



Draft Engineering Performance Standards
Public Review Copy

Appendix: Case Studies of Environmental Dredging Projects





UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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NEW YORK, NY 10007-1866

May 12, 2003

To All Interested Parties:

The U.S. Environmental Protection Agency (USEPA) is pleased to release the Draft Engineering Performance Standards - Public Review Copy, which is part of the remedial design for the Hudson River PCBs Superfund Site. The document presents the performance standards for dredging resuspension, dredging residuals, and dredging productivity that were developed by USEPA in accordance with its 2002 Record of Decision (ROD) for the Site.

The 2002 ROD states that the performance standards will be developed during the remedial design with input from the public. To that end, USEPA is accepting comments on the Draft Engineering Performance Standards through June 13, 2003. USEPA has designed its website, <http://www.epa.gov/hudson>, to allow for electronic submittal of public comment. The public can comment from any computer with internet access, including computers at the Agency's Hudson River Field Office in Ft. Edward, at the information repositories established throughout the Site, and at most libraries. The website allows the public to print a copy of their comments and receive a confirmation that their comments have been received.

The 2002 ROD also states that the dredging resuspension, dredging residuals, and dredging productivity standards and the attendant monitoring programs will be the subject of independent external peer review. USEPA is soliciting suggested questions from the public that will be used in developing the charge. USEPA's website also will allow the public to submit suggested charge questions electronically, to print out a copy of the questions submitted, and to get confirmation that the suggested charge questions were received. Comments and suggested charge questions for the peer review also can be submitted to Alison A. Hess, C.P.G., USEPA Region 2, 290 Broadway - 19th Floor, New York, NY 10007-1866.

USEPA will hold public sessions on the Draft Engineering Performance Standards. Prior notification of these meetings was sent to USEPA's mailing list and is presented below:

- Wednesday, May 21: Ft. Edward Fire House, 116 Broadway, Ft. Edward, 6 p.m. to 9 p.m., presentation at 6:30 p.m.
- Thursday, May 22: Best Western Inn & Conference Center, 2170 South Road, Route 9, Poughkeepsie, 6 p.m. to 9 p.m., presentation at 6:30 p.m.
- Monday, June 2: Queensbury Hotel, 88 Ridge Street, Glens Falls, 2 p.m. to 4 p.m., presentation at 2:30 pm; and 6 p.m. to 9 p.m., presentation at 6:30 p.m.
- Tuesday, June 3: Sage College of Albany, Kahl Center, 140 New Scotland Avenue, Albany, 2 pm to 4 pm, presentation at 2:30 pm; and 6 p.m. to 9 p.m., presentation at 6:30 p.m.

If you need additional information regarding the Draft Engineering Performance Standards, the public sessions, or the Hudson River PCBs Site in general, please contact USEPA's Community Relations Coordinators for this site, Leo Rosales at (518) 747-4389 and David Kluesner at (212) 637-3653.

Sincerely yours,

George Pavlou, Director
Emergency and Remedial Response Division

Executive Summary

Draft Engineering Performance Standards – Public Review Copy
Hudson River PCBs Superfund Site
Executive Summary
May 2003

In February 2002, the United States Environmental Protection Agency (USEPA) issued a Record of Decision (ROD) for the Hudson River PCBs Superfund Site (Site). The ROD calls for targeted environmental dredging of approximately 2.65 million cubic yards of PCB-contaminated sediment from the Upper Hudson River (approximately 40 river miles) in two phases over a six-year period, and monitored natural attenuation of the PCB contamination that remains in the river after dredging.

In the ROD, USEPA identified five remedial action objectives, which are as follows:

- Reduce the cancer risks and non-cancer health hazards for people eating fish from the Hudson River by reducing the concentration of PCBs in fish;
- Reduce the risks to ecological receptors by reducing the concentration of PCBs in fish;
- Reduce PCB levels in sediments in order to reduce PCB concentrations in river (surface) water that are above applicable or relevant and appropriate requirements for surface water;
- Reduce the inventory (mass) of PCBs in sediments that are or may be bioavailable; and
- Minimize the long-term downstream transport of PCBs in the river.

In selecting its cleanup remedy, USEPA required that performance standards for resuspension during dredging, production rates during dredging, and residuals after dredging (together called the “Engineering Performance Standards”) be established to address comments received from some of the public suggesting that the environmental dredging could “do more harm than good” and take much longer than stated. USEPA required these performance standards in its final cleanup decision to promote accountability and ensure that the cleanup meets the human health and environmental protection objectives set forth in the ROD.¹

This document presents the draft Engineering Performance Standards for public review and comment. For each performance standard, it discusses the major ways performance is measured, the techniques used to assess performance, the supporting analyses for the recommendations (including case studies), and some of the major interactions among the performance standards.

¹ Other performance standards will address public concerns related to potential impacts of the cleanup on the surrounding community, such as air emissions, navigation, and noise. These are being developed separately.

Consistent with the ROD, the Engineering Performance Standards were developed in consultation with New York State, the National Oceanic and Atmospheric Administration and the U.S. Fish and Wildlife Service. (New York State is developing substantive water quality certification requirements for the environmental dredging pursuant to the federal Clean Water Act, which has been delegated to the State; USEPA will review the requirements when they become available for any implications with respect to the Engineering Performance Standards). USEPA's consultants included a team of senior scientists and engineers who developed the standards, which then were reviewed by a separate team of recognized technical experts. General Electric Company reviewed a near-final version of the draft standards. Comments from these organizations were considered in preparing this Public Review Copy of the Draft Engineering Performance Standards.

Following the close of the public comment period, the Draft Engineering Performance Standards will be revised as appropriate and released to the public as the Draft Engineering Performance Standards – Peer Review Copy. The standards will be peer reviewed by a panel of independent experts, modified as appropriate to address the peer reviewers' recommendations, and then implemented during the Phase 1 dredging. The results from the first season of dredging (Phase 1) will be used to evaluate the project's progress compared to the assumptions in the ROD in order to determine whether there are any necessary adjustments to the dredging operations in the succeeding phase (Phase 2) or to the standards. The report evaluating the dredging with respect to the Phase 1 standards also will be peer reviewed. USEPA will use the peer reviewers' recommendations to help determine whether the dredging plan is feasible in achieving the human health and environmental protection objectives of the ROD. The Engineering Performance Standards will be refined or adjusted, if necessary, for the remaining dredging seasons (Phase 2).

Based on the analyses performed to develop the standards, USEPA believes that the standards are consistent with the human health and environmental protection objectives of the ROD. USEPA has determined:

- Compliance with the Resuspension Standard will limit the concentration of Total PCBs in river water one mile or more downstream of the dredging area to levels that are acceptable for potable water under the requirements of the Safe Drinking Water Act;
- Resuspension of PCBs in compliance with the Resuspension Standard will have a negligible adverse effect on Tri+ PCB concentrations in Hudson River fish, as compared to a scenario assuming no dredging-related PCB releases;²
- Compliance with the Control Level of the Resuspension Standard is expected to result in a Total PCB load (mass) transported downstream during remedial

² A negligible effect is defined, in this case, as a predicted Tri+ PCB concentration in Upper Hudson fish of 0.5 mg/kg or less, and in Lower Hudson River fish of 0.05 mg/kg or less, within 5 years after the completion of dredging in the Upper Hudson.

dredging that is similar to the range of Total PCB loads detected during recent baseline (*i.e.*, pre-dredging) conditions, as documented by weekly measurements from 1996 to 2001;

- The Residuals Standard specified in the ROD (approximately 1 mg/kg Tri+ PCBs prior to backfilling) is achievable based on case studies of other environmental dredging projects and can be applied in the Upper Hudson on an area-wide average basis;
- The Productivity Standard will result in completion of the dredging within the six dredging seasons called for in the ROD, based on an example conceptual schedule for project implementation; and
- The three Draft Engineering Performance Standards, including their respective monitoring programs, are achievable individually and in combination.

A summary of each of the three Draft Engineering Performance Standards is presented below, followed by discussion of some of the major interactions among the Standards.

Performance Standard for Dredging Resuspension

Objectives

The Performance Standard for Dredging Resuspension (*i.e.*, Resuspension Standard) is designed to limit the concentration of PCBs in river water such that water supply intakes downstream of the dredging operations are protected, and to limit the downstream transport of PCB-contaminated dredged material. The attendant water quality monitoring program will be implemented to verify that the objectives of the Resuspension Standard have been met during dredging. The analytical results obtained from the water quality monitoring will be compared to the Resuspension Standard and associated lower action levels to monitor and control resuspension through appropriate actions. Such actions could include, as appropriate, expanding the monitoring program, notifying public water suppliers, implementing operational or engineering improvements, and, if necessary, temporarily halting the dredging.

The ROD requires the development of a Resuspension Standard but does not set forth any framework or numerical value for the Standard. The Resuspension Standard and a series of tiered action levels were developed based on extensive modeling, review of environmental dredging case study data, and evaluation of applicable or relevant and appropriate requirements (ARARs) identified in the ROD for PCBs in river water.

Statement of the Resuspension Standard

Resuspension Standard

Under the Resuspension Standard, the maximum allowable Total PCB concentration in the water column is 500 nanograms per liter (ng/L) (*i.e.*, 500 parts per trillion) at any far-field monitoring station, regardless of the source of the PCBs. This concentration is the USEPA Safe Drinking Water Act Maximum Contaminant Level (MCL) for PCBs in drinking water supplies.³ Potential sources include dredging, tender and tugboat movements, materials handling, and PCBs from upstream and non-dredging sources. Dredging is only allowed to proceed when concentration of Total PCBs in the river water at any Upper River far-field station is 500 ng/L or less.

Action Levels

Action levels were developed to help identify potential problems and to guide appropriate responses, such as preventive actions or engineering improvements, as necessary, as a means of avoiding an exceedance of the Resuspension Standard. As shown in Table ES-1 below, there are three action levels leading up to the Resuspension Standard, which are designated “Evaluation Level,” “Concern Level,” and “Control Level.” The monitoring requirements become more stringent at each level to increase the types and quantity of data available to interpret the river’s response to the dredging. If the monitoring shows an exceedance at the Evaluation or Concern Level, engineering solutions are suggested. If the monitoring shows an exceedance at the Control Level, implementation of an engineering solution is required.

³ The New York State MCL is also 500 ng/L.

Table ES-1: Resuspension Standard and Action Levels

Action Level	Parameter	Required Action
Evaluation Level	300 g/day Total PCB load or 100 g/day Tri+ PCB load as a 7-day running average (far-field) 100 mg/L 6-hour running average net suspended solids increase or average net increase in the daily dredging period if the dredging period is less than 6 hours (near-field, 300 m, River Sections 1 & 3) 60 mg/L 6-hour running average net suspended solids increase or average net increase in the daily dredging period if the dredging period is less than 6 hours (near-field, 300 m, River Section 2) 700 mg/L net suspended solids average 3-hour continuous (near field, 100 m and channel-side) 12 mg/L 6-hour running average net suspended solids increase or average net increase in the daily dredging period if the dredging period is less than 6 hours (far-field)	Monitoring Contingencies Engineering Evaluations (recommended) Engineering Solutions (recommended)
Concern Level	350 ng/L Total PCBs as a 7-day running average (far-field) 600 g/day Total PCB load or 200 g/day Tri+ PCB load as a 7-day running average (far-field) 100 mg/L net suspended solids daily average for the dredging period (greater than 6 hours) or 24 hours (near-field, 300 m, River Sections 1 & 3) 60 mg/L net suspended solids daily average for the dredging period (greater than 6 hours) or 24 hours (near-field, 300 m, River Section 2) 24 mg/L net suspended solids daily average for the dredging period (greater than 6 hours) or 24 hours (far-field)	Monitoring Contingencies Engineering Evaluations Engineering Solutions (recommended)
Control Level	350 ng/L Total PCBs as a 4-week running average (far-field) 65 kg/year Total PCB load during the Phase 1 dredging season (far-field) 600 g/day Total PCB load or 200 g/day Tri+ PCB load as a 4-week running average (far-field)	Monitoring Contingencies Engineering Evaluations Engineering Solutions
Resuspension Standard	500 ng/L Total PCBs (confirmed far-field occurrence)	Temporarily Halt Dredging Monitoring Contingencies Engineering Evaluations Engineering Solutions

The Evaluation Level is based on PCB load (net mass loss) criteria and suspended solids concentrations. The PCB load criteria are 300 g/day Total PCBs (and 100 g/day Tri+ PCBs), which approximates the amount that could reasonably be distinguished from baseline conditions. These amounts are approximately three times the best engineering estimate of mass loss from the dredging operation at full production as reported in the ROD. The near-field suspended solids concentration criteria were derived for each River Section of the Upper Hudson to correspond to a far-field PCB concentration of 350 ng/L Total PCBs. There is a corresponding far-field suspended solids criterion derived for a far-field concentration of 500 ng/L Total PCBs, the Resuspension Standard. Consistent with the ROD, the Evaluation Level, Control Level and Concern Level each require the collection of site-specific data in Phase 1 that will be used to determine whether adjustment to the dredging operations or to the standards are needed in Phase 2. Once these data have been evaluated, it may be appropriate to eliminate the Evaluation Level in the Resuspension Standard for Phase 2.

The Concern Level includes both a PCB concentration and load-based criteria. The concentration criterion is a seven-day running average exceedance of 350 ng/L Total PCBs (*i.e.*, 70% of the 500 ng/L Resuspension Standard, which is a reasonable warning threshold). The load criteria are structured similarly, with a one-week exceedance of 600 g/day Total PCBs (and 200 g/day Tri+ PCBs). This daily load rate is based on a total project load of up to 650 kg Total PCBs over the duration of the dredging as estimated from various engineering and modeling analyses.⁴ The near-field suspended solids concentration criteria were derived for each River Section of the Upper Hudson to correspond to a far-field PCB concentration of 350 ng/L Total PCBs, but the threshold duration of the concentration criteria is longer. There is an associated far-field suspended solids criterion derived to correspond to a far-field PCB concentration at twice the Resuspension Standard (*i.e.*, 1000 ng/L).⁵

The Control Level criteria for PCB concentration and load are similar in form to those for the Concern Level, but the threshold duration of the concentration criteria is increased. In this case, the concentration criterion is a four-week running average concentration of 350 ng/L Total PCBs. The load criteria, likewise, consist of a four-week exceedance of 600 g/day Total PCBs (and 200 g/day Tri+ PCBs). There are no increased suspended solids criteria associated with the Control Level (*i.e.*, the Control Level is not triggered by suspended solids concentrations alone).

Near-field and Far-field Monitoring Stations

The Resuspension Standard requires water quality monitoring at both “near-field” stations (located within a few hundred meters of the dredging operation) and “far-field” stations (to be established at fixed locations in the Upper and Lower Hudson River, primarily dams and bridges). Monitoring is required at all far-field stations during Phase 1 (two stations upstream of the project area, four stations in the Upper River, two stations in the Lower River and one station in the Mohawk River at Cohoes). The Resuspension Standard of 500 ng/L Total PCBs is applied to the PCB concentration data collected at any far-field station that is at least 1 mile downstream of the dredging area. The data collected at both near-field and far-field stations are compared to the action level criteria.

Water quality impacts that are detected only in the immediate dredging area, including within containment barriers that the Contractor may employ around the dredging area, are not covered by the Resuspension Standard. Some resuspension within the dredging areas is likely unavoidable regardless of the type of dredging equipment used, and is of concern only to the extent it transports PCBs downstream.

⁴ The daily rate is based on attainment of the recommended target cumulative volume as specified in the Productivity Standard, and should be prorated according to the production rate planned in the Production Schedule to be submitted annually to USEPA.

⁵ This higher level recognizes the high degree of uncertainty in the suspended solids measurement. Additional PCB sampling prompted by this level will be used to confirm compliance with the Resuspension Standard.

Routine Monitoring Program⁶

The routine water quality monitoring program consists of PCB sampling and analysis at the far-field stations and the collection of suspended solids data at the near-field and far-field stations every three hours. The routine monitoring program is specific with respect to the details and frequency of the sample collection, potential development of continuous field monitoring techniques for suspended solids, requirements for representative discrete and composite sampling schemes at the far-field stations (Upper and Lower Hudson), and the number and configuration of near-field suspended solids sampling stations. Monitoring results will be made available to USEPA upon receipt from the laboratories. Corrective actions and analytical results will be summarized in weekly reports to USEPA.

Contingencies

Monitoring Contingencies

If an action level is exceeded, monitoring contingencies are required at both near-field and far-field stations. The monitoring contingencies consist of increased sampling frequency and more rapid laboratory turn-around of analytical data at the sampling locations, compared to the routine monitoring program. The monitoring contingency is intended to provide additional data to better characterize the developing changes and trends in water quality. The Resuspension Standard allows the monitoring program to revert to routine frequencies and normal turnaround times when conditions have decreased below the action levels for specific durations.

Engineering Contingencies

If the Evaluation Level is exceeded, the Resuspension Standard suggests that an engineering evaluation be undertaken and that a range of engineering contingencies be considered.

If the Concern Level is exceeded, the Resuspension Standard requires that an engineering evaluation be undertaken and suggests a range of engineering contingencies. However, at the Concern Level, implementation of an engineering solution is discretionary.

If the Control Level is exceeded, the Resuspension Standard requires implementation of an engineering solution, with the exact engineering solution to depend on the specific circumstances encountered in the field and an interpretation of the monitoring data collected in connection with the action level exceedance.

If the Resuspension Standard is exceeded, all dredging operations must be temporarily halted pending the results of an engineering evaluation and selection of an engineering solution in consultation with USEPA.

⁶ The term “routine” refers to a level of monitoring appropriate to this project to be conducted while the dredging operation is in compliance with the Resuspension Standard and all action level criteria.

The suggested engineering evaluations and solutions include examination of boat traffic patterns, additional evaluation of sediment pipelines for leaks, implementation or modification of silt barriers and may include, for the Control Level, temporarily halting the dredging operations.

Public Water Supply Monitoring and Contingencies

The Resuspension Standard provides for notification to downstream public water suppliers when the Total PCB concentration at the Waterford far-field station is predicted to be 350 ng/L or greater. The monitoring and notification required by the Resuspension Standard is in addition to monitoring and notification requirements that will be developed separately for the Community Health and Safety Plan for the remedial work activities.⁷

Supporting Analyses and Assumptions

A large number of analyses were conducted in developing the Resuspension Standard, including the action levels. Some of the most important analyses are summarized below.

Dissolved-Phase PCB Releases

Case studies regarding environmental dredging projects provide different conclusions regarding the importance of dissolved-phase PCBs in the absence of a release of suspended solids. Some data from the Fox River in Wisconsin suggest that relatively large dissolved-phase releases of PCBs are possible during dredging without an associated release of contaminated sediments (suspended solids). In contrast, field measurements of dissolved and particle-associated PCBs collected during environmental dredging at the New Bedford Harbor site in Massachusetts suggest that dissolved phase PCB releases are not significant.

In developing the Resuspension Standard, analyses were conducted to evaluate possible mechanisms for dissolved-phase PCB releases during dredging of the Upper Hudson. These analyses sought to consider the likelihood and magnitude of potential dissolved-phase effects. Potential releases of dissolved-phase PCBs, via 1) release of contaminated porewater from the dredged sediment surface and 2) a release of contaminated solids into the water column, were quantitatively modeled to estimate a range of potential PCB contaminant loads that could be experienced. The modeling indicated that the amount of dissolved-phase PCBs likely to be introduced into the system is relatively small compared to baseline concentrations (*i.e.*, without dredging).

⁷ The ROD requires development of a Community Health and Safety Plan to protect the community, including persons in residences and businesses, from potential exposures as a direct result of remedial work activities. The Community Health and Safety Plan will provide for community notification of ongoing health and safety issues, monitoring of contaminants and protection of the community from physical and other hazards. The plan will include a section that outlines the actions to be followed should monitoring of contaminants show contaminant levels above certain levels to be identified in the plan.

Modeling

USEPA's peer-reviewed fate and transport models and bioaccumulation models (HUDTOX and FISHRAND) were used to simulate concentrations of PCBs in the water column, sediment, and fish in the Upper Hudson that could result from resuspension during the remedial dredging. The Farley model, along with FISHRAND, was used to simulate conditions in the Lower Hudson. The modeling efforts examined the impact of allowing the dredging to proceed at the action levels (both PCB concentrations in the water column and PCB mass loads). The model results indicate that the PCB water column concentrations and the PCB mass loads would have a negligible impact on PCB concentrations in Hudson River fish as compared to a scenario with no dredging-related releases (see footnote 2).

Analyses of Baseline Water Quality Data

In developing the Resuspension Standard, analyses were conducted using historical Hudson River water quality data to distinguish between the pre-dredging baseline concentrations of PCBs and suspended solids in the water column and PCB concentrations expected due to resuspension during dredging. Data collected since 1996 as part of GE's ongoing weekly sampling program were statistically evaluated to derive the monthly mean concentration of PCBs and the variance for the months of the dredging season (*i.e.*, May through November). The findings indicate maximum PCB concentrations during May and June of each year. Subsequent sensitivity analyses also indicate that the Total PCB loads specified in the Concern and Control Levels are similar to the range of existing baseline loads experienced by the river system. The baseline data to be collected prior to Phase 1 dredging will be used to refine these statistical analyses.

Performance Standard for Dredging Residuals

Objectives

The Performance Standard for Dredging Residuals (*i.e.*, Residuals Standard) is designed to detect and manage contaminated sediments that may remain after initial remedial dredging in the Upper Hudson River. The ROD calls for removal of all PCB-contaminated sediments in areas targeted for dredging, and anticipates a residual of approximately 1 mg/kg Tri+ PCBs (prior to backfilling). The "residual sediments" may consist of contaminated sediments that were disturbed but escaped capture by the dredge, resuspended sediments that were redeposited/settled, or contaminated sediments remaining below the initial dredging cut elevations (*e.g.*, due to uncertainties associated with interpolation between core nodes of the design sediment sampling program or insufficient core recovery).

The Residuals Standard requires the implementation of a post-dredging sampling and analysis program to detect and characterize PCB concentrations in the residual sediments. The post-dredging sediment data are compared to the anticipated residual of approximately 1 mg/kg Tri+ PCBs stated in the ROD and a group of statistical action

levels developed for the Residuals Standard. The approach to be taken to manage the residual sediments (including re-dredging) is then selected depending on the statistical analyses of the post-dredging data. The use of statistical analyses to evaluate environmental datasets is a scientifically accepted practice.

Statement of the Residuals Standard

Sampling and Analysis

The Residuals Standard requires the collection of surface sediment samples following dredging and after USEPA has confirmed that the design cut-lines have been achieved. Based on engineering judgment, the dredging is assumed to proceed within work areas that are similar to the median size of the targeted areas identified in the ROD. Therefore, a 5-acre “certification unit” was considered for the post-dredging sampling program and the subsequent statistical evaluation of the post-dredging surface sediment data. The Residuals Standard specifies that each certification unit be sampled for compliance directly after it is dredged, so that appropriate actions can be taken as the project progresses. In each 5-acre certification unit, sediment samples representing the 0-6 inch depth interval below the dredged sediment surface are to be obtained from 40 grid nodes and analyzed for Tri+ PCBs. The analytical results from those samples will be compared to the action levels in the Residuals Standard, and the required actions taken.⁸

Action Levels and Required Responses

The Residuals Standard requires the review of: 1) the Tri+ PCB concentrations in all 40 individual sediment samples within each 5-acre certification unit, 2) the mean Tri+ PCB concentration of the certification unit, 3) the median Tri+ PCB concentration of the certification unit, and 4) the average of the mean Tri+ PCB concentrations of a 20-acre joint evaluation area (certification unit under review and the three units within 2 mile stretch of river). The following responses are required for Phase 1 of the dredging project. Adjustments may be made before finalizing the Residuals Standard for Phase 2 based on analyses of the post-dredging sediment data collected during Phase 1. For example, if justified, the joint evaluation area may be increased to 40 acres for Phase 2.

1. Backfill (where appropriate) and Demobilize: At certification units with an arithmetic average residual concentration less than or equal to 1 mg/kg Tri+ PCBs, no sediment sample result greater than or equal to 27 mg/kg Tri+ PCBs, and not more than one sediment sample result greater than or equal to 15 mg/kg Tri+ PCBs, backfill (where appropriate) and demobilize from the certification unit.
2. Jointly Evaluate 20-acre Area: At a certification unit with an arithmetic average residuals concentration greater than 1 mg/kg Tri+ PCBs and less than or equal to 3 mg/kg Tri+ PCBs, no sediment sample result greater than or equal to 27 mg/kg Tri+

⁸ The Residuals Standard does not preclude collection of samples from deeper intervals, which may be cost-effective.

PCBs, and not more than one sediment sample result greater than or equal to 15 mg/kg Tri+ PCBs, jointly evaluate a 20-acre area.

For 20-acre evaluation, if the area-weighted arithmetic average of the individual means from the certification unit under evaluation and the 3 previously dredged certification units (within 2 miles of the current unit) is less than or equal to 1 mg/kg Tri+ PCBs, backfill may be placed (with subsequent testing required). Otherwise, the certification unit must be re-dredged (see #4 below for actions required during and following re-dredging) or a sub-aqueous cap constructed. Re-dredging or capping is to be conducted at the specific areas within the certification unit that are causing the non-compliant mean concentration. If the certification unit does not comply with #1 or #2, above, after two re-dredging attempts, contingency actions may be implemented in lieu of further re-dredging attempts, as described in #5, below.

3. Re-dredge or Construct Sub-aqueous Cap: At a certification unit with an arithmetic average residuals concentration greater than 3 mg/kg Tri+ PCBs but less than or equal to 6 mg/kg Tri+ PCBs, no single sediment sample result is greater than or equal to 27 mg/kg Tri+ PCBs, and not more than one sediment sample result is greater than or equal to 15 mg/kg Tri+ PCBs, re-dredge or construct a sub-aqueous cap. The choice of two options is provided to maintain flexibility and productivity (*e.g.*, some areas may not be conducive to dredging). If re-dredging is chosen, the surface sediment of the re-dredged area must be sampled and the certification unit re-evaluated. If the certification unit does not meet the objectives of #1 or #2, above, following two re-dredging attempts, contingency actions may be implemented in lieu of further re-dredging attempts, as described in #5, below.
4. Re-dredging Required: For areas of elevated Tri+ PCB concentrations within a certification unit with an arithmetic average residuals concentration greater than 6 mg/kg Tri+ PCBs or to address individual sampling point(s) with concentrations greater than or equal to 27 mg/kg Tri+ PCBs or more than one sampling point with concentrations greater than or equal to 15 mg/kg Tri+ PCBs, re-dredging is required.

Sampling at depths greater than 6 inches will be triggered by an arithmetic average residual concentration of greater than 6 mg/kg Tri+ PCBs. The spatial extent of this sampling at greater depth will be determined by the median Tri+ PCB concentration. If the median concentration in the certification unit is greater than 6 mg/kg Tri+ PCBs, collection and analysis of additional sediment samples is required from deeper intervals over the entire certification unit (*e.g.*, 6-12 inch, 12-18 inch, etc.) as necessary to re-characterize the vertical extent of PCB contamination. If the median concentration is 6 mg/kg Tri+ PCBs or less, characterization of the vertical extent of contamination is required only in the areas within the certification unit that are contributing to the non-compliant mean concentration. Additional sampling to characterize the vertical extent of contamination is contemplated only once.

The Residuals Standard provides a mechanism for calculating the horizontal extent of re-dredging. All re-dredging attempts are to be designed to reduce the mean Tri+

PCB concentration of the certification unit to 1 mg/kg Tri+ PCBs or less. If after two re-dredging attempts, the arithmetic average Tri+ PCB concentration in the surface sediment still is greater than 1 mg/kg, then contingency actions are to be implemented as stated in #5, below.

5. Contingency Actions: At areas where two re-dredging attempts do not achieve compliance with the residuals criteria, as verified by USEPA, construct an appropriately designed sub-aqueous cap, where conditions allow.

A flow chart illustrating implementation of the *Performance Standard for Dredging Residuals* is shown in Figure ES-1. The flow chart options are summarized in Table ES-2.

**TABLE ES-2
SUMMARY OF DRAFT RESIDUALS STANDARD**

Case	Certification Unit Mean (mg/kg Tri+ PCBs)	No. of Sample Results where $27 > \text{result} \geq 15$ mg/kg Tri+ PCBs	No. of Sample Results ≥ 27 mg/kg Tri+ PCBs	No. of Re-Dredging Attempts Conducted	Required Action (when all conditions are met)*
A	$x_i = 1$	= 1	0	N/A	Backfill certification unit (where appropriate); no testing of backfill required.
B	N/A	≥ 2	N/A	< 2	Redredge sampling nodes and re-sample.
C	N/A	N/A	1 or more	< 2	Redredge sampling node(s) and re-sample.
D	$1 < x_i \leq 3$	= 1	0	N/A	Evaluate 20-acre average concentration. If 20-acre average concentration ≤ 1 mg/kg Tri+ PCBs, place and sample backfill. If 20-acre average concentration > 1 mg/kg, follow actions for Case E below.
E	$3 < x_i \leq 6$	= 1	0	< 2	Construct sub-aqueous cap immediately OR re-dredge.
F	$x_i > 6$	N/A	N/A	0	Collect additional sediment samples to re-characterize vertical extent of contamination and re-dredge. If certification unit median > 6 , entire certification unit must be sampled for vertical extent. If certification unit median ≤ 6 , additional sampling required only in portions of certification unit contributing to elevated mean concentration.
G	$x_i > 6$	N/A	N/A	1	Re-dredge.
H	$x_i > 1$ (and 20-acre average > 1)	≥ 2	≥ 1	2	Construct sub-aqueous cap (if any of these mean/sample result conditions are true) and two re-dredging attempts have been conducted OR choose to continue to re-dredge.

*Except for Case H, where any of the listed conditions will require cap construction.

Supporting Analyses and Assumptions

Certification Unit Sample Size and Sampling Grid

USEPA's 2002 "Guidance for Choosing a Sampling Design for Environmental Data Collection" provides methods to determine the number of samples required to estimate the mean contaminant concentration of a given area. Evaluation of the 1984 Upper Hudson River sediment data (which is the most comprehensive to date), case study residuals data from other environmental dredging projects, and USEPA statistical guidance supported the use of 40 samples to characterize each 5-acre certification unit.

The 40 samples are to be collected from a regular triangular grid, which equates to a sample spacing of approximately 80 feet. The residuals sampling grid is to be offset from the design support sediment sampling grid by 40-60 percent of the grid spacing. Criteria for relocating sampling points, when necessary, are provided in the Residuals Standard. The Residuals Standard accommodates the application of the sampling grid to certification units that differ in size from the conceptual 5-acre unit. This flexibility is provided to address circumstances in which the remedial dredging may result in certification units of varying sizes (*e.g.*, due to the installation of silt barriers, if used).

Action Level Development

The action levels originated with the statement in the ROD that anticipates a residual in dredged areas of approximately 1 mg/kg Tri+ PCBs (before backfilling). Statistical thresholds were developed to evaluate residuals sampling data and trigger responses, a common scientifically accepted practice for interpreting environmental data. The thresholds consist of action levels for the area-weighted mean concentration (upper confidence limits, or UCLs) and action levels for individual sample results (prediction limits, or PLs). Both UCLs and PLs are measures of the probability that a sample result belongs to a sample population that has a specific mean; consistent with the ROD, the desired mean for Upper Hudson River residuals is 1 mg/kg Tri+ PCBs or less).

Since no residual sediment data exist for the Upper Hudson River (and will not exist until after remedial dredging is initiated), UCLs and PLs were calculated based on residual sediment data from other environmental dredging projects. The values derived for the Residuals Standard are: 3 mg/kg Tri+ PCBs (95% UCL), 6 mg/kg Tri+ PCBs (99% UCL), 15 mg/kg Tri+ PCBs (97.5% PL), and 27 mg/kg Tri+ PCBs (99% PL). These criteria are used to evaluate the degree to which the residual of approximately 1 mg/kg Tri+ PCBs specified in the ROD is attained in a particular certification unit, and to trigger appropriate actions for managing residual sediments.

Requirement for Collection of Additional Core Samples

The Residuals Standard requires the collection of additional sediment samples where the initial mean Tri+ PCB concentration (0-6 inch interval) for the certification unit is greater than 6 mg/kg. Residual sediments with a Tri+ PCB concentration above the 99% UCL

indicates the dredge was still removing material from a contaminated stratum. In this case, it is possible that additional contaminated sediment “inventory” remains to be removed. The median concentration is used as a criterion to determine whether deeper sediment samples (e.g., 6-12 inch, 12-18 inch, etc. as necessary to define the vertical extent of contamination) must be collected from all 40 sampling points in the certification unit or, as appropriate, from smaller sub-areas where isolated or clustered elevated nodes are causing the mean concentration to exceed the requirements of the standard. Following the collection and evaluation of the deeper sediment samples, new cut-lines must be established and re-dredging conducted to reduce the residual concentrations.

Required Number of Re-dredging Attempts

To maintain dredging productivity, and noting that case studies of other environmental dredging projects report diminishing returns for successive re-dredging in an attempt to obtain the remedial objectives, the number of required re-dredging attempts was set at two attempts. Re-dredging attempts are dredging efforts conducted to reduce residual concentrations, and by definition occur subsequent to the USEPA’s confirmation of attainment of the initial design cut elevations to remove inventory. The Construction Manager may also choose to conduct additional re-dredging attempts, based on cost considerations or knowledge of the dredging area, with the intent of reducing the mean Tri+ PCB concentration in the certification unit to 1 mg/kg or less Tri+ PCBs.⁹

Based on the Phase 1 results and the second peer review, USEPA may modify the required number of redredging attempts (or the triggers for engineering contingencies and capping, described below).

Engineering Contingencies and Capping

In the event that the dredging operations after two or more dredging attempts cannot achieve the Residuals Standard of a mean concentration of 1 mg/kg Tri+ PCBs or less, engineering contingencies must be implemented, including the construction of a sub-aqueous cap, where conditions permit, over the recalcitrant area to address the residual PCB contamination.

Where further dredging is not practicable, the sub-aqueous cap is intended to support recovery of the Hudson River ecosystem following removal of inventory, similar to the function of the backfill. Two types of caps are envisioned: a residuals cap and an isolation cap, the latter being the more stringently designed. Selection of the sub-aqueous cap type is dependent on the residual PCB concentration; i.e., the residuals cap may be selected for certification units with mean concentrations of 6 mg/kg Tri+ PCBs or less (99% UCL), while the isolation cap is required for certification units with mean concentrations exceeding that level. The cost of cap construction and maintenance should be balanced by the Construction Manager, in consultation with USEPA, against the cost of additional re-dredging attempts and their respective impacts on the schedule.

⁹ This option is limited to circumstances where no project delays affecting the ability to meet the Productivity Standard will be incurred.

The installation of a sub-aqueous cap is likely to further reduce residual concentrations of PCBs and may require additional dredging to accommodate the cap thickness. While not expected, should conditions encountered in the navigation channel require the installation of a sub-aqueous cap, sufficient dredging may be required to install the cap and an upper, armored layer below the navigation depth. The armored layer would act as an indicator during future navigational dredging in the channel to prevent damage to the cap.

Joint Evaluations and Backfill Testing

The concept of a 20-acre joint evaluation was developed to maintain flexibility where the mean residual concentrations in selected 5-acre certification units are only slightly higher than 1 mg/kg Tri+ PCBs. The size of the joint evaluation area was chosen based on USEPA's peer-reviewed fate, transport and bioaccumulation models for the Upper Hudson River (HUDTOX and FISHRAND), which were used to evaluate recovery of the Upper Hudson following remediation. The models used river segments in the Thompson Island Pool that are similar in size to the 20-acre joint-evaluation areas. The benefits of targeted remedial dredging projected by the USEPA models hold if the mean residuals concentration is 1 mg/kg Tri+ PCBs or less on average, over 20-acre areas.

If a certification unit has a mean residuals concentration of greater than 1 mg/kg Tri+ PCBs but less than or equal to 3 mg/kg Tri+ PCBs, and the average concentration in the 20-acre joint evaluation area that contains the certification unit is 1 mg/kg Tri+ PCBs or less, backfill may be placed without a re-dredging attempt. In this case, testing of the backfill after placement is required.

The backfill testing is to be accomplished by collecting surface sediment samples (0-6 inches) of the backfill after it is placed, using the same grid spacing used for the residual sediment sampling. Each 0-6 inch backfill sample is to be analyzed for PCBs. The mean concentration of PCBs in the backfill samples must be 0.25 mg/kg Tri+ PCBs or less. If this criterion is not met, the non-compliant areas of the backfill layer must be removed via dredging, replaced, and retested until the criterion is achieved. Alternately, in some areas it may be possible to place additional backfill material. However USEPA approval is required for this option.

Performance Standard for Dredging Productivity

Objective

The Performance Standard for Dredging Productivity (*i.e.*, Productivity Standard) is designed to monitor and maintain the progress of the dredging to meet the schedule stated in the ROD. The project schedule stated in the ROD has a six-year duration and consists of the first dredging season designated "Phase 1" (initial dredging at a reduced scale) followed by five dredging seasons collectively designated "Phase 2" (each with dredging at full production to remove the remainder of the contaminated sediments identified for removal). The Productivity Standard specifies the cumulative volume of sediment to be

dredged during each dredging season, based on the current estimate of 2.65 million cubic yards of sediment to be removed.

Statement of the Productivity Standard

Required and Recommended Cumulative Annual Dredging Volumes

The Productivity Standard requires compliance with minimum cumulative volumes of sediment for each dredging season and targets larger volumes for the first five dredging seasons, as provided in Table ES-3 below. The minimum cumulative volume of sediment to be removed, processed and shipped off-site by the end of each dredging season is the quantity shown in the “Required Cumulative Volume” column. The targeted cumulative volumes allow for the work to be designed for completion at a somewhat faster rate, so that a reduced volume remains in the sixth and final dredging season. This recommended approach provides additional time to address any unexpected difficulties within the schedule called for in the ROD. The targeted cumulative dredging volumes are shown in the “Target Cumulative Volume” column.

Table ES-3: Productivity Requirements and Targets

Dredging Season⁽¹⁾	Required Cumulative Volume (cubic yards)	Target Cumulative Volume (cubic yards)
Phase 1 (Year 1)	Approx. 240,000	265,000
Phase 2 (Year 2)	720,000	795,000
Phase 2 (Year 3)	1,200,000	1,325,000
Phase 2 (Year 4)	1,680,000	1,855,000
Phase 2 (Year 5)	2,160,000	2,385,000
Phase 2 (Year 6)	2,650,000 ⁽²⁾	2,650,000 ⁽²⁾

⁽¹⁾ The overall completion schedule, if appropriate, should be adjusted to be consistent with the total volume of sediment to be dredged as determined by USEPA during remedial design (for example, based on the findings of the design support sediment characterization program).

⁽²⁾ Represents total estimated in-situ volume to be removed as per the ROD, exclusive of any amounts generated by re-dredging to meet the Residuals Performance Standard.

Monitoring and Recordkeeping

The Productivity Standard requires the Contractor managing the dredging project to track and report progress to the USEPA. The recordkeeping, in addition to and as verified by USEPA or its representatives in the field, will become the basis for measuring compliance with the Productivity Standard. By March 1 of each year, the Contractor shall provide USEPA with a schedule showing cumulative volumes planned to be removed each month during the upcoming dredging season (*i.e.*, Production Schedule). The production schedule should consider the targeted cumulative volumes and must meet or exceed the requirements of the Productivity Standard (or as revised in accordance with USEPA-approved design documents).

Monthly and annual productivity progress reports shall be submitted to USEPA. Monthly productivity progress reports will be compared to the production schedule submitted by the Contractor and will be the primary tool for assessing whether the project is on schedule. Annual production progress reports, prepared at the conclusion of each dredging season, will be used to evaluate compliance with the Productivity Standard.

The monthly and annual reports will summarize daily records of the dredging locations, approximate production and number of operating hours of operation for each dredge, estimates of in-situ sediment volumes removed, and the weight of dewatered sediments and estimated mass of PCBs shipped off-site.

Action Levels and Required Responses

The Productivity Standard's action levels and responses are summarized in Table ES-4 below.

Table ES-4: Action Levels and Required Responses

Action Level	Description	Response
Concern Level	Monthly production rate falls 10% below scheduled rate.	Notify USEPA and take immediate steps to erase shortfall in production over next two months.
Control Level	Production falls below scheduled production by 10% or more for two or more consecutive months.	Submit an action plan explaining the reasons for the production shortfall and describing the engineering and management actions taken or underway to increase production and erase shortfall by end of the dredging season.
Standard	Annual cumulative volume fails to meet required production requirements.	Action to be determined by USEPA.

In any dredging season, if the planned monthly cumulative production falls below the scheduled amount by 10 percent or more, the Contractor shall identify the cause of the shortfall to USEPA and take immediate steps (adding equipment and crews, working extended hours, modifying the plant and equipment or approach to the work, or other) to erase the cumulative shortfall over the following two months or by the end of the dredging season, whichever occurs sooner. Any steps taken to increase production shall conform to all other Performance Standards established for the project. Significant changes to operating procedures or equipment, such as use of an entirely different dredging technology or means of processing the dredged sediments prior to shipment, will require USEPA approval.

If the monthly productivity falls below the scheduled productivity by 10 percent or more for two or more consecutive months, the Contractor shall provide a written action plan to

the USEPA explaining the reasons for the production shortfall and describing the engineering and management steps taken or underway to erase the shortfall in production during that dredging season.

If an annual production shortfall occurs, USEPA will determine the appropriate action to address non-compliance with the Productivity Standard. USEPA will also evaluate the circumstances that led to the annual shortfall, if encountered, when assessing compliance.

Supporting Analyses and Assumptions

Conceptual Project Schedule

To evaluate the feasibility of the required and target cumulative annual volumes specified in the Productivity Standard (refer to Table ES-3), a detailed conceptual critical path schedule was developed using Primavera Systems, Inc. software. A number of conservative assumptions were made regarding means and methods that could be used during the dredging project in order to demonstrate that the Productivity Standard is achievable. The Productivity Standard, however, does not require that the remedial design adhere to the assumptions and work sequence used to develop the Productivity Standard conceptual schedule. The schedule output indicates that both the required and the target cumulative volumes developed for the Productivity Standard are reasonable and achievable. Selected examples of the supporting analyses and assumptions used to develop the schedule are summarized below.

Removal Volume

The Productivity Standard is based on the removal of approximately 2.65 million cubic yards of sediment, as stated in the ROD. This volume may be revised upward or downward based on the results of the design support sediment characterization program. The Productivity Standard requires adjustment if the final targeted dredging volume differs by more than 10% from the current estimate.

Construction Schedule and Dredging Season

The Productivity Standard is based on a construction period for the project of six (6) years (including Phases 1 and 2, as stated in the ROD) and assumes that there will be a minimum of 30 weeks available each year to conduct dredging operations, unconstrained by any work hours limitations. To implement this schedule, coordination would be required with the New York State Canal Corporation to extend their routine hours and season of operation.

Dredging Equipment

Both mechanical and hydraulic dredges were considered during the development of the conceptual schedule. Smaller specialty equipment was also considered for use near shorelines, in shallow water, and in difficult locations (such as shallow bedrock areas).

Estimated dredging volumes were developed by river section and dredge type for the schedule. The conceptual schedule included only the use of a mechanical dredge as a conservative approach, since mechanical dredging is typically a slower process. The schedule assumes that dredging can take place in multiple river sections simultaneously, with the dredging generally progressing from upstream to downstream within each river section.

Work Elements and Sequence

The conceptual schedule assumptions address the potential elements and sequence of the dredging work. The assumptions include, but are not limited to, the following:

- Silt barriers, while not required by the Productivity Standard, were assumed to be installed for all dredging work outside the navigation channel. The assumed silt barriers consist of segments of steel sheet piling installed at the upstream and downstream limits of the work area, connected by high density polyethylene (HDPE) curtains with floatation booms and weighted at the bottom. This assumption is conservative with respect to the schedule, which accounts for the time necessary to install and remove the silt barriers.
- Silt barriers are removed only after backfill and shoreline stabilization where appropriate, has been completed.
- Backfilling and shoreline stabilization at each area dredged in a particular season is completed prior to demobilization at the end of each dredging season.
- Work is conducted in a generally upstream to downstream sequence within a given river section.

Sediment Processing/Transfer Facility

The conceptual schedule of the Productivity Standard assumed the establishment of one land-based sediment processing/transfer facility, located at the northern extreme of the 40-mile long project area. Conceptual design calculations were prepared regarding railroad sidings, transportation of scows loaded with dredged sediments via the canal system, and other transportation issues to evaluate whether the dredged sediment volumes to be removed could be transferred, processed (*e.g.*, dewatered), and shipped off-site at an appropriate rate (compared to the required and target production rates). The assumption of one facility was made to be conservative with respect to the schedule, in that it requires sufficient time for sediments removed from any location within the Upper Hudson to be transported to one location. A less conservative assumption would entail two facilities, as was assumed for purposes of evaluating engineering feasibility of the remedy. Note, however, that the assumption does not reflect a worst case based on available information, which would be one facility at or below the southern extreme of the project area.

Interactions Among Performance Standards

The development of the Performance Standards included consideration of the degree to which they are interrelated. Some of the major points of interaction between the Standards, and issues identified as being significant to the compliance with all the standards, are summarized below. The design of the project should be optimized in consideration of these interactions.

- The Resuspension Standard controls PCB mass loss during dredging. It is important to note that PCB mass loss is intrinsically linked to dredging productivity, in that ongoing project activities (dredging, vessel traffic, installation and removal of barriers, if used, and debris removal) will contribute to PCB mass loss. The Resuspension Standard Concern Level and Control Level are triggered if the average daily Total PCB mass loss exceeds 600 g/day for more than a one-week, or four-week stretch, respectively.¹⁰ Non-compliance with the Productivity Standard beyond the six (6) year schedule will increase the total project PCB mass loss. If unforeseen difficulties require extensions to the schedule, the daily allocation of PCB mass loss will have to be commensurately lowered during the remainder of the dredging project to maintain the PCB mass loss of 650 kg upon which the Resuspension Standard action levels are based. Achievement of the target cumulative annual volumes in the Productivity Standard is strongly encouraged to minimize the total project-related downstream transport of PCBs.
- Balancing the limits on PCB concentrations in the water column in the Resuspension Standard and the cumulative annual volumes in the Productivity Standard requires careful planning during equipment deployment considering, for example, the impacts of the number and types of equipment selected, location of dredging areas, and the monthly baseline variation in PCB water column concentrations. This is an area where Phase 1 monitoring is expected to contribute significantly to the understanding of how to efficiently proceed with dredging and maintain compliance with the Performance Standards.
- The Residuals Standard requires characterization of residual sediments, which may include redeposited/settled sediments. To avoid recontamination of a satisfactorily completed certification unit, the Productivity Standard assumes that dredging generally will proceed from upstream to downstream within each River Section. The Resuspension Standard modeling also indicates that the dredge may create a deposit of resuspended sediments slightly downstream of each dredging area, providing further incentive for work to proceed generally from upstream to downstream.
- The Productivity Standard includes a conceptual sequence of work and schedule for the dredging work to validate the feasibility of the required and target cumulative annual dredging volumes. The conceptual sequence of work and schedule necessarily

¹⁰ The daily rate is based on attainment of the recommended target cumulative volume as specified in the Productivity Standard, and should be prorated according to the production rate planned in the Production Schedule to be submitted annually to USEPA.

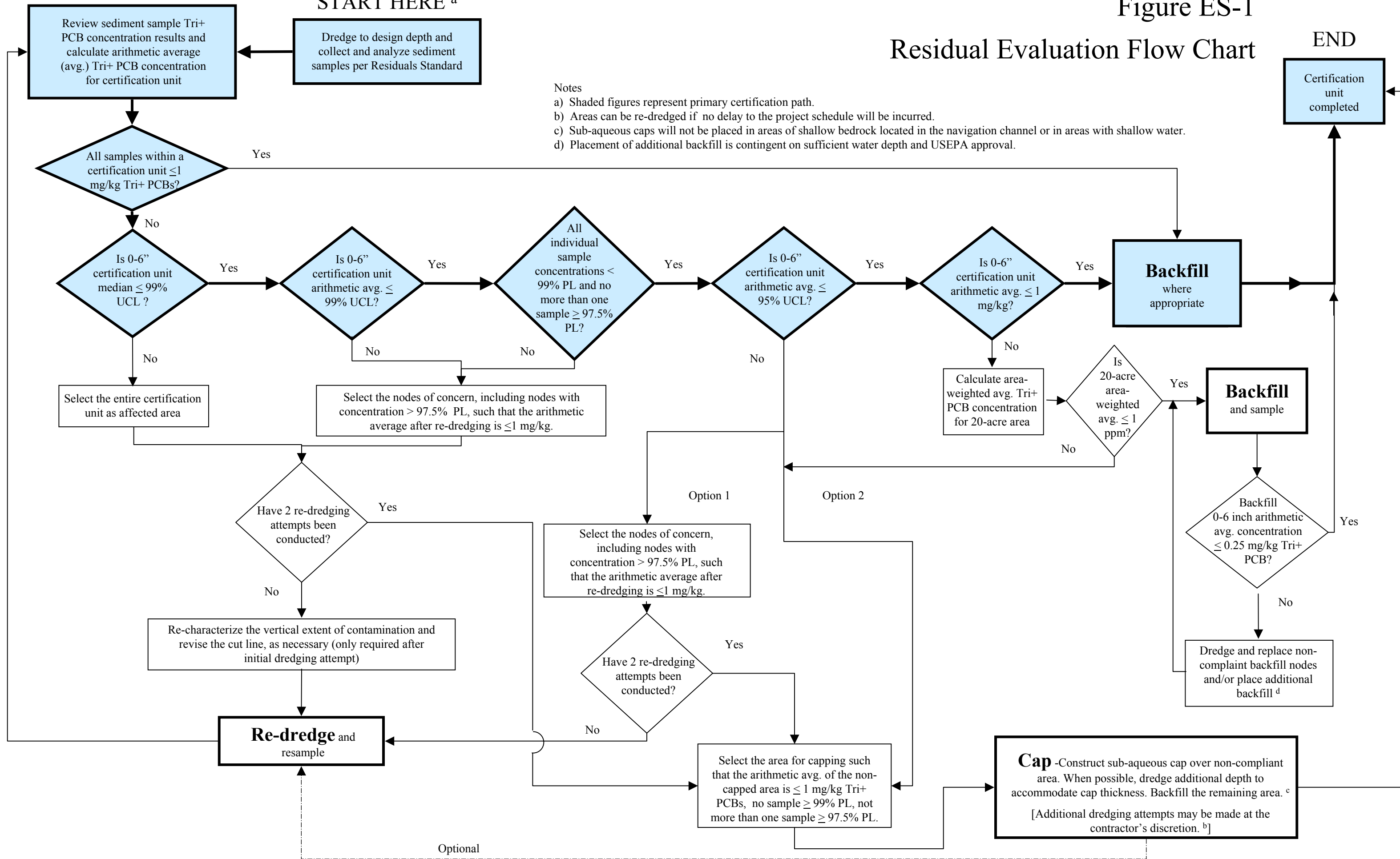
included, among other elements, the time needed to comply with the requirements of the Residual Standard for sampling and analysis of each certification unit, possibly two re-dredging attempts and/or sub-aqueous cap construction, and placement of backfill (where appropriate) prior to demobilization. For instance, USEPA conservatively assumed that re-dredging could require half of the total time spent on the initial dredging. However, if significantly more time is needed for re-dredging than was estimated in the conceptual schedule, it may affect the ability to meet the overall productivity standard. Understanding that these work elements contribute to the project duration, flexibility was designed in the Residuals Standard (*e.g.*, provisions for 20-acre joint evaluations during Phase 1, options for immediate capping where the certification unit mean is only slightly greater than the objective of 1 mg/kg Tri+ PCBs, and provisions for successively closing portions of a certification unit as dredging progresses) to maintain productivity. The experience and information gained during Phase 1 of dredging will be the subject of the second peer review. This peer review will evaluate the project performance in Phase 1, so that any necessary refinements and adjustments can be made to the dredging operations or standards, including the Productivity Standard, prior to the second phase of dredging.

Figure ES-1

Residual Evaluation Flow Chart

START HERE ^a

END



Introduction

Introduction

Draft Engineering Performance Standards – Public Review Copy Hudson River PCBs Superfund Site

Overview

In February 2002, the United States Environmental Protection Agency (USEPA) issued a Record of Decision (ROD) for the Hudson River PCBs Superfund Site (Site). The ROD calls for targeted environmental dredging of approximately 2.65 million cubic yards of PCB-contaminated sediment from the Upper Hudson River (approximately 40 river miles) in two phases over a six-year period, and monitored natural attenuation of the PCB contamination that remains in the river after dredging.

In the ROD, USEPA identified five remedial action objectives, which are as follows:

- Reduce the cancer risks and non-cancer health hazards for people eating fish from the Hudson River by reducing the concentration of PCBs in fish;
- Reduce the risks to ecological receptors by reducing the concentration of PCBs in fish;
- Reduce PCB levels in sediments in order to reduce PCB concentrations in river (surface) water that are above applicable or relevant and appropriate requirements for surface water;
- Reduce the inventory (mass) of PCBs in sediments that are or may be bioavailable; and
- Minimize the long-term downstream transport of PCBs in the river.

In selecting its cleanup remedy, USEPA required that performance standards for resuspension during dredging, production rates during dredging, and residuals after dredging (together called the “Engineering Performance Standards”) be established to address comments received from some of the public suggesting that the environmental dredging could “do more harm than good” and take much longer than stated. USEPA required these performance standards in its final cleanup decision to promote accountability and ensure that the cleanup meets the human health and environmental protection objectives set forth in the ROD.¹

This Public Review Copy of the Draft Engineering Performance Standards document is published in four volumes. The standards are presented in three parts, each contained in a single volume; an Appendix is contained in the fourth volume. Each part discusses one performance standard: *Part 1* discusses the Performance Standard for *Dredging Resuspension*, *Part 2* provides the Performance Standard for *Dredging Residuals*, and *Part 3* contains the Performance Standard for *Dredging Productivity*. Each of these parts includes a concise statement of the standard, discussion on the development approach,

¹ Other performance standards will address public concerns related to potential impacts of the cleanup on the surrounding community, such as air emissions, navigation and noise; these are being developed separately.

supporting analyses, and rationale used to derive the performance standard. Each part further provides a plan for refinement of the standard to account for additional data that may be obtained subsequent to publishing the standard, as well as to address evaluation of Phase 1. The Appendix contains a review of pertinent information derived from case studies of other environmental dredging projects considered in developing the draft Engineering Performance Standards. Some of the information was derived from research of the literature and public web sites, while additional information was developed from interviews with project managers and technical staff.

Consistent with the ROD, the Engineering Performance Standards were developed in consultation with New York State, the National Oceanic and Atmospheric Administration and the U.S. Fish and Wildlife Service. (New York State is developing substantive water quality certification requirements for the environmental dredging pursuant to the federal Clean Water Act, which has been delegated to the State; USEPA will review the requirements when they become available for any implications with respect to the Engineering Performance Standards). USEPA's consultants included a team of senior scientists and engineers who developed the standards, which then were reviewed by a separate team of recognized technical experts. General Electric Company reviewed a version of the draft standards previous to this one. Comments from these organizations were considered in preparing this Public Review Copy of the Draft Engineering Performance Standards.

Following the close of the public comment period, the Draft Engineering Performance Standards will be revised as appropriate and released to the public as the Draft Engineering Performance Standards – Peer Review Copy. The standards will be peer reviewed by a panel of independent experts, modified as appropriate to address the peer reviewers' recommendations, and then implemented during the Phase 1 dredging. The results from the first season of dredging (Phase 1) also will be peer reviewed, and the Engineering Performance Standards will be refined or adjusted, if necessary, for the remaining dredging seasons (Phase 2).

It is important to note that the standards developed herein are intended only for application to the remedial environmental dredging of the Upper Hudson River called for in USEPA's 2002 ROD for the Hudson River PCBs Superfund Site at this juncture in time. The standards are not intended to provide general or universal guidance for environmental dredging. Other projects and locations may have specific features differing from those of the Hudson River, and the standards presented here may not be applicable to those projects.

Site Background

The Hudson River PCBs Superfund Site encompasses the Hudson River from the Fenimore Bridge in Hudson Falls (River Mile [RM] 197.3) to the Battery in New York Harbor (RM 0), a stretch of nearly 200 river miles (about 320 km). The Upper Hudson River portion of the Site extends from the Fenimore Bridge to the Federal Dam at Troy (RM 153.9), a distance of just over 43 river miles. To facilitate effective project

management and address Site complexities, the Upper Hudson River has been further divided into three major sections: River Sections 1, 2 and 3. River Section 1 extends from the former Fort Edward Dam just north of Rogers Island (RM 194.8) to the Thompson Island (TI) Dam (RM 188.5), a stretch of the river also known as the Thompson Island Pool; River Section 2 extends from the TI Dam to the Northumberland Dam (RM 183.4), which includes a 2.3-mile, non-navigable stretch of the river from the TI Dam to the Fort Miller Dam; and River Section 3 extends from the Northumberland Dam to the Federal Dam. Upstream of River Section 1 is a river segment between the Fenimore Bridge and the former Fort Edward Dam, a distance of about 2.5 river miles.

During an approximately 30-year period ending in 1977, General Electric (GE) used PCBs in its capacitor manufacturing operations at its Hudson Falls and Fort Edward, NY facilities. PCB oils were discharged both directly and indirectly from these plants into the Hudson River. This included both non-permitted and permitted discharges. Even after GE received a permit in 1975, permit exceedances occurred. Estimates of the total quantity of PCBs discharged directly from the two plants into the river from the 1940s to 1977 are as high as 1,330,000 pounds (about 605,000 kg).

Many of the PCBs discharged to the river adhered to sediments and accumulated downstream with the sediments as they settled in the impounded pool behind the former Fort Edward Dam, as well as other depositional areas farther downstream. Because of its deteriorating condition, the Fort Edward Dam was removed in 1973. Five areas of PCB-contaminated sediments were exposed due to the lowering of the river water level when the Fort Edward Dam was removed. These five areas are known as the Remnant Deposits. During subsequent spring floods, PCB-contaminated sediments from the Fort Edward Dam area were scoured and transported downstream.

In 1984, USEPA completed a Feasibility Study (FS) and issued a Record of Decision (ROD) for the site (the 1984 ROD). The 1984 ROD contained the following components:

- An interim No Action decision with regard to PCBs in the sediments of the Upper Hudson River;
- In-place capping, containment, and monitoring of exposed Remnant Deposits (in the area of RM 195 to 196) from the former impoundment behind the Fort Edward Dam, stabilization of the associated river banks and revegetation of the areas; and
- A detailed evaluation of the Waterford Water Works treatment facilities, including sampling and analysis of treatment operations to see if an upgrade or alterations of the facilities were needed.

Although commercial uses of PCBs ceased in 1977, GE's Fort Edward and Hudson Falls plants continue to contaminate the Hudson River with PCBs, due primarily to releases of PCBs via bedrock fractures from the GE Hudson Falls plant. In September 1991, GE detected an increase in PCB concentrations at the Upper Hudson River water sampling stations being monitored as part of the construction monitoring program associated with Remnant Deposits capping. GE ultimately attributed the higher levels to the collapse of a

wooden gate structure within the abandoned Allen Mill located adjacent to the river bank near the GE Hudson Falls plant. As reported by GE, the gate structure had diverted water from a tunnel that had been cut into bedrock, thereby preventing oil-phase PCBs originating at the GE Hudson Falls plant, that had migrated to the tunnel via subsurface bedrock fractures, from flowing into the river. From 1993 to 1995, GE removed approximately 45 tons of PCBs from the tunnel under NYSDEC jurisdiction. In 1994, GE documented the presence of PCB-contaminated oils in bedrock seeps at Bakers Falls adjacent to its Hudson Falls plant. GE has instituted a number of mitigation efforts that have resulted in a decline, but not cessation, of PCBs entering the river through the seeps.

The 1984 ROD did not address the PCB-contaminated oil leaking through bedrock in the vicinity of the GE Hudson Falls plant, which was not known to USEPA at the time. GE is conducting remedial activities at the GE Hudson Falls Plant Site under an Order on Consent between the New York State Department of Environmental Conservation (NYSDEC) and GE. The changing upstream loading from the Hudson Falls site must be accounted for in any evaluation of PCB levels within the Hudson River. In addition, the GE Fort Edward Plant outfall area is likely a continuing source of PCBs to the Hudson River.

In December 1989, USEPA announced its decision to initiate a detailed Reassessment Remedial Investigation/Feasibility Study (RI/FS) of the interim No Action decision for the Upper Hudson River sediments. This was prompted by the five-year review required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), technical advances in sediment dredging and treatment/destruction technologies, as well as a request by NYSDEC for a re-examination of the 1984 decision. The February 2002 ROD is the result of the Reassessment.

Engineering Performance Standards Development

This document presents the development of the performance standards required by the ROD and discusses the major measure(s) of performance in each case, the technique(s) used to assess performance, the supporting analyses for the recommendations (including case studies), and major possible interactions among the performance standards.

To develop meaningful performance standards, it was necessary to envision a likely sequence of work for the major elements of the remediation project. It is understood that this “model sequence” may require adjustment as the remedial design is prepared. The model sequence of work outlined below is based on information in the ROD and emphasizes the points where the performance standards will interact with the work.

1. Extensive sediment sampling and analyses are conducted to identify locations where the Tri+ PCB mass per unit area (MPA) is 3 g/m^2 or greater in River Section 1 and 10 g/m^2 or greater in River Section 2. In River Section 3, identification of target areas is based on removal of selected sediments with high concentrations of PCBs, high erosional potential and potential for uptake by biota. This information, in conjunction with other field investigation data, is used to

- determine target area boundaries for dredging and to delineate dredging “cut-lines.” The dredging cut-lines are to be designed to remove all PCB-contaminated sediments within a particular targeted area (*i.e.*, the dredged bottom surface concentration is anticipated to be below 1 mg/kg).
2. Regular water column sampling and analysis is conducted to evaluate the PCB and total suspended solid (TSS) concentrations in the Hudson River prior to dredging (background concentrations).
 3. Upon commencement of remediation, environmental dredging is employed to remove contaminated sediments from the targeted areas. Water quality monitoring is conducted continuously according to the requirements of the Dredging-Related Resuspension Performance Standard. Contingency actions are implemented to control resuspension releases if the action levels in the standard are contravened.
 4. On completion of dredging in a particular targeted area, post-dredging sediment sampling is conducted according to the requirements of the Dredging Residuals Performance Standard to confirm that residual PCB concentrations are less than or equal to the anticipated residual concentration of approximately 1 mg/kg, as specified by the ROD. Contingency actions are implemented if sediment sample results from a particular targeted area are non-compliant. Following verification, backfill is placed where appropriate and shoreline stabilization is completed.
 5. The progress of the dredging project is monitored according to the requirements of the Dredging Productivity Performance Standard. Contingency actions are implemented if the dredging production rate deviates significantly from that required by the performance standard.
 6. At the completion of the first dredging construction season (Phase 1), remedial operations are assessed for compliance with the various performance standards. If necessary, adjustments to the remedial operations and performance standards are recommended, evaluated by the peer review panel, and implemented.
 7. Phase 2 dredging commences and continues through project completion. Extensive monitoring (including that required to establish compliance with the performance standards) continues throughout the life of the project. Adjustments to the remedial operations and performance standards may also be implemented during Phase 2 consistent with the peer-reviewed approach.
 8. Property restoration and decommissioning of the processing/transfer facility location(s) are conducted as expeditiously as practicable following completion of dredging and backfill activities. Habitat replacement and associated monitoring are performed in accordance with the approved plan.

Based on the analyses performed to develop the standards, USEPA believes that the standards are consistent with the human health and environmental protection objectives of the ROD. USEPA has determined:

- Compliance with the Resuspension Standard will limit the concentration of Total PCBs in river water one mile or more downstream of the dredging area to levels that are acceptable for potable water under the requirements of the Safe Drinking Water Act;

- Resuspension of PCBs in compliance with the Resuspension Standard will have a negligible adverse effect on Tri+ PCB concentrations in Hudson River fish, as compared to a scenario assuming no dredging-related PCB releases;²
- Compliance with the Control Level of the Resuspension Standard is expected to result in a Total PCB load (mass) transported downstream during remedial dredging that is similar to the range of Total PCB loads detected during recent baseline (*i.e.*, pre-dredging) conditions, as documented by weekly measurements from 1996 to 2001;
- The Residuals Standard specified in the ROD (approximately 1 mg/kg Tri+ PCBs prior to backfilling) is achievable based on case studies of other environmental dredging projects and can be applied in the Upper Hudson on an area-wide average basis;
- The Productivity Standard will result in completion of the dredging within the six dredging seasons called for in the ROD, based on an example conceptual schedule for project implementation; and
- The three Draft Engineering Performance Standards, including their respective monitoring programs, are achievable individually and in combination.

Performance Standard for Dredging Resuspension

The Performance Standard for Dredging Resuspension (*i.e.*, Resuspension Standard) is designed to limit the concentration of PCBs in river water such that water supply intakes downstream of the dredging operations are protected, and to limit the downstream transport of PCB-contaminated dredged material. The attendant water quality monitoring program will be implemented to verify that the objectives of the Resuspension Standard have been met during dredging. The analytical results obtained from the water quality monitoring will be compared to the Resuspension Standard and associated lower action levels to monitor and control resuspension through appropriate actions. Such actions could include, as appropriate, expanding the monitoring program, notifying public water suppliers, implementing operational or engineering improvements, and, if necessary, temporarily halting the dredging.

The ROD requires the development of a Resuspension Standard but does not set forth any framework or numerical value for the Standard. The Resuspension Standard and a series of tiered action levels were developed based on extensive modeling, review of environmental dredging case study data, and evaluation of applicable or relevant and appropriate requirements (ARARs) identified in the ROD for PCBs in river water. Thresholds for increased monitoring and engineering controls provide a basis for design

² A negligible effect is defined, in this case, as a predicted Tri+ PCB concentration in Upper Hudson fish of 0.5 mg/kg or less, and in Lower Hudson River fish of 0.05 mg/kg or less, within 5 years after the completion of dredging in the Upper Hudson.

and evaluation of a contingency plan in the event of a contravention of the action levels. Once a baseline monitoring program has been finalized and implemented for the project, new water quality data will be collected and evaluated. The improved understanding of baseline conditions will be used to prepare a more thorough description of the relationships between water quality parameters and to further refine or adjust the Resuspension Standard (primarily the associated monitoring program), as necessary, based on the peer-reviewed approach. A plan is presented for refinement of the standard and the associated monitoring program, both as a result of availability of ongoing baseline monitoring data prior to Phase 1, and following completion and evaluation of Phase 1.

Performance Standard for Dredging Residuals

The Performance Standard for Dredging Residuals (*i.e.*, Residuals Standard) is designed to detect and manage contaminated sediments that may remain after initial remedial dredging in the Upper Hudson River. The ROD calls for removal of all PCB-contaminated sediments in areas targeted for dredging, and anticipates a residual of approximately 1 mg/kg Tri+ PCBs (prior to backfilling). The “residual sediments” may consist of contaminated sediments that were disturbed but escaped capture by the dredge, resuspended sediments that were re-deposited/settled, or contaminated sediments remaining below the initial dredging cut elevations (*e.g.*, due to uncertainties associated with interpolation between core nodes of the design sediment sampling program or insufficient core recovery).

The Residuals Standard requires the implementation of a post-dredging sampling and analysis program to detect and characterize PCB concentrations in the residual sediments. The post-dredging sediment data are compared to the anticipated residual of approximately 1 mg/kg Tri+ PCBs stated in the ROD and a group of statistical action levels developed for the Residuals Standard. The approach to be taken to manage the residual sediments (including re-dredging) is then selected depending on the statistical analyses of the post-dredging data. The use of statistical analyses to evaluate environmental datasets is a scientifically accepted practice.

The development of the residuals performance standard was accomplished using information from remedial dredging project case studies, and consideration and implementation of statistical data evaluation tools. The standard also encompasses contingency options in the event of non-compliance, and the development of an approach to refine the standard following analysis and interpretation of Phase 1 data.

Performance Standard for Dredging Productivity

The Performance Standard for Dredging Productivity (*i.e.*, Productivity Standard) is designed to monitor and maintain the progress of the dredging to meet the schedule stated in the ROD. The project schedule stated in the ROD has a six-year duration and consists of the first dredging season designated “Phase 1” (with dredging at a reduced scale) followed by five dredging seasons collectively designated “Phase 2” (each with dredging

at full production to remove the remainder of the contaminated sediments identified for removal). The Productivity Standard specifies the cumulative volume of sediment to be dredged during each dredging season, based on the current estimate of 2.65 million cubic yards of sediment to be removed. Following the completion of Phase 1, the data obtained from the monitoring program will be analyzed to determine if refinements to the Productivity Standard or changes to the Phase 2 remedial program are necessary.

Structure and Content of the Engineering Performance Standards

As stated above, the Engineering Performance Standards are presented in three parts, one for each of the three standards. To provide a comprehensive and consistent presentation of each standard, each part is subdivided into four sections, as follows:

Section 1 – Statement of the Performance Standard

This section provides a concise statement of the standard and associated lower-tier action levels with no rationale or background explanation. It simply states the standard as it is to be implemented during the dredging program.

Section 2 – Technical Basis of the Performance Standard

This section contains three major subsections describing the technical basis for development of the standard.

Background and Approach

The objectives, development processes, and methodology used in the development of these standards are presented in this section. A brief summary of the scope for the development of the standard is included in this section. Summaries of several case studies that are similar in nature to this project are also presented.

Supporting Analyses

This section analyses the available information for its applicability to this project. This section includes the statistical evaluations and modeling required in order to derive the standard. Evaluations of baseline monitoring data or performance data from previous case studies, as well as any conceptual design activities, that give substance to the derivation of the standard are provided.

Rationale for Determination of the Standard

Based on the supporting analyses performed, a determination is made as to what the performance standard should be, and the rationale for this determination is discussed. Analysis of case studies, along with reasoning and explanation of decisions and judgments made to arrive at the standard is provided in this section.

Section 3 – Implementation of the Performance Standard

This section is a full presentation of the standard, including conceptual information to be provided to assist the user to interpret application of the standard in unforeseen circumstances. Action levels, including the standard proper, along with monitoring requirements and the basis for engineering controls and contingencies to be required at each level, are laid out in detail.

Section 4 - Plan for Refinement of the Performance Standard

This section contains a plan for refinement of the standard that may be appropriate due to ongoing collection of baseline data, or to discovery of additional case studies that shed new light on the development of the standard prior to implementation of Phase 1. In addition, the plan will address the means by which data developed during monitoring of Phase 1 operations and impacts will be used to refine or adjust the standard prior to and during Phase 2.

Within each Section, the presentation may vary from Standard to Standard, in order to suit the needs of that particular Standard.

Key Project Personnel and Roles

In order to facilitate development of engineering performance standards that are consistent with the state-of-the-art dredging technologies and methods, scientific and statistical analysis, and the current level of knowledge about the Hudson River system, Malcolm Pirnie assembled a technical team of highly qualified professionals, many of whom had been involved with the Reassessment RI/FS for the site, or previous work on the river on behalf of New York State. In addition, the quality review normally conducted internally was delegated to a diverse team of technical experts assembled from a broader pool of candidates, recognized in their respective fields, and functioning independently of the technical team developing the standards.

Technical Team

The technical effort was divided among three teams corresponding to the three standards to be developed. Key senior members of the technical team are presented below.

Bruce Fidler, P.E. – Engineering Performance Standards Development Leader

Mr. Fidler obtained his master's degree in civil and sanitary engineering in 1979 and has more than 23 years experience in environmental engineering and hazardous waste remediation. He has been involved with the Hudson River PCBs Superfund Site since 1991, virtually the entire period of the Reassessment RI/FS and subsequent design-phase work. While with TAMS Consultants, Inc., Mr. Fidler led various pre-feasibility evaluations and served as Project Manager for Phase 3 of the Reassessment, including preparation of the Feasibility Study and the summary of the selected remedy presented to

USEPA's National Remedy Review Board, and the final Reassessment Responsiveness Summary incorporating over 73,000 comment documents received from the public. Having joined Malcolm Pirnie in early 2002, Mr. Fidler is now providing consultation on various aspects of the design period activities in addition to leading the engineering performance standards development effort.

Edward Garvey, Ph.D., P.G. – Resuspension Standard Team Leader

Dr. Garvey is a senior environmental geochemist with TAMS Consultants, Inc., an Earth Tech Company. He has over 22 years of experience in environmental geochemistry, with additional experience in human health risk assessment and hydrogeology. His educational training includes a Ph.D. in geochemistry, a M.A. in geological sciences and a B.E. in chemical engineering. Dr. Garvey is a registered geologist/geochemist in the Commonwealth of Pennsylvania. Dr. Garvey's experience includes over 19 years of study specific to the Hudson River, including his Ph.D. dissertation and his efforts since 1991 as the chief scientist on the Hudson River PCBs Reassessment RI/FS for USEPA. For the Reassessment RI/FS, Dr. Garvey planned and directed the collection of environmental data, including extensive, multi-year sediment and water column sampling programs, coordinated the efforts of various scientists and consultants, and prepared several major reports on the investigation. His work on this project has produced several technical papers as well as many technical presentations on the fate of PCBs in the environment. In his role as the Resuspension Standard Team Leader, Dr. Garvey brings extensive experience on the geochemical interpretation of sediment contamination data and its implications for long-term PCB transport.

Neven Kresic, Ph.D. – Residuals Standard Team Leader

Dr. Kresic has more than 20 years of teaching, research and consulting experience in surface water and groundwater assessment, engineering and remediation for U.S. and international clients. He has designed site characterization and environmental sampling plans, and performed data analysis and evaluation of remedial design alternatives at numerous CERCLA, Resource Conservation and Recovery Act (RCRA) and other industrial sites throughout the US. His areas of expertise include subsurface modeling, geostatistical, probabilistic and stochastic analyses of spatial and time data series, and groundwater remediation. Dr. Kresic is a professional geologist and hydrogeologist, and teaches short professional courses in geographic information systems (GIS), Groundwater Modeling and Groundwater Remediation for the National Ground Water Association.

John Mulligan, P.E. – Productivity Standard Team Leader

Mr. Mulligan earned his master's degree in sanitary engineering from the School of Public Health at the University of North Carolina in 1967 and has over 35 years of experience in civil and environmental projects including a number of hazardous waste remediation projects involving dredging and disposal of contaminated sediments. He became involved in the Hudson River PCB project in 1974 when he served as Malcolm Pirnie's project engineer on the design of a new water main crossing the Hudson. This

was required to replace existing mains damaged by the removal of the former Fort Edward Dam, and involved removing timber cribs from the former dam pool, and stabilizing the sediment deposits left behind the old dam when the water level fell. From 1975 through 1991, he served as Malcolm Pirnie's Project Manager for the preparation of studies and designs for the NYSDEC aimed at remediating the PCB contamination of the river sediments. In more recent years, Mr. Mulligan has designed a dredging project to remove and dewater PCB-contaminated sediments from the St. Lawrence River for General Motors Corp. and assisted in the design of the demonstration project for the remediation of PCB-contaminated sediments at Deposit N in the Fox River near Green Bay, WI.

Donald J. Hayes, Ph.D., P.E. – Consulting Expert

Dr. Hayes has been working with environmental aspects of dredging, dredged sediment disposal, and contaminated sediment management for over 20 years. He has published extensively in these areas. He also contributed to a number of guidance documents and authored software used to evaluate contaminated sediments management alternatives. He is especially recognized for his expertise in water quality impacts associated with dredging operations. Dr. Hayes served on the National Academies of Engineering Committee on Contaminated Marine Sediments and co-authored the resulting report. He is currently actively working on seven contaminated sediment projects and has contributed to many more projects over the past few years; many of these are Superfund projects. He previously contributed to the Reassessment Feasibility Study for this Site, as well as the final Reassessment Responsiveness Summary. Dr. Hayes worked as a research Civil Engineer at the USACE's Waterways Experiment Station for over 10 years and has been in academia for the past 11 years. Dr. Hayes received his Ph.D. in Environmental Engineering and Water Resources Planning and Management in 1990.

In addition to the expertise contributed by these team members, modeling for the project was conducted by LimnoTech, Inc. (HUDTOX model) and Menzie-Cura & Associates, Inc. (FISHRAND model).

Quality Review Team

Quality reviews for the project are being performed by a team of experts that functions independently of the technical team. Reviewers include the following:

Kenneth J. Goldstein, C.G.W.P. - Quality Review Team Coordinator

Area of Expertise: Residuals Sampling

Mr. Goldstein is a professional hydrologist/hydrogeologist at Malcolm Pirnie, with over 20 years experience in contaminant hydrogeology and contaminant fate and transport. He has designed work plans, field sampling plans and quality assurance plans and directed numerous sampling and analytical programs for physical and chemical characterization of sediments, soil and groundwater.

Mr. Goldstein was responsible for the sampling and characterization of dredge spoil deposits and contaminated sediments in the Upper Hudson River through the late 1980s and early 1990s. In addition, Mr. Goldstein developed field sampling plans and performed sediment sampling on the Raritan River, Jamaica Bay, and Eastchester Bay. He has performed statistical and geospatial analysis of sediment quality data and physical characterization data. Mr. Goldstein's current focus is on remediation of contaminated media using in-situ remedial technologies.

Jonathan B. Butcher, Ph.D., P.H.

Areas of Expertise: Residuals, Resuspension, Reassessment RI/FS History

Dr. Jonathan Butcher is an environmental engineer and Professional Hydrologist with TetraTech, Inc., who has worked on the Reassessment RI/FS for the Hudson River PCBs Site since soon after its commencement. He has provided technical support in four key areas: (1) contaminant fate and transport modeling for PCBs within the river water and sediment; (2) predictive modeling of bioaccumulation of PCBs in fish; (3) data validation and reconciliation for historical data collection efforts, and (4) sampling design and statistical and geostatistical analyses of sample data.

Dr. Butcher developed the Phase 1 PCB fate and transport model application and Phase 2 model specifications for the study, and was responsible for internal model review during the FS. He developed a bivariate bioaccumulation factor method to predict PCB burdens in fish in systems where the water column and sediment fractions are not in equilibrium, and collaborated on development of mechanistic and stochastic bioaccumulation models. He was also responsible for an innovative study of the environmental partitioning behavior of PCB congeners in Hudson River water and sediments.

Dr. Butcher has taken a lead role in the review of GE's alternative modeling analyses of PCBs in the Hudson, and has developed methods for translating historical Aroclor quantitation results to a common Tri+ PCB basis. He has published several peer-reviewed papers on key scientific aspects of this work.

Gregory Hartman, P.E.

Areas of Expertise: Sediment Remediation, Environmental Dredging, Dredging Residuals

Mr. Hartman is a licensed Professional Engineer in Oregon and Washington, and is currently a consultant with the firm of Dalton, Olmsted & Fuglevand in Kirkland, WA. Mr. Hartman has a B.S. in Civil Engineering, and an M.S. in Coastal and River Engineering. He has 34 years experience working in the Coastal and Waterway Industry. As a Civil Engineer in the Navigation Division of the Portland District USACE, he was Chief of Dredging Operations, and gained direct working experience as a dredger. Since 1978 Mr. Hartman has been a consultant, working on coastal and river projects in the United States and overseas.

Mr. Hartman has taught the USACE Dredging Fundamentals Short Course every year since 1982. He has also taught courses intermittently on Dredge Cost Estimating, Dredge Contract Administration, and Dredge Inspectors Course to the USACE, and Dredge Remediation and Confined Disposal Site Design for the University of Wisconsin Short Course on Understanding Contaminated Sediment.

Mr. Hartman is Past President and Past Chairman of the Board for the Western Dredging Association, and Retired Board Member of the World Dredging Association. He is on the Board of Industry Advisors for the World Dredging, Mining and Construction Magazine. Relevant experience includes the remediation of the St. Paul Waterway in Tacoma, WA and the development, design and construction oversight for the Sitcum Waterway Remediation Project in the Port of Tacoma. Mr. Hartman was Dredge Consultant for various projects including: the design and contract oversight of navigation dredging and PCB remediation on the US Navy Puget Sound Shipyard in Bremerton, WA; Pilot Study 2000, to dredge PCBs for the New Bedford, MA remediation; preliminary design for remediation of PCBs in Fox River, WI; sediment remediation in Greens Bayou, TX and; Hylebos Waterway PCB remediation design and construction in Tacoma, WA.

Michael R. Palermo, Ph.D., P.E.

Areas of Expertise: Sediment Remediation, Environmental Dredging, Residuals

Dr. Palermo is a Research Civil Engineer and Director of the Center for Contaminated Sediments at the U.S. Army Engineer Research and Development Center, Waterways Experiment Station, where he manages and conducts research and applied studies concerning dredging and dredged material disposal and remediation of contaminated sediments. He has authored numerous publications in the area of dredging and dredged material disposal technology and remediation of contaminated sediments. He was the lead author of the USACE technical guidance for dredged material capping and the lead author of the USEPA ARCS program guidance for in-situ capping for sediment remediation. Dr. Palermo also serves on several technical advisory panels for superfund projects involving contaminated sediments.

Dr. Palermo is a Registered Professional Engineer and a member of the Western Dredging Association and the International Navigation Association. He is also Associate Editor for the Journal of Dredging Engineering. He received his B.S. and M.S. degrees in Civil Engineering from Mississippi State University and his Ph.D. degree in Environmental and Water Resources Engineering from Vanderbilt University.

William N. Stasiuk, Ph.D., P.E.

Areas of Expertise: Water Quality, Public Water Supply, Risk Assessment

Dr. Stasiuk is a Licensed Professional Engineer at Malcolm Pirnie, with experience in dealing with sites contaminated with PCBs. In 1975, he helped coordinate the NYSDEC's technical case in the original enforcement action against GE regarding Hudson River contamination. He directed the public health response to PCB contamination in the West Glens Falls, NY residential area in 1979 and the subsequent remedial action.

As Director of the Center for Environmental Health within the New York State Department of Health (NYSDOH) from 1985 through 1996, Dr. Stasiuk provided direction to the Bureaus which carried out exposure investigations, risk assessments and health studies at all contaminated sites in New York State. He was directly responsible for the post-cleanup assessment and further remedial actions leading to the reoccupancy of the Binghamton State Office Building. He provided oversight of assessment, response and remedial actions at the State University at New Paltz PCB contamination incident.

Also with NYSDOH in the late 1960s, Dr. Stasiuk was instrumental in development of a mathematical water quality model for the Hudson River from Corinth to the Battery. He also organized, staffed and supervised the first Toxic Substances Control Unit in NYSDOH in 1979, and assisted in development of drinking water standards for organic compounds, including PCBs. He was the NYSDOH's representative on the NYS Superfund Management Board.

In addition to providing executive direction to the Bureau of Water Supply (part of the Center for Environmental Health), Dr. Stasiuk's water supply experience includes serving from 1996-2000 as Deputy Commissioner and Director of the Bureau of Water Supply in the New York City Department of Environmental Protection, which is responsible for the New York City water supply system.

Quality Review Team Roles and Responsibilities

The above team of experts, collectively referred to as the Quality Review Team (or QRT), was charged with reviewing and evaluating the scope of work and approach for the development effort as well as a series of draft deliverables leading up to publication of the standards for review by the public and the peer review panel. The team members performed their reviews individually, but then sought to reach consensus and provide unified guidance to the technical team to the extent possible. All comments received from the QRT were considered carefully by the technical team and implemented in consultation with USEPA.

Although each of the five members of the QRT has a particular specialty (or specialties) relating to the project as indicated above, each was asked to review all three standards in the course of his work. The intention of this approach was to provide consistent review and evaluation of all standards individually and to provide evaluation of the interactions

among the standards. While each of the QRT members has reviewed the standards³, and concurs with their form and content, each has been operating solely within the framework of this project and not with the intention of providing generic or universal guidance on performance standards development related to other projects or sites.

Disclaimer Applicable to the Engineering Performance Standards Development

As indicated above, the standards developed herein are intended only for application to remedial environmental dredging of the Upper Hudson River called for in USEPA's 2002 ROD for the Hudson River PCBs Superfund Site at this juncture in time. The standards are not intended to provide general or universal guidance for environmental dredging. Other projects and locations may have specific features differing from those of the Hudson River, and the standards presented here may not be applicable to those projects.

³ Gregory Hartman, PE was unavailable to review later drafts of the standards documents as issued for agency review prior to public comment, but participated in review of the technical approach, as well as internal drafts. He also addressed specific questions and issues posed by members of the technical team.