaries. When answering these questions, the reviewers reiterated many of the findings they had presented earlier in the meeting and offered additional comments for debate and discussion. A general record of the peer reviewers' discussions on the two general questions follows. The reviewers' final conclusions and recommendations for the meeting are listed in Section 5.0.

Note: As was done in previous sections, the initials of the reviewers are used to attribute comments to the individuals who made them: RB=Dr. Reinhard Bierl, PL=Dr. Per Larsson, KM=Dr. Keith Maruya, RM=Dr. Ron Mitchum, KR=Dr. Ken Reimer, and BR=Dr. J. Bruno Risatti.

4.1 The Usefulness of the Data Set for Understanding Fate and Transport of PCBs in the Upper Hudson River

The first general question asked the reviewers: "Is the data set utilized to prepare the DEIR, LRC and Responsiveness Summaries sufficient to understand the fate and transport of PCBs in the Upper Hudson?" A summary of their responses, and the discussion that led to these responses, follows:

- *Agreement that the general conclusions of the reports are supported by the data.* After lengthy discussions on the question, and different interpretations of the question, the reviewers eventually agreed that the conclusions in the DEIR and LRC are generally supported by the data. In reaching this summary statement, one reviewer emphasized that the collective weight of evidence in the EPA reports supported the main conclusions and illustrated where PCBs generally originate and transport along the Hudson River, though this reviewer thought a lesser emphasis should have been placed on selected quantitative findings (KR). Most of the reviewers agreed, and indicated that the data collected by EPA's contractors were extremely thorough (RB,PL,RM,BR). One reviewer added that the compilation of data collected by EPA, GE, and USGS generated a very comprehensive database (RB). Despite these areas of agreement, the reviewers had differing opinions on certain aspects of this question, as summarized below.

- *Comments on transport mechanisms.* Though the reviewers generally agreed that the DEIR and LRC provided a basic understanding of PCB transport in the Hudson River, two reviewers suggested additional analyses of transport mechanisms. (Note, the reviewers identified other recommended analyses when responding to General Question 2.) First, noting that EPA collected only 1 year of water column transect data, one reviewer recommended validating the results of the transect study with data collected in more recent years (KM); this reviewer also noted that EPA's transect study did not fully characterize PCB transport between sampling locations (e.g., did PCBs transport conservatively between two locations? or was there trapping and resuspension?). Another reviewer thought EPA could have provided greater insight into PCB transport by conducting studies on sediment dynamics, even if only in the TIP, by more thoroughly characterizing the dissolved phase, and by analyzing data trends for other pollutants in the system (BR).

- *Comments on fate mechanisms.* The reviewers generally agreed that the DEIR and LRC did not provide sufficient data for understanding the fate of PCBs in the Hudson River, but several reviewers did not necessarily view this as a shortcoming of the reports. More specifically, several reviewers noted that EPA's study did not characterize the extent to which certain mechanisms remove PCBs from the Hudson River, such as evaporative losses, aerobic degradation, uptake by biota, and photolysis (PL,KM,RM). Nonetheless, other reviewers commented that losses by some of these mechanisms are not only very difficult to measure (RB) but also might not have been included in the scope of EPA's study (PL). Moreover, a reviewer suspected that EPA's future modeling efforts will address bioavailability and other phenomena related to the fate of PCBs (KR).

- *Discussion on the objectives of the study.* Two reviewers focused their responses on whether the reports, particularly the DEIR, met their stated objectives (RM,BR). Both reviewers were concerned that EPA's reports might not have identified "the major factors affecting the long term recovery of the Hudson"—an issue specified on page 1-3 of the DEIR. The reviewers did not discuss the study objectives further, but rather agreed to determine whether the general conclusions stated in the reports (and as modified in the Responsiveness Summaries) were supported by the data. That discussion is summarized in the previous bullet items.

- *Other comments on the data collected for the DEIR and LRC.* The reviewers raised, but did not discuss in detail, several general issues while responding to this question. For instance, one reviewer noted that a complete congener-specific mass balance could not be performed on the historical data, since the sampling effort in 1984 did not characterize the lower homologue PCBs (KM). Another reviewer recommended that EPA perform a more complete mass balance to characterize fate and transport of PCBs more completely (BR). This reviewer also thought the reports should have included representative chromatograms from sediment samples collected in different stretches of the river, such that readers can better understand the composition of PCBs in the sediments. Finally, one

reviewer suggested that future work should focus specifically on understanding the fate of coplanar PCBs, since these congeners might be important to distinguish due to their toxicity (RB).

4.2 Recommended Additional Data Analyses

The second general question asked the reviewers: "Are there any additional analyses that should be done to verify certain findings of the DEIR and LRC?" Since reviewers had identified additional analyses throughout the peer review meeting, they did not discuss and debate this question in detail. Rather, they compiled a list of recommended data analyses from their responses to earlier questions. The following bullet items present the recommendations and identify the reviewers who made them:

- All of the reviewers thought use of multivariate statistical analyses to quantify trends and patterns among the data would have strengthened the documents' conclusions.

- Two reviewers thought studies of sediment dynamics, at least for the TIP, concurrent with water column sampling might better illustrate PCB transport (BR,PL). One reviewer suggested that EPA should perform these studies during different seasons to characterize high-flow and low-flow conditions (BR).

- Noting that the "air compartment" for a PCB mass balance has not been quantified, one reviewer recommended further analysis of evaporative losses and photochemical degradation of PCBs (RM). This reviewer indicated that these issues could be addressed in many ways, such as by reviewing the scientific literature, modeling the processes, or actually measuring them. Other reviewers agreed that evaporative losses should be considered in EPA's future work on the site (PL,BR).

- Two reviewers recommended that the findings of the conceptual models presented in the DEIR should be validated against more recent water column sampling data (KM,KR).

- Several reviewers offered recommendations pertaining to interpretation and presentation of PCB analytical data in the reports. One reviewer suggested that EPA exhaust all possible methods for relating the 1977 sediment coring data to the 1994 data, such as analyzing archived samples and reviewing chromatograms, if any of this information is available (KM). Another reviewer agreed and added that the DEIR should clearly state the analytical variability of the water column and high resolution sediment coring measurements (KR).

- One reviewer suggested that EPA use more sophisticated statistical analyses, including nonlinear analyses, when calculating certain data trends (RB).

The reviewers reiterated some of these recommended data analyses, and added others, when presenting their final thoughts on the DEIR, the LRC, and the Responsiveness Summaries (see Section 5.0).

5.0 REVIEWERS' OVERALL RECOMMENDATIONS

After answering the specific and general questions in the charge, and after listening to the second set of observer comments, the reviewers reconvened to provide their final findings on EPA's reports.[3] The reviewers decided to offer these findings as individual statements, during which other reviewers did not discuss or debate each reviewer's final recommendations. Section 5.1 summarizes each peer reviewer's final statements, and Table 5-1 in Section 5.2 identifies common themes among these final recommendations.

5.1 Peer Reviewers' Final Statements

The peer review meeting concluded with each peer reviewer providing closing statements on the reports, including an "overall recommendation" in response to the final question in the charge: "Based on your review of the information provided, please identify and submit an explanation of your overall recommendation for both the DEIR and LRC.

1. Acceptable as is
2. Acceptable with minor revision (as indicated)
3. Acceptable with major revision (as outlined)
4. Not acceptable (under any circumstance)"

A detailed summary of the peer reviewers' final statements, in the order they were given, follows:

- *Dr. Keith Maruya.* Dr. Maruya indicated that he accepted the main conclusions of the reports, though he did have suggestions and recommendations for improving them. First, he suggested that EPA publish a concise summary of the information provided in the DEIR, LRC, and the Responsiveness Summaries. He recommended the use of multivariate statistical analyses to make certain conclusions in these reports more convincing. Dr. Maruya also recommended the reports more prominently acknowledge the uncertainty in some key findings, like the estimated mass loss of PCBs.

[3] Due to unforseen circumstances, one reviewer (Keith Maruya) had to leave the peer review meeting at the end of the second day. He gave his final recommendations before the second set of observer comments.

Focusing specifically on the DEIR, Dr. Maruya first reiterated a recommendation he had mentioned earlier in the meeting: EPA should validate the findings of the conceptual models with more recent water column sampling data. He thought such validation would better quantify PCB sources between Roger's Island and Waterford during times when upstream sources of PCBs are negligible. Dr. Maruya then suggested that EPA consider the limnology of the TIP and other pools in the Hudson River for a better understanding of PCB transport (e.g., how primary production affects partitioning, fate, and transport of PCBs). On the topic of partition coefficients, Dr. Maruya recommended that EPA only use the two-phase coefficients derived in the DEIR until sufficient data are available to estimate the three-phase coefficients. Dr. Maruya did not think the data in the DEIR supported a 30 ppm threshold below which PCB dechlorination reportedly does not occur.

Commenting on the LRC, Dr. Maruya first concluded that the comparisons between the PCB inventories in 1984 and 1994 were reasonable and the data from 1977 were not sufficient for inventory estimates. He thought the analytical variability contributed to considerable uncertainty in the inventory estimates, which the LRC did not acknowledge. Dr. Maruya thought EPA should further consider how elevated PCB concentrations in near-shore sediments might have affected the inventory estimates. Finally, Dr. Maruya maintained that the sampling data suggest that widespread burial of PCBs does not occur.

Overall, Dr. Maruya thought the DEIR and LRC were both "acceptable with minor revisions."

C *Dr. Ken Reimer*. Dr. Reimer concluded that the weight of evidence of the data presented in the DEIR and LRC generally support the reports' main conclusions, especially as they were modified in the Responsiveness Summaries. He thought the data collected for the reports provided an adequate basis for EPA to proceed with its reassessment.

Dr. Reimer then listed several suggestions and recommendations. First, noting that the public might have difficulty identifying the basic messages of the DEIR and LRC, Dr. Reimer recommended that EPA prepare a succinct summary of the major findings of these reports. Second, he strongly recommended that EPA's reports present quantitative findings in appropriate context, particularly with respect to uncertainty. Dr. Reimer suggested that EPA consider presenting ranges of data when the actual values are not known. He cautioned EPA about "over interpreting" data.

Focusing on the main conclusions of the reports, Dr. Reimer indicated that they were generally supported by the data, but with a few caveats. He thought the conceptual models used to interpret the water column transect studies could be improved, for example, with the use of multivariate analyses to "fingerprint" sources of PCBs. Further, Dr. Reimer suggested that the reports not infer that anaerobic dechlorination of PCBs

does not occur at PCB concentrations less than 30 ppm. He added, however, that dechlorination is "a very minor issue" in terms of the overall problem of contaminated sediments. Dr. Reimer then discussed the issue of estimating PCB mass loss in the sediments: he thought the 1984 and 1994 were sufficient for making these estimates; he cautioned against presenting firm estimates of the mass loss; and he also cautioned against using the 1977 sediment coring data for this purpose. Finally, Dr. Reimer concluded that the data suggest that widespread burial of PCBs does not occur in the TIP and that the TIP sediments act as a source of PCBs to the water column.

Overall, Dr. Reimer found the DEIR and LRC to be "acceptable with minor revisions."

C *Dr. Reinhard Bierl.* Dr. Bierl opened his final statements by indicating that the data reported in the DEIR and LRC are sufficient for EPA to proceed with its reassessment, but he identified several aspects of the reports that should be improved to make them more convincing. Regarding the statistical methods used in the reports, Dr. Bierl recommended the use of multivariate analyses to quantify certain trends and additional statistical analyses to calculate changes in PCB inventories. Dr. Bierl then suggested that EPA qualify its quantitative estimates of PCB mass loss to put these figures into perspective. Dr. Bierl added that he wanted to see more information in the reports on the PCB analytical methods (e.g., quality assurance plans and standard operating procedures). He thought this information was particularly lacking for the previous sediment coring studies.

Noting the time gaps between the various sediment coring studies, Dr. Bierl recommended that EPA consider reviewing more recent sampling data and possibly even consider implementing ongoing monitoring studies. He thought future studies should focus on characterizing how PCBs partition between the suspended and dissolved phases, among other research topics.

Overall, Dr. Bierl found the DEIR and LRC to be acceptable with revisions, but he was not sure whether his recommended revisions should be considered "minor" or "major."

C *Dr. Per Larsson.* Dr. Larsson concluded that the data summarized in the DEIR and LRC identified major source areas of PCBs in the Hudson River and characterized the extent of contamination in these areas. Dr. Larsson found that the data indicate a loss of PCBs from the river sediments, but he thought the exact amount of losses are difficult to quantify. He reminded the reviewers, however, that even "a very small percentage" loss of PCBs might have very serious consequences on downstream ecosystems.

Dr. Larsson then reviewed his responses to selected questions in the charge. First, he found that the river sediments in the TIP undoubtedly act as a source of PCBs to the water column; he recommended that EPA include a basic model in the final report to estimate the source loading of the sediments. Second, Dr. Larsson commended EPA's work on

differentiating dissolved phase PCBs from suspended phase PCBs—a distinction he thought would be important for future analyses of bioavailability. Third, Dr. Larsson noted that he and other reviewers had questions about the mechanisms that cause PCBs to enter the water column; he suspected that particle transport (rather than bioturbation or pore water diffusion) is probably the primary mechanism affecting PCB transport. Finally, Dr. Larsson addressed the findings of PCB mass loss and sediment burial. He was convinced that PCBs are gradually transporting with the sediments, and he speculated that the river sediments will continue to redistribute in the future. Noting that the Hudson River is a dynamic system, Dr. Larsson cautioned against assuming data trends from a 10-year time frame are representative of river conditions over the longer term.

Based on his review of the documents, Dr. Larsson thought two specific revisions were necessary. He recommended the use of multivariate statistics for identifying and quantifying trends and patterns among the large volume of congener-specific data. He also recommended the reports thoroughly describe the data analysis methodology, such that the statistical analyses are transparent and easier to follow.

Overall, Dr. Larsson thought the DEIR and LRC were "acceptable with minor revisions."

C *Dr. Ron Mitchum.* Dr. Mitchum split his comments into those specific to the DEIR and those specific to the LRC. Beginning with the DEIR, Dr. Mitchum noted that many of the report's original conclusions had been "softened" in the Responsiveness Summary. He then offered several suggestions for future work on the site and improving the DEIR. He first recommended that EPA include in its ongoing analysis some assessment of evaporative losses and photochemical degradation of PCBs. Dr. Mitchum then suggested that EPA use multivariate statistical analyses to verify many of the findings in the report. He also suggested that the report's conclusions include discussions about uncertainty, particularly in regard to sampling and analytical variability. Dr. Mitchum thought the DEIR's original conclusion of a concentration threshold for anaerobic dechlorination was not well founded.

Dr. Mitchum then summarized his major findings pertaining to the LRC. First, he concluded that EPA did "the best job possible" in comparing the 1984 and 1994 sediment coring data. Dr. Mitchum added, however, that sampling and analytical variability limited the confidence he had in the estimated PCB inventories. Regardless of the uncertainty, Dr. Mitchum believed the 1984 and 1994 data sets support EPA's conclusion that the hot spots in the river have lost PCBs. He cautioned EPA against using the 1977 sediment coring data in the ongoing reassessment. Finally, Dr. Mitchum suggested that use of multivariate statistical analyses was needed to verify conclusions in the LRC.

Overall, Dr. Mitchum thought the DEIR and LRC were both "acceptable with minor revisions."

- *Dr. J. Bruno Risatti*. During his final statements, Dr. Risatti provided general comments about both reports, followed by comments specific to the individual reports. Dr. Risatti thought the data collected for the reports provide a background for a better understanding of PCB transport in the Hudson River, but he did not think the reports should be considered as an "all encompassing" study. In general, Dr. Risatti was uncertain about some findings in the reports, due largely to the analytical variability in the data. He thought the PCB transport processes could be further characterized by conducting sedimentological studies concurrent with water column sampling. Though he found the reports extensive, Dr. Risatti thought they should have more thoroughly addressed the fate of PCBs by considering aerobic degradation and evaporative losses.

  Focusing specifically on the DEIR, Dr. Risatti's primary finding was that EPA should reconsider its conclusions regarding anaerobic dechlorination, particularly the finding of a 30 ppm threshold below which dechlorination does not occur. He then reiterated that the MDPR might underestimate actual dechlorination, since the MDPR is calculated from concentrations of lower homologue PCBs that are more likely to transport from the sediments.

  When presenting his comments on the LRC, Dr. Risatti suggested that the study had some evidence of cross contamination of the "vibracore" samples, and he recommended that EPA conduct a basic study to quantify the potential extent of this cross contamination. Noting that he had difficulties reading the LRC (and the DEIR), Dr. Risatti also recommended that EPA develop guidelines for writing technical reports in a format similar to articles in scientific journals.

  Overall, Dr. Risatti found the DEIR and LRC to be acceptable with revisions, but he was not sure whether his recommended revisions should be considered "minor" or "major."

5.2 Summary of Peer Reviewers' Final Recommendations

The reviewers' final recommendations, which are detailed in Section 5.1, are summarized by peer reviewer in Table 5-1. (Note that this table does not incorporate any additional recommendations the reviewers made during earlier portions of the meeting.)

Table 5-1
Peer Reviewers' Final Recommendations

Recommendation	Reinhard Bierl	Per Larsson	Keith Maruya	Ron Mitchum	Ken Reimer	J. Bruno Risatti
Overall DEIR recommendation	Acceptable, with revisions that fall between "minor" and "major"	Acceptable with minor revisions	Acceptable with minor revisions	Acceptable with minor revisions	Acceptable with minor revisions	Acceptable, with revisions that fall between "minor" and "major"
Overall LRC recommendation	Acceptable, with revisions that fall between "minor" and "major"	Acceptable with minor revisions	Acceptable with minor revisions	Acceptable with minor revisions	Acceptable with minor revisions	Acceptable, with revisions that fall between "minor" and "major"
Use multivariate statistical analyses of data	✓	✓	✓	✓	✓	
More prominently acknowledge uncertainty in conclusions; use data ranges to present findings that might be highly uncertain	✓		✓	✓	✓	✓
Publish a concise summary of the information in the DEIR, LRC, and Responsiveness Summaries			✓		✓	
Consider the limnology of the TIP and other pools in the Hudson River (e.g., how primary production affects PCB fate and transport)			✓			
Validate the conceptual models and other findings with more recent water column sampling data	✓		✓			

Note: This table summarizes recommendations made during the peer reviewers' final statements; some reviewers might have made additional recommendations during their earlier discussions.

Table 5-1 (Continued)
Peer Reviewers' Final Recommendations

Recommendation	Reinhard Bierl	Per Larsson	Keith Maruya	Ron Mitchum	Ken Reimer	J. Bruno Risatti
Use two-phase partition coefficients until enough data are available to derive three-phase coefficients			✓			
Modify the conclusion regarding the 30 ppm threshold for anaerobic dechlorination			✓	✓	✓	✓
Further consider how elevated PCB concentrations in near-shore sediments might affect inventory estimates			✓			
Use more sophisticated statistical analyses to estimate PCB inventory	✓					
Provide additional details on the analytical methods used in the various sediment coring studies	✓					
Better characterize exchange of PCBs between the suspended and dissolved phase	✓					
Describe the data analysis methodology in the reports		✓				
Consider other compartments in the PCB mass balance (e.g., evaporative losses, photochemical degradation, aerobic degradation)				✓		✓

Note: This table summarizes recommendations made during the peer reviewers' final statements; some reviewers might have made additional recommendations during their earlier discussions.

Table 5-1 (Continued)
Peer Reviewers' Final Recommendations

Recommendation	Reinhard Bierl	Per Larsson	Keith Maruya	Ron Mitchum	Ken Reimer	J. Bruno Risatti
Conduct sedimentological studies concurrent with water column sampling						✓
Conduct an experiment to characterize the extent of cross contamination in "vibracoring" samples						✓
Establish guidelines for writing future reports						✓

Note: This table summarizes recommendations made during the peer reviewers' final statements; some reviewers might have made additional recommendations during their earlier discussions.

6.0 REFERENCES

TAMS et al., 1997. "Data Evaluation and Interpretation Report." Volume 2C of the Hudson River PCBs Reassessment RI/FS. Review copy. Prepared by TAMS Consultants, Inc., The CADMUS Group, Inc., and Gradient Corporation. February, 1997.

TAMS et al., 1998a. "Responsiveness Summary for: Volume 2A: Database Report; Volume 2B: Preliminary Model Calibration Report; Volume 2C: Data Evaluation and Interpretation Report." Prepared by TAMS Consultants, Inc., The CADMUS Group, Inc., and Gradient Corporation. December, 1998.

TAMS et al., 1998b. "Low Resolution Sediment Coring Report." Volume 2C-A of the Hudson River PCBs Reassessment RI/FS. Review copy. Prepared by TAMS Consultants, Inc., The CADMUS Group, Inc., and Gradient Corporation. July, 1998.

TAMS et al., 1999. "Responsiveness Summary for: Volume 2C-A: Low Resolution Sediment Coring Report." Prepared by TAMS Consultants, Inc., and TetraTech, Inc. February, 1999.