



Hudson River

PCBs SUPERFUND SITE

Draft Engineering Performance Standards Public Review Copy

Part 3: Performance Standard for Dredging Productivity

May 2003

Prepared for:

U.S. Army Corps of Engineers, Kansas City District
USACE Contract No. DACW41-02-D-0003
On Behalf of: U.S. Environmental Protection Agency, Region 2



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1.0 Statement of the Performance Standard for Dredging Productivity

The Productivity Standard (*i.e.*, Productivity Standard) is designed to monitor and maintain the progress of the dredging project to meet the schedule stated in the ROD. The project schedule stated in the ROD has a six-year duration and consists of one dredging season designated Phase 1 and five dredging seasons collectively designated as Phase 2. Phase 1 consists of initial dredging at a reduced scale with extensive monitoring to evaluate compliance with the performance standards. Phase 2 consists of dredging at full production to remove the remainder of the contaminated sediments that are targeted for removal. The Productivity Standard accordingly defines the contaminated sediment volumes to be dredged during each project Phase and dredging season. Maintaining an appropriate dredging production rate will result in implementation of the project within the timeframe specified in the ROD, and simultaneously limit the duration of construction-related impacts. Following the completion of Phase 1, the data obtained from the monitoring program will be analyzed to determine if refinements to the performance standard or changes to the Phase 2 remedial program are necessary.

The volume of contaminated sediment referred to in this Productivity Standard is the volume as measured in-situ in the river bed. It is currently estimated to be approximately 2.65 million cubic yards based on sediment sampling data available through the end of 2001. It is recognized that new data from the on-going, sediment sampling program and other analyses begun by General Electric Company (GE) in 2002 are likely to result in a revision of this volume estimate. A methodology for revising the Productivity Standard to reflect a relatively minor change (10% or less) in the overall volume is presented as part of the Standard. However, should the volume of sediment to be dredged change by more than about 10 percent as a result of the current sampling program and final design considerations, the overall duration of the dredging program may be increased or decreased, as appropriate. In that event, the Productivity Standard may need to be revised to reflect the change in the overall project schedule.

The following Productivity Standard has been developed:¹

Dredging Productivity - Phase 1 (First Year Dredging)

1. The minimum volume of sediment to be removed, processed and shipped off-site during Phase 1 shall be one-half the minimum annual productivity volume required for full scale dredging in Phase 2, which is estimated to be 240,000 cubic yards;
2. For a time period of at least one month during Phase 1, the minimum production rate shall be the rate required to meet the Phase 2 Performance Standard (currently estimated at 68,600 cy/month based on a 7-month dredging season), in order to verify the capabilities of the dredging equipment and the sediment processing and transportation systems; and

¹ The volume of sediment to be dredged, processed, and disposed of has been estimated in the FS and ROD at 2.65 million cubic yards (USEPA, 2001, 2002). This estimate includes material to be dredged for remediation and material to be dredged for navigational purposes in order to implement the USEPA remedy.

3. Stabilization of shorelines and backfilling of areas dredged during Phase 1, where appropriate, shall be completed by the end of the calendar year. All dredged material shall be processed and shipped off-site for disposal by the end of the calendar year.

Dredging Productivity – Phase 2

1. Based on an estimate of 2.65 million cubic yards of sediment, the minimum volume of sediment to be removed, processed and shipped off-site during each of the 5 years of Phase 2 (full scale dredging) shall be as shown in the middle column of Table 1-1. Furthermore, Phase 2 should be designed to meet the targeted removal volumes shown in the right-hand column of Table 1-1. If possible, the project should be completed ahead of schedule, or at least with a reduced required volume for the final season of the project (Phase 2, Year 6).
2. Stabilization of shorelines and backfilling, where appropriate, of areas dredged during a dredging season in Phase 2 shall be completed by the end of the work season (*i.e.*, prior to the following spring high flow period in the River).
3. All dredged material should be processed and shipped off-site for disposal by the end of each calendar year. Processed sediment shall not be stockpiled for disposal the following dredging season.

1.1 Implementation

1.1.1 Minimum Monitoring and Record Keeping Requirements

By March 1 of each year, the contractor shall provide USEPA with a Production Schedule showing anticipated monthly sediment production for the upcoming dredging season. The schedule must meet or exceed the productivity requirements defined herein or as revised in accordance with USEPA-approved design documents.

Monthly and annual productivity progress reports shall be submitted to the USEPA according to a schedule to be defined by the Agency, for use in determining compliance with the Productivity Standard. Monthly productivity progress reports will be compared to the production schedule submitted by the Contractor and will be the primary tool for demonstrating whether the project is on schedule. Annual production progress reports will determine compliance with the Productivity Standard.

1.1.2 Action Levels and Required Responses

The action levels and required responses are summarized in Table 1-2. In any given dredging season, whenever the monthly dredging productivity falls below the scheduled productivity for that particular month by 10 percent or more, the Contractor shall identify the cause of the shortfall to USEPA and shall take immediate steps to correct the situation by adding equipment and crews, working extended hours, modifying his plant and equipment or approach to the work, or other steps needed to achieve the necessary production rate and erase the cumulative shortfall

in productivity over the following two months or by the end of the dredging season, whichever occurs sooner. Any such 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 shipments, 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 shortfall in production and describing the engineering and management steps taken or underway to erase the shortfall in production during that dredging season. Failure to erase the shortfall by the end of the dredging season will result in USEPA taking action. USEPA will review the specific circumstances that led to the annual production shortfall prior to determining what USEPA action would be appropriate to address noncompliance with the Productivity Standard.

2.0 Technical Basis of the Performance Standard for Dredging Productivity

2.1 Background and Approach

2.1.1 ROD Requirements Related to Performance Standard for Dredging Productivity

USEPA's ROD for the Hudson River PCBs Site (USEPA, 2002) specifies a number of conditions that influence the development of the Productivity Standard. For the purposes of developing the Productivity Standard, the ROD's mandates were placed into two categories:

- Requirements that relate directly to productivity and schedule; and
- Factors that influence or constrain productivity.

The principal elements of the remedy that directly influence the Productivity Standard are as follows (ROD at pp. ii to iii and 94 to 95):

- An estimated 2.65 million cubic yards of sediment are to be removed from the Upper Hudson River. This estimate was initially developed in the Feasibility Study (FS).
- Of the 2.65 million cubic yards, an estimated 341,000 cubic yards will be removed for purposes of improving project-related navigation;
- Dredging will occur in two phases: Phase 1 and Phase 2;
- Phase 1 dredging will be conducted initially at a reduced rate, and the results of monitoring during Phase 1 will be used to make any necessary adjustments to operations in Phase 2;
- Phase 2 dredging will be conducted at full scale;
- The design for the project will plan for a construction period of six years;
- The first year will be at less than full scale and the next five years will be at full scale.

In summary, USEPA's objective is to remove sufficient PCB-contaminated sediment from the Upper Hudson River to meet the objectives stated in the ROD, estimated at 2.65 million cubic yards, over a period of six years. The initial year of work will entail considerable monitoring of dredging operations to allow evaluation of and adjustments to the dredging program. Full-scale removal operations will then be conducted for five years during which the remaining targeted contaminated sediment will be removed.

2.1.2 Direct Implications of ROD Requirements for Productivity

To develop the Productivity Standard for Phase 1 and Phase 2, and to confirm the feasibility of accomplishing the remedy in accordance with the Productivity Standard, it is necessary to view the ROD requirements from the perspective of setting-up a construction and materials handling operation. The requirement to remove an estimated 2.65 million cubic yards of sediment establishes the overall scale of the effort but does not, in and of itself, set measurable targets for the remedial work as the project progresses. In addition, although the 2.65 million cubic yard figure is the current best approximation of the volume of sediment to be dredged, this estimate is expected to be revised during the remedial design. Based on engineering judgment, it was deemed reasonable to assume that the overall schedule would remain the same if the final

volume of sediment targeted for dredging falls within about 10 percent, more or less, of the estimated total volume presented in the ROD. If the volume (or location) of the sediment targeted for removal changes by more than 10 percent as a result of the new data collected during the design, it is likely that a change in the overall schedule may occur. To develop the quantitative and measurable Productivity Standard, the following assumptions were made and applied throughout this Chapter:

- The estimated volume of sediment that will be removed is 2.65 million cubic yards as stated in the ROD.
- Dredging during Phase 1 will require the removal of about 240,000 cubic yards of sediment, with a target for removal of 265,000 cubic yards;
- An average of approximately 480,000 cubic yards of sediment will have to be removed during each of five full-scale dredging years (Phase 2). A target removal objective is set at 530,000 cubic yards per year for the first four seasons of Phase 2 and 265,000 cubic yards for the final season of dredging;
- In the ideal case, there will be a minimum of 30 weeks available each year to conduct dredging operations, and dredging operations will occur seven days per week, as per the FS and Responsiveness Summary (RS). However, the project will be planned around a schedule that includes some downtime due to high river flows and other uncontrollable events.
- Transfer, processing and transportation (for disposal) facilities will be available to manage dredged sediments at the rate implied by the Productivity Standard.
- The sequence in which the various sediment deposits are dredged will not be influenced by whether the sediment is considered a TSCA waste (*i.e.* contains ≥ 50 mg/kg Total PCBs) or non-TSCA (contains <50 mg/kg Total PCBs). A determination of the regulatory status of the sediment will be made by sampling processed sediment prior to loading rail cars or barges for shipment to the disposal site.

Given the above assumptions, it is possible to set general productivity parameters for the project's full-scale production years. Assuming dredging proceeding every day and no lost time, the general productivity parameters would be those shown in Table 2-1. While they are presented for illustrative purposes and to provide transparency in describing the process of developing the Productivity Standard, USEPA does not consider the average weekly and average daily production parameters in Table 2-1 to be realistic. Realistically, the average weekly and average daily production rates will have to be increased to account for a lack of production on holidays and downtime due to high flow events in the river, breakdowns of equipment, the need to remove unanticipated submerged obstacles, and similar disruptions in the project schedule. The average seasonal production, however, will have to be met if the project is to be completed within the time frame established in the ROD.

From the perspective of meeting the project's overall goals, the seasonal production rate is most critical. The average monthly rate may be used as a basis for monitoring whether the project is on track toward achieving the seasonal target. The average daily production rate will have the greatest impact on setting requirements for the capacity of transfer, processing and transportation facilities. Knowing the project's average daily effective time (percent of time dredge is actually dredging and delivering sediment to the processing/shipping site), it is also possible to estimate

the hourly throughput that will have to be handled by various conveyance and processing subsystems. The capacities and redundancies to be designed and built into these subsystems should be based on an assessment of the peak hourly loads that are likely to be generated by the dredging equipment.

2.1.3 Indirect Implications of ROD Requirements for Productivity

In addition to those elements of the ROD that have a direct bearing on productivity, there are several facets of the ROD that have an indirect impact on project output. Among the most significant of these are the following:

- Backfilling dredged areas with approximately one foot of clean fill, to isolate PCB residuals and to expedite habitat recovery, where appropriate;
- Removal of all PCB contaminated sediments in areas targeted for remediation with an anticipated residual of approximately 1 mg/kg Tri+ PCBs (prior to backfilling); and
- Limiting allowable dredging related resuspension rates.

The implications of these particular ROD requirements relative to productivity are discussed in this Chapter.

With regard to placement of backfill, the additional equipment and time needed to conduct this facet of the remedial work is factored directly into the Productivity Standard. Essentially, backfilling is planned to occur and is treated as one component of the construction activities that comprise of the overall program, and it will impact project output much the way the other activities do.

The requirements identified in the second and third bullets above are reflected in the Resuspension Standard (see Volume 1) and the Residuals Standard (see Volume 2). The Resuspension Standard and Residuals Standard will influence productivity (and ultimately, the Productivity Standard) in a somewhat different manner. For instance, conforming to the Resuspension Standard may result in the following actions being taken, as appropriate:

- Selecting different dredging equipment;
- Implementing contingency measures such as modifying dredge operating procedures or collecting samples more frequently;
- Postponing or reducing operations until more favorable river conditions are present;
- Delaying operations while monitoring data are evaluated; and
- Installing turbidity containment barriers around the dredging site, if such barriers are not already in use.

Similarly, the Residuals Standard may result one of the following actions being taken:

- Selection different dredging equipment;
- Requirement of additional dredging passes within targeted areas or redredging of areas that fail to meet the Residuals Standard; and

- Construction of an engineered cap over residual sediments in extreme cases where the Residuals Standard is not met despite best efforts to remove the sediments.

2.1.4 Other Factors Influencing Productivity

A number of other factors, beyond those considered above, will impact project productivity. Among the more significant of these are the following:

- Distribution of targeted sediments within the Upper Hudson River;
- Limitations on in-river work imposed by river conditions and the need to maintain traffic on the Canal system;
- Limitations on in-river work as a result of standards set on equipment noise and air emissions; and
- The interrelationship of dredging productivity to the location and capacities of transfer, processing and transportation facilities.

The first two of these additional factors are addressed in the analysis presented below. The remaining two factors are not evaluated in this document but will be addressed in the project design. With regard to noise, it is assumed that the noise standards set by USEPA will not constrain the productivity of the dredging operations (*i.e.*, noise abatement will either not be necessary or noise abatement technology installed on dredging equipment will not significantly affect the productivity of the equipment). Furthermore, consistent with the ROD, it is assumed that in-river activities and sediment processing and transportation operations are not restricted to certain days or hours.

Since the location(s) and characteristics of sediment processing/transfer facility(ies) are not known at this time, it is not possible to factor into the productivity analysis the capacities of those facilities to handle dredged sediments. Rather, it is assumed that once the location(s) of the processing/transfer facility(ies) are identified, the facilities will be designed to ensure adequate processing capability to handle incoming sediments at rates commensurate with USEPA's project goals (five years of full scale operation). However, processing and shipping considerations have not been ignored in developing the Productivity Standard. Instead, the Productivity Standard has been developed with consideration of the design team's need for flexibility to avoid the problems associated with radical, short-term fluctuations in the volume of sediment sent to the processing/transfer facilities, so that on-site sediment staging requirements can be reduced and off-site transportation needs can be anticipated and coordinated.

2.1.5 Approach to Development of Standard

The approach taken to develop the Productivity Standard is to:

- a) Establish minimum productivity requirements for Phases 1 and 2 of the project that meet the requirements of the ROD;
- b) Identify and evaluate the anticipated field conditions that will impact productivity;

- c) Obtain, where possible, reports or other information on projects that are similar to the Upper Hudson River environmental dredging project and can provide support to the Productivity Standard;
- d) Identify typical production rates for available dredging equipment that has been demonstrated to function successfully under the field conditions anticipated in the Upper Hudson River; and
- e) Prepare an example Production Schedule based upon use of the identified plant and equipment that supports the assumption that the proposed Productivity Standard can be met and the project completed within the time frame established by the ROD.

While the development of the Productivity Standard includes an example Production Schedule, the actual project schedule will be developed by the design team as a separate activity. The purpose of the example Production Schedule is to support the assumption that the Performance Standards are feasible and can be met using conservative assumptions and at least one selection of equipment from the wide array of such equipment currently available and in use on environmental dredging projects.

2.2 Supporting Analyses

2.2.1 Recent Projects and Developments in Dredging Technology

To take into account the most current technologies and information available from other dredging sites, a search was conducted on the USEPA website, and parties associated with other sediment remediation/dredging projects were contacted to update the database developed during preparation of the FS and RS. In addition, follow-up conversations were held with site managers contacted during completion of the FS and RS where it was thought that additional information with regard to dredging, equipment, schedules, constraints and the like could be obtained. The information obtained from these sources is presented in Appendix A.

The review of recent projects and developments in dredging technology revealed a number of points that are of interest in developing the Productivity Standard. Some of the more significant findings are as follows:

- A large number of sediment remediation projects have been completed or are being designed using mechanical dredges equipped with special buckets designed to minimize resuspension and to produce a flat bottomed cut. Positioning of the dredge and bucket to ensure that sediment is not “missed” is accomplished with GPS equipment linked to computers on board the dredging vessel. This equipment has been demonstrated to achieve cut tolerances of less than 6 inches when properly operated.
- Many, if not most, projects reviewed made use of some type of containment structure around the dredges to minimize the loss of resuspended sediments to downstream areas. Containment systems ranged from interlocking steel sheet piling to traditional silt curtains.
- Resuspension has not been a major problem in most instances where containment systems have been used. Where such systems have not been employed, resuspension has been minimized through careful control of the dredging operation including reducing

dredge production rates and limiting dredging operations during adverse weather or high flow periods. A decision as to whether it is more cost effective to spend part of a dredging season installing an engineered containment system around an area to be dredged or to depend on very careful operation of the dredges and ancillary equipment, which usually results in some reduction in dredge production rates, must be made on a site-specific basis and should be addressed in final design.

- Achieving low cleanup levels (*e.g.*, 1.0 mg/kg) has proven difficult, particularly where boulders and other obstacles are present in or underlying the sediment to be removed. In many of the projects reviewed, it was necessary to re-dredge at least some areas to achieve the target cleanup level, and on some projects the target cleanup level was not reached in limited, extremely difficult areas despite multiple passes of the dredging equipment.

2.2.2 Analysis of Factors Affecting Productivity

A large number of factors will affect the length of time required to complete the Upper Hudson River environmental dredging project, including the actual volume of sediments to be dredged, the capacity and production rates of dredging equipment selected, the sediment processing/transfer facility(ies) (including the water treatment system), the distance from the dredging areas to the sediment processing/transfer facility(ies), any physical limitations on reaching areas targeted for dredging, the potential need to conduct a number of passes with the dredge to achieve target clean up goals, the rate at which backfill can be placed over dredged areas, engineering constraints imposed on the Contractor regarding resuspension, potential bottlenecks in the transportation networks required for shipping sediments to off-site disposal facilities, poor weather, and high river flows. All of these factors must be taken into account in developing the Productivity Standard to ensure that the Standard can be met. Some of the more critical factors are discussed below.

2.2.2.1 Dredging Equipment

Four general types of dredging systems are considered here:

- Mechanical dredges with scow transport;
- Hydraulic dredges with hydraulic transport;
- Mechanical dredges with hydraulic transport;
- Hydraulic dredges with scow transport.

Specialty equipment will also be required in some areas such as around docks, locks, retaining walls, submerged utility lines and bridge piers and in shallow water along the shoreline where access by large equipment is limited. This equipment may include small, diver-assisted dredges, amphibious excavators and trucks capable of working in shallow water and on beaches and conveying sediment to scows located in deeper water and similar equipment not usually associated with major dredging projects.

2.2.2.2 In-River Factors

Factors affecting the productivity of the various types of dredges and auxiliary operations that are likely to be considered and used in the Upper Hudson are described below.

- Need to Minimize Resuspension and Residuals (See Part1: Performance Standard for Dredging-Related Resuspension and Part 2: Performance Standard for Dredging Residuals): Environmental dredging to remove contaminated sediments is inherently slower than navigational dredging because of the care that must be taken to avoid excessive resuspension and ensure that sediment is not “missed” by the dredge. Numerous projects conducted over the past decade show that properly operated hydraulic dredges can function with limited resuspension of particulate matter into the water column. Recent improvements in bucket design and electronic controls have significantly reduced the problem of resuspension when using mechanical dredges (See Volume 4: Appendix: Case Studies of Environmental Dredging Projects). The use of properly designed silt barriers to isolate areas being dredged has been demonstrated to prevent the loss of resuspended sediment downstream. Although not required by the Productivity Standard, it is assumed that silt barriers will be considered for control by the design team.

The use of a global positioning system (GPS), coupled to an on-board computer running WINOPS or a similar software package, has been shown to be effective and essential in assisting dredge operators to position a dredge head or bucket to ensure overlapping cuts and reduce the probability of missing contaminated sediment. However, recent experience has shown that, even where these devices have been used, the problem of residual contamination has not been completely eliminated. In some instances, most notably the 1999-2000 dredging of PCB-contaminated sediments and paper mill sludges in Cumberland Bay in Lake Champlain, inspection of the lake bottom following initial dredging showed that windrows (long heaped rows) and pockets of undredged material remained despite the fact that GPS equipment was used to control and map dredge passes. Further investigations revealed that the GPS equipment suffered from numerous failures and that wind gusts, which blew the dredge off station, were a problem on a number of days. In the St. Lawrence River opposite the former Reynolds Metals Primary Aluminum Extraction Plant, where PCB-contaminated sediments were dredged from a 35 acre area using derrick dredges equipped with Cable Arm environmental buckets during the summer of 2001, sampling following initial dredging showed that the dredging had successfully removed the contaminated sediment to the target cleanup level set for the project in 134 of 268 “cells” established at the start of the project for control purposes. Although the WINOPS system was used to control the derrick dredges and the placement of the buckets, fully 50 percent of the cells had to be re-dredged to remove residual contamination despite the fact that the initial dredging included some over-cut in an attempt to avoid leaving contaminated material behind. This problem apparently did not result from failure of the WINOPS system, but rather from the inability of the bucket used to remove the final layer of PCB-contaminated sediment above a compacted glacial till. Re-dredging successfully remediated 78 additional cells in one additional pass of the dredge. A second attempt at re-dredging succeeded in remediating 22 more cells, and 34 cells were re-dredged 3 or more times. One cell was dredged a total of 10 times and still

did not achieve the target cleanup level. A report on the project concluded that, in addition to the problem encountered in removing all of the sediment overlying a compacted till, large rock fragments and other obstructions in the dredging area hindered the clean up work. Whatever the reason, the records for this project show that re-dredging was very time consuming and resulted in very low overall dredge production rates.

- Shallow water depth: The draft of a small hydraulic dredge is usually in the 30- inch range, while larger hydraulic dredges and mechanical dredges have drafts of three feet or more. Although a dredge can work from deep water toward the shore or shallow areas of the Upper Hudson River, it will not be able to operate where the post-dredging water depth is less than about 3 feet. The use of a hydraulic excavator or crane with a relatively long boom can extend the range of the mechanical dredge into shallow water to a limited extent but, even under these conditions, some areas of the river cannot be accessed by either a mechanical or hydraulic dredge unless some over-cutting of the riverbed is done.

Material removed by a mechanical dredge typically is deposited in a scow for transport to the treatment and shipping location. Typical scows designed for use on the Champlain Canal have a maximum draft, when loaded, of up to 12 feet and can accommodate a load of about 3,000 tons. An empty scow has a draft of about 1 foot. While a mechanical dredge can operate in post-dredging water depths of around 3 feet, a scow moored in 3 feet of water could not be loaded with more than about 500 tons of sediment and water. A scow located in 6 feet of water could be loaded with a little over 1,000 tons of sediment and water, and this is probably the practical minimum load that could economically be transported from a dredge site to an on-shore treatment and shipping location. Because the scow must be positioned within the reach of the dredge's derrick, excavator arm or crane boom for loading, the area where a mechanical dredge can function effectively is constrained by the water depth required for the loaded scow. To overcome this difficulty, some dredge manufacturers, notably Bean Environmental and Dry-Dredge Systems, Inc., have constructed dredges that receive mechanically dredged sediment in a hopper where it is slurried and pumped through a dredge pipeline to the disposal or materials dewatering site. Such mechanical dredges with hydraulic transport may be useful in remediating portions of the Upper Hudson where the water is too shallow to provide access for loaded scows.

Where contaminated sediments extend to the shore line or are found along the narrow beaches which line portions of the Upper Hudson, their removal may require the use of land based equipment or amphibious equipment capable of operating either on land or in water such as that manufactured by Marsh Buggy, Inc. In some instances where access to the shoreline is relatively easy, the excavated material could be loaded on trucks for delivery to the sediment processing site. Where access cannot be obtained along the shore, the sediment may have to be loaded onto amphibious carriers and transferred to shallow draft scows located as close to the shoreline as possible.

Small hydraulic cutterhead dredges typically have a draft of from 24 to 30 inches. These dredges can also work from deeper water to shallow areas to create the water depth required to prevent grounding and, because the slurry is pumped through a pipeline, the

area in which they operate is not constrained by a need for sufficient water depth to float a scow.

- Distance to Treatment and Shipping Site: In the FS, it was assumed that two, on-shore sediment processing/transfer facilities would be constructed for the project. One facility was assumed to be located near the northern reach of the project and the second facility would be located in the Albany area. While the availability of two separate on-shore sediment processing/transfer facilities might provide more flexibility in the design of the dredging program and facilitate a higher productivity rate, the Productivity Standard was developed with consideration that only one sediment processing/transfer facility (located in River Section 1) might be available. 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. Note, however, that the assumption does not reflect a worse case based on available information, which would be one facility at or below the southern extreme of the project area.

There is a practical distance limit that any given hydraulic dredge can pump sediments through a pipeline without the need for booster pumping stations. This limit is a function of the dredge pump and horsepower, the density of the slurry being pumped, the diameter of the dredge pipe, and any change in elevation between the dredge and the pipeline discharge point. As the distance pumped increases, the pump discharge rate decreases. Furthermore, to avoid plugging the dredge pipeline, it must be flushed of slurry before shutting down the dredge pump for maintenance, for moving the dredge to a new location or for adding slurry pipe. The time required to flush the pipeline increases with pipeline length and must be factored into any production schedule that anticipates shutting down the dredge for a period of time each day. Finally, the use of multiple booster pumping stations to extend the distance that a hydraulic dredge can work from the on-shore treatment and shipping location requires additional time in a dredge production schedule for starting, stopping and refueling, adds to the potential for operating problems that may stop production entirely until corrections can be made, and increases the time needed for mobilization and demobilization at the beginning and end of each dredging season. Experience has shown that each in-line booster pump can reduce the effective dredging time by from 5 to 10 percent.

Where the distance from the dredging location is too great for a hydraulic dredge and booster pumps to operate effectively, the dredge can pump to a scow located in deep water at the end of the dredge pipeline. However, the slurry contains a high percentage of water (usually from 85 to 90 percent of the flow) so the scows will only carry a small percentage of their normal load in terms of solids. Thus, hydraulic dredging with scow transport of the sediment will likely be restricted to small, difficult to access areas, if it is used at all.

The production rate of mechanical dredges using scows to transport the sediment to the on-shore treatment and shipping locations and hydraulic dredges pumping to scows, which in turn are towed to the treatment and shipping sites, is only affected if an

insufficient number of scows is available to ensure that the dredge is able to work continuously while scows are in transit. Provided that the movement of scows through the locks is not unduly restricted by the Canal operating schedule or by other navigation on the Canal, the distance from the dredge to a sediment processing/transfer facility should not have a major impact on production rates for a mechanical dredge or a hydraulic dredge with scow transport. However, as is noted above, the use of a hydraulic dredge with scows to transport the slurry will require a significantly greater number of scows, as each load will have a low solids content.

- Thickness of Sediment Layer to be Dredged: Both mechanical and hydraulic dredges are designed with an optimal depth of cut in mind. If a hydraulic dredge is designed to achieve optimal production at a cut of 2 feet per pass of the dredgehead, it will not be as efficient at deeper or shallower cut depths. At deeper cut depths, the operator may find that the cutterhead is overloaded or may clog the dredge discharge pipe by trying to pump too dense of a slurry at too low a velocity. At a shallower cut, the dredge head will not be completely immersed in the sediment and the slurry will contain a much higher ratio of water to solids than when in a production cut. Similarly, the bucket on a mechanical dredge is designed for a depth of cut that just fills the bucket when the jaws are moved from a fully open to a closed position. Allowing the bucket to penetrate further into the sediment before closing the jaws will cause the bucket to overflow, increasing the potential for resuspension or, if a completely enclosed bucket type is employed, may prevent the bucket from closing tightly. If a thinner layer of sediment is to be removed, the bucket will not be completely filled when it is closed, which would also reduce efficiency and thereby productivity.

The depth of contamination in the Upper Hudson River sediments varies from less than one foot to over 6 feet. If a hydraulic, cutterhead dredge designed for an optimal cut of 2 feet per pass is working in an area where three feet of sediment is targeted for removal, it may achieve a high production rate when removing the first two feet but a substantially lower production rate when it removes the remaining 1-foot layer. The same will be true for a mechanical dredge using an environmental bucket: it will be most efficient when operating at its optimal cut depth and less efficient when operating at shallower cut depths, as the bucket will not be completely filled when it closes.

- Boulders, Cobbles and Debris: Most of the dredging required to remediate the Upper Hudson River will occur in areas outside the navigation channel. The areas outside the channel have not been dredged in the past and are likely to contain a significant amount of debris.

The presence of boulders, cobbles and debris in the sediments has a significant impact on dredge production rates, especially for hydraulic dredges. Boulders, large numbers of cobbles, sunken logs, abandoned vehicles and other debris cannot be pumped and interfere with the progress of a hydraulic dredge. Other debris, such as tree roots and limbs, heavy growths of underwater weeds, old fence wire, cables and similar material can clog the cutterhead, intake pipe or main pump on a hydraulic dredge and force the operator to shut the dredge down until they can be cleared.

Boulders and debris can also interfere with mechanical dredge operations by preventing the bucket from closing tightly. If the bucket is not closed when retrieved, the sediment will fall back into the water and cause resuspension. If an environmental bucket is used, with controls and alarms to warn the operator when the bucket is not closed, the operator must reopen the bucket, shift its location and attempt to close it again until the operator is sure that it is sealed before lifting it from the river bottom.

For the most part, loose cobbles in the 1- foot diameter and smaller range do not interfere with mechanical dredges. Occasional cobbles in this size range will be tossed aside by the cutter on a cutterhead dredge, but numerous stones of this size will make it very difficult for the dredge to retrieve the sediment that generally surrounds the cobbles.

To minimize delays in dredging related to the presence of boulders and debris, visual surveys conducted by divers, ground penetrating radar and side scan sonar surveys are frequently used to determine where these adverse dredging conditions exist and to plan in advance for coping with them. Hydraulic excavators mounted on work boats and equipped with grapples or other material handling devices are generally used to remove sunken logs, appliances, and other debris, while heavy growths of weeds can be removed with weed harvesters. Boulders and cobbles can be moved to areas (outside of the navigation channel) that have already been dredged by a workboat operating in close coordination with the dredge, but a loss of production inevitably occurs under these conditions. Environmental buckets mounted on hydraulic excavator booms and equipped with hydraulic pistons to close the bucket can minimize the problem of debris for mechanical dredges but may have secondary problems of maintenance and repair that can impact overall production.

- Presence of Bedrock and Highly Compacted Sediments: Undulating and scalloped bedrock surfaces and compacted glacial till, which usually contains boulders and cobbles in the Hudson River valley, can impede dredge production rates if found at the base of a layer of contaminated sediment. It is very difficult to remove sediment from the uneven surface of water-eroded bedrock outcrops in the riverbed without leaving some material behind, regardless of the type of dredge employed. Following an uneven, hard surface with the dredgehead on a hydraulic dredge is very difficult and slow. The bucket on a mechanical dredge cannot remove sediment from small pockets and crevices in a bedrock surface and is not designed to sweep a hard, uneven surface clean of sediment. The problem of dealing with residual contamination located in a thin layer over a hard base material is a difficult one and multiple passes of a low production dredge or the need for small, diver assisted dredges should be expected in such areas if the target cleanup level is to be met.

Highly compacted glacial till located immediately below the contaminated sediment can also decrease dredge production rates. The environmental buckets currently in use for removing contaminated sediments by mechanical dredges are not efficient at cutting into highly compacted material. They are particularly inefficient when employed on a derrick dredge or crane, as these machines depend upon the weight of the bucket to penetrate the

sediment. They are more effective if they are mounted on the boom of a hydraulic excavator that can apply downward pressure on the bucket to force it into the compacted material.

- Interference with Navigation: The Champlain Canal is a popular route for travelers from and to Canada, Lake Champlain and Albany. Freight traffic has all but ceased on the Canal in the last decade due, in part, to the fact that dredging by the New York State Canal Corporation to maintain a 12-foot minimum navigation depth has not been performed, largely due to PCB contamination of the sediments. Inasmuch as a number of communities and marinas along this route are dependent upon the dollars spent by tourists using the Canal system, the dredging operations will have to be conducted in a manner that minimizes interference with boat traffic. This includes sinking hydraulic dredge pipelines beneath the navigation channel, allowing tourists' boats to pass through locks if they reach them ahead of scows carrying contaminated sediments, avoiding blocking the channel with work boats, and maintaining buoys, navigation lights, and markers identifying work zones to protect against accidents. The extent to which interference with navigation will impede dredging progress and productivity is very difficult to gauge as it is not known whether the fact that a major sediment remediation project is underway along the Canal will discourage tourists from using this route during the project or attract curiosity seekers who want to observe the work. Nevertheless, some delays must be expected due to navigation issues and should be included when estimating probable dredge production rates for development of a project schedule.
- Length of Dredging Season and Daily Operating Hours: The annual production rate during dredging is dependent upon the length of the dredging season. At present, the New York State Canal Corporation opens the Champlain Canal during the first week of May each year, provided the high flows characteristic of spring runoff from the Adirondack Mountains have subsided, and closes the Canal to traffic in early November. Ice does not normally form until mid to late December, and it may be possible to extend the dredging season into early December if the Canal Corporation will agree to keep the locks staffed or by organizing the work such that all of the dredging takes place in a single pool between locks following closure of the Canal to normal traffic.

The daily production rate during dredging is greatly affected by the number of hours that the dredges can work in a day. Dredging projects frequently continue around the clock, seven days per week, although maintaining, refueling, and moving the dredges to new areas usually require that they be shut down for some time period on a periodic basis. The Canal Corporation currently staffs the locks on the Champlain Canal from 7:00 A.M. until 7:00 P.M. each day, including weekends. Arrangements would have to be made to staff these locks during the night if transit through the locks is needed beyond the usual schedules (see RS, White Paper # 313398).

2.2.2.3 Implications of Post Dredging Sampling and Re-dredging

Sampling of the river bottom will be conducted when contaminated sediment has been removed from an area to the elevation established during design. If this sampling shows that residual contamination above the target cleanup level of 1 mg/kg PCB still exists, the contaminated areas

can be re-dredged as discussed in the Performance Standard for Dredging Residuals. It is expected that, in order to avoid delays in the overall program, sampling will be conducted as soon as the design elevation has been achieved and dredging will continue while the samples are being analyzed. If extensive re-dredging is found to be necessary in an area, and if the remaining sediments are amenable to removal by the equipment employed for the initial, production dredging work, that equipment may be used for the re-dredging process and the project will experience some delay. If the sampling indicates that the residual contamination exists as a thin layer of sediment or small pockets of sediment surrounding obstacles such as large boulders, a different dredge may be employed to remove it while the primary dredging equipment proceeds to other areas of the Upper Hudson River targeted for dredging. If the river is to be remediated within the time frame established in the ROD, the project schedule must account for delays resulting from the need to re-dredge an area. The schedule should reflect the fact that silt barriers and other structures erected to prevent the loss of resuspended sediments downstream, if used, will remain in place until an area has been completely remediated.

2.2.2.4 Backfilling of Dredged Areas and Stabilizing Disturbed Shorelines

The ROD requires that dredged areas outside the navigation channel of the Canal be backfilled, where appropriate, with one foot of clean soil. In addition, where dredging has resulted in undercutting banks along the shore, stone fill, gravel or other stabilizing material will have to be placed to prevent erosion and cave-ins. If the backfill material is fine-grained soil, placing this material is expected to create turbid conditions in the Upper Hudson River, and should be done while any silt barriers that may have been erected to isolate an area for dredging are still in place. The rate at which backfill or shoreline stabilizing material can be installed will be affected by the method of placing the material and whether the water depth is sufficient to allow barges loaded with soil to be moored within easy reach of the equipment used to place it. In order to minimize delays in dredging, it will be necessary for placement of the backfill and shoreline stabilization work to begin as soon as an area is deemed clean. This work is likely to have an impact on the rate that dredging can proceed, particularly toward the end of the dredging season, as all disturbed shorelines and all dredged areas should be backfilled before the work is shut down for the winter. Otherwise, banks areas may be eroded and residual contamination in sediments loosened by the dredges may be scoured and transported to downstream areas when high flows occur during the following spring runoff period.

2.2.2.5 Sediment Dewatering, Water Treatment, and Shipping

Experience on other projects has shown that production bottlenecks most often occur in the dewatering of dredged sediments and treatment of the resulting water. In fact, many dredging projects involving small volumes of contaminated sediments have been designed such that the rate at which dredging can proceed is limited to the rate that the sediment can be dewatered. For these projects, it has been judged to be more economical to erect small, low capacity dewatering and water treatment facilities that operate 24 hours per day and limit dredging to less than 8 hours per day rather than to invest in large capacity dewatering and water treatment facilities capable of keeping up with the dredge over a 24 hour dredging period. Given the scale of the Upper Hudson River project, it is consistent with the ROD and should be economical to erect

large, temporary dewatering and water treatment facilities with a capacity that is closely aligned to that of the dredge production rate so that the dredges can operate on a nearly continuous basis.

2.2.2.5.1 Mechanical Dewatering of Hydraulically Dredged Sediments

It is expected that the sediment will be mechanically dewatered or otherwise treated for immediate shipment from the area. A number of mechanical systems have been proven effective for dewatering hydraulically dredged sediments. One system, used in a number of recent sediment remediation projects including Cumberland Bay, Deposit N and SMU 56/57 on the Fox River, and the General Motors Powertrain facility on the St. Lawrence River, employed shaker screens and hydrocyclones to separate sand and gravel from the dredge slurry and either belt filter presses or recessed cavity filter presses to dewater the silt and clay sized fraction. In this type of system, the dredge slurry is discharged onto a series of shaker screens consisting of a coarse bar screen to remove stones and debris, followed by finer screens that remove gravel and coarse sand. The effluent from the screens is discharged into a large hopper. From the hopper, the slurry is pumped through a series of hydrocyclones sized to remove the sand fraction, which is discharged onto another shaker screen equipped with a fine screen. The overflow from the hydrocyclones contains the silt and clay sized particles and is usually discharged into tanks where chemicals are added to promote dewatering. From these tanks, the conditioned slurry is pumped into filter presses to separate the solids from the water. These presses can usually produce a filter cake containing over 50 percent solids, by weight. The filtrate water is discharged to a water treatment system for additional treatment prior to discharge back to the river.

A condition typically imposed on the dewatering system by designers and by operators of disposal facilities is that the solids must be dewatered to the point where they pass a paint filter test, *i.e.* the solids must be dry enough so that no free water will drip from them when placed in a paint filter (USEPA Method 9095). This is relatively easy and inexpensive to achieve when dewatering non-cohesive sediments consisting of sand and gravel, because these materials drain rapidly and are readily removed from the flow using hydrocyclones and shaker screens. Slurry can be pumped onto a shaker screen and through high capacity hydrocyclone at rates of 2500 gallons per minute and higher, so only a limited number would be required to handle the flow from a hydraulic dredge pumping 8,000 to 9,000 gallons per minute of slurry. However, nearly all sediments contain some amount of silt and clay sized particles which must be dewatered using some type of filter press, a centrifuge, or other device designed specifically to handle fine-grained material.

Hydraulically dredged sediments containing a high percentage silts and clays are much more difficult and expensive to dewater than non-cohesive sediments because most of the dewatering must be accomplished in the filter presses. Capturing and dewatering the fine-grained sediments in recessed cavity filter presses or belt filter presses require careful attention to the chemical conditioning of the slurry and the operation of the equipment. It is slow and labor intensive when compared to using screens and hydrocyclones. Furthermore, the capacity of individual presses is low and cycle times can be long, so a large number are usually needed to keep up with the volume of slurry produced by the dredge.

As might be expected, the sediments targeted for remediation in the Upper Hudson River include some deposits consisting of a high percentage of silts and clays and others that are primarily sand and gravel. Available data on the grain size distribution of the targeted sediments indicate that, on average, approximately 60 percent of the dredged material will be sand and gravel that can be dewatered using screens and hydrocyclones while 40 percent will be silts and clays that will have to be dewatered using filter presses or a similar technology (see FS, Appendix H). However, each deposit is different, and when the dredge is operating in an area where the sediment consists primarily of silt and clay, most of the material processed will have to be dewatered in the filter presses. Thus, if hydraulic dredging is used, the filter presses or other equipment selected to dewater the fine grained sediments should be sized to handle the maximum amount of fine material expected to be dredged on any given day.

Because the slurry produced by a hydraulic dredge usually contains from 85 to 90 percent water, by weight, a great deal of water must be treated prior to returning it to the Upper Hudson River. Water treatment systems typically used in conjunction with mechanical dewatering systems for the remediation of PCB contaminated sediments employ chemical mixing tanks for coagulants, settling tanks with skimmers to remove settleable solids and any floating oils or foam, mixed media pressure filters to remove particulates, and granular activated carbon pressure filters to remove dissolved PCBs. These treatment systems generally produce an effluent with turbidity of less than one NTU and PCB concentrations less than 0.065 parts per billion, the normal limit for discharge to a surface water in New York State.

The area requirements for dewatering and water treatment systems associated with a hydraulic dredging project are governed more by space needed for temporary staging of TSCA and non-TSCA sediments and rail or truck loading areas than for the actual dewatering and water treatment equipment. Typically, a mechanical dewatering system capable of handling 4000 to 5000 cubic yards of sediment per day requires about 3 acres of usable space and a water treatment system with a capacity of around 9000 gallons per minute can be constructed on 1.5 to 2 acres. Buffer space surrounding the facility, construction trailers, decontamination areas, equipment wash down areas, temporary staging areas, rail sidings and loading areas, etc, may require up to 10 additional acres, depending upon topography and layout. Overall, a location with about 15 acres of useable space will be needed if hydraulic dredging and mechanical dewatering is employed for those portions of the work within pumping distance of the material to be dredged.

2.2.2.5.2 Dewatering of Mechanically Dredged Sediments

Mechanical dredges are capable of removing sediment at close to its in-situ solids content. As a result, the amount of water collected with the sediment is significantly less than with hydraulic dredges. Nevertheless, the dredged sediment delivered to the material processing site will be too wet to load directly into rail cars for shipment, and some dewatering and water treatment will be required.

Mechanically dredged sediment will be delivered to the processing facility location by scow. If the trip from the dredging area to the site is long enough for the solids to settle in the scow, some of the supernatant water can be pumped off to a water treatment plant similar to that described

for treating water from a hydraulic dredging operation. If the supernatant contains too high a concentration of suspended solids, the liquid can be passed through a filter press prior to delivery to the water treatment system. After decanting the supernatant, the sediment is unloaded and mixed with a chemical agent that adsorbs or binds up the remaining free water.

The FS described a method of physically stabilizing mechanically dredged sediments by adding Portland cement to bind up the water and change the material into a low grade concrete. It was estimated that the amount of Portland cement needed would be approximately 8 percent of the weight of the sediment. A significant advantage of this method comes from the fact that storage silos for the cement and pug mills or other mixing equipment can be erected on a relatively small facility. The major disadvantage of this method of dewatering is that the weight of the material shipped to the disposal site is increased by the amount of cement added and the amount of water that is bound up in the mixture by the cement. Nevertheless, the addition of cement or another binder material to make the sediment pass a paint filter test can be a cost effective method of reducing the free water if transportation and tipping costs are low.

Other methods of removing water from mechanically dredged sediments include spreading the sediment on sand beds constructed over a grid of perforated pipe and allowing it to drain by gravity for a few days prior to shipping, modifying the scows to provide better drainage during the trip from the dredging location to the unloading site, decanting the scows at the dredging site and treating the decant water at a floating treatment system, and processing the sediment in the same manner as used for hydraulically dredged sediments.

The area required for dewatering mechanically dredged sediments is normally less than that required for hydraulically dredged sediments. As in the case of hydraulically dredged sediments, much of the area needed is for staging, loading and shipping facilities, and support facilities. Where mechanical dredging is employed and the scows are to be unloaded with clamshells, the sediment processing/transfer facility should be immediately adjacent to the Hudson River to avoid the necessity of double handling the sediment. Where hydraulic dredging is used, the facility can be located away from the Hudson River and the sediment pumped inland through the slurry pipeline.

2.2.2.5.3 Rail Shipping of Processed Sediment

The ROD calls for the transportation of processed sediments to licensed off-site landfills by rail or barge. The use of trucks for transporting such a large volume of sediment was considered to be too disruptive. Rail facilities in the Upper Hudson River corridor were considered adequate to handle the additional traffic associated with the dredged sediments although there is limited room in existing local rail yards to make up a full train of loaded gondolas.

An evaluation of the ability to process, load rail cars, and transport processed sediment from a candidate sediment transfer/processing facility at the northern end of the Thompson Island Pool, the Old Moreau Landfill, was presented in the FS and RS. The evaluation concluded that transporting 1,600 tons per day from this location should be possible. This evaluation has been revised to reflect the possibility of transporting all sediments - up to 4,500 tons per day - from this one location. The revised evaluation is presented in Attachment 4¹. This revised assessment

indicates that there is sufficient land area available at this location to construct rail sidings capable of holding 45 rail cars simultaneously, together with the necessary sediment processing and water treatment facilities, but cautions that the ability of the Canadian Pacific Railroad to transfer the loaded cars¹ to a local rail yard for assembly into a train needs to be confirmed.

The ability to construct rail loading facilities of an adequate size and capacity to handle the expected volume of sediments will be dependent upon the location(s) ultimately selected for the sediment processing/transfer facility(ies), but it is expected that potential transportation problems can be satisfactorily addressed during facility selection and design. If necessary, processed sediment could be loaded into barges carrying 2,000 tons or more each and transported to another facility with adequate rail sidings and transfer equipment to meet the schedule. Even at a production rate of 6,000 tons of dewatered sediment per day, only three barges would be required, and this should not interfere significantly with the current low level of traffic on the Canal.

2.2.2.6 Quality of Life Factors

Quality of life issues that may affect the time needed to complete the project include noise and lights from the dredges and ancillary equipment working on the Hudson River and from the sediment processing/transfer facility(ies), traffic delivering chemicals and fuel to the facility(ies), and similar factors. These factors are the subject of a separate study and report being performed by the USUSEPA. Quality of life performance standards will be established (under separate cover) to limit disturbance to the lifestyle of people and businesses along the river and in the immediate surroundings as much as practical. The effect of these “quality of life” standards on the dredging, treatment and shipping of contaminated sediments is not currently known, but will be taken into account in the schedule for the project as they are developed. The dredging sequence and operations may require adjustment in areas adjacent to population centers and operating marinas.

2.2.3 Example Production Schedule

An example production schedule has been prepared to illustrate the feasibility of achieving the Performance Standards for Dredging Productivity using relatively conservative assumptions and at least one selection of equipment from the wide array of such equipment currently available and in use on environmental dredging projects. It should be clearly understood that an actual project schedule will be developed during the design of the project and may be very different from this example. The actual volumes and locations of sediment to be dredged, the location(s) of the processing and transfer site(s), the need for containment of the dredging areas, the type and capacity of dredging equipment, among other major factors for which assumptions have

¹ This revised evaluation was performed to illustrate the feasibility of achieving the Performance Standard for Dredging Productivity under conservative assumption of one location, rather than a less conservative assumption of two or more locations. The location was selected near majority of dredging (in River Section 1). This evaluation does not suggest that USEPA has selected this location or that the location is considered preferable. Facility siting will be conducted in accordance with the procedures set for in Facility Siting, Concept Document (USEPA, 2002).

been made in developing the example schedule, will all be determined during final design. The example schedule is discussed in some detail and presented in Attachment 1. Backup for the example schedule is presented in Attachment 2. A summary of the major assumptions that were made in developing this schedule and the results of this work is presented below while a more detailed list of the assumptions used is presented in the attachment.

2.2.3.1 Major Assumptions used in Development of Example Production Schedule

- The volume and location of the sediments to be dredged are as presented in the FS and are based on the analytical results for samples collected during a number of sampling events conducted over the last 25 years. The example schedule assumes that the volume will be 2.65 million cubic yards. However, as noted in Section 1 of this document, a new sampling program is underway and it is expected that the locations and volumes used for the example schedule will change when this work is complete.
- A single, sediment processing and transfer facility has been assumed to be located at the northern end of the Thompson Island Pool. Although the FS assumed that two such facilities would be constructed, one at the northern end of the project area and one at the southern end, a single site has been assumed for development of the example schedule based on a belief that this would be a more conservative assumption. Furthermore, it has been assumed that the sediment processing and shipping facilities will be designed with sufficient capacity keep up with the rate at which sediment is delivered to the site.
- Dredging and similar work on the River will be conducted 24 hours per day, 6 days per week. Conducting routine weekly maintenance tasks on dredges and ancillary equipment is anticipated to occur on the seventh day of the week. Note that this is a conservative assumption since it does not rely on a seventh day of dredging activity. If dredging were to occur 7 days per week, a higher rate of production would be achievable.
- Overall, it has been assumed that the effective time available for dredging will average 13 hours per day. No dredging will take place at all on many working days during a construction season, as a significant amount of time is needed to relocate the equipment from one dredging site to another, install and remove sediment barriers, etc.
- The New York State Canal Corporation normally opens the Champlain Canal to traffic during the first week of May and closes the system in the first week of November. It has been assumed that the arrangements can be made with the Canal Corporation to extend the operating season until the end of November, and possibly longer during mild years, and that 24 –hour per day access through the locks will be provided to allow floating equipment to navigate the system. It has also been assumed that, following closure of the locks in the fall, work will still be permitted within a pool between locks for as long as weather and river conditions permit.
- For development of the example production schedule, it has been assumed that silt barriers would be used for all dredging work outside of the navigation channel and would not be removed until the dredging of that area was complete and backfill and shoreline

stabilization work was finished. This assumption was made so that a conservative scenario could be developed to estimate productivity. The installation and use of silt barriers delays the start of dredging each spring, causes delays in production due to the need to enter the enclosed area through gates in the barrier, and requires the dredging contractor to cease dredging and place backfill over a dredged area early enough in each dredging season to be able to remove the silt barriers before ice forms on the river. Although the use of silt barriers should make it possible to remove debris from the river and dredge at a relatively high rate without as much concern about meeting the Resuspension Standard, the time required to install and remove the barriers detracts from the number of days available for dredging each season. A detailed evaluation of the cost effectiveness of installing silt barriers and a decision on their use will be made as part of the final design process.

- Mechanical dredging has been assumed for the development of the example production schedule under the belief that mechanical dredging will be slower than hydraulic dredging in most instances where hydraulic dredging might be possible (see Attachment 3 for an evaluation of applicable dredging equipment). Two different size mechanical dredges have been assumed to be available:
 1. A dredge consisting of a hydraulic excavator with an extended boom fitted with a 4 cubic yard, hydraulically activated environmental bucket has been assumed to be the primary production dredge used where the depth of water is at least 3 feet following dredging and the thickness of the contaminated sediment layer and volume of sediment to be removed are great enough to warrant such a dredge. A production rate of 82 cubic yards per hour of actual dredging work has been assumed for mechanical dredges of this size and type.
 2. A dredge similar to that described above but with a 2 cubic yard, hydraulically activated environmental bucket has been assumed to be used in areas where the sediment layer to be dredged is less than about 2 feet, the water depth is less than that needed for the larger dredge, or the area and volume of sediment to be dredged is small. This dredge would also be used for redredging, if post-dredging sampling indicates that additional sediment must be removed from an area. A production rate of 27 cubic yards per hour has been assumed for this smaller dredge when dredging to achieve the original design cut lines. No production rate has been assumed for redredging an area using this dredge, as any production rate would be dependent upon the thickness of the sediment layer to be removed, the total area to be covered by the dredge, and the characteristics of the material to be removed. Rather than assuming a product rate for redredging in terms of cubic yards per hour and making additional assumptions regarding the amount of redredging that might be needed, the example production schedule assumes that redredging will require about one half as much time as needed to achieve the original design cuts established for the project, *i.e.* ,if 30 days are required to dredge an area to the design cut lines, 15 additional days have been allowed for redredging work in the same area following sampling and analysis of the initial results.

- The dredged sediment would be placed in scows located where a post-dredging water depth of six feet or more is available to provide the necessary draft. The extended booms on the dredges will make it possible for these machines to excavate sediments located at a distance of up to 30 feet from the dredge in shallow water. Where the post-dredging water depth is too shallow to permit scows to be placed in reach of the dredge, other dredging equipment, such as described in Section 2.4.2, and small, shallow draft scows are assumed to be used. The assumed production rate for this equipment is 27 cubic yards per hour of actual dredging work.
- Conducting post-dredging soundings to confirm that the sediment has been removed to the design depth and sampling to determine the level of residual contamination remaining, if any, is assumed to be carried out as soon as a sufficient area has been dredged to the design grade to permit this work to be done without interfering with the dredging effort. The example production schedule assumes that post-dredging sampling will be completed within a few days of completion of dredging in a particular area and prior to the removal of any silt barriers or other containment structures.
- If all the original inventory of contaminated sediment has been removed in accordance with the final design and sampling and analysis of the remaining sediment indicates that re-dredging is required to achieve compliance with the Residuals Standards, the redredging effort will be limited to two attempts at achieving compliance. As has been noted above, for the purposes of preparing an example production schedule it has been assumed that the time required to re-dredge an area is equal to 50 percent of the time required for removal of the original inventory.
- Although the ROD states that dredged areas will be backfilled, as appropriate, the Example Production Schedule assumes that all dredged areas will be backfilled. It is not possible to know, in advance, how much of the areas targeted for dredging will have to be backfilled, so a very conservative assumption has been made for the extent of this work.
- The shipping of dewatered or otherwise processed sediments from the processing and transfer site to a final disposal site is assumed to be done continuously to meet the requirement that no processed sediments be stockpiled on the site at the end of a construction season for disposal the following year.

2.2.3.2 Results of Example Production Schedule

The example production schedule, presented in Attachment 1, indicates that 4 primary (4 cubic yard bucket) and 6 alternative (2 cubic yard bucket) dredges will be needed for a significant portion of the time if the project is to be completed in the 6 year period stated in the ROD. However, the number of dredges in operation simultaneously may vary from zero to as many as 10, exclusive of any redredging equipment, for short periods of time. While this upper number could be reduced by using larger dredges in some areas, it indicates that very careful control and scheduling of the dredging effort will be required to minimize delays at locks, a backup of scows at the unloading location and similar problems.

The example also illustrates that if redreding is required in a given area, it should take place while the production dredges continue to work downstream. If the dredging is stopped to await post-dredging sampling, analysis and evaluation, and a decision as to whether redreding will be necessary in a given area, the project will not be completed on time.

Phase 1 work is anticipated to begin on or around the first of May and be completed by the early December. However, the example production schedule indicates that actual dredging would not begin until mid-June and would be completed by November 7. Mobilization and site preparation would be accomplished during the first 6 weeks of the Phase 1 construction season and shoreline stabilization, completion of backfilling, winterizing equipment to be left on site and demobilization would occur during the last 4 weeks or so.

The example schedule indicates that, during the second year of the project when full scale dredging is underway, actual dredging should begin in early May and be completed by mid October. In the third year of the project, the dredging would begin by May 2 and end by November 12. In the next two years, dredging would begin in the first week of May and end by November 6 and September 29, respectively. In the last year of the project, dredging would be completed by the end of August. The fact that dredging continues late into the fall in some years and ends sooner in others results from the selection of areas to be dredged in a given year. A different sequence of dredging would result in different beginning and ending dates than those shown in the example, and any changes in the volume of material to be dredged in a given target area would extend or shorten the time needed to complete that area.

A summary of the volumes assumed to be dredged, the area remediated, and completion date for work each calendar year, taken from the example schedule, is shown in Table 2-2.

The example schedule was developed to meet or exceed the Performance Standards for Dredging Productivity set forth in Section 1. Table 2-3 compares the volumes dredged in the example production schedule with the Productivity Standards and illustrates that the schedule meets these standards in all years.

While the example production schedule presented herein is based on a large number of assumptions, all of which will have to be confirmed during design of the project, it supports the belief that the project can be completed in the six-year time frame set forth in the ROD. It is anticipated that a final schedule for the project that meets these goals will be developed once sampling of the sediments has been completed, final designs have been prepared, and the work under Phase 1 has been completed and evaluated.

2.3 Rationale for the Development of the Performance Standard

The Productivity Standard - Phase 1 is based on achieving 50% of the average annual production rate for Phase 2. It is, furthermore, based on the fact that, as identified in the ROD, Phase 1 will span one construction season and Phase 2 activities will span five construction seasons. Utilizing 2.65 million cubic yards as the total estimated project volume, the total production rates for Phase 1 and Phase 2 activities was calculated as follows:

- Phase 1 Required Production Volume = $\frac{1}{2} \times 2,650,000 / (5 + 0.5) = 240,000$ CY
- Phase 2 Required Production Volume = $2,650,000 - 240,000 = 2,410,000$ CY or 480,000 CY annually.

A target dredging rate has been developed and included in the standard to reflect the recommendation to attempt to complete the work ahead of schedule, with approximately $\frac{1}{2}$ of a season's worth of work being completed in the final season. The recommended target productivity rate was calculated as follows:

Phase 2 Target Annual Production Volume (Seasons 1 through 4 of Phase 2): $(2,650,000)/5 = 530,000$ (Note: $\frac{1}{2}$ a season's worth or 265,000 CY is targeted to be performed in Phase 1 and $\frac{1}{2}$ a season's worth is targeted to be performed in the final season of Phase 2).

3.0 Implementation of the Performance Standard for Dredging Productivity

3.1 Summary of the Standard

The Performance Standard for Dredging Productivity is defined in Section 1 of this document, and are summaries here for convenience.

The Performance Standard for Dredging Productivity – Phase 1, reduced scale dredging, is as follows:

1. The minimum volume of sediment to be removed, processed and shipped off-site during Phase 1 shall be about 240,000 cubic yards or about one-half the minimum annual productivity volume required for full scale dredging in Phase 2, whichever is less.
2. For a period of at least one month during Phase 1, the minimum production rate shall be the rate required to meet the Phase 2 Performance Standard in order to demonstrate the capabilities of the dredging equipment and the sediment processing and transportation systems; and
3. Stabilization of shorelines and backfilling of areas dredged during Phase 1, as appropriate, shall be completed by the end of the calendar year and prior to the spring high flow period on the River. Processed sediment shall not be stockpiled and carried over to Phase 2 for disposal.

The Performance Standard for Dredging Productivity – Phase 2, full scale dredging, is as follows:

1. Based on an estimate of 2.65 million cubic yards of sediment, the minimum volume of sediment to be removed, processed and shipped off-site during each of the 5 years of Phase 2 (full scale dredging) shall be as shown in the middle column of Table 3-1. Furthermore, Phase 2 should be designed to meet the targeted removal volumes shown in the right-hand column of Table 3-1. If possible, the project should be completed ahead of schedule, or at least with a reduced required volume for the final season of the project (Year 6).
2. Stabilization of shorelines and backfilling, as appropriate, of areas dredged during a dredging season in Phase 2 shall be completed by the end of the work season and prior to the spring high flow period in the River.
3. All dredged material should be processed and shipped for disposal by the end of each calendar year. Processed sediment shall not be stockpiled for disposal the following dredging season.

Phase 1 activities will not only accomplish a portion of the work required to remediate the River, but will provide data that will be useful for planning the work in subsequent years. USEPA will select the areas to be dredged during Phase 1. It is expected that Phase 1 dredging will be

performed in areas exhibiting a range of dredging conditions which might be expected during the full scale project including dredging in both deep and shallow areas of the river and in areas with differing bottom characteristics. It is further expected that the monitoring program conducted during this phase will provide sufficient productivity and other performance data to refine the project design, as necessary, for the full scale dredging work to be done in Phase 2 (years 2 through 6).

The Productivity Standard (Phase 1 and Phase 2), as well as the recommended targeted productivity volumes, are expected to be recalculated during remedial design once the final estimated volume of sediments to be dredged has been approved by USEPA. The formulas used to develop the Performance Standards for Productivity and the recommended target productivity volumes are described in Section 4 of this document and should be used for recalculating these volumes.

3.2 Potential Impacts of Other Performance Standards on Productivity

The Performance Standards for Resuspension and for Residuals must also be met while achieving the Performance Standards for Dredging Productivity. The Resuspension Standard controls PCB mass loss during project activities, requiring that the daily Total PCB mass loss be restricted to 600 g/day and project Total PCB mass loss be restricted to 650 kg over the course of the scheduled six-year duration. The Resuspension Standard also sets forth requirements and procedures for monitoring PCB concentrations in the water column downstream from the dredging operation. Failure to achieve the Performance Standard for Resuspension will require that steps be taken to reduce resuspension, and these steps may cause delays in dredging while engineering controls are put in place or result in the need to dredge at a slower rate than anticipated.

The Performance Standard for Residuals establishes criteria for determining when dredging in an area of the River has achieved the target cleanup level. The Residuals Standard requires that a maximum of two attempts be made at redredging an area in order to achieve the cleanup standard following initial removal of the PCB contaminated sediment inventory. Failure to meet the standard after two attempts at redredging may result in additional backfilling requirements. Extensive redredging and complying with additional backfill requirements will slow completion of the project and may lead to a failure to meet the Performance Standard for Dredging Productivity.

The example production schedule prepared during development of the Performance Standards for Dredging Productivity assumes that silt barriers would be employed to contain resuspended sediments in the immediate area being dredged. The use of such containment structures would reduce the potential for exceeding the maximum allowable release of 650 kg of total PCB to the lower River as defined in the Performance Standards for Resuspension. However, as noted in Section 2 of this document, the time needed to install (and remove) such barriers and the potential for work boats to resuspend sediments during their installation may actually delay the completion of dredging and lead to a greater loss of PCBs to the Lower River than if the project were completed without them.

Furthermore, the example production schedule assumes that any containment structures employed during dredging would be left in place until shoreline stabilization and backfilling of the dredged area have been completed so that residual sediments loosened by the dredging operation would not be eroded and carried downstream, en mass, when the barriers were removed and normal river currents again passed over the dredged area. As shown in example production schedule, this assumption caused delays in the dredging schedule that may not be justified. The use of silt barriers is not mandated by the Productivity Standard, and the decision as to whether to install them will be made during final design.

3.3 Monitoring, Record Keeping and Reporting Requirements

Implementation of the Performance Standards for Dredging Productivity will require certain monitoring, record keeping and reporting activities. At a minimum, the following requirements should be met:

- Dredging productivity shall be monitored and detailed records shall be maintained to document production throughout the duration of the project. Specific monitoring and record keeping requirements will depend upon the dredging methodology employed and will be determined during final design. At a minimum, however, daily records shall be kept of the location(s) of working dredges, the approximate number of hours of operation of the dredge(s), the approximate volume of material dredged, and the weight and moisture content of processed sediment transported off site.
- By March 1 of each year, the contractor shall provide USEPA with a production schedule showing anticipated monthly sediment production for the upcoming dredging season. The schedule must meet or exceed the productivity requirements defined herein or as revised in accordance with USEPA-approved design documents.
- Monthly and annual productivity progress reports shall be submitted to the USEPA for determining compliance with the Productivity Standard. Monthly productivity progress reports will be compared to the production schedule submitted by the contractor and will be the primary tool for demonstrating whether the project is on schedule. Annual production progress reports will determine compliance with the Productivity Standard and will be used to plan subsequent seasons' dredging work.
- At the end of each month, a monthly progress report shall be prepared and submitted to USEPA for review and comparison to expected production rates as described by the contractor in his anticipated schedule and required to meet the Productivity Standard. Monthly reports shall present monthly, dredging season, and project totals/information and shall include:
 1. A summary of the estimated total volume of sediment dredged, as measured in-situ in the River,
 2. A map showing the locations where dredging, confirmatory sampling and backfilling has been completed and where work is ongoing. The map shall display the general type of ongoing work in each area under remediation, confirmatory

- sampling, re-dredging, backfilling, etc.
3. The total weight and average moisture content of sediments shipped off site or added to the temporary stockpiles on the site
 4. A graph showing the anticipated cumulative dredging production as necessary to meet the productivity performance standard and the actual cumulative production achieved to date.
 5. A table, graph or other means of showing the cumulative total mass of PCB released to the lower river from the beginning of the project through the date of the monthly report, and a projection as to whether the cumulative PCB loss to the lower River will be below the of 650 kg restriction for the six-year scheduled duration of the project.

3.3.1 Action Levels

As describe in Section 1 of this document, two action levels have been identified: a concern level and a control level. Implementation of the Performance Standards for Dredging Productivity requires the following actions if these action levels are exceeded.

1. Concern Level: In any given dredging season, whenever the monthly dredging productivity falls below the anticipated productivity for that month by 10 percent or more, the contractor shall identify the cause of the shortfall and take immediate steps to correct the situation by adding additional equipment and crews, working extended hours, modifying his plant and equipment or approach to the work, or other steps needed to achieve the necessary production rate and erase the deficit in productivity over the following two months or by the end of the dredging season, whichever occurs sooner.
2. Control Level: If the monthly productivity falls below the anticipated productivity by 10 percent or more for two or more consecutive months, the Contractor shall provide a written report to USEPA's site manager detailing steps underway or to be taken to erase the shortfall in production that season. If the contractor fails to erase the shortfall at the end of the dredging season, the Contractor will be subject to action taken by USEPA.

4.0 Plan for Refinement of the Performance Standard for Dredging Productivity

This section addresses modifications to the Productivity Standard that may be required, as follows:

- During design and prior to start of construction (*i.e.*, following completion of the sediment data collection and interpretation efforts)
- After evaluation of the Phase 1 data.

4.1 Incorporation of Data Collected and Interpreted during Remedial Design

A great deal of information and data will be collected during the design phase of the project to refine the precise areas of the river bottom that require dredging, which in turn will refine the volumes that were estimated in the FS and ROD based on currently available data. USEPA will use the new data from the project design to update the Productivity Standard using the approach and methods outlined herein, as refined by further internal review, public input during the comment period, and external peer review.

The Productivity Standard - Phase 1 is based on achieving 50% of the average annual production rate for Phase 2. It is, furthermore, based on the fact that, as identified in the ROD, Phase 1 will span one construction season and Phase 2 activities will span five construction seasons. Utilizing 2.65 million cubic yards as the total estimated project volume, the total production rates for Phase 1 and Phase 2 activities was calculated as follows:

- Phase 1 Required Production Volume = $\frac{1}{2} \times 2,650,000 / (5 + 0.5) = 240,000$ CY
- Phase 2 Required Production Volume = $2,650,000 - 240,000 = 2,410,000$ CY or 480,000 CY annually.

A target dredging rate has been developed and included in the standard to reflect the recommendation to attempt to complete the work ahead of schedule, with approximately $\frac{1}{2}$ of a season's worth of work being completed in the final season. The recommended target productivity rate was calculated as follows:

- Phase 2 Target Annual Production Volume (Seasons 1 through 4 of Phase 2): $(2,650,000)/5 = 530,000$ (Note: $\frac{1}{2}$ a season's worth is or 265,000 CY is targeted to be performed in Phase 1 and $\frac{1}{2}$ a season's worth is targeted to be performed in the final season of Phase 2).

The above formulae will be used to define revised production volumes if the sampling and analyses data collected during pre-design studies result in a change in the estimated volume of sediment to be dredged of 10 percent or less. If new data indicate that the volume of material to be dredged varies by more than 10 percent from the 2.65 million cubic yards estimated in the FS and ROD, or if the locations of the various dredging areas change in a manner that will have a significant impact on the ability to achieve the Performance Standard for Dredging Productivity, the Standard will be re-evaluated and may be revised to reflect the changed conditions.

4.2 Revisions to the Performance Standard for Dredging Productivity Following Phase 1

During Phase 1, it will be necessary to carefully track the progress and adherence to the Productivity Performance Standard. Key information will be collected during Phase 1, including:

- Setup time (mobilization, containment) hourly and daily production rates for the various types of dredging
- Downtime
- Aerial Coverage
- Rate of Backfilling
- Closure time (sampling, surveying, demobilization)
- Number of dredge passes necessary.
- Impact of Performance Standards for Resuspension, Residuals, and Quality of Life on productivity.

These data may be used to adjust the Productivity Standard for Phase 2. Any adjustments, modifications or refinements to the Productivity Standard as a result of Phase 1 work will be the subject of a second peer review by independent experts, as required by the ROD.

Tables 1-1 to 3-1

Table 1-1: Productivity Requirement and Targets

Table 1-2: Action levels and Required Responses

Table 2-1: Phase 2 Productivity Parameters

Table 2-2: Mechanical Dredging Schedule by Phase and Year

Table 2-3: Cumulative Dredge Volumes

Table 3-1: Productivity Requirements and Targets

**Table 1-1
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, will be adjusted in accordance with the USEPA-approved remedial design schedule.

⁽²⁾ Represents total estimated, in-situ volume projected for remediation as per the ROD. Requirements and targets shall be adjusted based on new information as described in Footnote 1 and Section 3.2 of this document.

Table 1-2
Action Levels and Required Responses

<u>Action Level</u>	<u>Situation</u>	<u>Response</u>
Concern Level	Monthly production rate falls 10% or more 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 to EPA explaining the reasons for the lower production 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 production requirements.	USEPA action to be determined based on Agency review of specific circumstances.

Table 2-1
Phase 2 Productivity Parameters

Timeframe	Required Production Rate	Target Production Rate
Dredging Season	480,000 cy/season	530,000 cy for first four seasons of Phase 2, 270,000 cy for final season of Phase 2
Average Weekly ⁽¹⁾	16,000 cy/week	17,400 cy/week ⁽³⁾
Average Daily ⁽²⁾	2,300 cy/day	2,500 cy/day ⁽³⁾

⁽¹⁾ Based on a 30-week schedule.

⁽²⁾ Based on a 7-day work week.

⁽³⁾ These are the rates for the 530,000-cy/year seasons.

**Table 2-2
Mechanical Dredging Schedule by Phase and Year**

Season	Volume Remediated (cubic yards)	Area Remediated (acres)	Dredging Completion Date	Work Completion Date
Phase 1 (Year 1)	268,977	50	11/07/06	12/14/06
Phase 2 (Year 2)	529,440	78	10/15/07	12/20/07
Phase 2 (Year 3)	491,618	86	11/12/08	12/22/09
Phase 2 (Year 4)	548,535	62	11/06/09	12/22/09
Phase 2 (Year 5)	621,332	53	9/29/10	11/12/10
Phase 2 (Year 6)	128,983	63	8/30/11	11/12/11

**Table 2-3
Cumulative Dredge Volumes**

Season	Cumulative Volume From Example Production Schedule (cubic yards)	Required Cumulative Volume (cubic yards)	Target Cumulative Volume (cubic yards)
Phase 1 (Year 1)	268,977	240,000	265,000
Phase 2 (Year 2)	798,417	720,000	795,000
Phase 2 (Year 3)	1,400,227	1,200,000	1,325,000
Phase 2 (Year 4)	1,964,760	1,680,000	1,855,000
Phase 2 (Year 5)	2,412,147	2,160,000	2,385,000
Phase 2 (Year 6)	2,650,000	2,650,000	2,650,000

**Table 3-1
Productivity Requirements and Targets**

Project Phase and Year ⁽¹⁾	Required Cumulative Volume (cubic yards)	Target Cumulative Volume (cubic yards)
Phase 1 (Year 1)	approximately 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, will be adjusted in accordance with the USEPA-approved remedial design schedule.

⁽²⁾ All productivity requirements and target volumes discussed herein are based on the volume estimate presented in the ROD (USEPA, 2001, 2002). The volume estimate of 2.65 million cubic yards is expected to be refined, as described in Section 4, as new sampling data are obtained and analyzed during remedial design.

Attachment 1.0

Productivity Schedule

Attachment 1.0 Production Schedule

In order to evaluate the feasibility of achieving the Performance Standards for Dredging Productivity, an example production schedule was prepared using Primavera Systems[®], Inc. project scheduling software. This production schedule is provided as a series of pullout sheets at the end of this Attachment 1. It should be clearly understood that an actual production schedule will be developed during final design of the project and may be significantly different from this example.

In developing this example schedule, a large number of assumptions have been made that have an impact on dredging productivity. These assumptions are based on available information and, in some instances, are expected to change as the project is further developed during design. Where production rates have been assigned to particular aspects of the work, an attempt has been made to recognize the difficulty of the project and to be conservative in estimating the amount of work that can be accomplished in a given time period.

1.1 Assumptions Relating to Productivity

1.1.1 Locations and Volume of Sediment to be Dredged

A major assumption that affects the time required to dredge the Upper Hudson is related to the actual volume of sediment to be dredged and the depth of water in which these sediments are located. The delineation of sediment to be removed was taken from the FS and was based on the analytical results for samples collected during a number of prior sampling events. The delineation may vary based on the outcome of GE's sampling efforts, and the volume estimates will be adjusted accordingly.

Given the distribution of targeted sediments presented in the FS, a preliminary assessment has been performed of the practical working limits of the dredging technologies that appear to be relevant to remedial work in the Upper Hudson River. For a mechanical dredging system it was assumed it could function in proximity to the river shoreline in those areas where there would be at least 6-feet of water after dredging. Also, it was further assumed that a mechanical dredge could effectively reach and remove sediments lying 30 feet beyond its location in shallow water.

For a hydraulic dredging system it has been assumed that the system could successfully remove shoreline sediments where there would be as little as three feet of water in the post-dredging condition. Material not accessible by conventional mechanical and hydraulic technologies would have to be excavated by alternative specialty dredging systems.

In River Section 1 (River Mile 188.5 upstream to the area around Rogers Island), a total of approximately 1.56 million cubic yards of sediment will be removed. Approximately 1.25 million cubic yards (about 80%) of this material could be removed using a mechanical dredge, while a hydraulic dredge could remove 1.39 million cubic yards (about 89%). An alternative dredge would be required for the remaining material (approximately 20%, or 0.31 million cubic yards, for mechanical dredging and 11%, or 0.17 million cubic yards, for hydraulic dredging).

In River Section 2 (River Mile 183.24 to River Mile 188.5), approximately 0.50 million cubic yards of sediment will be removed. Approximately 0.48 million cubic yards, or 95% of this material, can be removed using either a mechanical or hydraulic dredge. The remainder would have to be dredged using an alternative dredge.

For River Section 3 (River Mile 163.25 to 170.25), approximately 0.56 million cubic yards of sediment will be removed. Of this, approximately 0.37 million cubic yards (about 65%) can be removed using a mechanical dredge, with the remaining 0.20 million cubic yards (35%) removed by an alternative dredge. The entire 0.56 million cubic yards of the material can be removed using a hydraulic dredge if processing and shipping sites are available within pumping distance of the dredge.

A summary of dredge volumes (cubic yards) by location and method is provided in Table 1-1 of this Attachment 1 and in Tables 3B-1 and 3C-1 in Attachment 3.

1.1.2 Location of Processing Facilities

The ROD assumed the establishment of two processing facilities, one near the northern extent of the project area and one near the southern extent of the project area. However, for the purpose of a conservative production estimate, it was assumed that only one facility would be available at the northern end of the project River Mile 194 on or near the Old Moreau Landfill or New Moreau Landfill. Under this assumption, all dredged sediments will have to be delivered to this one site for processing and shipping. The location was selected near the majority of dredging (in River Section 1). This selection does not suggest that USEPA has selected this location or that the location is considered preferable. Facility siting will be conducted in accordance with the procedures set forth in Facility Siting, Concept Document (USEPA, 2002).

1.1.3 Need for Silt Barriers/Curtains

Silt barriers/curtains are most appropriate in water depths less than 21 feet and flow velocities less than 1.5 feet per second. For the purpose of the example production schedule development, it was assumed that silt barriers would be used for all dredging work outside of the navigation channel. This assumption was made so that a conservative, if not worse case, scenario could be developed to estimate productivity. The need for silt barriers/curtains should be determined during the design phase. The silt barrier type selected for preparation of the schedule presented herein consists of steel sheet piling at the upstream and downstream limit of the active work area. In shallow water areas, Jersey barrier or a similar portable barrier may be used. The steel sheeting would extend perpendicularly from the high water mark on the shoreline to the navigation channel or the limits of the active work area. The sheeting would then be installed parallel to the river channel and extended an additional 30 to 50 feet. The steel sheeting on the upstream end of the active work area would extend in a downstream direction and the steel sheeting on the downstream end of the active work area would extend in an upstream direction. High-Density Polyethylene (HDPE) geomembrane would be installed between the ends of the sheet piling. The HDPE sheeting would be supported at the top by a floatation boom and anchored or weighted to the riverbed to hold it in position. A sketch of an assumed silt barrier

installation is presented in Figure 1-1. This type of barrier differs from the conventional silt curtain in that its mode of failure is through submergence of the floatation boom rather than a lifting of the bottom of the curtain in response to pressure waves.

1.1.4 Dredging Procedure

In developing tentative dredge production rates, it has been assumed that, where the thickness of the sediment layer exceeds 2 feet for hydraulic dredging or 1 foot for mechanical dredging, multiple passes of the dredge will be required to achieve the target removal depth, referred to herein as the “design cut.” By removing the sediment in two or more passes, taking shallow cuts each time rather than dredging to the design depth at one setup of the dredge, contaminated material that sloughs from the face of the cut during the first pass of the dredge will be excavated on the second pass. This reduces, but does not eliminate, the potential for contaminating the surface of the riverbed exposed by the dredge with contaminated material from above. Under this assumption, the dredge will make passes covering at least an acre before returning to begin another pass or passes as needed to achieve the design cut.

1.1.5 Need for Redredging

Regardless of the dredging technology that is used, it should be assumed that some redredging will be required to achieve target cleanup levels in some areas of the River. It is very difficult to estimate the potential time required to redredge areas which do not achieve the performance standard for residuals after initial dredging. The Project Completion Report on remediation of the St. Lawrence River at the former Reynolds Metals Site indicates that about 50 percent of the areas targeted for dredging achieved the target cleanup level of 1.0 mg/kg during initial dredging. A first attempt at redredging succeeded in achieving cleanup targets in an additional 30 percent of the areas, while two redredging attempts were needed to raise the total to 88 percent. Some areas were redredged 3 or more times and failed to meet the cleanup requirements. Ultimately, it was necessary to change the dredging method to achieve the target cleanup level in some areas with rocky and/or compacted till underlying the sediment (See Volume 4, Appendix: Case Studies of Environmental Dredging Projects).

Satisfactory completion of the initial dredging to achieve the design cut and remediation goals will be determined based on the requirements set forth in the Performance Standard for Dredging Residuals. For the purposes of this productivity estimate, it has been assumed that redredging will require 50 percent of the time required to dredge to the design elevation, *i.e.* if 30 days are required to dredge a given subarea to the design elevation, an additional 15 days will be needed to redredge portions of this area to meet the target cleanup level. The validity of this assumption will be tested during Phase 1 of the project, provided that some areas require a second attempt at dredging during Phase 1.

1.1.6 Shoreline Stabilization

In many areas, the defined limits of sediment removal may extend to, or beyond, the mean water level along the shoreline. For the purposes of devising a Production Schedule, it was assumed that all shoreline disturbances would be stabilized using one of three methodologies:

- Shoreline areas where the depth of sediment to be removed is less than 2 feet and dredging can be conducted such that the post dredging river bottom slopes gently to the existing shoreline will be stabilized by hydro seeding any disturbed areas above the waterline.
- Shoreline areas where the sediment removal depth is greater than 2 feet and the dredge cut ends abruptly at a vertical face will be stabilized by placing a filet of stone fill with a slope of 1 vertical to 2 horizontal against the vertical face.
- Shoreline areas which are currently stabilized with riprap, dumped stone fill, or similar armoring will be restored in-kind.

1.1.7 Wetland Restoration

To estimate the effort associated with wetland restoration, the following assumptions have been made: following dredging activities, those areas identified as wetlands will be backfilled with a mixture of sand and fine material to achieve a water depth approximately equal to the pre-dredging depth. These areas will then be planted with appropriate wetland vegetation.

1.1.8 Weather and River Flow Issues

Low temperatures, high winds, and high flow rates or flooding may occur during the dredging season. Based on meteorological data from the Glens Falls (Warren County) and Albany Airports for the years 1991 through 2000, it appears that low temperatures should not limit work during the proposed period. In fact, based on temperature data alone, it would appear that productive work could occur for 33 to 34 weeks per construction season (RS, White Paper #313398).

The Upper Hudson River is relatively sheltered (compared to a bay or sound) and is not prone to wave formation. It is not expected that significant wind-related delays will occur.

Between 1997 and 2001, the Canal Corporation issued one Memo to Mariners indicating that the canal system between Lock C-1 and Lock C-4 would be closed for a few days until water levels receded to safer levels and debris could be removed. Based on estimated river velocities and associated water depths, it has been assumed that dredging activities can be effectively conducted in river flows up to 10,000 cfs. Based on flow data collected at the USGS Fort Edward gauging station from 1978 to 2000, river flows in excess of 10,000 cfs occur approximately 5 percent of the time during the proposed dredging season (RS, White Paper #313398).

1.1.9 Canal Operating Schedule

The canal operates approximately 29 weeks per year and generally has daily limits on passage through the Champlain Canal lock system. It has been assumed that the Canal Corporation will extend their operating season to provide a minimum of 30 weeks per year (and possibly longer during mild years) and that 24-hour per day access through the locks will be provided to allow loaded and empty scows to navigate the system. It is further assumed that working within a pool

between locks will be permitted even after the canal is closed to normal traffic in the fall (RS, White Paper #313398).

The Canal Corporation conducts most major rehabilitation and repair activities on the lock system during the winter months to avoid impeding boat traffic. Repairs, largely limited to above-water work, are performed on a maintenance cycle throughout the operating season of the Canal. These repairs are not expected to inhibit travel. It is expected that the only repairs or maintenance activities that may inhibit use of the lock system would be emergency repairs, which have typically been very few. In addition, periodic events such as boat parades and land-based emergencies may also impede navigation.

1.1.10 Equipment-Related Delays

Some level of downtime due to equipment malfunction is unavoidable. However, the duration of the downtime and the affect on the overall schedule can be largely overcome through proper planning and design. For the purpose of this productivity assessment, the production hours (effective time) for the most critical mechanical equipment (e.g., dredging equipment) have been de-rated to account for typical downtime (for further information see RS White Paper #313398).

1.1.11 Processing and Shipping Assumptions

As noted in Section 2.1.4 of the main document, it has been assumed that the on-shore treatment and shipping facilities will be designed with adequate capacity to process the maximum daily output from the dredges.

1.1.12 Sequence of the Work

In order to identify the major pieces of equipment needed to complete the project and develop a preliminary schedule to evaluate the feasibility of remediating the River within the time frame defined in the ROD, a plan must be developed regarding the sequence of work. The following sequence of work has been assumed for the full scale dredging program. Only the major, definable features of the work are listed, as these features generally control the overall production schedule. For the purposes of this example schedule, it has been assumed that turbidity barriers will be installed around each dredging area as this is a time consuming operation and will result in a conservative estimate of the amount of work that can be accomplished each season. If turbidity barriers are not used on the project and the equipment selected for dredging is capable of being operated in conformance with the Performance Standards for Resuspension, it should be possible to shorten the schedule.

1. It has been assumed that mobilization will begin as soon as weather permits each spring, usually by the first week of April, and will concentrate on making the on-shore facilities ready for the dredging season. Dredges that were demobilized and removed from the site the previous winter will be mobilized on the first day that the canal opens in May.
2. The installation of turbidity barriers, if used, and monitoring equipment will begin as soon as flows in the River permit. Equipment needed to install these structures is assumed to have been trucked to the site prior to the opening of the Canal and installation

is assumed to start on or about the first of May each year. A gate will be constructed in any barrier around each major work area. Installation of a turbidity barrier around the next area designated for dredging will be done while the first area is being dredged.

3. Where hydraulic dredging is proposed, dredge pipe will be installed as the turbidity barrier is being constructed so that the necessary penetration of the barrier can be made. The pipe will be submerged where it crosses the navigation channel or obstructs private docks and marinas but will be floating or laid in shallow water along the river bank in most other areas.
4. Clearing and snagging fallen trees from the waters edge will be accomplished at the same time the turbidity barrier is installed so that dredging will not be delayed by this work.
5. Dredging will begin within one to two days of the arrival of the dredges on the site and will continue until the area enclosed by the turbidity barrier is dredged to the design elevations. Unless post-dredging sampling indicates that the production dredges will be required for redredging portions of the area that did not meet the residuals standards, they will move immediately to the next area designated for dredging.
6. Soundings will be taken at least weekly to confirm that the design elevations are being met as dredging proceeds in a given area. When a sufficient area is dredged to the design elevations, samples will be collected and analyzed for residual PCBs. Sampling should be done while the dredges are still working in an area and should follow the dredges by no more than a week.
7. The dredging will be divided into certification units for sampling of residuals. If redredging is required in a certification unit, , but sampling indicates that it should consist of a very shallow cut or of removing a very limited amount of residual sediment overlying clean sediment, or from a small portion of the acceptance area, the production dredges will move to the next acceptance area to be dredged and a smaller, alternative dredge will be employed for the redredging effort. It has been assumed that redredging will begin as soon as the need for it is identified in an certification unit rather than after an entire river reach has been completely dredged to the design elevations and all sampling has been completed in the large reach area.
8. Soundings will be taken as redredging proceeds in an area, and a second round of post-dredging samples will be collected as soon as the dredge completes a defined area.
9. Backfilling and shoreline stabilization will begin as soon as a portion of a work area has been determined to meet cleanup levels and generally while the production dredges are still working in the area. The example production schedule assumes that the backfill and shoreline stabilization work will be isolated from the dredging effort by conventional silt curtains installed within the overall area surrounded by the turbidity barrier.
10. As soon as a work area has been completely backfilled and shoreline stabilization work has been completed, removal of the turbidity barrier surrounding that work area will begin.
11. As the dredging season draws to a close, dredging will cease in time to permit backfilling and shoreline stabilization work to be completed in all areas dredged prior to demobilization for the winter.
12. Unless there is a specific reason for leaving a particular section of silt barrier in place over the winter and it can be shown that the barrier can withstand the spring runoff and ice movement, all silt barriers will be removed from the river at the end of each dredging season.

13. It has been assumed that demobilization of major pieces of dredging equipment that cannot be moved by truck will be moved out of the area on the last possible day of the canal operating season but that smaller dredges and work boats that can be transported by truck will remain on the site to complete any required work such as completing backfill and shoreline stabilization work, removing turbidity barriers, and dismantling dredge pipe for storage on site for the following year's work. It has also been assumed that demobilizing and winterizing on-shore treatment and shipping facilities will occur after the canal has closed for the season.

1.2 Selection of Equipment and Estimates of Production Rates

1.2.1 Silt Barrier Installation and Removal

Equipment required to install and remove the turbidity barrier consists of a work boat with a flat deck at least 100 feet long and equipped with a light crane for handling the HDPE barrier material. A hydraulic excavator type machine, similar to a Caterpillar 350 Materials Handler, would be mounted on a deck barge and equipped with a vibratory hammer or pile driver for installing steel sheet piling. The assumed production rate for this work is as follows:

- Installing sheet piling - 90 linear feet per day of wall per crew
- Installing HDPE barrier - 200 linear feet of barrier per day per crew
- Removing sheet piling - 130 linear feet per day per crew
- Removing HDPE barrier - 300 linear feet per day per crew

1.2.2 Mechanical Dredging

Two different size mechanical dredges have been selected for use wherever the water depth is great enough to permit access for scows. These are the same dredges as described in Appendix E-1 of the FS and are as follows:

- A dredge consisting of a hydraulic excavator with an extended boom and fitted with a 4 cubic yard, hydraulically actuated horizontal profiler bucket. The assumed effective production rate of this piece of equipment is 82 cubic yards per hour.
- A dredge consisting of a hydraulic excavator with an extended boom and fitted with a 2 cubic yard, hydraulically actuated horizontal profiler bucket. The assumed effective production rate of this piece of equipment is 27 cubic yards per hour.

1.2.3 Hydraulic Dredging

The hydraulic dredge selected for evaluation is the same dredge described in Appendix H-1 of the FS and consists of a 12 inch cutterhead dredge with a 600 HP pump and 200 HP auxiliaries, and 900 HP booster pumps where required. Typically, a dredge of this size has a capacity of from 400 to 575 cubic yards per hour depending upon the distance pumped and whether it is pumping sand and gravel or silts and clay sediments. However, because dredging contaminated sediments requires careful attention to cut depths and location, resuspension of sediments other

special issues, it has been assumed that the effective production rate for this dredge would be from 260 to 275 cubic yards per hour, depending upon the type of sediment and distance pumped.

1.2.4 Alternative Dredging Equipment

Alternative dredging equipment will be required for use in areas where the post-dredging water depth is less than about 3 feet and for re-dredging areas where post dredging diver inspections and/or sampling indicates that a very shallow layer of sediment must still be removed, or where sediment remains in pockets in bedrock or is surrounded by boulders or other obstructions. Two types of equipment have been considered: an amphibious, hydraulic excavator with a hydraulically actuated, horizontal profiler bucket of about 1 cubic yard capacity; and a small, probably 8 or 10-inch, hydraulic dredge fitted with a cleanup dredge head or a plain suction mouth for cleanup work.

The amphibious excavator would be used in conjunction with a scow with a capacity of from 500 to 1000 cubic yards and a draft, when empty, of less than 1 foot. The scow would be equipped with a hopper containing a screen to remove debris and would be towed into the shallow water and loaded with the hydraulic excavator until it sits on the river bottom. It would be unloaded in-place using a Toyo Pump that would transfer the sediment to a second scow located in the navigation channel which would carry the sediment to the on-shore processing facility. Alternatively, mechanical dredges which utilize a hopper and hydraulic dredge pump to transfer mechanically dredged sediments to a scow located in deep water could be used. This equipment typically incorporates specific gravity loops with provisions for adjusting the water content of the slurry as needed.

Small hydraulic dredges fitted with cleanup dredgeheads have been used to remove unconsolidated sediment deposits with high, in-situ moisture contents. These dredges are capable of effective production rates in the 100 to 120 cubic yards per hour range but would probably average no more than 40 to 60 cubic yards per hour under difficult dredging conditions or when used to redredge an area where the layer of sediment to be removed is less than one foot.

Hydraulic dredges usually do not operate continuously for extended periods of time. Some down-time, usually on the order of 8 hours per week, is necessary for routine maintenance. It is also necessary to stop dredging to add slurry pipeline and booster pumping units as the equipment moves down the river, to remove debris that has become lodged in the intake, to relocate the dredge from one work area to another, and other reason. Accordingly, an allowance must be made for the time that the dredge is not actively removing sediment.

In preparing the example production schedule, it has been assumed that dredging will be permitted 24 hours per day, six days per week and that routing weekly maintenance on the equipment will be accomplished on Sundays. Thus, the total time available for dredging would be 24 hours per day times 6 days per week or 144 hours per week. The length of the dredging season has been assumed to be 30 weeks, so the total available time for dredging over the entire season would be 30 weeks at 144 hours per week, or 4,320 hours per year. In order to meet the Performance Standard for Dredging Productivity of 480,000 cubic yards per year during Phase 2

of the project, a single production dredge working at a reduced rate of 260 cubic yards per hour would have to operate for 1,846 hours out of the 4,320 hours available, or about 43 percent of the total available time. To meet a target removal of 530,000 cubic yards in a year, the dredge would have to operate effectively for 2038 hours per year, or about 47 percent of the time. In actuality, with one “production” hydraulic dredge operating at about 260 cubic yards per hour and one alternative hydraulic dredge operating at about 50 cubic yards per hour, the two dredges would only have to operate about 36 percent of the time to meet the 480,000 cubic yard per year dredging productivity standard and 40 percent of the time to meet the 530,000 cubic yard per year target productivity rate.

1.2.5 Backfilling

Two methods of placing backfill have been considered: mechanical placement using a clamshell bucket on a crane, and hydraulic placement with a sand spreader. Placement of backfill with a clamshell bucket has been demonstrated to be feasible at the Grasse River near Massena, NY and achieved a production rate of approximately 1200 square feet of coverage per hour for a 1-foot lift of backfill. The material was brought to the work area by barge and spread with a 2.5 cubic yard clamshell bucket on a crane. The crane boom was moved as the bucket was opened to spread the material, and produced a cap varying in thickness from about 6 inches to 18 inches with an average thickness of 1 foot. Obtaining complete coverage of the river bottom was assisted by the use of WINOPS GPS equipment to identify the location of each bucket full of soil placed. The proper placement of the backfill material at a reasonable production rate was highly dependent upon the skill of the crane operator.

Hydraulic equipment especially designed to spread backfill or capping material over a dredged bottom is available and has been used successfully on a number of projects. Typically, this equipment consists of a dredge pump to pump a sand slurry from a scow or a shoreline materials preparation area, dredge pipeline from the dredge pump to the spreader barge, and a spreading device mounted on a deck barge. The backfill material is hauled to the site in a barge or placed in a basin on shore close to the area to be backfilled. River water is pumped through high-pressure nozzles located at the dredge pump suction intake to create a slurry, and the slurry is pumped through a pipeline to the spreader. The spreader consists of a deck barge with a spreader pipes arrayed like fingers on a hand and connected to a splitter box. The slurry of backfill material is pumped into the splitter box and flows out through the spreader pipes. The spreader pipes protrude over the end of the deck barge and discharge below the water surface as the spreader barge is slowly moved over the area to be backfilled. Hydraulic spreaders are easily capable of placing sand or a silt-sand mixture of backfill at effective production rates in the 250 cubic yards per hour range and can cover over an acre per day or more with a 1-foot thick layer of backfill.

For the purposes of this document, it has been assumed that the river bottom can be backfilled at an effective production rate of 0.5 acres per day. It has also been assumed that backfilling will begin as soon as work in a certification unit has been determined to be complete.

1.3 Conceptual Production schedule

Utilizing the production rates developed and presented above, an example production schedule has been developed for the mechanical dredging option using Primavera Systems[®], Inc. software. This example schedule portrays the conceptual sequence and duration of one possible approach. The mechanical dredging option was selected for use in preparing a schedule because mechanical dredging is typically a slower process, and therefore more conservative, than hydraulic dredging. To verify the assumption that mechanical dredging is the slower option, a schedule of similar level of detail was developed that incorporates hydraulic dredges for use in River Section 1 only and mechanical dredges in all other River Sections plus any areas in River Section 1 that contain boulders or excessive debris. This example schedule was developed under the assumption that there would be only one processing site and that it would be located at the northerly limit of the Thompson Island Pool. The results of this analysis indicated that hydraulic dredging (including the additional effort of installing/removing dredge pipeline) is significantly faster than mechanical dredging, thus verifying the assumption. This holds true until distances from the dredge to the processing facility approach about 5 miles, the approximate distance from the Thompson Island Dam to the assumed processing site at the northerly end of the Thompson Island Pool.

This example production schedule provided as a series of pullout sheets at the end of this Attachment 1. The production schedule backup, including estimates of volumes of sediment to be dredged mechanically, by phase and river mile, site preparation quantities, and site restoration (backfill) quantities, and maps of each one-mile reach of the river, are provided in Attachment 2. The estimated volumes of sediment to be dredged, by river mile, whether the sediment consists of cohesive or non-cohesive soil, and information on pre- and post-dredging water depths, together with maps of each one-mile reach of the river, are provided in Attachment 3 to this Part. The information on water depths, types of sediment, probable volumes to be dredged, etc, are all preliminary in nature and must be confirmed as part of the design. However, this information is judged to be accurate enough to support the development of an example schedule that illustrates the feasibility of completing the project in the time frame defined by the ROD. While changes in the percentage of cohesive or non-cohesive sediment, for instance, will affect the design of the sediment processing facility, they will have a relatively minor effect on the rate at which the sediment can be dredged.

Table 1-2 summarizes the seasonal activities that would be completed if the project were implemented as shown on the example production schedule. The dredging work generally proceeds from upstream to downstream, and the work would be completed in 6 construction seasons. The volume remediated includes all targeted remediation and navigational dredging areas. The area remediated includes both standard and critical backfill areas. Critical backfill areas are defined as wetland areas that require additional backfill. These areas will in turn take longer to backfill due to their sensitive nature. The dredging completion date reflects the date when all dredging activities (including redredging after confirmatory sampling) would be completed. The work completion date reflects the time needed after dredging completion to complete site restoration activities (backfilling, post backfill surveying, obstruction replacement, shoreline stabilization, containment removal) and all demobilization activities.

Table 1-3 shows the amounts of dredging, taken from the example production schedule, that would be completed during Phase 1 broken down by different river conditions. Of the 268,980 cubic yards assumed to be dredged during Phase 1, about 246,065 cubic yards could be accomplished with the 2 cubic yard and 4 cubic yard mechanical dredges devoted to production work while about 22, 910 cubic yards are located in shallow areas where alternative dredging equipment would be required. About 80,370 cubic yards of the “production” dredging is located in the navigation channel of the canal. The amount completed during Phase 1 in the example production schedule exceeds the 240,000 cubic yards established as the productivity standard for Phase 1.

Table 1-4 presents the overall performance as shown in the example production schedule. The cumulative volume shown in the example production schedule exceeds the target cumulative volume requirement for both phases of dredging. The cumulative volumes presented in Table 1-4 include remediation and navigational dredging areas.

The key assumptions and parameters used in developing the example production schedule are as follows:

- All three river sections (R1, R2, & R3), (total estimated volume of 2.65 million cubic yards, covering approximately 40 miles) are presented in the example production schedule.
- Mechanical dredging scenario is presented in the production schedule.
- Dredging activities will generally proceed from upstream to downstream.
- Where possible, contiguous dredge certification units are dredged sequentially.
- Phase 1 will be completed during the first season.
- The dredging crews must achieve the full production-dredging rate for at least a 30 day period by end of the Phase 1 season, (min 240,000 cubic yards, dredging starting late ~ mid June 2006).
- Phase 2 will be completed during years 2 through 6, (min 480,000 cubic yards/year, work season from May 1 - Nov 30, 2007 to 2011).
- Dredging work will be done 6 working days/week, and that at least 13 hours of dredging can be achieved during a work day when dredging is taking place..
- Winterization of equipment can begin 10 days after completion of season’s dredging.
- The production rate for critical area backfilling (1/2 acre/day) is based on half of the production rate for general backfill areas (1 acre/day) due to additional time needed for shallow backfill areas and preparation time for future shoreline planting.
- The same crew(s) used for containment barrier placement will be used for containment barrier removal.
- Different crews will be used for shoreline stabilization/restoration tasks: backfilling, shoreline stabilization, and containment removal.

Production rate assumptions for site preparation, mechanical dredging, and site restoration activities are presented in Table 1-5. Production rates were used in the critical path schedule for each dredge certification unit.. Depending on scheduling, work can be performed on more than one certification unit at a time; therefore the number of crews needed for site preparation, dredging, and site restoration activities can vary at any one point in the schedule (the average

number of crews is presented in the key assumptions). Production rates based on linear footage of shoreline and shoreline obstacles were based on the figures presented in Attachment 2.

Tables 1-1 to 1-5

Production Schedule

Table 1-1: Hydraulic and Mechanical Dredge Volumes by Location

Table 1-2: Mechanical Dredging Schedule by Phase

Table 1-3: Phase 1 Dredging Quantities

Table 1-4: Cumulative Dredge Volumes

Table 1-5: Example Production Schedule Production Rates

**Table 1-1
Hydraulic and Mechanical Dredge Volumes by Location**

River Section	Mechanical Dredge					Hydraulic Dredge				
	4 C.Y. Dredge		2 C.Y. Dredge		Total	Main Production Dredge		Small, Cleanup Dredge		Total
1	1,256,000	(80%)	309,000	(20%)	1,565,000	1,390,000	(89%)	174,000	(11%)	1,564,000
2	475,000	(95%)	27,000	(5%)	502,000	480,000	(96%)	22,000	(4%)	502,000
3	366,000	(65%)	196,000	(35%)	562,000	562,000	(100%)	0	(0%)	562,000
Total	2,097,000	(80%)	532,000	(20%)	2,629,000	2,432,000	(93%)	196,000	(7%)	2,628,000

* Total volumes may not equal across dredging methods due to operational requirements of the equipment

**Table 1-2
Mechanical Dredging Schedule by Phase**

Phase and Year	Volume Remediated (cubic yards)	Area Remediated (acres)	Dredging Completion Date	Work Completion Date
Phase 1 (Year 1)	268,977	50	11/07/06	12/14/06
Phase 2, (Year 2))	529,440	78	10/15/07	12/20/07
Phase 2, (Year 3)	491,618	86	11/12/08	12/21/08
Phase 2, (Year 4)	548,535	62	11/06/09	12/22/09
Phase 2, (Year 5)	621,332	53	9/29/10	11/12/10
Phase 2, Year 6)	128,983	63	8/30/11	11/12/11

**Table 1-3
Phase 1 Dredging Quantities**

Phase 1 Activities	Amount Completed During Phase 1 Demonstrated by Production Schedule	Phase 1 Performance Standard Requirement
Total Dredging	268,977 cubic yards	Approximately 240,000 cubic yards
Production Dredging	246,065 cubic yards	Approximately 175,000 cubic yards
Alternative Dredging Equipment (Shallow areas)	22,911 cubic yards	Approximately 15,000 cubic yards
Uncontained Dredging (Navigational Dredging)	80,366 cubic yards	Approximately 50,000 cubic yards

**Table 1-4
Cumulative Dredge Volumes**

Phase and Year	Cumulative Volume Shown in Example Production Schedule (cubic yards)	Required Cumulative Volume (cubic yards)	Target Cumulative Volume (cubic yards)
Phase 1 (Year 1)	268,977	240,000	265,000
Phase 2, (Year 2)	798,417	720,000	795,000
Phase 2, (Year 3)	1,400,227	1,200,000	1,325,000
Phase 2, (Year 4)	1,964,760	1,680,000	1,855,000
Phase 2, (Year 5)	2,412,147	2,160,000	2,385,000
Phase 2, (Year 6)	2,650,000	2,650,000	2,650,000

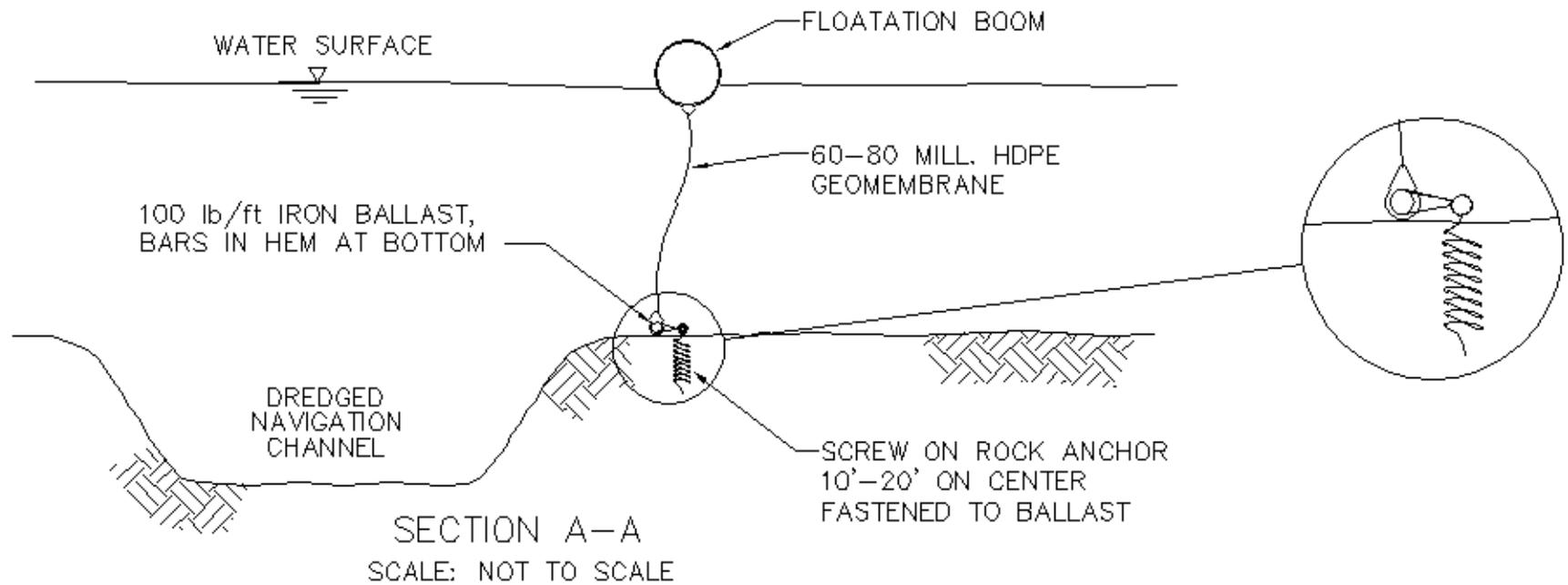
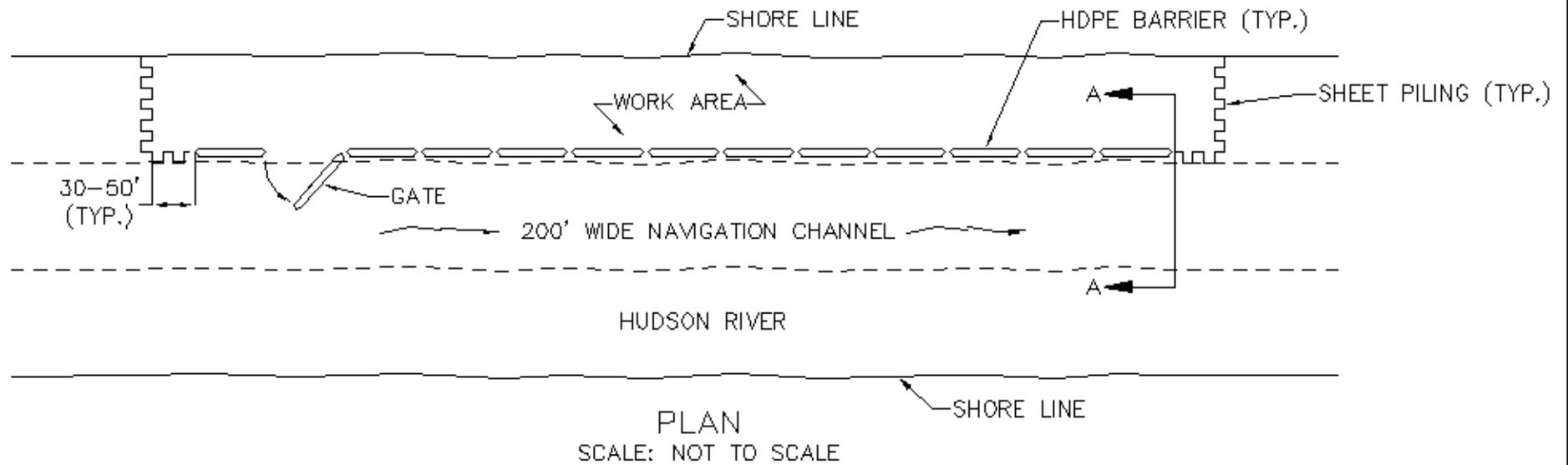
**Table 1-5
Example Production Schedule Production Rates**

Site Preparation		
Work Element	Production Rate	Key Assumptions
Installing Containment Barriers:		Jersey barriers may be used in lieu of sheet piling in areas < 2' deep. HDPE silt barrier and steel sheet piling are not needed for navigational dredging areas or in areas of rock outcrops.
Steel Sheet Piling	90 l.f./day	Steel sheet piling installation assumes 1 crew (max 2 crews), 8 hours production time per day.
HDPE Barriers	200 l.f./day	HDPE silt barrier installation assumes 2 crews (minimum 1 crew, maximum 4 crews), 8 hours production time per day.
Clearing and Snagging Shoreline	400 l.f./day	Assumes <2 trees/down trees/logs on average per 100 l.f. shoreline. Assumes 8 hours production time per day. Clearing and Snagging Shoreline assumes 1 crew (maximum 2 crews).
Remove Obstacles	1/2 day/ obstruction plus 1 day/ dock removal	Assumes 8 hours production time per day, assumes 1 crew.
Dredging		
Work Element	Production Rate	Key Assumptions
Mechanical Dredging		
Production Equipment Dredging	82 CY/hr or 1066 CY/day	Schedule based on 13 hr day Schedule based on 13 hr day of effective dredging time when dredging is actually under way. Alternative dredge(s) start work in an area 3 days after production dredge. 1/2 day delay per obstruction.
Alternative Equipment Dredging	27 CY/hr or 351 CY/day	
Additional Duration for Obstruction Dredging		
Confirmatory Testing and Surveying	Calculated lag	Starts 2 days after Alternative dredge starts and finishes 2 days after dredging is completed. Schedule assumes 1 crew, 13 hour days. Minimum one day for surveying for all areas less than 30 acres (approximately 30 acres/day).
Redredging	Calculated lag	Re-dredging (equipment will vary) schedule equal to 1/2 the total number of days required for design cut with the primary and alternative dredges.. Re-dredging finishes 10

**Table 1-5
Example Production Schedule Production Rates**

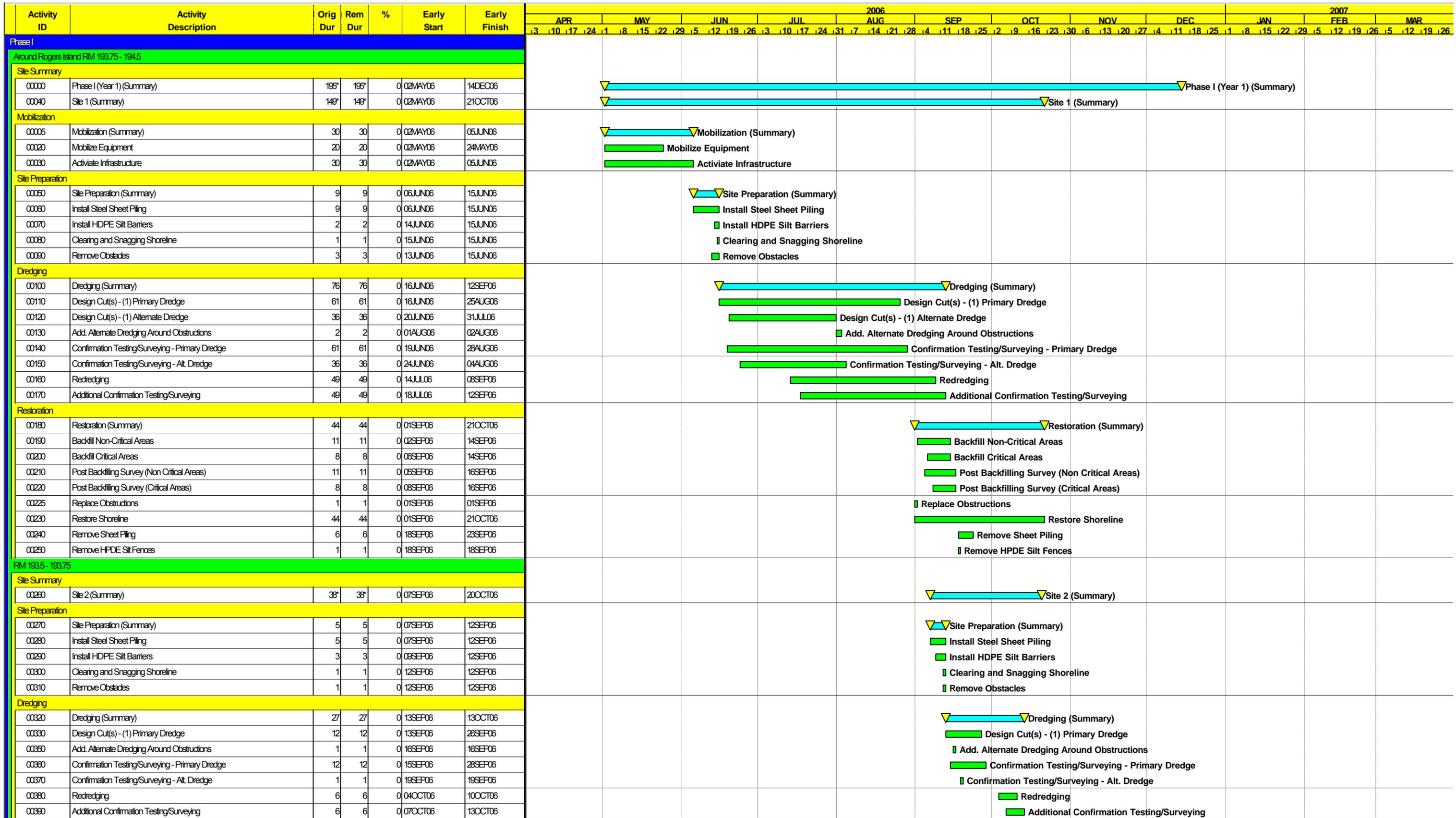
		days after sampling completed. Schedule assumes 13 hours of effective dredging per day..
Additional Confirmatory Testing and Surveying	Calculated lag	Starts 2 days after Redredging starts and finish 2 days after re-dredging is completed. Schedule assumes 1 crew, 13 hour days.
Site Restoration		
Work Element	Production Rate	Key Assumptions
Backfilling		Backfilling finishes 7 days after re-confirmatory testing and surveying ends. Assumes closure areas managed in less than 5 acre areas.
Non-Critical Sub-sites	1 acre/day	Schedule assumes maximum 2 crews for non-critical backfill areas, 8 hours per day.
Critical Sub-sites	1/2 acre/day	Schedule assumes maximum 3 crews for critical backfill areas, 8 hours per day.
Shoreline Stabilization/ Restoration	150 l.f./day	Assumes 8 hours production time per day. Assumes fine stone fill, 50 c.y./day; 9 c.f. per linear foot of shoreline; placed from water. Shoreline restoration assumes maximum 2 crews. Assumes 8 hours per day. Shoreline restoration included for navigational dredging areas that are not contained but are adjacent to the shoreline.
Post Backfill Surveying	Calculated lag	Starts 2 days after the start of backfilling.
Non-Critical Sub-sites		Schedule assumes 1 crew (maximum 2 crews) 8 hours per day.
Critical Sub-sites		Schedule assumes 1 crew (maximum 3 crews) 8 hours per day.
Removing Containment Barriers		Removal of containment barriers will occur after backfill stabilization. Containment will be extracted and salvaged.
Steel Sheet Piling	130 l.f./day	Schedule assumes 1 crew (maximum 2 crews) will be used for Steel Sheet Piling removal. Assumes 8 hours per day.
HDPE Barrier	300 l.f./day	Schedule assumes 2 crews (minimum 1 crew, maximum 4 crews) will be used for Steel Sheet Piling removal. Assumes 8 hours per day.
Obstruction Replacement	1 day/dock	Obstruction Replacement assumes 1 crew 8 hours per day.

Figure 1-1
Silt Barrier



Production Schedule:

Phase 1 (Year 1)



Start Date 18APR05
 Finish Date 15NOV11
 Data Date 18APR05
 Run Date 22APR03 10:25

HPCB
 Malcolm Pirnie, Inc.
 Hudson River PCB Dredging
 Phase I (Year 1)

Sheet 1 of 3

Date	Revision	Checked	Approved

Production Schedule:

Phase 2 (Year 2)

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish	2007												2008														
							APR			MAY			JUN			JUL			AUG			SEP	OCT		NOV		DEC		JAN	FEB	MAR		
							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Phase II																																	
RM 191.5 - 192.5 W Part 2																																	
Site Summary																																	
00918	Phase II (Year 2) (Summary)	218*	218*	0	11APR07	20DEC07	▼Phase II (Year 2) (Summary)																										
00920	Site 5 (Part 2) (Summary)	144	144	0	11APR07	25SEP07	▼Site 5 (Part 2) (Summary)																										
Mobilization																																	
00702	Seasonal Mobilization	20	20	0	11APR07*	03MAY07	■ Seasonal Mobilization																										
00704	Activate Infrastructure	30	30	0	11APR07	15MAY07	■ Activate Infrastructure																										
Site Preparation																																	
00930	Site Preparation (Summary)	14	14	0	04MAY07	19MAY07	▼Site Preparation (Summary)																										
00940	Install Steel Sheet Piling	2	2	0	18MAY07	19MAY07	■ Install Steel Sheet Piling																										
00950	Install HDPE Silt Barriers	14	14	0	04MAY07	19MAY07	■ Install HDPE Silt Barriers																										
00960	Clearing and Snagging Shoreline	1	1	0	19MAY07	19MAY07	■ Clearing and Snagging Shoreline																										
00970	Remove Obstacles	0	0	0	21MAY07	19MAY07	I Remove Obstacles																										
Dredging																																	
00980	Dredging (Summary)	70	70	0	21MAY07	09AUG07	▼Dredging (Summary)																										
00990	Design Cut(s) - (2) Primary Dredges	55	55	0	21MAY07	23JUL07	■ Design Cut(s) - (2) Primary Dredges																										
01000	Design Cut(s) - (2) Alternate Dredges	28	28	0	24MAY07	25JUN07	■ Design Cut(s) - (2) Alternate Dredges																										
01010	Add. Alternate Dredging Around Obstructions	0	0	0	26JUN07	25JUN07	I Add. Alternate Dredging Around Obstructions																										
01020	Confirmation Testing/Surveying - Primary Dredge	55	55	0	23MAY07	25JUL07	■ Confirmation Testing/Surveying - Primary Dredge																										
01030	Confirmation Testing/Surveying - Alt. Dredge	27	27	0	28MAY07	27JUN07	■ Confirmation Testing/Surveying - Alt. Dredge																										
01040	Redredging	41	41	0	20JUN07	06AUG07	■ Redredging																										
01050	Additional Confirmation Testing/Surveying	41	41	0	23JUN07	09AUG07	■ Additional Confirmation Testing/Surveying																										
Restoration																																	
01060	Restoration (Summary)	74	74	0	02JUL07	25SEP07	▼Restoration (Summary)																										
01070	Backfill Non-Critical Areas	0	0	0	13AUG07	11AUG07	I Backfill Non-Critical Areas																										
01080	Backfill Critical Areas	36	36	0	02JUL07	11AUG07	■ Backfill Critical Areas																										
01090	Post Backfilling Survey (Non Critical Areas)	26	26	0	15AUG07	13SEP07	■ Post Backfilling Survey (Non Critical Areas)																										
01100	Post Backfilling Survey (Critical Areas)	36	36	0	04JUL07	14AUG07	■ Post Backfilling Survey (Critical Areas)																										
01105	Replace Obstructions	0	0	0	11AUG07	10AUG07	I Replace Obstructions																										
01110	Restore Shoreline	21	21	0	11AUG07	04SEP07	■ Restore Shoreline																										
01120	Remove Sheet Piling	1	1	0	14SEP07	14SEP07	■ Remove Sheet Piling																										
01130	Remove HPDE Silt Fences	10	10	0	14SEP07	25SEP07	■ Remove HPDE Silt Fences																										
RM 189.5 - 190.5 W																																	
Site Summary																																	
01800	Site 10 (Summary)	178	178	0	04MAY07	27NOV07	▼Site 10 (Summary)																										
Site Preparation																																	
01810	Site Preparation (Summary)	13	13	0	04MAY07	18MAY07	▼Site Preparation (Summary)																										
01820	Install Steel Sheet Piling	6	6	0	12MAY07	18MAY07	■ Install Steel Sheet Piling																										
01830	Install HDPE Silt Barriers	13	13	0	04MAY07	18MAY07	■ Install HDPE Silt Barriers																										
01840	Clearing and Snagging Shoreline	1	1	0	18MAY07	18MAY07	■ Clearing and Snagging Shoreline																										
01850	Remove Obstacles	0	0	0	19MAY07	18MAY07	I Remove Obstacles																										
Dredging																																	
01860	Dredging (Summary)	128	128	0	19MAY07	15OCT07	▼Dredging (Summary)																										
01870	Design Cut(s) - (2) Primary Dredges	19	19	0	19MAY07	09JUN07	■ Design Cut(s) - (2) Primary Dredges																										
01880	Design Cut(s) - (4) Alternate Dredges	110	110	0	23MAY07	27SEP07	■ Design Cut(s) - (4) Alternate Dredges																										
01890	Add. Alternate Dredging Around Obstructions	0	0	0	28SEP07	27SEP07	I Add. Alternate Dredging Around Obstructions																										
01900	Confirmation Testing/Surveying - Primary Dredge	19	19	0	22MAY07	12JUN07	■ Confirmation Testing/Surveying - Primary Dredge																										
01910	Confirmation Testing/Surveying - Alt. Dredge	110	110	0	25MAY07	29SEP07	■ Confirmation Testing/Surveying - Alt. Dredge																										
01920	Redredging	64	64	0	30JUL07	11OCT07	■ Redredging																										
01930	Additional Confirmation Testing/Surveying	64	64	0	02AUG07	15OCT07	■ Additional Confirmation Testing/Surveying																										

Start Date 18APR05
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Malcolm Pirnie, Inc.
 Hudson River PCB Dredging
 Phase II (Year 2)

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish	2007												2008																																										
							APR			MAY			JUN			JUL			AUG			SEP			OCT			NOV			DEC			JAN			FEB			MAR																					
							1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Restoration																																																													
01940	Restoration (Summary)	90	90	0	15AUG07	27NOV07	Restoration (Summary)																																																						
01950	Backfill Non-Critical Areas	0	0	0	18OCT07	17OCT07	Backfill Non-Critical Areas																																																						
01960	Backfill Critical Areas	54	54	0	16AUG07	17OCT07	Backfill Critical Areas																																																						
01970	Post Backfilling Survey (Non Critical Areas)	0	0	0	20OCT07	19OCT07	Post Backfilling Survey (Non Critical Areas)																																																						
01980	Post Backfilling Survey (Critical Areas)	54	54	0	18AUG07	19OCT07	Post Backfilling Survey (Critical Areas)																																																						
01985	Replace Obstructions	0	0	0	15AUG07	14AUG07	Replace Obstructions																																																						
01990	Restore Shoreline	90	90	0	15AUG07	27NOV07	Restore Shoreline																																																						
02000	Remove Sheet Piling	4	4	0	20OCT07	24OCT07	Remove Sheet Piling																																																						
02010	Remove HPDE Silt Fences	8	8	0	20OCT07	29OCT07	Remove HPDE Silt Fences																																																						
RM 190.5 - 191.5 W																																																													
Site Summary																																																													
01580	Site 8 (Summary)	113	113	0	18MAY07	26SEP07	Site 8 (Summary)																																																						
Site Preparation																																																													
01580	Site Preparation (Summary)	20	20	0	18MAY07	09JUN07	Site Preparation (Summary)																																																						
01600	Install Steel Sheet Piling	13	13	0	26MAY07	09JUN07	Install Steel Sheet Piling																																																						
01610	Install HDPE Silt Barriers	20	20	0	18MAY07	09JUN07	Install HDPE Silt Barriers																																																						
01620	Clearing and Snagging Shoreline	1	1	0	09JUN07	09JUN07	Clearing and Snagging Shoreline																																																						
01630	Remove Obstacles	0	0	0	11JUN07	09JUN07	Remove Obstacles																																																						
Dredging																																																													
01640	Dredging (Summary)	74	74	0	11JUN07	04SEP07	Dredging (Summary)																																																						
01650	Design Cut(s) - (2) Primary Dredges	59	59	0	11JUN07	17AUG07	Design Cut(s) - (2) Primary Dredges																																																						
01660	Design Cut(s) - (2) Alternate Dredges	5	5	0	26JUN07	30JUN07	Design Cut(s) - (2) Alternate Dredges																																																						
01670	Add. Alternate Dredging Around Obstructions	0	0	0	02JUL07	30JUN07	Add. Alternate Dredging Around Obstructions																																																						
01680	Confirmation Testing/Surveying - Primary Dredge	59	59	0	13JUN07	20AUG07	Confirmation Testing/Surveying - Primary Dredge																																																						
01690	Confirmation Testing/Surveying - Alt. Dredge	5	5	0	28JUN07	03JUL07	Confirmation Testing/Surveying - Alt. Dredge																																																						
01700	Redredging	32	32	0	26JUL07	31AUG07	Redredging																																																						
01710	Additional Confirmation Testing/Surveying	32	32	0	30JUL07	04SEP07	Additional Confirmation Testing/Surveying																																																						
Restoration																																																													
01720	Restoration (Summary)	29	29	0	24AUG07	26SEP07	Restoration (Summary)																																																						
01730	Backfill Non-Critical Areas	11	11	0	25AUG07	06SEP07	Backfill Non-Critical Areas																																																						
01740	Backfill Critical Areas	8	8	0	29AUG07	06SEP07	Backfill Critical Areas																																																						
01750	Post Backfilling Survey (Non Critical Areas)	11	11	0	28AUG07	08SEP07	Post Backfilling Survey (Non Critical Areas)																																																						
01760	Post Backfilling Survey (Critical Areas)	8	8	0	31AUG07	08SEP07	Post Backfilling Survey (Critical Areas)																																																						
01765	Replace Obstructions	1	1	0	24AUG07	24AUG07	Replace Obstructions																																																						
01770	Restore Shoreline	29	29	0	24AUG07	26SEP07	Restore Shoreline																																																						
01780	Remove Sheet Piling	9	9	0	10SEP07	19SEP07	Remove Sheet Piling																																																						
01790	Remove HPDE Silt Fences	13	13	0	10SEP07	24SEP07	Remove HPDE Silt Fences																																																						
RM 188.5 - 198.5 W																																																													
Site Summary																																																													
02460	Site 12 (Summary)	99	99	0	03JUL07	25OCT07	Site 12 (Summary)																																																						
Site Preparation																																																													
02470	Site Preparation (Summary)	18	18	0	03JUL07	23JUL07	Site Preparation (Summary)																																																						
02480	Install Steel Sheet Piling	6	6	0	17JUL07	23JUL07	Install Steel Sheet Piling																																																						
02490	Install HDPE Silt Barriers	18	18	0	03JUL07	23JUL07	Install HDPE Silt Barriers																																																						
02500	Clearing and Snagging Shoreline	1	1	0	23JUL07	23JUL07	Clearing and Snagging Shoreline																																																						
02510	Remove Obstacles	0	0	0	24JUL07	23JUL07	Remove Obstacles																																																						
Dredging																																																													
02520	Dredging (Summary)	44	44	0	24JUL07	12SEP07	Dredging (Summary)																																																						
02530	Design Cut(s) - (2) Primary Dredges	29	29	0	24JUL07	25AUG07	Design Cut(s) - (2) Primary Dredges																																																						
02540	Design Cut(s) - (2) Alternate Dredge	10	10	0	27JUL07	07AUG07	Design Cut(s) - (2) Alternate Dredge																																																						
02550	Add. Alternate Dredging Around Obstructions	0	0	0	08AUG07	07AUG07	Add. Alternate Dredging Around Obstructions																																																						

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Hudson River PCB Dredging

Phase II (Year 2)

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Date	Revision	Checked	Approved

Production Schedule:

Phase 2 (Year 3)

Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish	2008												2009																					
							M	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR																					
							24	31	7	14	21	28	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	1	8	15	22	29	5	12	19	26	2	9
Phase II																																								
RM 192.5 - 193.5 E																																								
Site Summary																																								
00699	Phase II (Year 3) (Summary)	226	226	0	03APR08	22DEC08	▼												▼Phase II (Year 3) (Summary)																					
00700	Site 4 (Summary)	109	109	0	03APR08	07AUG08	▼												▼Site 4 (Summary)																					
01801	Seasonal Mobilization	20	20	0	03APR08*	25APR08	■												■ Seasonal Mobilization																					
01802	Activate Infrastructure	30	30	0	03APR08	07MAY08	■												■ Activate Infrastructure																					
Site Preparation																																								
00710	Site Preparation (Summary)	17	17	0	26APR08	15MAY08	▼												▼Site Preparation (Summary)																					
00720	Install Steel Sheet Piling	2	2	0	14MAY08	15MAY08	■												■ Install Steel Sheet Piling																					
00730	Install HDPE Silt Barriers	17	17	0	26APR08	15MAY08	■												■ Install HDPE Silt Barriers																					
00740	Clearing and Snagging Shoreline	1	1	0	15MAY08	15MAY08													Clearing and Snagging Shoreline																					
00750	Remove Obstacles	1	1	0	15MAY08	15MAY08													Remove Obstacles																					
Dredging																																								
00760	Dredging (Summary)	40	40	0	16MAY08	01JUL08	▼												▼Dredging (Summary)																					
00770	Design Cut(s) - (2) Primary Dredges	25	25	0	16MAY08	13JUN08	■												■ Design Cut(s) - (2) Primary Dredges																					
00780	Design Cut(s) - (2) Alternate Dredges	2	2	0	20MAY08	21MAY08	■												■ Design Cut(s) - (2) Alternate Dredges																					
00790	Add. Alternate Dredging Around Obstructions	0	0	0	22MAY08	21MAY08													Add. Alternate Dredging Around Obstructions																					
00800	Confirmation Testing/Surveying - Primary Dredge	25	25	0	19MAY08	16JUN08	■												■ Confirmation Testing/Surveying - Primary Dredge																					
00810	Confirmation Testing/Surveying - Alt. Dredge	2	2	0	22MAY08	23MAY08	■												■ Confirmation Testing/Surveying - Alt. Dredge																					
00820	Redredging	14	14	0	12JUN08	27JUN08	■												■ Redredging																					
00830	Additional Confirmation Testing/Surveying	14	14	0	16JUN08	01JUL08	■												■ Additional Confirmation Testing/Surveying																					
Restoration																																								
00840	Restoration (Summary)	40	40	0	23JUN08	07AUG08	▼												▼Restoration (Summary)																					
00850	Backfill Non-Critical Areas	25	25	0	24JUN08	22JUL08	■												■ Backfill Non-Critical Areas																					
00860	Backfill Critical Areas	0	0	0	04JUL08	03JUL08													Backfill Critical Areas																					
00870	Post Backfilling Survey (Non Critical Areas)	25	25	0	26JUN08	24JUL08	■												■ Post Backfilling Survey (Non Critical Areas)																					
00880	Post Backfilling Survey (Critical Areas)	0	0	0	07JUL08	05JUL08													Post Backfilling Survey (Critical Areas)																					
00885	Replace Obstructions	1	1	0	23JUN08	23JUN08													Replace Obstructions																					
00890	Restore Shoreline	23	23	0	23JUN08	18JUL08	■												■ Restore Shoreline																					
00900	Remove Sheet Piling	1	1	0	25JUL08	25JUL08													Remove Sheet Piling																					
00910	Remove HPDE Silt Fences	12	12	0	25JUL08	07AUG08	■												■ Remove HPDE Silt Fences																					
RM 191.5 - 192.5 E																																								
Site Summary																																								
01140	Site 6 (Summary)	152	152	0	26APR08	20OCT08	▼												▼Site 6 (Summary)																					
Site Preparation																																								
01150	Site Preparation (Summary)	25	25	0	26APR08	24MAY08	▼												▼Site Preparation (Summary)																					
01160	Install Steel Sheet Piling	11	11	0	13MAY08	24MAY08	■												■ Install Steel Sheet Piling																					
01170	Install HDPE Silt Barriers	25	25	0	26APR08	24MAY08	■												■ Install HDPE Silt Barriers																					
01180	Clearing and Snagging Shoreline	1	1	0	24MAY08	24MAY08													Clearing and Snagging Shoreline																					
01190	Remove Obstacles	7	7	0	17MAY08	24MAY08	■												■ Remove Obstacles																					
Dredging																																								
01200	Dredging (Summary)	99	99	0	26MAY08	17SEP08	▼												▼Dredging (Summary)																					
01210	Design Cut(s) - (2) Primary Dredges	84	84	0	26MAY08	30AUG08	■												■ Design Cut(s) - (2) Primary Dredges																					
01220	Design Cut(s) - (4) Alternate Dredges	47	47	0	29MAY08	22JUL08	■												■ Design Cut(s) - (4) Alternate Dredges																					
01230	Add. Alternate Dredging Around Obstructions	0	0	0	23JUL08	22JUL08													Add. Alternate Dredging Around Obstructions																					
01240	Confirmation Testing/Surveying - Primary Dredge	84	84	0	26MAY08	02SEP08	■												■ Confirmation Testing/Surveying - Primary Dredge																					
01250	Confirmation Testing/Surveying - Alt. Dredge	47	47	0	31MAY08	24JUL08	■												■ Confirmation Testing/Surveying - Alt. Dredge																					
01260	Redredging	89	89	0	03JUN08	13SEP08	■												■ Redredging																					
01270	Additional Confirmation Testing/Surveying	89	89	0	06JUN08	17SEP08	■												■ Additional Confirmation Testing/Surveying																					
Restoration																																								
01280	Restoration (Summary)	73	73	0	28JUL08	20OCT08	▼												▼Restoration (Summary)																					

Start Date 18APR05
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Hudson River PCB Dredging

Phase II (Year 3)

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Date	Revision	Checked	Approved

Production Schedule:

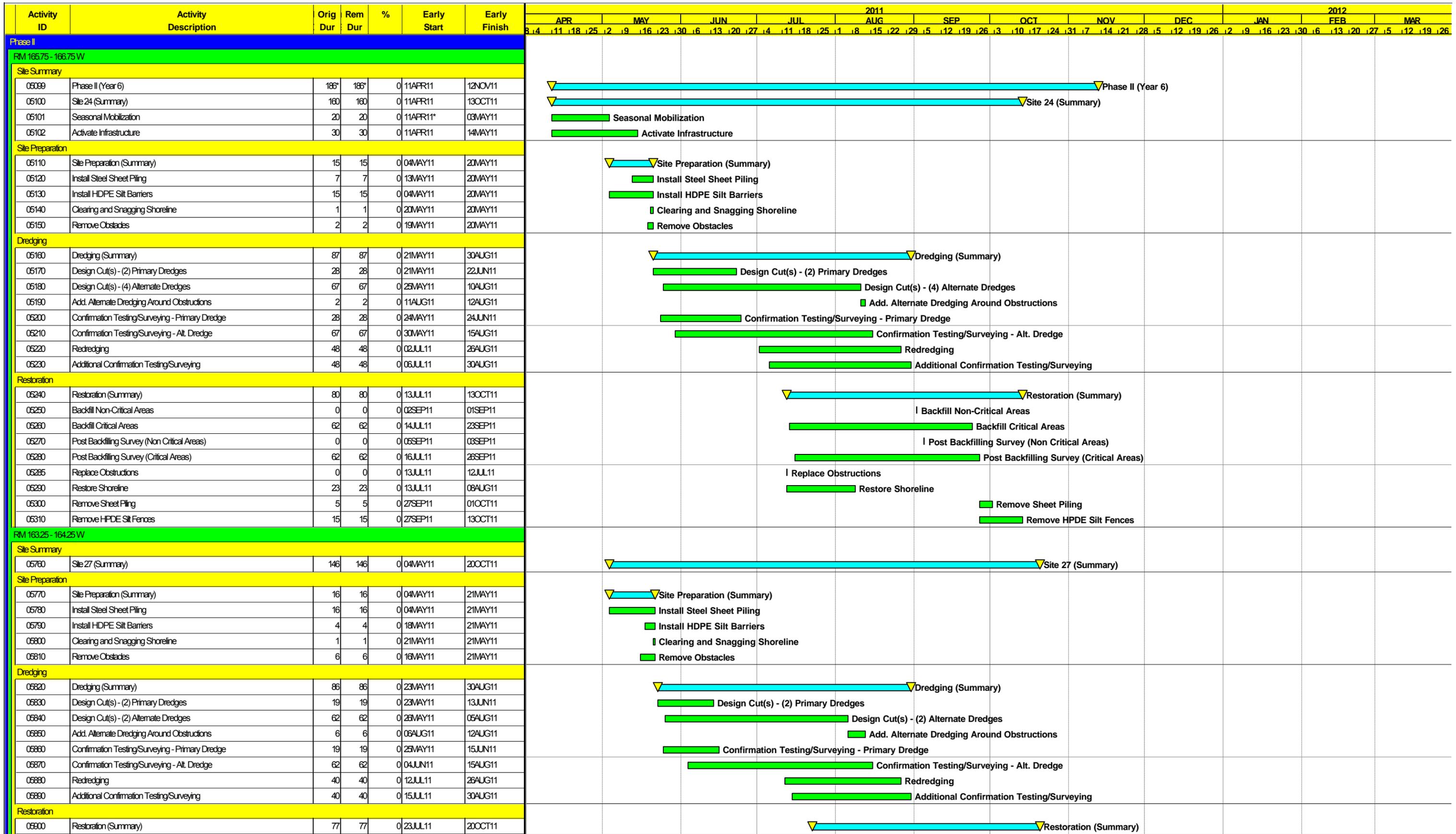
Phase 2 (Year 4)

Production Schedule:

Phase 2 (Year 5)

Production Schedule:

Phase 2 (Year 6)



Start Date 18APR05
 Finish Date 12NOV11
 Data Date 18APR05
 Run Date 22APR03 12:26

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Hudson River PCB Dredging

Phase II (Year 6)

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