EPA NEW ENGLAND
REGION 1

RECORD OF DECISION

NYANZA CHEMICAL WASTE DUMP SUPERFUND SITE, OPERABLE UNIT 4 (SUDBURY RIVER)

ASHLAND, FRAMINGHAM, SUDBURY, WAYLAND, LINCOLN AND CONCORD, MASSACHUSETTS

SEPTEMBER 2010

PART 1: DECLARATION FOR THE RECORD OF DECISION

A. SITE NAME AND LOCATION

Nyanza Chemical Waste Dump Superfund Site, Operable Unit 4
Ashland, Massachusetts
MAD990685422

B. STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for Operable Unit 4 (OU4) of the Nyanza Chemical Waste Dump Superfund Site ("the Site"). OU4 consists of that portion of the Sudbury River ("the river") that was contaminated by the former Nyanza, Inc. textile dye facility – i.e., the river as it stretches from the Nyanza facility in Ashland, Massachusetts to its confluence with the Assabet River in Concord, Massachusetts. This remedial action was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), 42 USC § 9601 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300, as amended. The Director of the Office of Site Remediation and Restoration (OSRR) has been delegated the authority to approve this Record of Decision (ROD).

This decision was based on the Administrative Record, which has been developed in accordance with Section 113(k) of CERCLA, and which is available for review at the Ashland Public Library and at the United States Environmental Protection Agency (EPA) Region 1 OSRR Records Center in Boston, Massachusetts. The Administrative Record Index (Appendix F to the ROD) identifies each of the items comprising the Administrative Record upon which the selection of the remedial action is based.

The Massachusetts Department of Environmental Protection (MassDEP) has reviewed the various alternatives and has indicated its support for the selected remedy. MassDEP has also reviewed the Risk Assessments and the Feasibility Study. MassDEP concurs in the selected remedy for the Site.

C. ASSESSMENT OF THE SITE

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

D. DESCRIPTION OF THE SELECTED REMEDY

This ROD sets forth the selected remedy for OU4 of the Nyanza Chemical Waste Dump

Superfund Site. The selected remedy has several components: institutional controls ("ICs"), monitored natural recovery ("MNR"), enhanced natural recovery ("ENR"), long-term monitoring, and five-year reviews. Each of these components addresses human consumption of fish contaminated by mercury or methylmercury. Human consumption of mercury-contaminated fish caught from the river represents the sole actionable threat to human health; there is no actionable threat or risk to the environment. Nine sections or reaches of the Sudbury River were evaluated as part of OU4 (Reaches 2-10). Two reaches, Reaches 5 and 7, do not present unacceptable impacts to human health or the environment. As a result, the selected remedy focuses on Reaches 2, 3, 4, 6, 8, 9, and 10. Reach 1 is upstream and has not been impacted by contamination from the Nyanza facility. This remedy will allow most of OU4 to be used for fishing and fish consumption assuming "recreational" quantities of fish are consumed. This conclusion is, however, dependent on projections about the quantity of mercury deposited in the river by sources unrelated to the Nyanza facility. There is also an exception for Reach 8 of the river, which is less amenable to remediation measures, primarily due to ongoing atmospheric deposition of mercury (unrelated to the Nyanza facility) and natural hydrological features of Reach 8 that convert even small amounts of mercury into relatively high levels of contamination in fish. In this reach, fish contamination is expected to continue at levels that would not allow for consumption of fish by recreational anglers; exposures will be reduced to acceptable levels by reliance on institutional controls (e.g., fish advisories). Because Reach 8 is a national wildlife refuge managed by the U.S. Fish and Wildlife Service, EPA believes it will be easier to implement, monitor and maintain/enforce institutional controls there, including maintaining fish advisory signs and performing outreach on a nearly continual basis (e.g., warnings in brochures or elsewhere at the visitors' center and informal reminders by FWS staff).

<u>The major components of this selected remedy are:</u>

1. ENR. ENR entails placing a six-inch layer of sand over sediments containing a concentration of mercury in excess of 10 parts per million ("ppm") in surface sediment, so as to accelerate natural recovery processes by which mercury is diluted in river sediments. This, in turn, will contribute to a reduction of mercury concentrations in fish tissue over time. ENR will occur in a portion of Reach 3, which is the reach with the highest level of mercury contamination.
2. MNR. MNR will involve taking samples of fish tissue, sediment, and/or surface water to monitor natural recovery processes. This will occur in Reaches 2, 4, 6, 9, and 10.
3. Long-term Monitoring. Reach 8 will be monitored to verify the impact of the selected remedy and the effects of ongoing atmospheric deposition. EPA expects mercury concentrations in fish will be stable or decrease over time in this reach, although it is possible that atmospheric deposition of mercury will result in increases in fish tissue contamination.
4. ICs. The ICs for OU4 shall include posting of fish advisory signs, coordination with State agencies responsible for maintaining dam structures along the river, and public outreach to discourage consumption of contaminated fish. Reach 8 will rely on institutional controls in the long term for the remedy to remain protective.
5. Five Year Reviews. There will be five-year reviews of the remedy's protectiveness and

performance.

Not withstanding ambient and/or background sources of mercury, which are unrelated to the former Nyanza facility, the primary source of mercury contamination within the Sudbury River remains the historical operation at the former Nyanza facility. Although active discharges have ceased, mercury deposits within river sediment continue to contaminate surface water and fish, which (if consumed) represent a risk to humans. This sediment is not a principal threat waste, because it can be "reliably contained" and is not "highly toxic," within the meaning of EPA's "Guide to Principal Threat Waste and Low Level Threat Waste" (November 1991). The sediment therefore constitutes a low-level threat waste, which will be addressed through ENR, MNR, long-term monitoring, ICs, and five-year reviews.

E. STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

The statutory preference for treatment of principal threats does not apply, because principal threat waste is not addressed in this operable unit. Previous response actions in other operable units addressed principal threat wastes (e.g., removal of contaminated soil and sediment located near the former Nyanza facility).

The thin sand layer contemplated under the selected remedy will have impacts in wetlands and constitutes modification and occupancy of a floodplain. Under the federal wetlands executive order (EO 11990), the state wetlands rules applicable to riverbed, riverfronts and banks (310 CMR 10.54, .56, .58), and the state and federal regulation of dredge-and-fill operations in rivers (Clean Water Act § 404 and 314 CMR 9.00), EPA is required to avoid adverse impacts to wetlands and other aquatic environments, or avoid discharges of fill material to the river, unless there is no practicable alternative. In addition, the floodplain executive order (EO 11988) requires EPA to avoid actions that result in the occupancy and modification of floodplains, unless there is no practicable alternative. Because mercury contamination that leads to an unacceptable risk to human health exists in the river sediment, there is no practical alternative to conducting work that impacts these areas. The selected remedy is the least damaging practicable alternative because this alternative impacts the smallest area among all active alternatives considered, is expected to meet cleanup goals in a short timeframe (approximately 10 years) in the most contaminated part of the river, and presents fewer impediments to successful restoration of the aquatic environment. The selected remedy is not expected to result in a loss of flood storage capacity.

Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure to mercury in fish tissue, a review will be conducted within five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

F. ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this Record of Decision. Additional information can be found in the Administrative Record file for this Site.

- Chemicals of concern (COCs) and their respective concentrations
- Baseline risk represented by the COCs
- Cleanup levels established for COCs and the basis for the levels
- Assumptions (primarily related to fish consumption) in the baseline risk assessment and the ROD.
- Levels of fish consumption that will be safe at OU4 as a result of the selected remedy
- Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected
- Decisive factor(s) that led to selecting the remedy.

G. AUTHORIZING SIGNATURES

This ROD documents the selected remedy for the remediation of fish tissue at Operable Unit 4 of the Nyanza Chemical Waste Dump Superfund Site. This remedy was selected by EPA with the concurrence of the Massachusetts Department of Environmental Protection.

Concur and recommended for immediate implementation:

U.S. Environmental Protection Agency

By: [signature] Date: Sept 30, 2010

James T. Owens III, Director
Office of Site Remediation and Restoration
Region 1

PART 2: SUMMARY OF THE DECISION

A. SITE NAME, LOCATION AND BRIEF DESCRIPTION

The Nyanza Chemical Waste Dump Superfund Site ("Site") includes all areas contaminated as a result of the Nyanza, Inc. textile dye facility that formerly operated on Megunko Road, in Ashland, MA. The Site has been divided into four operable units, or OUs. OU1 consists of the former Nyanza plant, inclusive of the landfill at the Site. OU2 addresses contaminated groundwater. OU3 addresses contamination in the Eastern Wetland, Chemical Brook, Trolley Brook and Outfall Creek. Remedies have been selected (and in some cases, completed) for each of the first three OUs.

This Record of Decision selects a final remedy for OU4. OU4 consists of those portions of the Sudbury River that are contaminated by the former Nyanza, Inc. textile dye facility and includes 26 downstream miles from the Nyanza facility to the river's confluence with the Assabet River, passing through the Towns of Ashland, Framingham, Sudbury, Wayland, Lincoln, and Concord, Massachusetts. The river has been divided into ten reaches or sections, based on hydrologic properties (e.g., fast-flowing areas, impounded areas, wetlands). These reaches are depicted on Figure A-1 located in Appendix A.

The river is a flowing stream (Reach 1)[1] upstream of the Nyanza facility. Reach 2 consists of Mill Pond and a small flowing steam which is the location of historic surface water discharges from the Nyanza Site. The river continues first into Reservoir 2 (Reach 3), which consists of a series of lobes, and then into Reservoir 1 (Reach 4). Each of the reservoirs effectively acts as a settling basin, as velocity decreases and depth and width increase within these impoundment areas. After Reach 4, the Sudbury River increases in velocity and returns to a narrow channel (Reach 5) until it reaches the Saxonville impoundment (Reach 6), where the channel widens and the velocity decreases allowing sediments to deposit again in the river's third impoundment area. Control structures (dams) exist at the outlets of all three impounded areas (Reservoir 2, Reservoir 1, and Saxonville impoundment).

As the river flows from the Saxonville impoundment, the river channel narrows again and has adjacent areas of isolated wetlands along its banks (Reach 7) until it reaches the Great Meadows National Wildlife Refuge ("GMNWR") (Reach 8), where the Sudbury River follows a narrow channel surrounded by an extensive floodplain and wetlands region. Downstream of GMNWR, the river enters Fairhaven Bay (Reach 9), where it widens and velocity decreases again. The last portion of the river is Reach 10, where the river returns to a flowing stream in a narrow channel with isolated areas of wetlands along the banks until its confluence with the Assabet River.

[1] Reach 1 is upstream of the Nyanza facility, is not contaminated by the Nyanza facility, and is therefore not part of OU4 or the Site.

B. SITE HISTORY AND ENFORCEMENT ACTIVITIES

1. History of Site Activities

The 35-acre former Nyanza chemical facility ("facility") is located in Ashland, Massachusetts, approximately 22 miles west of Boston. As shown on Figure B-1, the facility is situated in an industrial area 0.4 km south of the Sudbury River. The facility was occupied from 1917 through 1978 by several companies that manufactured textile dyes and dye intermediates. Nyanza, Inc. ceased operations in 1978.

Mercury was used as a catalyst in the production of textile dyes from 1917 to 1978. Approximately 2.3 metric tons (2,300 kg) of mercury were used per year from 1940 to 1970; a total of approximately 45 to 57 metric tons of mercury were released to the Sudbury River during this period. From 1970 until the facility closed in 1978, wastes were treated on-site and wastewater was discharged to Ashland's town sewer system. These revised treatment practices reduced the quantity of mercury released to the Sudbury River to between 23 and 30 kg per year, or about 400 to 500 pounds during that eight-year period.

During the period of operation, large volumes of chemical waste were disposed of in burial pits, below-ground containment structures and various lagoons. Process chemicals that could not be reused or recycled, such as phenol, nitrobenzene, and mercuric sulfate, were also disposed of on-site or discharged into the Sudbury River mainly through a small collection of streams and culverts referred to as Chemical Brook, Trolley Brook, Outfall Creek and the Lower Raceway.

A more complete description of the Site history can be found in Section 2.1 of the Feasibility Study ("FS") report.

2. History of Federal and State Investigations and Remedial Actions

a. Federal Responses

The Site was listed on the National Priorities List (NPL) on September 9, 1983. Initial actions were conducted between 1987 and 1988; these activities included the removal of an underground storage vault containing various chemicals and removal of associated contaminated soil for off-site disposal.

Due to the size and complexity of environmental impacts at the Site, multiple Operable Units ("OUs") were created to allow independent evaluation of distinct portions of the Site or media. OU1 is the landfill at the Site; OU2 is the contaminated groundwater; OU3 addressed contamination in the Eastern Wetland, Chemical Brook, Trolley Brook and Outfall Creek. OU4, addressed in this Record of Decision, is the remaining affected portions of the Sudbury River.

EPA addressed contaminated soil within OU1 via consolidation and onsite capping; these remedial activities were completed in 1992. Then EPA began addressing off-site groundwater contamination (OU2) by selecting an interim pump and treat remedy in a 1991 ROD. Due to the discovery of Dense Non-Aqueous Phase Liquid (DNAPL) within the groundwater plume and additional risk to human health via vapor intrusion in dwellings located above the groundwater plume, changes to the OU2 remedy were documented in a 2006 Explanation of Significant Differences (ESD) and are currently being implemented.

Contaminated surface water runoff and groundwater discharged from the Nyanza Site to Trolley Brook, Outfall Creek, the Lower Raceway and the Eastern Wetland resulted in the creation of OU3 to address contaminated sediment and surface water. A remedy was selected in 1993 which provided for the excavation of contaminated soil and sediments. Remedial actions at OU3 began in 1999 and all cleanup and restoration activities were completed in August 2001. To address both human and environmental risks beyond the limits of OU3 (i.e., within the Sudbury River), the 1993 ROD for OU3 created the Sudbury River operable unit, OU4, to allow further evaluation and eventual selection of a remedy.

Additional information on responses to contamination at the Site can be found in the EPA's Record of Decision for OU3, issued in 1993.

EPA has completed a number of studies on OU4, which collectively (along with the 1992 OU3 Remedial Investigation) form EPA's remedial investigation of OU4. A Human Health Risk Assessment ("HHRA") was completed in 1999. It concluded that the only unacceptable risk to human health within the river was from the consumption of mercury-contaminated fish. Incidental ingestion and direct contact of surface water and sediment were also evaluated but were determined not to pose an unacceptable risk to human health. Following the collection of fish from all 10 reaches, a 2006 Supplemental HHRA, as further modified by an EPA Technical Memorandum of May 20, 2009, concluded that the only exposure scenario resulting in an unacceptable risk to human health was the consumption of mercury-contaminated fish by a recreational angler -- someone assumed to eat approximately ten to 15 servings per year of fillets from fish caught in the Sudbury River (see Section H for details). A Baseline Ecological Risk Assessment ("BERA") was completed in 1999. The 1999 BERA relied significantly on food chain modeling and, based on this modeling, the 1999 BERA projected the possibility of certain ecological risks. In 2002-2005, comprehensive field studies were completed and numerous samples collected to directly measure the degree of risk to ecological receptors, the results of which were reported in a 2008 Supplemental Baseline Ecological Risk Assessment ("SBERA"). The SBERA found no unacceptable ecological risks from contamination in OU4.

A Feasibility Study ("FS") and Proposed Plan were completed for OU4 in June 2010. The Proposed Plan recommended the remedy selected by this Record of Decision.

b. <u>State fishing advisories</u>

Currently multiple advisories applicable to the Sudbury River have been issued by the

Massachusetts Department of Public Health (MassDPH). The first, an advisory applicable to all freshwater bodies in the State, recommends that fish not be consumed by children and women who are pregnant or may become pregnant; this is due to the statewide distribution of mercury from atmospheric (non-point) sources. There is also a Sudbury River-specific advisory that warns against the consumption of any fish caught from the Sudbury River by all segments of the population.

3. History of CERCLA Enforcement Activities

By 1992, EPA had identified approximately 18 entities that it believed were responsible parties, all of whom received general notice letters. EPA subsequently entered into five separate settlements with certain parties, including the former operator of the Nyanza facility and certain of its employees, under which EPA settled its claims in return for (among other things) payments of cash. These payments to EPA totaled more than $8 million.

C. COMMUNITY PARTICIPATION

Throughout the Site's history, community concerns and involvement have been moderate, with periods of increased public participation. EPA has kept the community and other interested parties apprised of Site activities through informational meetings, fact sheets, press releases and public meetings. Below is a brief chronology of public outreach efforts.

- In 1986, EPA released a Community Relations Plan (CRP) that outlined a program to address community concerns and keep citizens informed about and involved in remedial activities at the Nyanza Site. This plan was further updated in April 1993.

- From 1993-1995, EPA issued the following Press Releases relating to OU4:
  - Technical Assistance Grant to Framingham Advocates for the Sudbury River (1993)
  - Availability of Fish Advisory Brochures (1995)
  - Announcement regarding Multi-Agency Meeting on River Investigations (1995)

- From 1994-1995, there were six meetings of the Sudbury River Task Force; this group consisted of both citizens and government agencies that worked on developing fish advisory materials (brochures, signs, etc).

- From 1995-1996, there were three Public Meetings in Framingham to update the public and discuss both the Continuing Source Area (OU3) remediation plan as well as issues affecting the Sudbury River.

- From 1999-2004, EPA provided technical assistance and information to the Massachusetts Department of Public Health and the Ashland/Nyanza Health Study Community Advisory Council.

- In June 2003, EPA issued a fact sheet to mailing list recipients announcing the start of data collection from the river for the completion of supplemental human health and ecological risk assessments.

- In June 2006, EPA issued a Press Release and provided a status update regarding the supplemental human health risk assessment and ecological studies which were underway at that time.

- In June and July 2006, EPA gave a presentation to the SuAsCo Watershed Community Council and the Framingham Board of Selectman, respectively.

- In June 2007, EPA issued a fact sheet (in both English and Spanish) to mailing list recipients to announce the conclusion (in 2006) of the human health risk assessment, and describe progress on the ecological risk assessment. This Factsheet was distributed to Town Halls and Boards of Health within each of the six towns located along the river. In addition, these factsheets were also placed at bait shops located in the watershed and/or adjacent the Sudbury River.

- In June 2007, EPA gave an update and a presentation to the Framingham Board of Selectman.

- In July 2007, EPA met with representatives of the State (MassDEP, Massachusetts Department of Conservation and Recreation) and the Massachusetts Water Resources Authority to discuss utilization and future anticipated used of the Sudbury River reservoirs.

- In November 2007, EPA gave a presentation during the annual "Rivervisions" conference sponsored by the SuAsCo Watershed Community Council.

- In June and November 2008, EPA participated in public meetings along with the natural resources trustees (MassDEP, NOAA, and F&WS) to discuss restoration along the Sudbury River.

- On March 11, 2010, EPA met with representatives of the State (MassDEP, DCR) and the MWRA to discuss utilization and future anticipated used of the Sudbury River reservoirs

- On June 16, 2010, EPA published a Public Notice and summary of the Proposed Plan. Based on this, an article subsequently ran in the Metrowest Daily News announcing the plan's availability to the public.

- On June 21 and 24, 2010, EPA held informational meetings to discuss the results of the Feasibility Study, cleanup alternatives evaluated, and to present the Agency's Proposed Plan. Given the 26 downstream miles of river and multiple towns potentially affected by remedial decisions, multiple meetings were held, one at Great Meadows National Wildlife Refuge Headquarters (Sudbury/Wayland town line) and another in Framingham. At these meetings, representatives from EPA answered questions from the public.

- On June 22, 2010, EPA held a supplemental meeting to discuss its use of computer models as part of its evaluation of remedial alternatives. This meeting was held at GMNWR Headquarters. At this meeting, representatives from various EPA offices (Region I and ORD) were available and answered questions from the public.

- On June 25, 2010, EPA made the administrative record available for public review at EPA's offices in Boston and at the Ashland Public Library, Ashland, Massachusetts.

- From June 25 to July 25, 2010, EPA held a 30-day public comment period to accept public comment on the alternatives presented in the Feasibility Study and the Proposed Plan and on any other documents previously released to the public. An extension to the public comment period was requested and granted, thus extending the comment period to August 26, 2010.

- On July 19, 2010, the EPA held a formal Public Hearing to discuss the Proposed Plan and to accept any oral comments. A transcript of this meeting and the comments and the Agency's response to comments are included in the Responsiveness Summary, which is part of this Record of Decision.

- Beginning in 2008, EPA has been coordinating with the Metrowest Nyanza Advisory Committee – a task force organized under the Metropolitan Area Planning Council (formerly Metrowest Growth Management Committee). The Nyanza Advisory Committee's focus, to date, has been providing third-party review (via a consultant) of EPA risk assessments, Feasibility Study, and Proposed Plan. More recent discussions (since 2009) have been focused on results of a "fishing survey" (conducted by the Committee) and a discussion of those results with the Massachusetts Department of Public Health (MassDPH). Numerous discussions have ensued regarding effective means of communicating risks to local ethnic populations and reviewing outreach materials prepared by the Committee.

D. SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

There are four operable units at the Site.

- OU1 is the landfill at the Site;
- OU2 is the contaminated groundwater;
- OU3 addressed contamination in the Eastern Wetland, Chemical Brook, Trolley Brook and Outfall Creek; and
- OU4, addressed in this ROD, is the portion of the Sudbury River downstream of the former Nyanza facility, as described above.

EPA addressed contaminated soil within OU1 via consolidation and onsite capping; these remedial activities were completed in 1992. Then EPA began addressing off-site groundwater contamination (OU2), by selecting an interim pump and treat remedy in a 1991 ROD. Due to the discovery of DNAPL within the groundwater plume and additional risk to human health via vapor intrusion in dwellings located above the groundwater plume, changes to the selected remedy were documented in a 2006 ESD and are currently being implemented. Contaminated surface water runoff and groundwater discharged from the Nyanza Site to Trolley Brook, Outfall Creek, the Lower Raceway and the Eastern Wetland resulted in the creation of OU3 to address contaminated sediment and surface water. A remedy was selected in 1993 which provided for the excavation of contaminated soil and sediments. Remedial actions at OU3 began in 1999, and all cleanup and restoration activities were completed in August 2001. To evaluate both human and environmental risks beyond the limits of OU3 (i.e., within the Sudbury River), the 1993 ROD for OU3 created the Sudbury River operable unit, OU4.

Nyanza Operable Units

	Remedial Action	**Date of Completion**
OU1	Consolidation and landfill cap	1992
OU2	Pump & treat contaminated groundwater	Ongoing
OU3	Excavation of contaminated soil and sediment in creeks, wetlands	2001
OU4	Monitored and Enhanced Natural Recovery of surface water/fish tissue	Ongoing

OU4, the subject of this ROD, addresses contamination in the Sudbury River. Consumption of fish from certain portions of the Sudbury River poses an unacceptable risk to recreational anglers – i.e., results in an exposure to mercury that would exceed

EPA's acceptable risk range for non-carcinogenic risks. This operable unit presents the final response action for this Site and addresses a low-level threat at the Site through (among other things) enhanced natural recovery, monitored natural recovery, other monitoring, and institutional controls.

Although there are multiple contaminants associated with historic Nyanza operation and there are multiple contaminants of concern in other media (e.g., volatile organic compounds in groundwater), the only significant contaminant in OU4 is mercury (or methylmercury, in its organic form). Inasmuch as operations at the former Nyanza facility terminated in 1978 and other source areas in OU3 have already been cleaned up, the mercury source that continues to degrade the river is predominantly located in downstream sediment; from sediment it passes into surface water and fish tissue. It presents an unacceptable risk to human health only in fish tissue, and only then if consumed in quantities associated with recreational angling

Mercury is not a principal threat at the Site, because at its source, in sediment, it is not highly mobile, it is found at relatively low levels, and it can be reliably contained, within the meaning of EPA's "Guide to Principal Threat Waste and Low Level Threat Waste" (November 1991). It is instead classified as a low-level threat waste. EPA's response to this threat is to "enhance" the rate of natural recovery (ENR) by depositing a thin layer of sand over the most-contaminated sediments, thereby reducing mercury levels in surficial sediment and surface water and decreasing fish-tissue concentrations. EPA's selected remedy also involves, among other things, a sampling program to monitor natural recovery (MNR) throughout most of the river as well as sampling other areas of the river that are not expected to recover naturally in a reasonable time, five-year reviews (FYRs) to evaluate the progress of the remedy, and institutional controls (ICs) -- e.g., continued posting of signs warning against consumption of fish from the river.

<u>Principal and Low-Level Threats at OU4</u>

Principal Threats	**Medium**	**Contaminant(s)**	**Action To Be Taken**
NA[2]	NA	NA	NA
Low-Level Threats	**Medium**	**Contaminant(s)**	**Action To Be Taken**
Contaminated sediment	Sediment	Mercury, methylmercury	ENR, MNR, FYRs, ICs, other monitoring

2 As discussed above, principal threat wastes were addressed in prior responses at other operable units.

E. SITE CHARACTERISTICS

EPA has performed or commissioned a number of investigations of contamination in OU4. These include a Draft Baseline Ecological Risk Assessment (BERA) in 1999, a Supplemental Baseline Ecological Risk Assessment (SBERA) in 2008, a Supplemental Baseline Human Health Risk Assessment (SBHHRA) in 1999 and another Human Health Risk Assessment in 2006 (HHRA). In 2010, EPA issued a Feasibility Study (FS), which included a Conceptual Site Model (CSM) and a discussion of the results of a computer model developed as part of the FS and used to evaluate the various remedial alternatives which were considered. The FS also summarized the results of samples taken in 2007 and 2008, which were used to calibrate the computer model.

The RI for OU3, completed in 1992, concluded that the only contaminant of concern potentially presenting an unacceptable risk in the Sudbury River was mercury. Subsequent evaluations (specifically the 1999 SHHRA) determined that the only unacceptable risk in the river was to humans, specifically to anglers who consumed their catch from the river and which contain high concentrations of mercury. There was no risk from ingestion or direct contact with either surface water or sediment. These risk assessments are discussed in greater detail in Section G, below. This section, in particular, reviews:

- The hydrology of the river.
- Processes by which mercury enters the river, and is converted into its most toxic form, methylmercury (MeHg).
- Sampling results from the river for the following media: sediment, surface water and fish tissue.
- The Conceptual Site Model (CSM).
- The computer model developed by EPA used to evaluate remedial alternatives.

1. Hydrology of the River

OU4 consists of the Sudbury River as it stretches approximately 26 miles from the Nyanza facility in Ashland, Massachusetts to its confluence with the Assabet River in Concord, Massachusetts. The river follows a general pattern of high flow during the spring and very low flow in the summer. For example, the Saxonville gauge reported a yearly high flow of 36 cubic meters per second on April 18, 2007, and a yearly low of 0.1 cubic meters per second from September 5 to 9, 2007.

EPA divided the river into 10 reaches, the latter nine of which (Reaches 2 through 10) are part of OU4, being downstream of the Nyanza facility and potentially affected by Nyanza mercury contamination. Reach 1 is upstream of the Nyanza facility and is not part of the Site, as no contamination from the Nyanza facility was found in this part of the river. Reach 2 is the most upstream portion of the river affected by Nyanza operations; it consists of Mill Pond and a flowing stream. The river then flows into two reservoirs: first into Reservoir 2 (Reach 3), which consists of a series of lobes of increasingly larger size, and then into Reservoir 1 (Reach 4). Each reservoir effectively acts as a settling basin, as velocity decreases and depth and width increase within these impoundment areas. Reservoir 2, being the most-upstream "settling basin," has been estimated to reduce the total mercury load by 23% via sedimentation. These reservoirs were once designated as an emergency drinking water supply, but are no longer designated as such, due to high turbidity and insufficient volume.

After Reservoir 1, the river increases in velocity and returns to a narrow flowing channel (Reach 5) until it reaches Saxonville impoundment (Reach 6), where the channel widens and the velocity decreases, allowing sediments to deposit again in the river's third impoundment area. Control structures (dams) exist at the outlets of all three impounded areas (Reservoir 2, Reservoir 1, and Saxonville impoundment).

As the river outlets from Saxonville impoundment, the river channel narrows again and has adjacent areas of isolated wetlands along its banks; this is Reach 7. At this point the Sudbury River enters Reach 8 (Great Meadows National Wildlife Refuge, or GMNWR), and follows a narrow channel surrounded by a wide floodplain and wetlands region. Downstream of GMNWR, the river enters Fairhaven Bay (Reach 9), where it widens and velocity decreases again. The last portion of the river is Reach 10, where the river returns to a flowing stream in a narrow channel with isolated areas of wetlands along the banks until its confluence with the Assabet River.

As part of the effort to model the river (discussed below), EPA assumed that, during low flow periods, the impoundment areas of the Sudbury River function as large settling basins or lakes. In periods of high flow, the impoundments flow more like rivers. The reaches between the impoundments flow as rivers all year long, flowing at low velocities and shallow depths during periods of low flow and increasing in velocity and depth during periods of high flow.

2. Sources of Mercury Contamination; How It "Methylates" and Enters Fish

This section discusses sources of mercury contamination in the river, the "methylation" process by which mercury tends to enter fish tissue, and how this process is affected by conditions in the river.

Mercury in the river has two main sources: old mercury from the former Nyanza facility, and new mercury deposited from the atmosphere. Mercury in the atmosphere is attributable to man-made sources (e.g., combustion of fossil fuels and municipal waste incineration), and is an important source of mercury contamination in rivers and lakes throughout the Northeast. Although new mercury from atmospheric deposition is more likely to enter fish tissue than old mercury from the Nyanza facility (in part because new mercury lies on top of river sediments), the overall amount of mercury in the river from the Nyanza facility is high and is clearly responsible for a significant portion of the unacceptable contamination in fish, even if the exact amount is difficult to quantify. This determination is supported by the fact that fish from the river appear to be more contaminated than fish from nearby rivers that are unaffected by Nyanza contamination

Once mercury, including Nyanza-related mercury, enters the river, some portion of it is likely to be converted into a form called methylmercury. The process is called "methylation." Methylation is important, because the degree to which it happens depends on local conditions, and because methylmercury is more readily absorbed by animals than regular mercury and is retained for longer in human and animal tissue than other species of mercury. Methylmercury is also the most toxic type of mercury. Ninety percent or more of the mercury contamination in fish tissue in the Sudbury River is in the form of methylmercury.

Although methylation is not perfectly understood, the process is promoted by dissolved organic carbon, which abounds in wetlands. Several reaches in the Sudbury River have wetland areas, the most significant being Reach 8, which includes the 3600-acre Great Meadows National Wildlife Refuge. Wetlands may have production rates of methylmercury up to 15 times greater than typical reservoir or lake production rates. This means a very small amount of mercury in these parts of the river can lead to a disproportionate level of contamination in fish tissue, making it difficult or impossible to undertake active remediation when these naturally occurring conditions exist. As a result, concentration of mercury in sediment and surface water is only one factor in determining appropriate response actions at this Site. The cycling dynamics of mercury within different local environments along the Sudbury River are illustrated on Figure E-1. A schematic diagram is provided in Figure E-2. Together these figures depict the various sources and competing reactions of mercury that determine the speciation of mercury in an ecosystem.

3. Sampling results
This section summarizes EPA's sampling results. A map showing the locations and results of the most recent comprehensive round of sampling (2003- 2005) is included in Figures E-3 (Reach 1); E-4 (Reaches 2, 3, and 4); E-5 (Reaches 5, 6, and 7); E-6 (Reach 8); and E-7 (Reaches 9 and 10).[3] In sum, Reach 3 generally has the highest or among the highest methylmercury levels in sediment, surface water and fish tissue of any reach; Reach 8 also has high levels of contamination in surface water and fish tissue, but not in sediment. EPA also analyzed trends in the sampling data, as discussed below; this analysis was based on limited data but suggests small decreases in contamination levels in certain media and certain reaches since the 1990s.

The table below presents the average and median concentration, by reach, of (a) total mercury in sediment, (b) total mercury in surface water, and (c) total mercury in fish tissue, as well as certain median methylmercury surface water samples. A more detailed description of the sampling results follows the table.

[3] In addition to the most recent comprehensive sampling conducted from 2003 to 2005, select surface water, sediment and fish samples were collected in 2007 and 2008 from certain reaches and were predominantly used to calibrate the WASP computer model. These data were collected from Reach 3, Reach 4 and Reach 8. Surface water sample locations are depicted in Figures E-10 and E-11 and the data from Reach 3, represented graphically, is presented in Figure E-12. All the 2007/2008 data is located in Appendix A of the FS.

Analytical Summary of Recent (2000- 2008) Total Mercury Results in Sediment, Surface Water, and Fish Fillets (Skin-on)

		Sediment (mg/kg)	Surface Water (ng/L)	Fish (mg/kg)		
				Bullhead	Largemouth Bass	Yellow Perch
Reach 1	Range of Detected Concentrations	0.129 – 3.150	1.73-2.26	0.423 – 0.847	0.296 – 0.418	0.034 – 0.365
	Median	0.322	2.09 (0.264 MeHg)	0.635	0.357	0.265
Reach 2	Range of Detected Concentrations	0.005 – 9.649	3.81-41.8	NA - NA	0.405 – 1.500	0.194 – 0.876
	Median	0.434	4.25 (0.287 MeHg)	NA	0.792	0.368
Reach 3	Range of Detected Concentrations	1.321 – 44.880	2.250 – 5.890	0.198 – 4.180	0.573 – 1.760	0.299 -0.911
	Median	12.573	3.17 (0.122 MeHg)	0.699	0.873	0.483
Reach 4	Range of Detected Concentrations	0.822 - 15.640	0.0910 – 4.440	0.102 – 0.413	0.466 – 0.913	0.168 -0.742
	Median	7.548	1.54 (0.040 MeHg)	0.285	0.709	0.575
Reach 5	Range of Detected Concentrations	0.043 – 3.200	1.59-1.59 (n=1)	0.126 – 0.342	0.398 – 0.824	0.122 – 0.824
	Median	0.941	1.59 (0.125 MeHg)	0.174	0.674	0.287
Reach 6	Range of Detected Concentrations	0.032 – 9.757	NA*	0.192 – 0.610	0.364 – 1.090	0.124 – 0.602
	Median	1.905		0.395	0.684	0.309
Reach 7	Range of Detected Concentrations	0.012 – 1.551	1.33-23	0.147 – 0.644	0.387 – 1.050	0.153 – 0.336
	Median	0.132	4.06 (0.151 MeHg)	0.350	0.740	0.189
Reach 8	Range of Detected Concentrations	0.073 – 1.191	2.240 – 27.600	0.090 – 0.862	0.621 – 1.660	0.197 – 0.609
	Median	0.389	6.84 (0.189 MeHg)	0.293	0.974	0.344
Reach 9	Range of Detected Concentrations	0.435 – 1.898	ND (n=1 sample)	0.175 – 0.285	0.645 – 1.830	0.240 – 0.610
	Median	1.226		0.216	1.010	0.456

		Sediment (mg/kg)	Surface Water (ng/L)	Fish (mg/kg)		
				Bullhead	Largemouth Bass	Yellow Perch
Reach 10	Range of Detected Concentrations	0.054 – 1.508	All NDs (n=7)	0.099 – 0.871	0.396 – 1.660	0.216 – 0.663
	Median	0.413		0.276	0.879	0.313

mg/kg = Milligrams per kilogram
ng/L = nanograms per liter
* = no data collected during this time frame
All results are total mercury, unless otherwise indicated.

MeHg = methylmercury
NA = Not analyzed
ND = Not detected

Sediment. The median concentration of total mercury (i.e., all forms of mercury, including methylmercury) in sediment is highest in Reaches 3 and 4. There are much smaller concentrations of methylmercury in sediment, but again Reach 3 has the highest median concentration of methylmercury, followed by a portion of Reach 7 (Heard Pond) and Reach 8, GMNWR. The most recent sediment data is presented graphically in Figure E-8.

EPA has also completed a Trend Analysis Memorandum (which can found in Appendix A of the FS) to identify statistically-significant trends in sediment mercury concentrations using data from various sampling events between 1989 and 2008. The data available to conduct this trend analysis was limited and its usefulness is further hampered by the small sample sets (often N=3) and the tendency of mercury concentrations to be highly spatially variable over short distances and depths. The results of the analysis indicate no statistically significant changes in the total mercury in sediment from either Reaches 3 or 4 between 1994 and 2008 -- although if older data from 1989 are included, a downward trend is indicated. Within Reach 8, an upward trend was noted, with the greatest increase in concentration observed between 2003 and 2008. It is unclear whether this is due to transport of Nyanza-related mercury downstream, the result of increased atmospheric deposition, or data/laboratory variability. In Reach 9, a downward trend was noted with the largest decrease observed between 1994 and 2003.

Surface water. The reaches with the highest median concentration of both total mercury and methylmercury in unfiltered surface water are Reach 3 (Reservoir 2) and Reach 8 (GMNWR). A summary of the most recent comprehensive surface water data (2003-2005) is provided in Figure E-9.

Although limited comparable data make it difficult to identify trends, EPA completed a trend analysis for reaches of the river where sufficient data exists. For unfiltered total mercury, a downward trend was noted in Reach 3, with the greatest decrease between 1995 and 2001. No significant changes in concentrations were noted in data from Reach 4 and only a marginal change was noted in data from Reach 8. There was no total mercury data available for analysis of other reaches. Analysis of methylmercury in unfiltered samples yielded the following trends: in Reach 3, a decrease in mean methylmercury concentrations was noted between 1994 and 1995, with no change observed between 1995 and 2008. In Reach 4, a decrease in mean concentration was noted between 1994 and 2007, but no change was noted recently between 2007 and 2008. Within Reach 8, an increase in mean methylmercury was noted between 1994 and 1995 followed by a drop until 2003, after which no change was observed.

Fish tissue. The most recent comprehensive (i.e., all reaches) collection of fish tissue data occurred between 2003 and 2005. This data is summarized in Figure E-13. The data shows that some species have much higher concentrations of methylmercury than others, with concentrations significantly dependent on the age (and hence total size) and location of the fish. For example, largemouth bass (being higher in trophic status) generally have higher concentrations of methylmercury than do other native species collected; the most-contaminated individual bass were caught in Reaches 3, 8, 9 and 10.

EPA completed a trend analysis of mercury concentrations in fish tissue from samples taken between 1989 and 2008. Older data (which, unlike newer data, was age-normalized based on length) appear to show fish tissue concentrations are lower now than they were in 1989-1990 in all reaches among all species. But more recently collected data are inconclusive as to the existence of any trend; this may be due to the relatively small data set from which comparisons over time can be made. It may also be that the rate of natural attenuation of mercury in fish is slower than in the past, as background concentrations are approached.

4. Conceptual Site Model

Based on the sampling results, the hydrology of the river, and literature on mercury methylation, EPA has developed a Conceptual Site Model (CSM) for OU4. This CSM describes the source of contamination and how this contamination ends up in fish tissue, where it becomes a threat to human health for those who eat these fish. The CSM documents current Site conditions and shows what is known about human and environmental exposure through contaminant release and migration to potential receptors. The risk assessments and the selected remedy for the OU4 are based on this CSM. Its basic points can be summarized as follows:

- *Methylmercury is absorbed from the river sediment, pore water and surface water by lower trophic levels organisms, and biomagnifies up the food chain.* In the lower trophic levels (e.g., zooplankton) organisms ingest mercury and methylmercury through direct contact with and/or ingestion of contaminated sediment, pore water and surface water. Methylmercury contamination then biomagnifies up the food chain – for example when smaller fish eat the zooplankton and are in turn eaten by larger fish. This results in contaminated fish that pose a risk to recreational anglers if consumed, as described further in Section G. Fish can also absorb methylmercury directly when their gills take up mercury from contaminated surface water. Mercury (including methylmercury) in fish tissue has three fates: 1) removal from the river by anglers, 2) consumption by another piscivore, or 3) death and decomposition. The latter two fates result in contamination being retained within the system; angling is the only outcome that removes mercury from the river.

- *Mercury contamination in sediment is one of several sources of mercury available for methylation; the degree to which methylation occurs is highly variable and highly significant.* In both surface water and sediment, Reach 3 has the highest median concentrations of methylmercury, as well as some of the highest concentration of methylmercury in fish tissue (depending on which species is evaluated). But other reaches – particularly Reach 8 and the reaches downstream of Reach 8 – also have fairly high surface water and fish tissue concentrations, but relatively low sediment concentrations. This demonstrates that concentrations of methylmercury in fish are not necessarily proportional to sediment concentrations of mercury. A variety of other factors affect the degree to which mercury is made available and hence accumulates in fish. For example, wetland areas adjacent to downstream reaches periodically flood and recede; this can contribute substantially to the surface water flow and water quality after significant rainfall events. Moreover, it is likely that the higher surface water mercury concentrations in the downstream, wetland reaches (e.g., Reach 8) are driven in significant part by the superior methylating properties of the wetlands. Additional evidence for this is seen in that, as Nyanza-contaminated sediments become buried by natural sedimentation, surface water concentrations of methylmercury appear to be slowly declining over time in the upstream reaches – but not in the downstream reaches. In Reach 3, which is not a traditional wetland, high sediment concentrations appear to be correlated with high surface water and fish tissue concentrations.

- *Natural processes are slowly burying the mercury deposited in sediment.* Mercury in sediment is less likely to be converted into methylmercury as contaminated sediments are buried via natural sedimentation processes. This burial can be seen in the fact that the highest levels of mercury are located approximately 3 inches below the surface of the reservoirs and as deep as 8 inches in downstream (wetland) reaches – which is to say that mercury is progressively moving out of the biologically-active zone. This study has observed burial to occur at a rate of approximately 0.04 centimeters per year in the impounded areas of the Sudbury River, using radioactive dating techniques. Sediment cores from Reach 3 dated using these methods showed no signs of physical disturbance, and indicated that the highest rate of mercury deposition in this reach occurred in the 1970s. Finally, the trend analysis, though it is based on limited data, suggests that overall mercury contamination in sediment is declining in certain reaches of the river (though not in Reach 8). These lines of evidence all indicate that mercury is being made less bioavailable as a result of natural burial processes.

- *There is no significant migration of Nyanza-contaminated sediment, but there may be some transport of Nyanza-related mercury in surface water.* EPA believes the likelihood of significant transport of the bulk of Nyanza-related contamination is low, based on past studies that concluded that river sediments are stable. The depth of water above the most-contaminated sediment (Reach 3 and Reach 4) may also help prevent future disturbance and re-suspension. However, the shallow depth of water in the Saxonville impoundment (Reach 6) likely does not provide equally effective protection from future disturbance, e.g., by a large storm event or occasional recreational use. But even if the sediment is generally stable, the faster-flowing reaches (Reach 5 and portions of Reaches 2 and 7) may transport mercury in surface water from the reservoirs to downstream reaches, which have the greatest potential for creating methylmercury. This is consistent with high methylmercury in fish in the downstream reaches, notwithstanding the low concentration of total mercury in sediment in these reaches.

- *Fish generally do not move between reaches.* On average each reach is almost 3 miles long; some, like Reach 8, are much longer. Many reaches are separated from one another by barriers such as dams. The three species of fish in the river believed to be used for food are generally territorial; that is to say the vast majority of individuals stay within a home range that is much narrower than the size of each reach. The fish in each reach can therefore be treated as a distinct population with a distinct level of contamination; fish caught by an angler in a given reach will generally reflect the environmental conditions in that reach.

- *Volatilization and burial reduce the amount of Nyanza-related mercury available for methylation, but these processes are negated by ongoing atmospheric deposition. The degree to which this occurs is dependent on local conditions that convert atmospheric mercury into methylmercury; some reaches are expected to recover naturally much more quickly than others.* The contribution to the total risk that is attributable to historic (Nyanza-related) mercury sources will gradually decrease, as dissolved methylmercury volatilizes into the air and as mercury-contaminated sediments are buried. But atmospheric deposition continues to occur. Overall, it is believed that the factors making mercury less bioavailable in the river are partially negated by atmospheric deposition. This means that reduction in fish tissue concentrations of mercury will likely occur at different rates for the variety of environments present within the Sudbury River. In particular, Reach 3 (primarily because it is the most-contaminated reach) and Reach 8 (primarily because it is so efficient at converting atmospheric mercury into methylmercury) are likely to have unacceptably high levels of fish contamination for decades. By contrast, the other reaches in the river, which are less contaminated and less efficient at converting mercury into methylmercury, are likely to recover more quickly.

5. WASP Computer Model

EPA used the Water Quality Analysis Simulation Program to construct a computer model (hereinafter referred to as the "model" or "WASP") that was used to estimate future methylmercury concentrations in surface water in Reaches 3 through 8 under various remedial scenarios. This model was constructed consistent with the CSM described above, and uses both Site-specific and literature-based values to represent mercury distribution and mercury-cycling dynamics within the study area. In the model, Reaches 3 through 8 were divided into 33 segments, with numerous inputs for factors like precipitation, physical characteristics of each segment and its sediment, and regional rates of atmospheric deposition of mercury. The model assumed consistent on-going atmospheric sources of mercury for the duration of each scenario (approximately 35 years).

Reaches 2, 9 and 10 were not modeled, but have hydrological conditions similar to those present in Reaches 5, 6 and 7. EPA has instead relied on trend analyses and comparisons to Reaches 5, 6, and 7 to estimate future contaminant concentrations in fish from these unmodeled reaches.

The partitioning coefficient used in the model – the figure used to represent the amount of methylmercury that enters surface water from a given concentration in sediment – was a particularly critical variable. The WASP model developed separate partitioning coefficients that capture the different methylation potentials of Nyanza-related mercury (i.e., "old" mercury) and background sources of mercury (i.e., "new" mercury) within the Sudbury River. "New" mercury is generally considered to be more susceptible to methylation than "old" mercury, which has had time to become more strongly sorbed to the sediment particles. When simulations were run to calibrate the model and see whether its predictions matched the most recent observations, it turned out that separate partitioning coefficients generated more accurate results.

The model simulations also supported several hypotheses. First, the effect of ambient sources of mercury can account for the concentration of total mercury within surface water reasonably well, but ambient sources of mercury do *not* explain the elevated concentrations of methylmercury in surface water in the most-contaminated parts of the river (which are generally "lower-methylating" environment as compared to other river reaches e.g., wetlands). This suggests a significant and on-going contribution of Nyanza-related mercury (in sediment) to the overall concentration and subsequently availability of methylmercury to aquatic species, notwithstanding its relatively lower susceptibility to methylation. Second, model simulations were most accurate when a higher methylation rate was used for mercury in the wetlands (i.e., Reach 8). This is consistent with the CSM, which posits that wetlands methylate mercury more efficiently than the impounded parts of the river.

After calibration, the WASP model was used to simulate the effectiveness of various active remedial alternatives (discussed below). The output of the model was dissolved methylmercury in surface water.

A Site-specific bioaccumulation factor (BAF) was used to convert dissolved methylmercury concentrations into predicted fish tissue concentrations. In calculating a BAF for the river, filtered surface water methylmercury concentrations were paired with fish tissue (bass and perch) mercury concentrations, collected at approximately the same time and from the same reach (i.e., Reach 3). The 2007/2008 data was used to perform initial BAF calculations for Reaches 3 and 8. As the reach-specific BAFs were similar, the BAF of 7.8E+06 liters per kilogram (L/kg) for Reach 3 (highest BAF calculated) was selected to provide a conservative estimate of bioaccumulation.

A Site-specific BAF, instead of the national value of 5.74E+06 L/kg, is preferred when a robust data set exists. The BAF value developed for OU4 more likely reflects local contaminant loading and ecosystem parameters that are having a direct effect on fish tissue concentrations within the Sudbury River. Two technical papers (Volume 1 and Volume 2) which describe the computer modeling are included in Appendix C to the FS. Further details on the derivation of the BAF are presented in Volume 1.

EPA is aware that the WASP model and the BAF do not capture all the complexities of mercury contamination (which are not perfectly understood even under laboratory conditions, let alone in a stretch of river that is 26 miles long). EPA is also aware that, as a result of these imperfections, the predictions made with the model and the BAF about fish tissue and surface water will not be completely accurate. Nonetheless, EPA decided to rely on these predictions to evaluate the relative performance of different remedies, including the selected remedy. This was for several reasons. First, the model is far from a purely mathematical or a theoretical instrument -- rather it was constructed and calibrated using literally hundreds of Site-specific hydrological and chemical measurements and other direct observations. Second, as noted above, the model was validated – that is to say, the model was allowed to run to predict mercury concentrations in the recent past which were then compared to data actually measured from the river (this data is in the first of the two WASP technical papers included in Appendix C to the FS). The output of this analysis revealed that, while the computer model is generally not accurate in predicting concentrations of *total mercury* in surface water, the model was substantially more accurate in predicting *methylmercury* in surface water (refer to Figures E-14 and E-15). This is significant because methylmercury, particularly dissolved methylmercury, is generally considered the most salient factor in predicting fish tissue concentrations. Finally, where approximation was necessary – e.g., in applying to the whole river the highest BAF generated from any part of the river, or in the assumption that all mercury in fish is methylmercury – EPA erred on the side of protecting human health, consistent with basic CERCLA principles.

A Sensitivity Analysis was also performed to evaluate which of the computer model variables have the greatest potential impact on model-predicted results. The variables evaluated included: critical shear stress, re-suspension velocity, dispersion rate, and flow field. A complete copy of the Sensitivity Analysis is available in the administrative record. Of the parameters evaluated, the model was found to be most sensitive to the critical shear stress. Whereas higher critical shear stress had no effect on the model predictions, decreasing the critical shear stress of native sediment resulted in storm events where erosion was more likely to occur. These events resulted in higher concentrations of mercury and methylmercury in surface water during these events, predominantly in the reservoirs; downstream reaches were less sensitive to these changes. However, EPA believes the critical shear stress value used in the model is an accurate number. This shear stress value was based on Site-specific observations. A much lower shear stress figure would suggest continual erosion of sediments in the river, but this does not reflect the actual conditions; the river in general has been observed to have a positive burial sediment rate.

F. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCES USES

A large portion of the land surrounding the Sudbury River is suburban residential, consisting of several closely spaced urban centers connected by arterial commuting routes. In Reach 8 of the river, the surrounding area is an undeveloped wetland that forms part of the Great Meadows National Wildlife Refuge. The watershed area of the Sudbury River is approximately 165 square miles.

The river is classified by the state as a "Class B" body of water, which means that under state law it is to be managed to protect and propagate fish and other aquatic life and wildlife. Class B waters are also intended for primary and secondary contact recreation. Unlike Class A waters, they are not intended as public drinking water sources.

The river is currently used solely for recreational purposes. These recreational purposes include wading, swimming, boating, hiking and recreational angling, by both children and adults. At one time EPA considered the possibility that subsistence fishing was occurring in the river, but this scenario was ultimately discarded because there was no evidence for it. (Subsistence anglers are assumed to rely on fish that they catch themselves for most or all of their annual dietary protein).

EPA does not expect these uses of the river to change substantially in the future, and also does not expect any new uses, such as the identification of river water as a drinking water source. Regular informal correspondence between EPA and the Massachusetts Department of Conservation and Recreation (which owns the reservoirs and surrounding property) indicates that DCR does not expect the river to be used as a drinking water source in the future because of low volume, high turbidity, and insufficient watershed protection (i.e., highly urbanized). EPA has also had informal discussions and meetings with local organizations, such as the SuAsCo Watershed Council and the Metropolitan Area Planning Council; these groups also see the river as continuing to be used for recreational purposes only. Recreational uses are also consistent with the state's classification of the river as a Class B water body.

These recreational uses are assumed to lead to three types of exposure to mercury contamination: through incidental ingestion of surface water and sediment, through dermal contact with surface water and sediment, and through consumption of fish. These exposures scenarios are further described in Section G.

G. SUMMARY OF SITE RISKS

Baseline risk assessments were performed to estimate the probability and magnitude of potential adverse human health and environmental effects from exposure to contaminants (mercury) associated with the Site assuming no remedial action was taken. These baseline risk assessments provide the basis for taking action and identify the contaminants and exposure pathways that need to be addressed by the remedial action. The human health risk assessment followed a four-step process: 1) hazard identification, which identified those hazardous substances which, given the specifics of the Site, were of significant concern; 2) exposure assessment, which identified actual or potential exposure pathways, characterized the potentially exposed populations, and determined the extent of possible exposure; 3) toxicity assessment, which considered the types and magnitude of adverse health effects associated with exposure to hazardous substances, and 4) risk characterization and uncertainty analysis, which integrated the three earlier steps to summarize the potential and actual risks posed by hazardous substances at the Site, including carcinogenic and non-carcinogenic risks and a discussion of the uncertainty in the risk estimates. A summary of those aspects of the human health risk assessment which support the need for remedial action is discussed below, followed by a summary of the ecological risk assessment (addressing impacts on the environment and ecological receptors).

1. Human Health Risk Assessment

a. Hazard Identification

The 1992 Nyanza OU3 Remedial Investigation (RI) report identified a number of Site-related contaminants, including volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and metals (including mercury) detected at the Nyanza Site. These contaminants were evaluated in the human health risk assessment due to their toxicity, concentration, frequency of detection, mobility and/or persistence in the environment. A discussion of these other contaminants can be found in Section 6.0 of the 1992 RI report for Nyanza OU3. This 1992 RI report concluded that mercury in the river presented an unacceptable risk to human health. Other contaminants did not present an unacceptable risk to humans.[4] Subsequently, a Supplemental Baseline Human Health Risk Assessment (1999) (SBHHRA) determined that mercury in the river presented an unacceptable risk only through fish consumption; recreational uses of the river and even use of river water for drinking water did not present unacceptable risks to human health, as discussed more fully in the next part. More comprehensive samples of mercury in fish tissue were taken between 2003 and 2006, resulting in the issuance of a Human Health

[4] Specifically the 1992 RI showed that: (a) Cancer risk estimates for direct exposure to river sediment did not exceed 1.3×10^{-4}. The principal contaminants contributing to this risk are not related to the Site. There was no excess cancer risk from Nyanza contaminants in sediment. (b) EPA's acceptable risk range for carcinogenic risk was not exceeded for any of the surface water exposure scenarios, and (c) Cancer risks estimated for the fish ingestion scenarios range up to 5.5×10^{-3}. The principal contaminants of concern contributing to these risks are arsenic, several pesticides and PCBs, which are not Site-related contaminants. There was no excess cancer risk from Nyanza contaminants for this scenario. Tables from the 1992 RI summarizing carcinogenic risks are included as a separate appendix to this ROD, Appendix C.

Risk Assessment (HHRA). Unlike the 1992 RI and the 1999 SBHHRA, this 2006 HHRA focused solely on OU4.

Sampling results of mercury concentrations in fish tissue from the 2006 HHRA are summarized in the table below. This table contains the exposure point concentrations used to evaluate the reasonable maximum exposure scenario (RME) in the baseline risk assessment for the chemicals of concern. Estimates of average or central tendency exposure concentrations for the chemicals of concern and all chemicals of potential concern can be found in Section 4.4 of the 2006 HHRA. Exposure Point Concentrations (EPCs) were calculated for each of three distinct species of fish that are known to exist in the river and that are believed to be capable of being used as a food source. There is a state fishing size limit that prohibits taking large-mouth bass smaller than 12 inches; the EPC was calculated using only bass of this size or greater. The EPCs were determined using EPA's Pro UCL statistical software, based on the data distribution of individual species. For the evaluation of human health risk in a given reach, the species-specific EPCs for the reach were then averaged to produce a single average EPC for the reach.

Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations

Scenario Timeframe: Current/Future
Medium: Fish Tissue
Exposure Medium: Fillet Fish Tissue (Skin On)

Exposure Point	Chemical of Concern	Concentration Detected		Unit	Frequency of Detection	Exposure Point Concentration	EPC Unit	Statistical Measure
		Min	Max					
Reach 1	Total mercury	0.30	0.85	mg/kg	N/A	0.52	mg/kg	N/A
Reach 2		0.19	1.50	mg/kg	N/A	0.83	mg/kg	N/A
Reach 3		0.20	1.76	mg/kg	N/A	0.94	mg/kg	N/A
Reach 4		0.10	0.91	mg/kg	N/A	0.58	mg/kg	N/A
Reach 5		0.12	0.82	mg/kg	N/A	0.46	mg/kg	N/A
Reach 6		0.12	1.09	mg/kg	N/A	0.60	mg/kg	N/A
Reach 7		0.15	1.05	mg/kg	N/A	0.50	mg/kg	N/A
Reach 7 – Heard Pond		0.02	0.25	mg/kg	N/A	0.12	mg/kg	N/A
Reach 8		0.09	1.66	mg/kg	N/A	0.69	mg/kg	N/A
Reach 9		0.18	1.83	mg/kg	N/A	0.69	mg/kg	N/A
Reach 10		0.09	1.66	mg/kg	N/A	0.72	mg/kg	N/A
Charles River		0.12	0.56	mg/kg	N/A	0.35	mg/kg	N/A
Sudbury Reservoir		0.07	0.62	mg/kg	N/A	0.25	mg/kg	N/A

Note: The table presents total mercury and exposure point concentrations for mercury in fish. These concentrations are used to estimate the exposure and risk from the consumption of mercury-contaminated fish. The table includes the range of concentrations detected for mercury in different fish species collected for the study (i.e., bullhead, largemouth bass, and yellow perch). The minimum concentration for each reach is the detected minimum concentration among all species collected within that reach and the maximum concentration is the detected maximum concentration among all species collected within that reach. Therefore, it is not applicable (N/A) to present the frequency of detection in the table because the frequency is different for each species. The exposure point concentration (EPC) is developed for each species per reach, using different statistical rationales, such as maximum concentrations and statistical tests, depending on the data distribution. These species-specific EPCs are then aggregated and the average concentration per reach is the EPC used to quantify risks. Therefore, it is also not appropriate to present the statistical measure used for each reach because it varies per reach and the EPCs are combined-fish EPCs, not species-specific.

b. Exposure Assessment

The 1992 RI included an evaluation of current and future exposures to mercury for the following receptors:

- recreational users -- those who may accidentally ingest and/or have dermal contact with contaminated surface water and sediment while wading, boating, hiking, and swimming;
- sports and subsistence anglers -- those who may consume contaminated fish; and
- residents living along the Sudbury River -- those who may accidentally ingest and have dermal contact with sediment (see Table 6-8 of the 1992 RI Report).

The 1999 SBHHRA included an evaluation of current and future exposures to mercury for a "recreational" angler and for ethnic and subsistence anglers. The SBHHRA also included a semi-quantitative discussion of the exposures for future residents -- those who may ingest surface water if the river were to be used as a potable water source in the future (see Section 3.2 and Table 3-1 of the 1999 SBHHRA). At the time of the SBHHRA, the river was designated as an emergency backup water supply, but is so no longer. Both the 1992 RI and the 1999 SBHHRA concluded that the only exposures from the river that presented an unacceptable risk were catching and eating contaminated fish – i.e., the recreational, ethnic and subsistence angler scenarios.

The 2006 HHRA focused on evaluating the current and future exposures from the consumption of mercury-contaminated fish by the following types of fish consumers: recreational anglers, subsistence anglers, and ethnic anglers. Subsistence anglers are assumed to eat fish more often and are assumed to get all or most of their dietary protein from the affected resource. Ethnic anglers differ from subsistence anglers in that they are assumed to consume the whole fish. This assessment was conducted with the assumption that the fish caught from the river were consumed by these receptors despite a fish advisory which has been posted throughout the river system. In the FS, the subsistence fishing scenarios (inclusive of the ethnic fishing scenario) were eliminated from consideration, because there was no data (anecdotes aside) indicating the likelihood of subsistence fishing on the Sudbury River.

Recreational anglers are thus the only receptors of concern for the Site. Due to the lack of Site-specific information on fish consumption rates and patterns, the quantity of fish consumed by a recreational angler at the Sudbury River was determined based on a creel survey of the consumption of fish caught by recreational anglers in Maine, the Maine Angler Survey (Ebert et al., 1993). Using this survey, EPA developed certain assumptions about the reasonable maximum exposure ("RME") to adults and children fishing in different parts of the Sudbury River. These RME assumptions were as follows:

- The RME for an *adult* fishing in *standing* parts of the river (i.e., Reaches 2, 3, 4, 6, 7/Heard Pond, 9 and the Sudbury Reservoir) is 18 grams of fish fillet per day.[5] At 8

[5] In 2008, EPA updated its risk calculation for Reaches 2 and 9 (see EPA's Technical Memorandum dated October 2008). Reaches 2 and 9 are standing waters in certain places, and flowing waters in others. The Maine

ounces of fillet per meal, this works out to about 28 fish meals per year.[6] Half of this quantity of fish (9 grams/day, 14 meals per year) is assumed to come from the Sudbury River, with the other half coming from other sources of fish.

- The RME for an *adult* fishing in *flowing* parts of the river (i.e., Reaches 1, 5, 7, 8, 10 and the Charles River) is 14 grams of fish fillet per day. At 8 ounces of fillet per meal, this works out to about 22 fish meals per year. Half of this quantity of fish (7 grams/day, 11 meals per year) is assumed to come from the Sudbury River, with the other half coming from other sources of fish.
- The RME for a *child* fishing in *standing* parts of the river (i.e., Reaches 2, 3, 4, 6, 7/Heard Pond, 9 and the Sudbury Reservoir) is 6.9 grams of fish fillet per day. At 4 ounces of filet per meal, this works out to about 21 fish meals per year. Half of this quantity of fish (3.5 grams/day, 10.5 meals per year) is assumed to come from the Sudbury River, with the other half coming from other sources of fish.
- The RME for a *child* fishing in *flowing* parts of the river (i.e., Reaches 1, 5, 7, 8, 10 and the Charles River) is 6.1 grams of fish fillet per day. At 4 ounces of filet per meal, this works out to about 19 fish meals per year. Half of this quantity of fish (3.1 grams/day, 9.5 meals per year) is assumed to come from the Sudbury River, with the other half coming from other sources of fish.

Section 4.5 and Table 4-26 of the 2006 HHRA provide a more thorough description of all exposure assumptions used to evaluate risks for recreational anglers in both the average and reasonable maximum exposure scenarios.

c. <u>Toxicity Assessment</u>
Mercury was the only contaminant of concern identified in the prior assessments. As mentioned in Section E.2 above, methylmercury in fish generally comprises 90-99 percent of the total body burden of mercury in fish. For the 2006 HHRA, it was assumed that all mercury measured in fish was in the form of methylmercury. Therefore, methylmercury toxicity values were applied to quantify risks from exposures to mercury in fish from the Sudbury River.

Although methylmercury is classified by EPA as a possible human carcinogen, EPA has not developed a cancer toxicity value for methylmercury due to inadequate data for humans and limited evidence of carcinogenicity in animals. Thus, EPA has assumed that the only unacceptable risks from mercury in OU4 are attributable to non-cancer health effects.

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creel survey shows different ingestion rates depending on whether fish are from flowing or standing waters. In the 2006 HHRA, EPA assumed the ingestion rate for Reaches 2 and 9 was the *sum* of the ingestion rates for standing and flowing waters (or 32 grams/day). However, in a 2008 Technical Memorandum, EPA determined that this method was overly conservative and recalculated the risk within these reaches using the higher of the two ingestion rates, rather than the sum – i.e., EPA used the standing waters ingestion rate of 18 grams/day.

[6] The feasibility study stated that the RME for the whole river for both children and adults was based on an assumption of 25 fish meals per year from the Sudbury River. The methodology used in EPA's risk assessments is described more fully and accurately above.

In assessing the potential for non-carcinogenic adverse effects, it is EPA policy to assume that a safe exposure level exists, which is described by the reference dose (RfD) for the ingestion pathway. RfDs have been developed by EPA as estimates of a daily exposure that is likely to be without an appreciable risk of an adverse health effect when exposure occurs over the duration of a lifetime. In other words, RfDs represent a level to which an individual may be exposed that is not expected to result in any deleterious effect. RfDs are derived from epidemiological and/or animal studies and incorporate uncertainty factors to help ensure that adverse health effects will not occur. The RfDs relevant to this Site are presented in the table below. More discussion on the toxicity assessment for mercury can be found in Section 3 and Appendix A of the 2006 HHRA.

Non-Cancer Toxicity Data Summary						
Chemical of Concern	**Chronic/ Subchronic**	**Oral RfD Value**	**Oral RfD Unit**	**Primary Target Organ**	**Sources of RfD**	**Dates RfD Searched**
Mercury	Chronic	1.0×10^{-4}	mg/kg-day	Developmental/ Neuropsychological Impairment	IRIS	2010

d. <u>Risk Characterization</u>
The risk characterization combines the exposure estimate with the toxicity information to estimate the probability or potential that adverse health effects may occur if no action were to be taken at a site. The potential for adverse non-cancer effects is described in terms of what is thought to be a safe exposure level.

In assessing the potential for adverse non-carcinogenic effects, a hazard quotient (HQ) is calculated by dividing the daily intake level by the reference dose (RfD), reference concentration (RfC) or other suitable benchmark. A HQ ≤ 1 indicates that a receptor's exposure to a single contaminant is less than the safe value (RfD in this case) and that toxic non-carcinogenic effects from that chemical are unlikely. Conversely, a HQ >1 indicates that adverse effects as a result of exposure to the contaminant are possible. To account for additive effects resulting from exposure to more than one compound, a Hazard Index (HI) is generated by adding the HQs for all chemicals of concern that affect the same target organ (e.g., liver, nervous system) within or across those media to which the same individual may reasonably be exposed. However, in this case there is only one contaminant, so the HI and the HQ will be identical. Generally, EPA views HI values based on site-related exposure in excess of unity (1) as unacceptable. It should be noted that the magnitude of the HQ or HI is not proportional to the likelihood that an adverse effect will be observed.

The 2006 HHRA evaluated the likelihood of adverse health effects occurring from exposure to mercury in fish caught and consumed from the Sudbury River for a recreational angler, the only receptor potentially subject to an unacceptable risk. The table below depicts the non-carcinogenic hazard quotient (HQ) summary for mercury in fish evaluated to reflect present and potential future recreational anglers (both child and adult) consuming fish caught from the Sudbury River in quantities corresponding to the reasonable maximum exposure (RME) scenario. Section 5 along with Tables 5-11 and 5-12 of the 2006 HHRA provide a more comprehensive risk summary of all exposure receptors evaluated for mercury in fish and the risk estimates for the central tendency exposure scenario.

Risk Characterization Summary – Non-Carcinogens						
Scenario Timeframe: Current/Future **Receptor Population:** Recreational Angler **Receptor Age:** Child/Adult **Exposure Pathway:** Fish Ingestion						
Medium	**Exposure Medium**	**Exposure Point**	**Chemical of Concern**	**Primary Target Organ**	**Non-Carcinogenic Hazard Quotient**	
					Child	**Adult**
Fish Tissue	Fillet Fish Tissue (Skin On)	Reach 2	Mercury	Developmental (Nervous System)	**1.8**	1.0
		Reach 3			**2.1**	**1.2**
		Reach 4			**1.3**	0.7
		Reach 5			0.9	0.4
		Reach 6			**1.3**	0.7
		Reach 7			1.0	0.5
		R7–Heard P.			0.3	0.1
		Reach 8			**1.3**	0.7
		Reach 9			**1.5**	0.9
		Reach 10			**1.4**	0.7
Risk Characterization						
This table provides hazard quotients (HQs) for the fish ingestion route of exposure, the only exposure pathway of concern for current and future recreational angler receptors (child and adult). The Risk Assessment Guidance (RAGS) for Superfund states that, generally, a hazard quotient greater than 1 indicates the potential for adverse non-carcinogenic health effects.						

Section 6 of the 2006 HHRA summarized uncertainties in the risk assessment. The principal assumptions/uncertainties in the estimates of health effects include the inclusion/exclusion of subsistence and ethnic anglers, the use of aggregate (combined) fish species exposure point concentrations, and the assumption that 50% of fish ingested are from the relevant portion of the Sudbury River. These and other uncertainties incorporated in the risk assessment may make the true risk of adverse health effects higher or lower than stated here.

Since the consumption of mercury-contaminated fish from the Sudbury River results in HQs exceeding 1, it was necessary to develop a fish tissue mercury concentration that could be used as a remediation goal (RG). A risk-based derivation was completed and it was determined that the fish tissue concentration of total mercury that would result in an HQ of 1 was 0.48 mg/kg. This calculation was based on the most sensitive receptor (a child recreational angler). This value was adopted as the cleanup level for fish tissue in OU4 -- except in Reach 8, which has no cleanup level and where fish are expected to remain contaminated above levels allowing for recreational consumption due to local hydrological conditions that magnify the effect of ongoing atmospheric deposition of mercury.[7] This 0.48 ppm value is slightly higher than the average background methylmercury concentration in fish, which was determined to be 0.43 mg/kg, based on fish sampling at the reference water bodies (Reach 1 of the Sudbury River and the Charles River). As discussed further below, EPA's National Recommended Water Quality Criterion (NRWQC) of 0.3 mg/kg methylmercury in fish tissue was not used as a potential cleanup level for OU4, due to its being lower than the background value.

EPA has also calculated the number of fish meals per year that the child and adult recreational anglers can consume from the Sudbury River under current conditions without unacceptable risk of adverse health effects, i.e., without resulting in an HI greater than one. These fish meal values per year were calculated using the exposure assumptions from the 2006 HHRA, including the assumption that a child's fish meal consists of 4 ounces of fish and an adult's fish meal consists of 8 ounces of fish. This is shown in the table below. The table below also shows the maximum numbers of fish meals from the Sudbury River a recreational angler can consume per year from each reach if the mercury concentration in fish is reduced to the cleanup level (i.e., 0.48 mg/kg).

[7] In the remainder of this ROD, "cleanup level" may be used without qualification or merely as a means of referring to the 0.48 ppm fish tissue concentration, but should be understood not to imply a cleanup of Reach 8.

Sudbury River Fish Meals per Year				
	Child Recreational Angler		Adult Recreational Angler	
Reach	Maximum Safe Number of Fish Meals, Current Conditions[1]	Number of Fish Meals A Recreational Angler Is Assumed To Eat From the river[2]	Maximum Safe Number of Fish Meals, Current Conditions[1]	Number of Fish Meals A Recreational Angler Is Assumed To Eat From the river[2]
Reach 2	6	10.5	14	14
Reach 3	5	10.5	12	14
Reach 4	8	10.5	19	14
Reach 6	8	10.5	19	14
Reach 8	7	9.5	16	11
Reach 9	7	10.5	16	14
Reach 10	7	9.5	16	11

Notes to Table:

1. These numbers represent the number of fish meals that can now be eaten from the Sudbury River without triggering a risk of adverse health effects (i.e., an HI less than or equal to 1.0). It is based on the most recent sampling data, from 2003-2005. EPA assumed four ounces of fish fillet per meal for children and eight ounces for adults.

2. These numbers represent the number of fish meals that a child and adult recreational anglers would be assumed to consume from the river in the absence of fish advisories. It is based on a "creel" survey of fish consumption by anglers at comparable freshwater bodies in Maine, adjusted to account for the assumption that only half of a recreational angler's annual catch comes from the Sudbury River.

It may also be useful to bear in mind that, once fish contamination is at the cleanup level, the child recreational angler will be able to eat approximately the number of fish meals shown in this column (or more accurately, an average of the standing and flowing values -- 10 fish meals per year). An adult angler, being less sensitive to mercury contamination, would be able to safely eat considerably more fish at the same contamination level – about 23 meals per year. This is because the cleanup level in fish (0.48 ppm) was calculated using the exposure assumptions for the most sensitive population – child recreational anglers.

2. Ecological Risk Assessment
This section summarizes the results of the 2008 Final Supplemental Baseline Ecological Risk Assessment (SBERA) developed for the Sudbury River.

The final SBERA evaluated the ecological risk in Reaches 2 to 10 (Reach 1 represented an upstream reference location). This evaluation included multiple receptor groups and lines of evidence, as summarized in Table G-1 (this and all ecological risk tables are presented in Appendix B). This section summarizes only the risks identified in the "primary" target areas of the Sudbury River, namely Reaches 2, 3, 4, and 8. Reach 9, identified as a "secondary" target area in the final SBERA report, is also discussed in this section because of its proximity to Reach 8. The reasons for this approach were threefold:

- The final SBERA focused mostly on the four "primary" target areas: (a) Reach 2 is where Site contamination historically entered the Sudbury River via overland flow, (b) Reaches 3 and 4 represent the first habitats on the Sudbury River below the Site where mercury-contaminated sediment particles could settle out of the water column into the substrate, and (c) Reach 8 represents a vast wetland complex highly susceptible to mercury methylation. Reach 9 is included in the discussion below because it represents a ponded area located just downstream from Reach 8.

- The potential for ecological risk in the other reaches (i.e., Reaches 5, 6, 7, and 10) was, in general, equivalent to or lower than that observed in the primary target areas.

a. Identifying Chemicals of Ecological Concern
The final SBERA report focused specifically on quantifying the potential ecological risk of mercury measured in the Sudbury River. Previous investigations over the last two decades document that mercury is the only Contaminant of Ecological Concern (COECs) to the river ecosystem. Hence this section does not follow the usual format of (a) identifying the benchmarks used to screen for COECs, (b) summarizing the COECs in each medium, (c) providing statistics for each COEC in each medium (e.g., minimum detect, maximum detect, frequency of detection, mean and 95% upper confidence limit concentrations for each COEC), (d) calculating ecological Hazard Quotients (HQs), and (e) applying the COEC flag (Yes or No).

b. Exposure Assessment
   i. Description of key species potentially exposed

Tables G-2 and G-3 list common wildlife and aquatic species which may use the Sudbury River either for part of the year or year-round. These tables are not comprehensive inventories; rather, they reflect key species that may come in direct or indirect contact with mercury in the river.

The tables also provide an overview of the communities and biological diversity found along the length of the river.

The Massachusetts Natural Heritage and Endangered Species Program (MNHESP) database was searched to see if Threatened and Endangered (T&E) species, or rare plant, animals or communities may be present in the Sudbury River watershed. Table G-4 presents the results of this search. The review identified six species of "special concern": Blue-spotted salamander, Eastern box turtle, Common moorhen, Hessel's hairstreak (a butterfly), Umber shadowdragon (a dragonfly), and River bullrush (a plant). The review also identified four threatened species: Blanding's turtle, Clubtail dragonfly, Long's bulrush (a plant), and Britton's violet (a plant). There were also three endangered species: American bittern, Least bittern, and Pied-billed grebe (all bird species). The Blue-spotted salamander and Eastern box turtle are both predominantly upland species, and there are no complete exposure pathways for these species because mercury in the Sudbury system was transported in surface water. Currently there are no viable methods for evaluating ecological risk specifically for butterfly or dragonfly species. Similarly, there is little toxicological information available for evaluating risks to retiles such as the Blandings Turtle. Plants generally have extremely low uptake of mercury and were therefore not considered in the SBERA. The bird species (Common Moorhen, Bitterns, and Pied-billed Grebes) were represented through various measurement endpoints, including modeled and measured risk to the Belted Kingfisher, Hooded Merganser, Wood Duck, and Great Blue Heron. No actionable risk was identified for these surrogate species.

The US Fish and Wildlife (FWS) "Federally Listed Endangered and Threatened (T&E) Species in Massachusetts" was also reviewed. Only three of the 14 FWS T&E species listed for Massachusetts could be present in counties within the study area, namely the eastern cougar (*Felis concolor couguar*), bald eagle (*Haliaeetus leucocephalus*), and small-whorled pogonia (*Isotria medeoloides*). The cougar is an historic resident of the entire state and is listed as endangered but is not known to live near the river. The bald eagle is delisted as a FWS T&E species, but is still protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Worcester County, among others, is listed as part of the eagle's distribution area. Reach 1, located upstream of the Site, is the only portion of the Sudbury River in Worcester County. Lastly, the small whorled pogonia (an orchid) is listed as threatened by FWS and includes Middlesex and Worcester counties in its distribution area. It is unlikely that this species would be found in the study areas because it occurs only in upland sites (USFWS, 2001), and there is no reasonable exposure pathway for mercury from Nyanza to have moved into upland soils.

Appendices B and C of the final SBERA report give the documentation provided by the MNHESP and USFWS, respectively.

ii. Complete exposure pathways

The following receptors of concern present in the Sudbury River were evaluated in the final

SBERA:

- The benthic invertebrate community
- The fish community
- Birds (specifically, insectivores and piscivores)
- Mammals (specifically, piscivores)

A complete exposure pathway exists when contamination (in this case mercury) can move from an abiotic matrix (e.g., sediment or surface water) to a receptor, either via direct exposure to the abiotic matrix or indirectly via ingestion of contaminated food. The final SBERA collected sediment samples from reaches 2 through 10, but surface water samples only from Reaches 2, 3, 4, 5, 7, and 8. The SBERA further quantified exposure to mercury by collecting and analyzing tissue samples from whole fish, whole crayfish, birds, and mammals from various reaches on the Sudbury River, as follows:

- Sunfish, bullheads, yellow perch, and largemouth bass of different sizes were collected from all nine reaches of the Sudbury River, plus at reference locations.
- Crayfish (species not specified) were collected from Reaches 2, 3, 4, 5, 6, and 7, plus at reference locations. The remaining reaches of the Sudbury River were also sampled but did not yield crayfish.
- Tree swallows were sampled for eggs, blood (nestlings and/or adults, depending on availability), and feathers (nestlings and/or adults, depending on availability) in 2003 and 2004 from Reaches 3, 4, 7, and 8, plus at reference locations. The other reaches of the Sudbury River were not sampled for tree swallows.
- Other bird species were also sampled between 2003 and 2005, mainly from Reaches 7 and 8 (plus at reference locations) for eggs (eastern kingbirds, wood ducks, belted kingfisher, and hooded mergansers) and/or blood and feathers (red wing black birds, common yellow throats, northern water thrushes, song sparrows, swamp sparrows, yellow warblers, wood ducks, hooded mergansers, and belted kingfishers).
- Mink were sampled for blood and fur from Reaches 3, 4, 5, and 7. Only a single animal was captured in Reaches 3, 4, and 7. Traps were set in other reaches of the Sudbury River and at reference locations but did not capture mink.

iii. <u>Exposure Point Concentrations (EPCs)</u>

Site-specific exposures were measured by collecting surface water and sediment samples, plus tissues from fish, crayfish, birds, and mammals from the various reaches in the Sudbury River (as described above) and analyzing all of these samples for mercury. Exposure was further quantified for target wildlife receptors using food chain modeling to calculate Total Daily Intakes (TDIs) using Site-derived tissue residues for emergent insects and Site-specific tissue residues measured in crayfish and in fish of different size classes.

The final SBERA summarized and presented the sediment, surface water, and tissue mercury EPCs for all the Sudbury River reaches and the reference locations. The EPCs were provided as Reasonable Maximum Exposures (RMEs) and Central Tendency Exposures (CTEs). The RMEs were calculated either as the maximum detected value or the 95% Upper Confidence Limit (UCL) of the mean, depending on the data set. The CTEs were calculated as the arithmetic means. It should be noted that this subsection of the ROD presents only a subset of the EPCs in order to streamline the presentation and focus the discussion on the major exposure pathways, ecological receptors, and tissue types used in the decisions-making process. Those key exposure pathways and receptors were as follows:

- Sediment
- Surface water
- Benthic invertebrates (specifically, crayfish)
- Fish tissue residues for use in wildlife food chain modeling:
  - size class "A" fish (all species combined): > 5 cm - ≤ 10 cm;
  - size class "B" fish (all species combined): 10 cm - ≤ 15 cm;
  - size class "C" fish (all species combined): 15 cm - ≤ 20 cm;
  - size class "D" fish (all species combined): ≥ 20 cm.
- Fish tissue residues for comparison to fish Critical Body Residues (CBRs):
  - size class "D" largemouth bass (all size classes)
  - size class "D" yellow perch: ≥ 20 cm.
- Tree swallow tissue residues (nestling and/or adults, depending on availability)
- Belted kingfisher tissue residues (nestling and/or adults, depending on availability)
- Red wing blackbird tissue residues (yearlings and/or adults, depending on availability)
- Mink tissue residues (post-weaned individuals, depending on availability)

The EPCs discussed here focus specifically on the five target areas discussed above (namely Reaches 2, 3, 4, 8, and 9) and specific receptors. The final SBERA report should be consulted to obtain information related to the other reaches and receptors.

The EPC tables are as follows: sediment (Table G-5), surface water (Table G-6), emergent insects (Table G-7), crayfish (Table G-8), size class "A" fish (Table G-9), size class "B" fish (Table G-10), size class "C" fish (Table G-11), size class "D" fish (Table G-12), Size class "D" largemouth bass and size class "D" yellow perch (Table G-13), tree swallow tissues collected in 2003 (Table G-14), tree swallow tissue collected in 2004 (Table G-15), belted kingfisher tissues (Table G-16), red wing blackbird tissues (Table G-17), hooded merganser tissues collected in 2004 data (Table G-18), hooded merganser tissues collected in 2005 (Table G-19), mink tissues (Table G-20), and the TDIs derived from food-chain modeling (Table G-21).

iv. <u>Monitoring or modeling data and assumptions for characterizing EPCs</u>

Table G-22 summarizes the input parameters for the target wildlife receptors. These parameters were used to calculate a total daily intake (TDI) for mercury based on ingestion of sediment, surface water, and food items.

- Tree swallows were assumed to feed exclusively on emergent insects in each of the primary target areas of the Sudbury River. Although mercury tissue residues were available for mayfly and dragonfly larvae collected during earlier Site investigation studies, these values were deemed too old for use in food chain modeling. Instead, the emergent insects' mercury EPCs were estimated using a regression equation derived from a laboratory study using *Hexagenia* nymphs exposed to Sudbury River sediment. Emergent insect concentrations were calculated for each sediment sample. Individual concentrations, as well as the summary statistics by reach, are presented in Appendix G of the final SBERA report.

- Belted kingfishers were assumed to feed on crayfish (for reaches in which crayfish were successfully collected) and fish (size class A and B) exclusively. The crayfish and fish mercury EPCs were calculated based on mercury levels measured in field-collected organisms.

- Mink were assumed to feed on crayfish (if collected from a reach) and fish (size classes A, B, C, and D) exclusively within each Sudbury River reach. The crayfish and fish mercury EPCs were calculated based on mercury levels measured in field-collected organisms.

The following deterministic exposure model was used to calculate the TDI for the target wildlife receptors:

$$TDI = FT \times \left[\left(FIR \times \sum_{i=1}^{n} C_i \times P_i \right) + SIR \times C_{sed} + WIR \times C_w \right]$$

Where:

TDI	=	Total daily intake (mg/kg BW-day)
FT	=	Foraging time in the exposure area (unitless)
FIR	=	food intake rate normalized for body weight (kg WW/kg BW-day)
C_i	=	Mercury concentration in the i^{th} prey item (mg/kg WW)
P_i	=	Proportion of the i^{th} prey item in the diet (unitless)
SIR	=	Sediment ingestion rate normalized for body weight (kg DW/kg BW-day)
C_{sed}	=	Mercury concentration in sediment (mg/kg DW)
WIR	=	Water ingestion rate normalized for body weight (L/kg BW-day)
C_w	=	Mercury concentration in water (mg/L; converted from ng/L by dividing by 1E+06)

c. Ecological Effects Assessment

i. Summary of toxicity tests

A. *Hexagenia* mayfly bioaccumulation studies

The USGS performed 21-day sediment toxicity and bioaccumulation studies using *Hexagenia*, a genus of burrowing mayfly. Fine-grained sediments were collected from the top 4 to 6 cm in several river reaches. Appendix N of the final SLERA report presents the experimental procedure in detail. Mayfly survival as well as their mercury concentration for food-chain effects was the endpoints of interest. Total mercury concentrations and methylmercury levels in sediment, water, and mayflies were determined after 21 days of exposure. These data were analyzed statistically to detect if the responses differed significantly among the sampling locations. A regression equation quantifying the relationship between mercury in sediment and mayflies was then developed to estimate mercury levels in mayflies based on sediment mercury levels measured in untested reaches of the Sudbury River. These estimated mayfly residue data supported the tree swallow food chain modeling effort.

B. Eastern mussel (*elliptio complanata*) bioaccumulation study

NOAA conducted an *in-situ* bioaccumulation study using caged freshwater mussels deployed in several reaches of the Sudbury River. Appendix O of the final SBERA report presents the experimental procedure in detail.

Survival, shell length, shell width, shell height, and whole animal wet weight were measured before deployment, after 42 days, and after 84 days (end of test). Mussel tissue and sediment samples were analyzed for total mercury. These data were analyzed statistically to detect if the responses observed in the mussels differed significantly among the sampling locations or were related to mercury levels.

ii. Mercury benchmarks, Critical Body Residues, and Toxicity Reference Values

A. Surface water mercury benchmarks

EPA promulgated a chronic surface water benchmark of 1,400 ng mercury/L and an acute surface water benchmark of 770 ng/L for dissolved mercury. These criteria were derived from inorganic mercury data, but applied to total mercury. (Total mercury refers to the sum of all mercury species, including methylmercury.) The criteria were converted from a dissolved value to a total value for comparison against Site-specific data because the concentration data were analyzed and reported as recoverable total mercury instead of dissolved total mercury. The following equation was used for this conversion:

$$\text{Total Recoverable Criterion} = \frac{\text{CMC or CCC}}{0.85}$$

As such, the chronic and acute benchmarks used to evaluate total mercury in surface water were 1,600 ng/L and 910 ng/L, respectively

B. Sediment mercury benchmarks

The potential effects to benthic invertebrates exposed to mercury in sediment were evaluated by comparing total mercury levels in sediment to consensus-based values, namely the Threshold Effect Concentration (TEC) (0.18 mg/kg DW) and the Probable Effect Concentration (PEC) (1.06 mg/kg DW). These two benchmarks were compared to Site-specific sediment mercury levels to bracket potential risk to benthic organisms exposed to mercury in the Sudbury River.

C. Critical body residues (CBRs)

An extensive literature review was conducted to (a) create a database quantifying the relationship between, on the one hand, measured mercury levels in crayfish, whole body fish or fish muscle, bird eggs, bird blood, feathers, mammal blood, and fur, and, on the other hand, toxicological responses in crayfish, fish, birds and mammals, and (b) identify potential effects to birds and mammals exposed to mercury via ingestion (see Appendices H through J in the final SBERA report). Preference was given to studies that measured the effects of mercury exposures on reproduction, survival, behavior, and/or growth. Table G-23 summarizes the no effect and effect CBRs used in the final SBERA.

D. Toxicity Reference Values (TRVs)

An extensive literature review was conducted to create a database quantifying the relationship between daily mercury ingestion by birds and mammals and toxicological responses in terms of survival, growth, behavior, or reproduction (see Appendix J in the final SBERA report).

A no-effect dose of 0.047 mg MeHg (methlymecury)/kg body weight (BW)-day and an effect dose of 0.093 mg MeHg/kg BW-day were calculated as the generic bird TRVs, whereas a no-effect dose of 0.014 mg MeHg/kg BW-day and an effect dose of 0.035 mg MeHg/kg BW-day were calculated as the generic mammal TRVs, based on the available information. The bird TRVs were non-species specific. The mammal TRVs, however, were based on a mink reproductive study and were therefore specific for this targeted species.

E. Assessment and measurement endpoints

Risk assessors must understand how site-related contamination links to ecological endpoints to ensure well-informed risk management decisions. A key step in an ERA is deciding which aspects of the environment to evaluate, since only a small subset of organisms or ecosystem features can be studied.

Endpoints are ecological characteristics that may be adversely affected by site contaminants. The final SBERA used two types of endpoints. Assessment endpoints are explicit expressions of environmental values to be protected, such as a species of specific concern (e.g., a T&E species), a functional group of species (e.g., piscivorous mammals), a community (e.g., benthic invertebrates), a unique ecosystem (e.g., a wetland), or other entities of concern. Assessment endpoints help evaluate the site and the extent of contamination, establish a basis to assess the potential risks to identified receptors, and help identify the ecological structure and function at the site.

A measurement endpoint represents a measurable ecological characteristic (such as mercury levels in bird eggs) that is related to its assessment endpoint (such the ability to reproduce and sustain a healthy population). Measurement endpoints link the conditions existing on-site to the goals established by the assessment endpoints by integrating modeled, literature, field, or laboratory data. Whenever possible, the final SBERA selected more than one measurement endpoint for each assessment endpoint to provide multiple lines of evidence for the evaluation.

Table G-24 summarizes the assessment endpoints and measurement endpoints evaluated by the final SBERA to quantify the potential impacts of mercury on the Sudbury River.

d. <u>Ecological risk characterization</u>

i. Introduction

HQs were developed to determine potential impacts to target receptors from exposure to mercury-contaminated surface water, sediment, and prey items, or from the presence of mercury in different types of tissues collected from birds and mammals. This approach allows for a standardized interpretation because an HQ reflects the magnitude by which the mercury concentration is above or below the benchmark, CBR, or TRV. Some potential for risk is assumed possible if an HQ exceeds 1.0.

The SBERA calculated HQs as follows:

$$HQ = EEL/TV$$

Where:

HQ	=	hazard quotient (unitless)
EEL	=	estimated exposure level (for aquatic communities: sediment or surface water mercury levels in units of µg or mg/kg or ng/L; for wildlife receptors: mercury dose in units of mg/kg body weight-day)
TV	=	toxicity value (sediment or surface water mercury benchmark in µg or mg/kg or ng/L; mercury CBRs in µg or mg/kg wet weight or fresh weight tissue; or mercury TRVs in mg/kg BW-day)

Specifically, HQs were calculated by comparing the following data sets to their respective mercury toxicity values:

- Reach-specific reasonable maximum exposure (RME) and central tendency exposure (CTE) mercury levels in surface water compared to federal acute and chronic mercury freshwater benchmarks.

- Reach-specific RME and CTE mercury levels in sediment compared to published no effect and effect mercury sediment benchmarks.
- Reach-specific RME and CTE mercury levels in field-collected crayfish compared to literature-derived no effect and effect mercury CBRs for crayfish.
- Reach-specific RME and CTE mercury levels in field-collected fish, classified by size class, compared to literature-derived no effect and effect mercury CBRs for fish.
- Reach-specific RME and CTE mercury levels in field-collected tissues of birds (eggs, blood, and/or feathers) and mammals (blood and fur) compared to literature-derived no effect and effect mercury CBRs for birds and mammals.
- Reach-specific modeled RME and CTE mercury exposure doses in birds and mammals compared to literature-derived mercury TRVs for birds and mammals.

The mayfly and freshwater mussel tests from the mid-1990's did not lend themselves to an HQ analysis. Instead, the results from on-site samples were compared statistically to their respective reference locations to determine the significance of an observed response.

A Weight-of-Evidence (WOE) approach was used to evaluate how well the measurement endpoints (e.g., mercury in bird eggs) represented their assessment endpoints (e.g., bird reproduction). This analysis integrated all the SBERA findings to help determine the potential for risk by: 1) assigning a confidence level ("low", "moderate" or "high") to all the measurement endpoints; 2) evaluating the magnitude of risk with respect to each measurement endpoint (e.g., the magnitude of an HQ, where applicable); and 3) determining the agreement among the multiple measurement endpoints used for a given assessment endpoint. Using this approach allows the SBERA to give greater weight to Site-specific endpoints such as measured toxicity to benthic organisms, than to generic literature-based endpoints such as comparison of sediment mercury concentrations with sediment benchmarks.

The table below shows six risk categories used in the SBERA, each based on a different line of evidence, to illustrate how risk findings are evaluated both in terms of magnitude and in terms of how much confidence can be placed in the underlying evidence. Risk categories are also ranked as to whether they are based on maximum or higher-end exposure values (i.e., RME case) or mean exposure values (i.e., CTE Case) although typically more emphasis is placed on the RME. As an example, risk indicated by a measurement endpoint -- such as measured mercury in blood from birds -- would be given greater weight than an exposure estimate from food chain modeling and non-Site-specific literature values. The possible outcomes of each evaluation are summarized below. Risk Category 1 is the category least likely to result in substantial or "population-level" risk and conversely Risk Category 6 has the greatest likelihood of substantial risk.

Risk Category	RME case	CTE case	Population Risk?	Confidence Level
1	N≤1 & L≤1	N≤1 & L≤1	unlikely	high
2	N>1 & L≤1	N≤1 & L≤1	unlikely	moderate
3	N>1 & L>1	N≤1 & L≤1	possible	low
4	N>1 & L≤1	N>1 & L≤1	possible	low/moderate
5	N>1 & L>1	N>1 & L≤1	possible	moderate
6	N>1 & L>1	N>1 & L>1	possible	high

"N" represents an HQ obtained by dividing a RME or CTE by a no-effect toxicity value (or the acute surface water benchmark), whereas "L" is an HQ obtained by dividing an RME or CTE by an (Lowest) effect toxicity value (or the chronic surface water benchmark). In the Population Risk column, "unlikely" indicates that population-level effects are unlikely to the receptors represented by the measurement endpoint; "possible" indicates a potential for adverse population-level effects to the receptors represented by the measurement endpoint. The right-hand column in the matrix above describes the level of confidence assigned to each finding depending on the number and magnitude of HQ exceedances. Endpoint-specific risk matrices are presented in Tables 4-17 through 4-45 of the final SBERA report.

Tables G-25 to G-29 summarize the ecological risks for selected receptors in reaches 2, 3, 4, 8, and 9, and their respective reference locations. Note that these tables show only (a) the selected receptors for which data were available from a target reach (i.e., the selected receptor was omitted if it lacked data), and (b) the low effect-based, or "L"-based, HQs. The "N"-based HQs derived from the no effect-based toxicity values are not shown so as to streamline the risk summary process and acknowledge that risk management decisions were generally based on the low effect-based HQs. Chapter 4, and Table 4-61 (Reach 2), Table 4-62 (Reach 3), Table 4-63 (Reach 4), Table 4-68 (Reach 8), and Table 4-69 (Reach 9) in the final SBERA report summarize the full risk characterization for these five target reaches.

In addition, the table below summarizes the endpoints showing the most significant risks. Most of these risks are discussed in the remainder of this section.[8]

[8] A few of these endpoints (e.g., the mink endpoints) are *not* discussed in the remainder of this section. In those cases, there was a great weight of evidence in the other 200+ endpoints indicating that the endpoint suggesting higher risk was an outlier.

Sudbury River Reach[a]	Media	Hazard Quotients				Incremental Risk[b]	
		Site		Reference			
		Effect RME	Effect CTE	Effect RME	Effect CTE	Effect RME	Effect CTE
Benthic Invertebrates							
Reach 2	sediment	**9.1**	**1.9**	**3.0**	0.8	**6.1**	**1.1**
Reach 3	sediment	**42.3**	**14.1**	0.4	0.2	**42.0**	**14.0**
Reach 4	sediment	**14.7**	**6.2**	0.4	0.2	**14.3**	**6.0**
Reach 5	sediment	**3.0**	1.0	**3.0**	0.8	<1	<1
Reach 6	sediment	**9.2**	**2.4**	0.4	0.2	**8.8**	**2.2**
Reach 7	sediment	**1.5**	0.3	**3.0**	0.8	<1	<1
Reach 7-Heard Pond	sediment	**2.8**	**2.4**	0.4	0.2	**2.5**	**2.2**
Reach 8	sediment	**1.1**	0.4	0.3	0.2	<1	<1
Reach 9	sediment	**1.8**	**1.1**	0.3	0.2	**1.5**	<1
Reach 10	sediment	**1.4**	0.5	**3.0**	0.8	<1	<1
Tree Swallows							
Reach 2	food chain modeling	**3.7**	**1.5**	**2.2**	0.7	**1.5**	<1
Reach 3	food chain modeling	**12.2**	**9.7**	0.4	0.3	**11.8**	**9.4**
Reach 4	food chain modeling	**6.0**	**4.3**	0.4	0.3	**5.6**	**4.0**
Reach 5	food chain modeling	**1.1**	0.8	**2.2**	0.7	<1	<1
Reach 6	food chain modeling	**3.1**	**1.8**	0.4	0.3	**2.7**	**1.5**
Reach 7-Heard Pond	food chain modeling	**2.0**	**1.8**	0.4	0.3	**1.7**	**1.5**
Reach 7-Heard Pond	adult blood-2004	**1.0**	0.5	**NA**	**NA**	**1.0**	< 1
Reach 8	adult blood-2004	**1.0**	0.6	0.4	0.3	<1	<1
Reach 9	food chain modeling	**1.1**	0.9	0.4	0.3	<1	<1
Belted Kingfisher							
Reach 2	food chain modeling	**1.2**	**1.0**	0.8	0.6	<1	<1
Reach 3	food chain modeling	**1.2**	**1.1**	0.2	0.2	**1.0**	<1
Reach 4	food chain modeling	**1.0**	0.9	0.2	0.2	<1	<1
Reach 5	food chain modeling	**1.1**	**1.1**	0.7	0.6	<1	<1
Reach 7	food chain modeling	**1.1**	0.9	0.7	0.6	<1	<1
Reach 8	food chain	**1.2**	**1.1**	0.7	0.6	<1	<1

Sudbury River Reach[a]	Media	Hazard Quotients				Incremental Risk[b]	
		Site		Reference			
		Effect RME	Effect CTE	Effect RME	Effect CTE	Effect RME	Effect CTE
	modeling						
Reach 8 - Transfer St. Pit	adult feather	**1.4**	**1.4**	0.8	0.8	<1	<1
Reach 8 - Route 117 Pit	adult feather	**1.2**	0.8	0.8	0.8	<1	<1
Reach 9	food chain modeling	**1.2**	**1.1**	0.7	0.6	<1	<1
Reach 10	food chain modeling	**1.4**	**1.3**	0.7	0.6	<1	<1
Hooded Merganser							
Reach 8	egg-2005	**2.0**	0.7	**2.4**	**1.6**	<1	<1
Red-winged Blackbird							
Reach 8	adult blood (2005)	**7.5**	**3.2**	**NA**	**NA**	**7.5**	**3.2**
Song Sparrow							
Reach 8	adult blood (2003)	**1.1**	0.5	0.3	0.3	<1	<1
Yellow Warbler							
Reach 8	adult feather (2003)	**1.3**	**1.3**	1.0	0.4	<1	<1
Mink							
Reach 3	fur	**3.1**	**3.1**	**NA**	**NA**	**3.1**	**3.1**
Reach 8	food chain modeling	**1.2**	**1.1**	0.4	0.4	<1	<1
Reach 9	food chain modeling	**1.5**	**1.2**	0.4	0.4	**1.1**	<1
Reach 10	food chain modeling	**1.9**	**1.3**	0.4	0.4	**1.4**	<1
Largemouth Bass							
Reach 8	whole fish	**1.2**	0.8	0.4	0.3	<1	<1
Reach 9	whole fish	**1.3**	1.0	0.4	0.3	<1	<1
Reach 10	whole fish	**1.3**	**1.1**	0.3	0.2	**1.0**	<1

[a] - Only those reaches with an Effect HQs > 1.0 are included in this table
[b] - The incremental risk is the hazard quotient for the Site minus the hazard quotient for the reference location.

RME - Reasonable Maximum Exposure
CTE - Central Tendency Exposure
NA - Not available

The narrative that follows does not repeat the information provided in Tables G-25 to G-29. Instead, it focuses on the most significant risks issues identified in the final SBERA report, most of which are shown in the table above.

For most of the Sudbury River reaches, all six assessment endpoints (see Table G-24) were evaluated with two or more lines of evidence to assess risk using a WOE approach. Only four lines of evidence described in the final SBERA report showed a potential for adverse ecological effects above regional baseline conditions, as follows:

- Mercury levels in sediment compared to no effect and low effect sediment benchmarks,
- Mercury levels in largemouth bass above 20 cm compared to reproductive CBRs,
- Mercury levels in redwing blackbird blood collected (as by-catch) from Reach 8 compared to a generic avian blood effect level, and
- Mercury levels in hooded merganser eggs from Reaches 4 and 8.

The following paragraphs discuss the confidence and uncertainty with these four lines of evidence and evaluate the risks associated with the assessment endpoints related to these lines of evidence. Note that the tree swallow food chain modeling indicated the potential for ecological risk from feeding on aquatic insects, particularly in reaches 3 and 4 (see Table G-26 and Table G-27). This modeled estimation of risk was given much less weight in the final analysis of the SBERA because the measured mercury levels in eggs, blood, or feather samples from nestling and/or adult tree swallows captured from these same reaches did not trigger concern. Much greater weight was given to measured tissue concentrations than to modeled exposures.

There is a regional exposure to mercury associated with atmospheric deposition from sources such as power plants that has resulted in fish advisories in many water bodies with no history of mercury contamination from a point source such as Nyanza. In order to take this into account, the SBERA included a comparison of risk from the Nyanza-affected reaches with risk in the off-site reference areas, in order to identify risk over and above regional "background" conditions. Several measurement endpoints were found to have risk similar to regional conditions. In such instances the risk would not require remedial action because remediation goals cannot be set below background conditions.

Mercury levels in sediment
Mercury levels in sediment were compared to the TEC (threshold effects benchmark for mercury) and the PEC (probable effect benchmark for mercury). The uncertainty analysis in the final SBERA report identified many concerns with using sediment benchmarks to assess the potential for sediment toxicity. It was also noted that the mercury TEC did not meet the criteria for predicting no toxic effects in 75% of the samples evaluated (the mercury TEC was successful 34% of the time). The PEC was more successful in predicting toxic effects in test samples;

however, the dataset used for the PEC development only had four toxic samples. The final SBERA report also cited several studies showing that total mercury in sediments did not correlate well with mercury bioavailability.

The freshwater mussel study showed lower growth, but no effect on survival, in Reaches 2 and 3, whereas growth was unaffected in Reaches 9 and 10. The latter two reaches were retained as surrogate reference areas because growth was impaired at the actual reference location. The two other lines of evidence used to evaluate impacts to the benthic community (i.e., the mayfly studies [Reaches 3, 4, 8, and 9] and crayfish tissue levels [Reaches 2 through 7]) did not show risk to the benthic community.

The final SBERA report followed the convention used at most CERCLA sites that generic benchmarks, while useful for identifying areas requiring further evaluation, should not be used for stand-alone risk management decision making. It was concluded that risk to the benthic community in the Sudbury River did not require remedial action, given the lack of concurrence between measurement endpoints, the high degree of uncertainty associated with sediment benchmarks, and the surface water data indicating that increased methylation was mostly confined to the those reaches with significant associated wetlands.

Mercury levels in largemouth bass
No exceedances of the probable effect CBR for reproduction in fish were observed in the Sudbury River, except for four largemouth bass (> 20 cm); one each from Reaches 8 and 9, and two from Reach 10. In general, mercury levels in over 90% of all the fish sampled (more than 300) in support of the SBERA fell below the no effect CBR for reproduction.

Even though fish mercury levels were typically higher in impacted reaches (e.g., reaches 2, 3, or 8) when compared to reference areas or regional background levels, any potential adverse effects, if present, would be limited to larger, older fish at a higher trophic level. These results were consistent with previous studies describing the biomagnification potential of mercury in aquatic systems. However, the fish residue data collected from the Sudbury River did not support a conclusion of population-level risk for fish based on reproductive impairment.

Mercury levels in redwing blackbird blood
Ten blood samples were collected in Reach 8 from four juvenile and six adult redwing blackbirds in August of 2005. All ten samples exceeded the conservative avian blood CBR derived from field observations of loon chick behavior, where a strong correlation was found between higher blood mercury levels in loon chicks and less time riding parents' backs but more time spent preening.

A key factor to consider when interpreting these data is that the ten redwing blackbirds were sampled well passed the point in the season (typically May-June) when reproduction and chick rearing occur. Most of the other insectivorous bird blood samples collected in support of the

SBERA were obtained in the spring and early summer. Only about one quarter of the 235 insectivorous bird blood samples were collected as late as August. It was recognized that early-season blood samples may not fully reflect longer-term, Site-specific exposures; however, these samples did quantify exposure during nesting and are expected to be the best indicators of survival, growth, and reproductive effects. The results of comparing other insectivorous bird tissue data to CBRs did not suggest a high concern with this assessment endpoint.

Blood samples collected from birds captured later in the summer reflected long-term Site exposure, which would have included periods of lower river flow and higher water temperatures when both methylmercury levels in surface waters and the bioaccumulation potential increase. The lack of blackbird data on nesting success or blood mercury levels from an off-Site reference location (in this case, the Charles River) made it difficult to determine if the high blood mercury levels measured in Reach 8 indicated adverse impacts. While Red-wing Blackbird blood results show mercury accumulation above the low-effect benchmarks, the only studies available for evaluation of bird mercury risk after nesting season suggested that population-level risk was not indicated.

Any effects after the nesting season and their implications for bird population dynamics are unknown, because the state of the science offers little insight on how high mercury levels in one year might affect nesting success the next year. Re-sampling of the same birds between May and July showed that adult mercury blood levels often increased during the summer in contaminated areas (Oksana Lane, BRI, November 21, 2007, Personal Communication). It was therefore hypothesized, that tree swallows follow the redwing blackbird pattern by further increasing their blood mercury levels later in the summer. Although the available data support this hypothesis, it could not be verified because it was unfeasible to capture adult swallows after their chicks had fledged and left the nest boxes. Overall, the final SBERA report concluded that the available evidence did not suggest a consistent population-level risk based on effects to reproductive endpoints.

Mercury levels in hooded mergansers

Most of the hooded merganser eggs collected in 2005 from Reaches 4 (n = 2) and 8 (n = 21) exceeded the no-effect level CBR (500 µg/kg). These results alone suggested that adverse reproductive effects were possible for this fish-eating bird species. However, three of the four merganser egg samples collected at the two reference locations (Charles River and Sudbury Reservoir) in 2005 also exceeded the no-effect CBR. These findings, while limited by a small sample size for the reference areas, suggested that mercury accumulation in merganser eggs may be a regional phenomenon and not strictly associated with Nyanza-related discharges. The final SBERA report gave the reference area data much weight in interpreting the potential for ecological risk due to the widely-recognized regional problem of mercury accumulation in fish tissue caused by regional atmospheric deposition.

Overall, the results of the SBERA did not indicate that mercury from past Nyanza Site discharges resulted in population-level risk to ecological receptors residing in or using the Sudbury River. The conservative assumptions built into this approach supported this conclusion, even though there was an acknowledged amount of uncertainty with several of the lines of evidence used to evaluate the six assessment endpoints.

H. REMEDIAL ACTION OBJECTIVES

Based on preliminary information about types of contaminants, environmental media of concern, and potential exposure pathways, Remedial Action Objectives (RAOs) were developed to aid in the development and screening of alternatives. These RAOs were developed to mitigate, restore and/or prevent existing and future potential threats to human health. As previously described (Section G), the results of the SBERA indicated that there were no unacceptable risks to ecological receptors. However, based on the HHRA, there were several reaches of the Sudbury River where the non-cancer hazard quotient for an individual who consumes fish from the Sudbury River exceeded the benchmark level of 1.0.

To address this risk, EPA has established the following RAOs for OU4:

Human Health: Prevent the ingestion of mercury-contaminated fish to the extent that such ingestion would result in a non-cancer hazard quotient greater than 1.0 for an individual who consumes fish from the Sudbury River.

Human Health: Reduce the amount of mercury in sediment and/or surface water to ensure that mercury concentration in fish tissue no longer presents an unacceptable risk (hazard quotient greater than 1.0) except in Reach 8.

The first RAO focuses on mercury concentrations in fish, because this is the source of risk; preventing or reducing the consumption of fish is one way to achieve this risk reduction. The second RAO focuses on sediment and surface water because sediment remedies are the primary means of cleaning up surface water and (in turn) fish tissue. As discussed in the section G, fish tissue concentrations must be reduced to the remediation goal of 0.48 mg/kg (which can also be rendered as 0.48 parts per million, or ppm) to achieve this RAO.

This second RAO has an exception for Reach 8, the Great Meadows National Wildlife Refuge. In this reach, sediment concentrations are low (generally between 1 and 3 ppm), yet fish tissue concentrations remain marginally above safe levels. EPA believes that the risk in Reach 8 is largely attributable to ongoing atmospheric deposition and the wetland environment's superior methylating capacity, which converts atmospheric mercury into methylmercury available for bioaccumulation. Because so much of the problem is attributable to contamination that is not Site-related, EPA's only goal for Reach 8 is the first RAO, which aims to prevent ingestion of contaminated fish.

I. DEVELOPMENT AND SCREENING OF ALTERNATIVES

1. Statutory Requirements/Response Objectives

Under its legal authorities, EPA's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences, including:

- a requirement that EPA's remedial action, when complete, comply with all federal and more stringent state environmental and facility siting standards, requirements, criteria or limitations, unless a waiver is invoked;
- a requirement that EPA select a remedial action that is cost-effective and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and
- a preference for remedies in which treatment which permanently and significantly reduces the volume, toxicity or mobility of the hazardous substances is a principal element, as opposed to remedies not involving such treatment.

Response alternatives were developed to be consistent with these Congressional mandates.

2. Technology and Alternative Development and Screening

CERCLA and the National Contingency Plan (NCP) set forth the process by which remedial actions are evaluated and selected. In accordance with these requirements, a Feasibility Study (FS) was prepared and which developed a wide range of remedial alternatives. Within the FS, an evaluation of each alternative was also completed; this consisted of an assessment of each alternative's ability to attain specific remediation levels. A no action alternative was included as a baseline to which other alternative could be compared.

As discussed in Section 10 of the FS, remedy options were identified, assessed and screened based on implementability, effectiveness, and cost. Section 11 of the FS presented the remedial alternatives developed by combining the technologies identified in the previous screening process in the categories identified in Section 300.430(e)(3) of the NCP. The purpose of the initial screening was to narrow the number of potential remedial alternatives for further detailed analysis while preserving a range of options. Each alternative was then evaluated in detail in Sections 12 and 13 of the FS.

In summary, of the 14 remedial alternatives screened in Section 10, eleven were retained as possible options for the cleanup of the Site and were selected for detailed analysis.

J. DESCRIPTION OF ALTERNATIVES

This Section provides a narrative summary of each alternative evaluated. These alternatives are summarized by reach in Figure J-1 and described in the following sections. These alternatives were developed by combining response actions and technologies to address the elevated risk to human health. The alternatives were also intended to represent a wide range of effectiveness, duration of time required to achieve RAOs and cost to implement, thus allowing for an evaluation of the trade-offs between effectiveness and cost.

The table below briefly lists how much each alternative costs and how many years it takes each alternative to achieve the cleanup level (0.48 ppm mercury in fish tissue) in Reaches 3, 4, and 6 – i.e., in all reaches contaminated at unacceptable levels that were evaluated using the computer model, except Reach 8. Reaches 2, 9 and 10 were not modeled, thus making it difficult to predict the exact number of years before the cleanup level is achieved in the fish there. But these reaches are similar to reaches 5, 6 and 7, and are therefore expected to recover naturally within a timeframe similar to the approximate ten-year timeframe predicted for the modeled reaches to recover under the active remediation scenarios. Fish in Reach 8 are expected to remain contaminated at levels above 0.48 ppm under all the alternatives evaluated, primarily due to hydrological conditions there which tend to promote conversion of relatively small amounts of atmospheric mercury into the methylmercury that tends to be absorbed most by fish.

Alternative	Est. time to cleanup level (Reaches 3, 4, 6)	Cost
Alternative 1	~70 years	$0
Alternative 2	~70 years	$190,000
Alternative 3A	~70 years	$1.07 million
Alternative 3B	~10 years	$8.45 million
Alternative 3C	~10 years	$20.82 million
Alternative 4A	~10 years	$24.31 million
Alternative 4B	~10 years	$48.91 million
Alternative 5A	~10 years	$59.71 million
Alternative 5B	~10 years	$88.51 million
Alternative 5C	~10 years	$99.82 million
Alternative 5D	~10 years	$213.49 million

1. No Action Remedial Alternative (Alternative 1)

In accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and RI/FS Guidance, a "No Action" Alternative is discussed, so as to provide a baseline that other alternatives can be compared to. Under this alternative, it is assumed that no active treatment or monitoring would occur. Any reduction in toxicity or volume of contaminants would occur as a result of natural processes. The existing fishing advisories (banning consumption of fish from the river) and warning signs would presumably remain in place, but only for so long as MassDPH elected to continue these measures; there would be no federal cleanup plan to ensure this outcome. As required by the NCP, this alternative was retained for further analysis.

The WASP computer model predicts an average percent reduction in fish tissue concentrations across all modeled reaches of approximately 7% over the next 30 years, based solely on naturally-occurring processes.[9] This reduction is sufficient to attain the cleanup level in all modeled reaches (and in the reaches that were not modeled – 2, 9 and 10 – given their similarity to certain modeled reaches) within a 30-year timeframe, except for Reach 3 and Reach 8. (The conceptual site model discussed in Section E.4 reviews the evidence for this natural recovery, which includes evidence of ongoing natural sedimentation in the river, the fact that the most contaminated sediments have already been buried, and the trend analyses of sampling data.)

In Reach 3, EPA's model showed that natural processes would not achieve the cleanup level within 30 years, which was the period covered by the model; EPA believes it would take approximately 70 years. Reach 8 is not subject to this cleanup level but is also expected to have fish tissue levels above 0.48 ppm for the duration of the model, and perhaps indefinitely. The observation that concentrations in Reach 8 would not significantly attenuate is consistent with the CSM, which describes increased rates of mercury methylation within extensive wetlands. The negligible costs associated with the "No Action" remedial alternative are not shown.

2. Limited Action Alternative (Alternative 2)

A Limited Action alternative was developed, which would rely solely on institutional controls (ICs) as a means of reducing the risk to human health – primarily signs advising against fish consumption. MassDPH (and EPA as an interim measure) have already posted signs which reflect the current fishing advisory; if these signs were not maintained or the fishing advisories were to be modified, new advisories and/or other public outreach and education would need to be implemented as part of this alternative. Under this scenario, no active remediation would be conducted. Like the "No Action" alternative, this does not provided for routine monitoring although it could be conducted at any point to evaluate natural recovery and/or calculate risk to human health.

As noted in Section B, multiple advisories applicable to the Sudbury River have been issued by MassDPH. The first, a State-wide advisory, recommends that fish not be consumed by children and women who are pregnant or may become pregnant; this is due to the statewide distribution

9 This estimate, and all the other estimates presented in this ROD about the speed with which various remedial alternatives are expected to reduce fish contamination, are based on the WASP computer model, which is subject to all the uncertainties described in Section E.5, above.

of mercury from atmospheric (non-point) sources. There is also a Sudbury River-specific advisory that warns against the consumption of any fish caught from the Sudbury River by all segments of the population. To institute a Limited Action alternative, EPA would ensure posting of the most appropriate advisory. If the existing advisories were to be modified and/or lifted and a risk remained from consumption of mercury-contaminated fish from Nyanza-related mercury, new advisories and/or continued public outreach and education would be undertaken by EPA as part of the selected response.

The estimated time required to establish a new (or revise existing) advisories under this alternative is one year. The time required to maintain signage and conduct public outreach and education to ensure the protectiveness of human health is indefinite, being dependent on the natural rate of recovery. As with the No Action alternative, EPA's WASP computer model projects that natural recovery processes would achieve the cleanup level in fish tissue within 30 years in all modeled reaches, except for Reach 3 and Reach 8. EPA also expects that Reaches 2, 9 and 10, which were not modeled but which are similar to certain modeled reaches, would recover naturally over this period. In Reach 3, EPA's model showed that natural processes would not achieve the cleanup level within 30 years, which was the period covered by the model; EPA believes it would take approximately 70 years. Reach 8 is not subject to this cleanup level but is also expected to have fish tissue levels above 0.48 ppm for the duration of the model, and perhaps indefinitely. As in the no-action alternative, there would be no monitoring to verify future fish tissue concentrations.

The costs shown in Table12-1 of the FS primarily include the effort to periodically evaluate the current advisory, discuss with MassDPH, design, fabricate and install signs, and facilitate other public outreach and education activities. The total estimated cost associated with the Limited Action alternative is $190,000.

3. Natural Recovery Alternatives (Alternative 3A, 3B, and 3C)

Three variations of this alternative were developed. Alternative 3A was developed to evaluate the effectiveness of Monitored Natural Recovery (MNR) at the Site in all reaches except Reach 8. This would involve long-term monitoring to ensure that natural processes are effective in reducing the amount of mercury in fish, to a point where fish would eventually be safe for consumption by a recreational angler in all reaches except Reach 8. Reach 8 would also be monitored, but is not expected to recover sufficiently to allow for safe consumption of fish by a recreational angler. This is due to Reach 8's greater ability to convert even low concentrations of mercury (including non-Nyanza related mercury) into methylmercury.

Alternatives 3B and 3C are similar to Alternative 3A, but with the addition of Enhanced Natural Recovery (ENR) via thin-layer sand capping in the most-contaminated portions of the river. According to a recent study of other cleanup sites where this type of remedy was employed, surficial sediment concentrations of contaminants were immediately reduced and afterward appeared to be relatively constant following implementation. This thin layer of sand would expedite the natural burial processes, effectively "enhancing" or speeding up the rate of natural recovery by which clean sediment is added along the river.

More specifically, in Alternative 3B, thin-layer capping with sand would occur within a portion of Reach 3 where the highest mercury sediment concentrations have been detected (i.e., uniformly greater than 10 ppm in surface sediment). Alternative 3C was developed to assess the effectiveness of thin-layer capping in portions of Reaches 3, 4 and 6 where total mercury concentrations are greater than 2 ppm.[10]

Institutional Controls similar to those described for Alternative 2 would also be implemented under each of the natural recovery alternatives: i.e., EPA would ensure that warning signs were maintained and would engage in periodic discussion with State agencies responsible for issuing advisories. If the existing fish advisories were to be lifted or modified, new advisories or other public outreach and education would need to be implemented by EPA as part of these alternatives.

Each of these alternatives is described in greater detail below:

Alternative 3A – Monitored Natural Recovery (MNR)

Alternative 3A contemplates MNR for most reaches, except that in Reach 8 monitoring would occur without an expectation that natural attenuation will lead to an acceptable level of mercury in fish. In addition, the institutional controls described in Alternative 2 would be implemented in each reach as part of this alternative until the cleanup level of 0.48 ppm in fish tissue were achieved in each reach, except that institutional controls would be continued indefinitely in Reach 8, since this reach is not subject to the cleanup level and is in any event not expected to achieve the cleanup level by natural processes within a foreseeable period of time.

Similar to the analyses above for Alternatives 1 and 2, the model-predicted rate of natural recovery, while variable from reach to reach, projects to attain the cleanup level for most reaches within 30 years (excluding Reach 3 and Reach 8); Reaches 2, 9 and 10 were not modeled but are also expected to recover within this timeframe. Monitoring, inclusive of collecting sufficient analytical data, would provide a means for periodically quantifying the reduction in risk posed to human health over time due to natural recovery processes. Primary components of monitoring under this alternative are provided below:

10 In developing active remediation alternatives, EPA decided to evaluate alternatives addressing sediment contaminated at levels above 2 ppm and 10 ppm, but these sediment concentrations are not cleanup goals per se. The 2 ppm and 10 ppm target sediment concentrations were chosen because these concentrations identify distinct areas of the river with consistently elevated levels of mercury, and because, when tested by the model, it was determined that addressing such areas would generate acceptable fish tissue concentrations in most of the river. Targeting sediments within these ranges was also found to lead to a variety of distinct remedial alternatives (which became the alternatives evaluated in the Feasibility Study).

- Sediment Monitoring – Periodic sediment sampling and analysis for mercury and methylmercury would be performed not less than every 5 years;
- Surface Water Monitoring – Periodic surface water sampling and analysis for total and filtered mercury and methylmercury would be performed not less than every 5 years;
- Fish Tissue Monitoring – Periodic single-species fish tissue sampling would be performed to evaluate changes in fish tissue concentrations over time. The frequency and number of species collected would be determined during the Remedial Design. Additionally, every 10 years, more comprehensive fish tissue monitoring would be performed; this would entail collecting sufficient samples so as to recalculate the risk to Human Health; and
- Five-Year Reviews would be performed to monitor the effectiveness of the remedy.

A Proposed Monitoring Plan was included as Appendix F to the FS; it describes one approach to the monitoring to be performed as part of this alternative (and as part of all the alternatives below, each of which would employ a similar monitoring program). This Monitoring Plan recommends that monitoring continue for up to 30 years or until the cleanup level is attained in all reaches except Reach 8. The Monitoring Plan also includes a requirement to check that current fish advisories remain in place and to maintain fish advisory signs and notices. As with Alternative 2, if current bans were lifted or modified and a risk remained from Nyanza-related mercury, new fish advisories and/or continued public outreach and education would be required. The modeling results for the no-action and limited action alternatives would also apply to this alternative.

Just as in Alternatives 1 and 2, this alternative is expected to achieve the cleanup level in all modeled reaches within a 30-year timeframe, except for Reach 3 and Reach 8. Reaches 2, 9 and 10 were not modeled but would also be expected to recover within this timeframe, based on their similarity to certain modeled reaches. In Reach 3, EPA's model showed that natural processes would not achieve the cleanup level within 30 years, which was the period covered by the model; EPA believes it would take approximately 70 years. Reach 8 is not subject to this cleanup level but is also expected to have fish tissue levels above 0.48 ppm for the duration of the model, and perhaps indefinitely.

Detailed costs associated with monitoring that would be conducted under the Alternative 3A scenario are provided on Table 12-2 of the FS. The total estimated cost associated with the Alternative 3A scenario is $1,070,000.

<u>Alternative 3B – Enhanced Natural Recovery of Sediment with Mercury > 10 ppm (Reach 3) and Monitored Natural Recovery</u>

Alternative 3B is the Selected Remedy. It is described in detail in Section L.

Alternative 3B has the same components (e.g., MNR and ICs) as Alternative 3A, except that Enhanced Natural Recovery (ENR) would also be performed in the most-contaminated portion of Reach 3. That is, a thin-layer (6 inches) of sand would be placed over the sediment in Reach 3 with mercury concentrations uniformly greater than 10 ppm in surface sediment (Refer to Figure J-2). This thin layer of sand would be expected to "enhance" the rate of natural recovery and decrease the concentration of mercury in the biologically-active zone. The observed natural burial rate for Reach 3 is approximately 0.04 cm/yr. Based on this depositional rate, the addition of 6 inches of clean sand in Reach 3 is equivalent to over 400 years of natural recovery via sedimentation. The total estimated cost for active remediation under the Alternative 3B scenario is $8,450,000.

Once the thin sand layer and any related active remediation components have been fully implemented, this alternative is expected to take approximately 10 years to reach the fish tissue concentration associated with avoiding unacceptable risks to human health (0.48 ppm) in Reaches 3, 4 and 6. Reaches 2, 9 and 10 were not modeled but are expected to recover within a similar amount of time. Reach 8 is expected to remain contaminated at unacceptable levels for an indefinite period of time.

Alternative 3C – Enhanced Natural Recovery of Sediment with Mercury > 2 ppm (Reaches 3, 4, and 6) and Monitored Natural Recovery

Alternative 3C is similar to Alternative 3B, except that the areal extent of capping would be greater. Alternative 3C contemplates placement of a thin layer of sand over sediments with mercury concentrations greater than 2 ppm; this includes all of Reach 3 and portions of Reach 4 and 6. Based upon the observed burial rates for Reach 3 and Reach 4, approximately 0.04 cm/yr and 0.07, respectively, the addition of 6 inches of sand would be equivalent to almost 400 years of natural accumulation in Reach 3 and over 200 years of natural accumulation in Reach 4. Although an observed burial rate for Reach 6 was not available, the model-predicted rate of burial was 0.1 cm/yr after calibration, which would indicate a simulated recovery via sedimentation of 150 years with the addition of a thin-layer sand cap.

In addition to the sampling and monitoring tasks described for Alternative 3A and major construction activities described for Alternative 3B, implementation of Alternative 3C would include:

- Placement of capping materials over approximately 110 acres in Reach 3, 86 acres in Reach 4 and 27 acres in Reach 6 where mercury concentrations exceed 2 ppm.
- Evaluation and possible sediment removal in Reach 6 to accommodate sand capping. This is due limit thickness of the water column and that the thin sand layer might disrupt aquatic habitat or diminish flood storage capacity.
- Estimated time required to implement this alternative is 4 years inclusive of the Remedial Design and site restoration phase.

Detailed costs associated with remedial action that would be implemented under Alternative 3C are provided in Table 12-4 of the FS.

According to the WASP computer model, implementation of ENR under this alternative would be able to attain lower mercury concentrations in fish tissue as compared to the results predicted for natural recovery alone (Alternative 1, 2 or 3A). Alternative 3C also projects to reduce fish tissue concentrations more than Alternative 3B, insofar as Alternative 3C contemplates thin layer capping over a larger area. See Figure 8-1B and 8-1C of the FS. Similar to Alternative 3B, hydrological investigations described in the draft Monitoring Plan (groundwater flow, grain size, flow and velocity measurements) would be completed as part of the remedial design and before the start of remedial action. Other investigations that would reduce project uncertainty and thus would also likely be completed include sediment stability testing (if warranted) as well as an assessment of amendments to add to the thin layer of sand.

The total estimated cost for the implementation of Alternative 3C is $20,820,000.

Once the thin sand layer and any related active remediation components have been fully implemented, this alternative is expected to take approximately 10 years, or perhaps slightly less, to reach the fish tissue concentration associated with avoiding unacceptable risks to human health (0.48 ppm) in Reaches 3, 4 and 6. Reaches 2, 9 and 10 were not modeled but are expected to recover within a similar amount of time. Reach 8 is expected to remain at unacceptable levels for an indefinite period of time.

4. In-Situ Containment Alternatives (Alternative 4A and 4B)

Two variations of in-situ containment were developed. These alternatives are different from the thin-layer sand capping alternatives (Alternatives 3B and 3C) in that these provide containment and physical isolation of contaminants, whereas the thin-layer sand cap is predominantly intended to dilute contaminated sediment.

Alternative 4A would isolate mercury contaminants in sediment within Reach 3 only, whereas Alternative 4B was developed to evaluate isolating contaminated sediment in Reaches 3, 4 and 6. Both alternatives target containment of the contaminated sediments with total mercury concentrations greater than 2 ppm. For the remaining reaches (except for Reach 8) these alternatives rely on MNR; however, within Reach 8 monitoring would be conducted without any expectation of attaining the risk-based cleanup level. Just as in Alternatives 2 and 3, ICs would be relied upon to ensure protectiveness of human health until the cleanup level has been achieved (or indefinitely, in the case of Reach 8). If existing fishing bans were lifted or modified, new advisories and/or public outreach and education would need to be implemented by EPA as part of these alternatives.

Per EPA guidance, a cap intending to provide isolation should serve three primary functions: 1) prevent direct exposure of receptors to the contaminated sediment; 2) minimize erosion and the subsequent downstream migration of contaminated material; and 3) provide chemical isolation of contaminated sediment. During the screening of potentially applicable technologies, it was determined that in situ containment should be evaluated by assuming use of an innovative capping material called AquaBlok.

While application of a sand cap generally results in a saturated hydraulic conductivity of 10^{-3} to 10^{-4} cm/s, use of a clay/polymer cap can further decrease the saturated hydraulic conductivity to 10^{-7} to 10^{-8} cm/s and can thus provide better isolation of contaminated sediments. Additional chemical isolation is provided by a clay/polymer cap as the partitioning coefficient of the clay/polymer material is approximately two orders of magnitude greater than that of sand due to the increase in surface area available for binding particulates.

Based on a preliminary review of available literature regarding design and installation of a cap made of a material such as AquaBlok, it was assumed that the cap may need to be no more than 5 to 6 inches thick and may be used without other surface amendments as the material's inherent properties provide a suitable habitat for re-colonization by the benthic community. Because restoration of the aquatic environment may be necessary with these types of covers, other measures may be needed to minimize impacts, such as placement of an additional sand layer above the AquaBlok to assist with the re-colonization of the benthic community. Had this alternative been selected, the optimum thickness and the need for addition of a sand layer or other material which favors re-colonization would have been evaluated during remedial design.

As with the ENR alternatives (Alternatives 3B and 3C), these alternatives would have required hydrologic investigations during the remedial design phase, inclusive of sediment stability testing (if warranted) and an evaluation of amendments to add to the capping material which favor mercury sequestration and/or benthic re-colonization.

The primary components of remediation for the two in-situ containment alternatives are similar to ENR Alternatives 3B and 3C, with the following exceptions:

- Capping materials would have to be mixed on-site; and
- Long-term monitoring which would include performance testing of the cap (e.g., boring for ecological recovery and contaminant testing).

Each of these alternatives is described in greater detail below:

Alternative 4A – In-situ Containment of Sediment with Mercury > 2 ppm (Reach 3) and Monitored Natural Recovery

The estimated spatial coverage of the cap required to meet the objective of this alternative in Reach 3 is 110 acres (refer to Figure 8-1A of the FS). According to the WASP computer model, implementation of In-situ Containment (Alternative 4A) would be able to attain lower mercury concentrations in fish tissue as compared to the results predicted for natural recovery alone (Alternative 1, 2 or 3A) and would also result in the cleanup level in fish tissue (0.48 ppm) being attained within approximately 10 years, or perhaps slightly less, in Reaches 3, 4 and 6. Reaches 2, 9 and 10 were not modeled but are expected to recover within a similar amount of time. Reach 8 is not subject to the cleanup level; it is expected to remain above the cleanup level for the duration of the model analysis, and perhaps indefinitely.

Alternative 4A also projects to result in marginally lower fish tissue concentrations than Alternative 3B, due in part to its wider application within Reach 3 (targeting sediments above 2 ppm instead of 10 ppm), and also in part to the lower likelihood of re-suspension associated with this material as compared to sand. Downstream effects were projected to result in reductions in Reaches 4, 5, 6 and 7.

Over and above the inherent uncertainties of the WASP model, it bears mentioning an additional assumption that went into modeling the AquaBlok alternatives (4A and 4B). Specifically, the AquaBlok material was modeled as not being subject to *any* re-suspension. This is based on the cohesive properties of the AquaBlok material and is a reasonable assumption. However, subsequent sedimentation (i.e., organic matter) which may accumulate on the cap was also assumed not to re-suspend; this was due to a limited number of "solid types" allowed in the model. This assumption means that, in the model, any new mercury (from either upstream sources or non-point sources such as watershed run-off) would also be assumed not to re-suspend. For this reason, the model may over-predict the reduction in surface water concentrations and thus the effectiveness of these alternatives.

The total estimated cost for active remediation under Alternative 4A is $24,310,000 (refer to Table 12-5 of the FS). Estimated time required to implement this alternative is 3 years inclusive of the Remedial Design and site restoration phase.

<u>*Alternative 4B – In-situ Containment of Sediment with Mercury > 2 ppm (Reaches 3, 4, and 6) and Monitored Natural Recovery*</u>
Alternative 4B differs from Alternative 4A in that it includes in-situ containment within Reach 4 (86 acres) and Reach 6 (27 acres) for sediments with mercury greater than 2 ppm. This significantly affects the cost of this remedial alternative. However, the additional capping activities would provide a greater reduction in risk (as compared to Alternative 4A) as the spatial coverage of the cap would be greater (refer to Figures 8-1B and 8-1C of the FS).

According to the WASP computer model, implementation of In-Situ Containment under this alternative would be able to attain lower mercury concentrations in fish tissue as compared to the results predicted for natural recovery alone (Alternative 1, 2 or 3A) and would also result in the cleanup level in fish tissue (0.48 ppm) being attained within approximately 10 years, perhaps slightly faster, in Reaches 3, 4 and 6. Reaches 2, 9 and 10 were not modeled but are expected to recover within a similar amount of time. Reach 8 is not subject to the cleanup level; it is expected to remain above the cleanup level for the duration of the model analysis, and perhaps indefinitely.

Alternative 4B also projects to result in marginally lower fish tissue concentrations than Alternative 4A, insofar as Alternative 4B contemplates application of a containment layer over a larger area. As with previous alternatives (Alternative 3B, 3C, and 4A), this alternative assumes the necessity of hydrological and other investigations during remedial design – e.g., groundwater flow, grain size, flow and velocity measurements, sediment stability testing, and an assessment of amendments to add to the capping material.

The total estimated cost for active remediation under Alternative 4B is $48,910,000 (refer to Table 12-6 of the FS). Estimated time required to implement this alternative would be 4 years inclusive of the Remedial Design and site restoration phase

There are some additional considerations specific to Alternative 4B that, had it been selected as the remedy for OU4, would have had to have been evaluated during remedial design:

- The existing elevation of the riverbed in Reach 6 cannot be significantly raised due to the low-flow conditions that seasonally exist. Therefore, dredging would likely be required prior to cap placement to maintain the current riverbed elevation. The methods and implications of using dredging as a remedial component would be similar to those described for Alternative 5 below.
- Restoration of the riverbed and banks would be required to provide suitable habitat (riffle/pools) for sediment and water body dwelling organisms. Some re-planting of the native aquatic vegetation may be required; however, the two dominant native species of water lilies would be likely to recover naturally. Additionally, the vegetation adjacent to Reach 6 is denser than that of Reach 3 or Reach 4, therefore all haul road and staging areas would require extensive clearing and preparation followed by restoration similar to that described in Alternative 4A.

5. Sediment Removal Alternatives (Alternative 5A, 5B, 5C, and 5D)

Four variations of Alternative 5 were developed. All of these employ sediment removal as a means of reducing mercury concentrations in sediment and, subsequently, mercury concentrations in surface water and fish. Sediment removal was examined as both an independent technology and as a companion technology to be used in combination with In-Situ Containment. Just as in Alternatives 3 and 4, long-term monitoring and ICs would be relied upon to ensure protectiveness of human health until the cleanup level (0.48 ppm in fish tissue) has been achieved. As described previously, it is unlikely the cleanup would be achieved in Reach 8 under these or any other alternatives. New fish advisories and/or public outreach and education by EPA would be required if existing ones were modified or lifted.

The four variations in Alternative 5 differ in the amount of dredging involved and in whether or not dredging is combined with a sediment cap, as follows:

- Alternative 5A: sediment removal within Reach 3 where total mercury concentration in sediment exceeds 10 ppm inclusive of those areas of Reach 3 where the concentration is at depth.
- Alternative 5B: sediment removal within Reach 3 where total mercury concentration in sediment exceeds 10 ppm and sediment containment (i.e., AquaBlok capping) within the remainder of Reach 3 plus Reaches 4 and 6 where total mercury concentration in sediment exceeds 2 ppm.
- Alternative 5C: sediment removal within Reach 3 where total mercury concentration in sediment exceeds 2 ppm.
- Alternative 5D: sediment removal within Reaches 3, 4 and 6 where total mercury concentration in sediment exceeds 2 ppm.

Sediment removal is a proven and widely used technology for sediment remediation. The role of sediment removal in these cleanup alternatives is to reduce the contribution of mercury to surface water as well as to provide more favorable benthic conditions, both of which are projected to contribute to a reduction of methylmercury in fish.

Institutional controls and MNR would also be components of each of these Alternatives. Reach 8 would be monitored without any expectation of reducing mercury levels in fish to below the cleanup level.

Various methods of sediment removal were evaluated during the technology screening portion of the FS, including dry excavation. As a result of the screening process, wet dredging via the Eddy Pump, operated by Tornado Motion Technologies, was selected as the representative technology to evaluate. The use of this dredging process has many advantages in comparison to other technologies and processes. Key features of the Eddy Pump technology that other sediment removal processes may not possess include:

- Minimum particle re-suspension, which would eliminate the need for silt curtains during slow current conditions (pending turbidity testing while using the technology), notwithstanding EPA best management practices which dictate the need for silt curtains around the dredge.
- Good control of sediment thickness removed and minimal residual contamination utilizing a real-time kinetic global positioning system (RTK GPS) with the ability to pinpoint the position of the pump on the riverbed within 5 cm both horizontally and vertically.

- Applicability under restricting Site conditions (e.g. working under limited Site access with capability to transfer slurry up to 15,000 ft from a floating barge using an extensive pipeline, wide range of water depth from 1 to 100 ft).
- Capability of pulling sediment at a rate of 350 cy/hr.

Once removed from the riverbed, the slurry mixture would be piped to a treatment facility located adjacent to the river for the separation of sediment from surface water (a process called dewatering). Following dewatering, sediment would be collected, characterized, stabilized (if needed), and transported off site for disposal at an approved facility. Toxicity Characteristic Leaching Procedure (TCLP) and possibly Synthetic Precipitation Leaching Procedure (SPLP) testing may be necessary to determine if the removed sediment meets hazardous waste criteria (mercury TCLP criterion of 0.2 ppm) and would affect selection of disposal facilities. For purposes of cost estimating, it was assumed that sediment would be stabilized on site and therefore would not require disposal at a hazardous waste facility.

Process water would require treatment at an on-site water treatment facility to remove excessive dissolved and particulate mercury using one or more potential technologies such as precipitation/coagulation, adsorption, ion exchange and/or membrane filtration. Precipitation/coagulation using a ferric salt was anticipated to be suitable for treating the mercury in slurry water due to its effectiveness at removing both inorganic and organic mercury and due to the fact that it can handle wastewater with high content of suspended particles at relatively low cost. Following treatment, the water would be discharged back to the river providing it meets applicable discharge criteria. Had any of the variants of Alternative 5 been selected, a treatability study would have been required to determine the effectiveness of coagulants, system design, and operating parameters for a precipitation/coagulation process for generated wastewater.

Extensive site restoration would be required following sediment removal to mitigate impacts to the ecological community in the remediated areas and repair river frontage used for managing dredged sediment and wastewater treatment process equipment. Restoration effort in Reaches 3 and 4 would focus on mimicking the geomorphology and structural features of the riverbed, restoring and reconstructing damaged ecological features, and maintaining riverbank stability. Additional restoration efforts would be required in Reach 6 to reestablish fish habitats and maintain river bank stability to the extent possible due to the shallow depth of water in this reach. Processes for improving substrate conditions, armoring, pool/riffle construction, and aquatic cover construction would be applied when necessary.

According to the WASP computer model, implementation of dredging would be able to attain lower mercury concentrations in fish tissue as compared to the results predicted for natural recovery alone (Alternative 1, 2 or 3A) in the reaches where implemented. As discussed below and as shown in Figures 13-1A and 13-1B of the FS, it is more difficult to characterize the performance of the dredging alternatives compared to the other active remediation alternatives, being better in some upstream reaches and worse in some downstream reaches. The WASP model assumed that some limited contaminated sediment would be re-suspended during dredging. However, engineering controls (i.e., silt curtains) would be used to provide additional protection against downstream migration of contaminated sediment.

Implementation of each scenario under Alternative 5 would include the following common elements:

- Mobilizing personnel and equipment for dredging and dewatering;
- Site preparation including clearing, grubbing, installation of erosion and sedimentation control measures, construction of haul/access roads within the work area and preparation of multiple staging areas required for both personnel and equipment along the length of the Sudbury River to be remediated;
- Developing and implementing a Traffic Control Plan to deal with increased truck traffic in residential areas due to sediment removal activities;
- Performing a treatability study to determine the effectiveness of water treatment, sediment treatment, system design and operating parameters;
- Construction of pipelines (slurry may be moved approximately 5,000 linear feet per pump) to transport slurry to the on-site treatment facility;
- Designing and constructing a treatment facility capable of dewatering the slurry, compacting contaminated sediment;
- Dredging the contaminated sediment using the Eddy Pump technology;
- Confirmation sampling during sediment dredging to confirm attainment of target sediment clean up goals and characterization of dredged sediment for off-site disposal;
- Transporting impacted sediment to an approved off-site facility for disposal as non-hazardous waste (after on-site stabilization). Disposal of stabilized sediment was assumed to be able to meet either Subtitle D landfill criteria or landfill daily cover criteria;
- Demobilizing personnel and equipment used for dredging and dewatering tasks after decontamination procedures;
- Implementing ecological assessments of fauna in the impacted reach(es);
- Conduct sediment, surface water and fish tissue monitoring as described previously;
- Restoration of fish habitat with similar fill, as necessary;
- Completion of 5-year reviews to monitor the effectiveness of the remedy; and
- Restoration of disturbed areas.

Variations offered by each scenario developed for Alternative 5 are discussed below.

Alternative 5A – Removal of Sediment with Mercury > 10 ppm (Reach 3) and Monitored Natural Recovery

Alternative 5A contemplates the removal of sediments within Reach 3 with mercury exceeding 10 ppm, regardless of depth. Figure 8-1A of the FS shows the areas of Reach 3 where sediment mercury concentrations are known to exceed 10 ppm. The estimated acreage that would be disturbed is 84 acres. Alternative 5A was developed based on the following assumptions:

- The depth of contaminated sediment with concentrations exceeding 10 ppm mercury in Reach 3 is estimated to be 20 cm.
- The estimated volume of sediment to be removed is approximately 111,155 cy (this accounts for over-dredging by 5 cm beyond the depth of contamination due to mechanical limitations on precision).
- It was assumed that a staging/support area could be constructed and that dredging equipment could access necessary portions of Reach 3 from these staging areas.
- Estimated time required to implement this alternative was estimated at 3 years inclusive of the Remedial Design and site restoration phase (once access agreements are obtained).

The WASP model results indicate that Alternative 5A may be able to attain reductions in fish tissue methylmercury concentrations such that the concentration of mercury in fish would be below the cleanup level of 0.48 ppm in Reaches 3, 4 and 6 within approximately ten years, perhaps slightly less. Reaches 2, 9 and 10 were not modeled but are expected to recover within a similar amount of time. In Reach 8, fish tissue concentrations are expected to remain indefinitely above 0.48 ppm. The total estimated cost associated with the Alternative 5A is $59,707,000. Table 12-7 of the FS provides details regarding the costs associated with implementation of this alternative.

Alternative 5B – Removal of Sediment with Mercury > 10 ppm (Reach 3) and In-Situ Containment of Sediment with Mercury > 2 ppm (Reaches 3, 4 and 6) and Monitored Natural Recovery

This alternative involves the removal of sediments with mercury concentrations exceeding 10 ppm in Reach 3, with in-situ containment through capping in portions of Reaches 3, 4, and 6 where mercury concentrations exceed 2 ppm (including the dredged area of Reach 3 to mitigate the effect of dredge residuals). The estimated acreage that would be disturbed is 110 acres in Reach 3, 86 acres in Reach 4, and 27 acres of Reach 6. These areas are depicted on Figures 8-1B, 8-1C and 8-1D of the FS. Alternative 5B was developed based on the following assumptions:

- The depth of contaminated sediment with mercury concentrations exceeding 10 ppm in Reach 3 is estimated to be 20 cm.
- As shown in Figure 8-1 of the FS, the estimated area of Reach 3 where contamination in sediment exceeds 10 ppm is approximately 84 acres.
- The estimated volume to be removed is 111,155 cy (accounts for over-dredging by 5 cm beyond depth of contamination due to mechanical limitations of precision noted above).
- It is assumed that a staging/support area could be constructed and that dredging equipment could access all necessary sections of Reach 3 from these staging areas.
- It is assumed that additional staging areas along Reach 4 and Reach 6 could be constructed at potential staging areas for storage of additional equipment.
- Estimated time required to implement this alternative is 4 years inclusive of the Remedial Design and site restoration phase (after access agreements are obtained).

The WASP model results indicate that Alternative 5B may be able to attain reductions in fish tissue methylmercury concentration such that the concentration of mercury in fish would be below the cleanup level of 0.48 ppm in reaches 3, 4 and 6 within approximately ten years, perhaps slightly less, except for Reach 8. Reaches 2, 9 and 10 were not modeled but are expected to recover within a similar amount of time. In Reach 8, fish tissue concentrations are expected to remain indefinitely above 0.48 ppm. The total estimated cost associated with the Alternative 5B is $88,511,000. Table 12-8 of the FS provides details regarding the costs associated with implementation of this alternative.

Alternative 5C – Removal of Sediment with Mercury > 2 ppm (Reach 3) and Monitored Natural Recovery

This alternative involves the removal of sediments with total mercury concentrations greater than 2 ppm in Reach 3. Unlike Alternative 5B, no additional remediation would be performed in Reaches 4 or 6. The estimated acreage that would be disturbed is 110 acres, as shown on Figure 8-1B of the FS. Alternative 5C was developed based on the following assumptions:

- The depth of contaminated sediment with mercury concentrations exceeding 2 ppm in Reach 3 is estimated to be 30 cm.
- The estimated volume to be removed is approximately 204,000 cubic yards (accounts for over-dredging by 5 cm beyond depth of contamination).
- It is assumed that a suitable staging area exists for dredging operations;
- Estimated time required to implement this alternative is 4years inclusive of the Remedial Design and site restoration phase (once access agreements are obtained).

The WASP model results indicate that Alternative 5C would achieve results similar to those that would be obtained by Alternative 5A, with fish tissue concentrations in Reach 3 predicted to decrease to below the cleanup level of 0.48 ppm. Under this alternative, Reaches 3, 4 and 6 are anticipated to attain the cleanup level within approximately ten years, perhaps slightly faster. Reaches 2, 9 and 10 were not modeled but are expected to recover within a similar amount of time. In Reach 8, fish tissue concentrations are expected to remain indefinitely above 0.48 ppm. The total estimated cost associated with the Alternative 5C is $99,820,000. Table 12-9 of the FS provides details regarding the costs associated with implementation of Alternative 5C.

Alternative 5D – Removal of Sediment with Mercury > 2 ppm (Reaches 3, 4, and 6) and Monitored Natural Recovery

This removal alternative is the most comprehensive of all removal alternatives evaluated and contemplates the removal of sediments with mercury concentrations exceeding 2 ppm in Reaches 3, 4, and 6. The estimated acreage that would be disturbed is 110 acres in Reach 3, 86 acres in Reach 4 and 27 acres in Reach 6, as depicted on Figure 8-1B, Figure 8-1C, and Figure 8-1D of the FS. Alternative 5D was developed based on the following assumptions:

- The estimated depths of sediment with mercury concentrations exceeding 2 ppm in Reaches 3, 4, and 6 are 30 cm, 40 cm, and 30 cm, respectively.
- The estimated volumes to be removed for Reaches 3, 4, and 6 are approximately 204,000 cubic yards, 138,000 cubic yards, and 121,000 cubic yards respectively (this accounts for over-dredging by 5 cm beyond depth of contamination due to mechanical limitations of precision noted above).
- The total combined volume to be removed from the three reaches is approximately 463,000 cubic yards.
- It is assumed that multiple staging areas are available for access, equipment storage, and construction of stabilization and sediment transfer facilities.
- Estimated time required to implement this alternative is 5 years inclusive of the Remedial Design and site restoration phase (once access agreements are obtained).

The WASP model results indicate that Alternative 5D may be able to attain reductions in fish tissue methylmercury concentration such that the concentration of mercury in fish would be below the cleanup level of 0.48 ppm in Reaches 3, 4 and 6 within approximately ten years, perhaps slightly faster, except for Reach 8. Reaches 2, 9 and 10 were not modeled but are expected to recover within a similar amount of time. In Reach 8, fish tissue concentrations are expected to remain indefinitely above 0.48 ppm. The total estimated cost associated with the Alternative 5D scenario is $213,490,000. Table 12-10 of the FS provides details regarding the costs associated with implementation of this alternative

Other alternatives were evaluated and were screened out prior to the detailed analysis. These include electrochemical oxidation of various reaches (Alternative 7A and 7B) and a dredging scenario for Reach 8 (Alternative 8).

K. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

Section 121(b)(1) of CERCLA presents several factors that EPA is required to consider in its assessment of alternatives. Building upon these specific statutory mandates, the NCP articulates nine evaluation criteria to be used in assessing the individual remedial alternatives. A detailed analysis was performed on the alternatives described in Section J, using the nine evaluation criteria in order to select a Site remedy. The following is a summary of the comparison of each alternative's strength and weakness with respect to the nine evaluation criteria. These criteria are divided into three categories: threshold criteria, which must be met for an alternative to be selected; primary balancing criteria, which are used to compare and evaluate the elements of one alternative to another that meet the threshold criteria; and modifying criteria, which are used as the final evaluation of remedial alternatives, generally after EPA has received public comment on the RI/FS and Proposed Plan.

1. Threshold Criteria

There are two threshold criteria that *must* be met in order for the alternatives to be eligible for selection in accordance with the NCP. These are overall protection of human health and the environment, and compliance with applicable or relevant and appropriate requirements (ARARs).

Overall Protection of Human Health and the Environment

This criterion addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering controls, or institutional controls.

Overall, Alternative 1, the No Action Alternative, is the least protective alternative since no active remedial action, monitoring, or communication of risk to the public is proposed. The Massachusetts Department of Public Health has maintained a fish advisory but there is nothing under this alternative that would require this to remain in place and there is no requirement for additional action in the event this advisory is withdrawn or eliminated. The existing elevated concentrations of mercury would be allowed to persist; only some reaches are expected to naturally recovery to acceptable levels, although in most cases this would take many years. Based on the WASP model, the rate of natural recovery would be less than approximately 10 years for Reaches 4 and 6 (Reaches 5 and 7 currently do not present a human health risk).

Although not modeled specifically, EPA believes that Reaches 2, 9 and 10 will naturally recover to acceptable levels based on hydrological conditions similar to those present in Reaches 5, 6 and 7. Reach 8, for reasons discussed previously (i.e., its greater ability to methylate background sources of mercury), is not projected to meet remediation goals within the 30-year time frame modeled. In addition, fish in Reach 3, the most-contaminated reach, are expected to be contaminated above the 0.48 ppm cleanup level for approximately 70 years under a no action scenario.[11] Given the persistence of unsafe concentrations of mercury in fish in these reaches, given the possibility that MassDPH fish advisories may not be continued, and given the length of time and number of areas where advisories would be required, EPA has determined that Alternative 1 is not protective.

The remaining alternatives all offer varying degrees of protection. Alternative 2 (Limited Action) offers additional protection over Alternative 1 in the form of institutional controls such as revised and continued signage and public outreach and education. This provides some protection, assuming that institutional controls are implemented, monitored and enforced. This may be difficult to do, given the length of the river that would be subject to ICs and the timeframes involved until safe levels are achieved in fish tissue. Reach 8 would depend upon ICs for an indefinite period of time, although ICs may more effective in this reach given that it is managed as national wildlife refuge by the Fish and Wildlife Service. Overall, Alternative 2 is considered less protective than alternatives that reduce contamination in fish.

Alternative 3A (MNR) is similar to Alternative 2 in that it relies primarily on institutional controls; no active remediation is proposed. However, this option does contemplate monitoring to confirm natural recovery processes (except in Reach 8, which would be monitored without any expectation of recovery); this affords a level of evaluation not offered by Alternative 2. It is thus marginally more protective than Alternative 2.

The remaining alternatives (Alternatives 3B through 5D) include some type of active remediation to reduce or mitigate mercury contamination in sediment and thus reduce the expected concentration of mercury in fish, resulting in a higher level of protectiveness than in Alternatives 1, 2 or 3A. All of these "active remediation" alternatives are expected to produce fish tissue concentrations below the cleanup level (0.48 ppm) in Reaches 3 through 7 within approximately ten years; 5 and 7 are already below the cleanup level. Although they have not been modeled, Reaches 2, 9 and 10 are also expected to naturally recover over a similar timeframe under all the active remediation scenarios, although without modeling it is difficult to estimate the exact number of years.

None of the alternatives are able to achieve an acceptable fish tissue concentration in Reach 8, which would, instead, be addressed through institutional controls. Certain active remediation alternatives (namely thin layer capping and in-situ containment, Alternatives 3B-C and 4A-B) achieve modest reductions in fish tissue contamination in Reach 8, but still are not expected to achieve the 0.48 ppm fish tissue concentration over the duration of the modeled period (30 years). However, institutional controls may be somewhat more effective in Reach 8 than elsewhere in the river. Because Reach 8 is a national wildlife refuge managed by the U.S. Fish and Wildlife Service, EPA believes it will be easier to implement, monitor and maintain/enforce

[11] This prediction is from the WASP computer model. As discussed previously, despite inherent uncertainty involved, EPA has made every reasonable effort to calibrate the model and believes it is the best way to evaluate the effectiveness of the different remedial alternatives at reducing fish tissue concentrations.

institutional controls including maintaining fish advisory signs and performing outreach on a nearly continual basis in that area (e.g., warnings in brochures or elsewhere at the visitors' center and informal reminders by FWS staff).

In Reach 3, the most contaminated reach, all active remediation alternatives are expected to result in fish tissue concentrations below the cleanup level in approximately ten years. The lowest projected fish tissue concentrations in Reach 3 are predicted with Alternatives 3C, 4A, 4B and 5B (0.43 ppm); these alternatives would also be expected to achieve the cleanup level perhaps slightly faster than less extensive alternatives, such as Alternative 3B, though still on the order of approximately 10 years. The highest projected concentration in Reach 3 (post-remediation) is associated with Alternative 3B (0.47 ppm). Projected fish tissue concentrations in Reach 3 under Alternative 5A, 5C and 5D are in between (0.45 ppm). Overall, while there is some additional risk reduction in Reach 3 from the more extensive remedial alternatives, the difference between these alternatives and Alternative 3B is minimal.

FS Figures 12-10 and 12-11 illustrate the predicted fish tissue results for Reach 3 and Reach 8 respectively. FS Figure 13-1A and Figure 13-1B show the change predicted by the model in fish tissue concentrations for each of the reaches at approximately 5 years and 30 years after completion of active remediation, respectively.

Compliance with ARARs and TBCs

This criterion addresses whether or not a remedy will meet all Federal environmental and more stringent State environmental and facility siting standards, requirements, criteria or limitations, unless a waiver is invoked.

A full comparison of the remedial alternatives' ability to attain ARARs is provided in Appendix D of the FS. There are essentially no chemical-specific ARARs; typically the NRWQC and the state analog would be the main chemical-specific ARARs, but these were determined to be not relevant and appropriate because the NRWQC and the state analog are at a concentration that is below the background concentration of mercury and below the risk-based figure calculated for the river.[12]

The most significant ARARs are the wetlands Federal Executive Order (EO 11990), the state wetlands rules applicable to riverbed, riverfronts and banks (310 CMR 10.54, .56, .58), and the state and federal regulation of dredge-and-fill operations in rivers (Clean Water Act § 404 and 314 CMR 9.00).[13] These rules essentially require EPA to avoid adverse impacts to wetlands and

[12] In the event that EPA determines at any point over the course of the remedy that the relevant background concentrations of methylmercury in fish tissue have declined below the NRWQC or analogous state standard for methylmercury, or that achieving the NRWQC or state surface water quality standard is practical in all or part of the river, then EPA may elect to continue remedial actions until such time as this standard is achieved in all or part of OU4.

[13] There are also a number of action-specific ARARs that would potentially apply to handling and disposal of

other aquatic environments, and avoid discharges of fill material to the river, unless there is no practicable alternative. In addition, the floodplain Executive Order (EO 11988) requires EPA to avoid actions that result in the occupancy and modification of floodplains, unless there is no practical alternative.

Alternative 2 and 3A do not involve activity in the river (except sampling, in the case of 3A); they do not have an adverse impact of any kind and thus they attain these ARARs. However, all the active remediation alternatives (Alternatives 3B through 5D) do have an adverse impact as the thin-layer sand, in-situ containment (i.e., AquaBlok cap), and dredging all constitute a temporary degradation of the river bottom environment, which is a wetland. They all also constitute a discharge of fill material into the river under CWA § 404. Because contamination that leads to an unacceptable risk exists in the sediment/wetlands, there is no practical alternative to conducting work that impacts these areas. Thus the question is which alternative that addresses this contamination constitutes the least damaging practicable alternative to the aquatic environment. EPA has determined that Alternative 3B, which would place a thin layer of sand over sediments in Reach 3, is the least damaging practicable alternative because this alternative impacts the smallest area among all active alternatives while at the same time meeting cleanup goals in a short timeframe (approximately 10 years) in this portion of the Site. It also presents fewer possible impediments to successful restoration of the aquatic environment. While the dredging alternatives may in fact have fewer impacts (insofar as they permanently remove contamination and some do not permanently occupy the floodplain), these alternatives are not cost-effective under the conditions found at this Site, and are therefore, not practicable.

Under the floodplain Executive Order, all active restoration alternatives, with the exception of the dredging alternatives, involve modification and occupancy of the floodplain. There is no practicable alternative to conducting this work as the non-active alternatives do not meet RAOs, while the dredging alternatives are not cost-effective under the conditions found at this Site, and are therefore not practicable.

2. Primary Balancing Criteria

There are five primary balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. These are used to compare and evaluate the elements of the alternatives that meet the threshold criteria.

sampling waste in all alternatives except Alternatives 1 and 2, and also potentially apply to the much larger quantity of contaminated sediment generated by Alternatives 5A-5D. However, EPA believes that this waste is unlikely to be hazardous, so the ARARs tables for the selected remedy (Appendix D) list only the rules pertinent to identification of hazardous wastes. EPA would expect to comply with additional hazardous waste requirements if the waste was determined to be hazardous. Alternatives 5A-5D would also have to comply with National Pollution Discharge Elimination System (NPDES) limits in the wastewater generated from dewatering sediment. It is believed that these ARARs could be attained.

Long-term Effectiveness and Permanence

This criterion assesses alternatives for the long-term effectiveness and permanence they afford, along with the degree of certainty that they will prove successful.

The magnitude of the residual risk remains high under all alternatives (except the dredging alternatives), as contamination permanently remains on site. These risks are addressed in different ways by the different alternatives.

Under Alternative 1, there are no measures to adequately or reliably address the contamination.

Alternative 2 relies exclusively on institutional controls – fish advisories, public outreach, and posting of warning signs to address the contamination. These are not enforceable measures and are therefore less effective and reliable over the long term than the active remediation alternatives, which will reduce fish tissue concentrations. Alternative 3A is similar to Alternative 2; however there is a monitoring component that will verify the natural recovery of most reaches. But Reach 3 will not recover naturally for a very long time (and Reach 8 may never recover to levels below the cleanup level). The long-term effectiveness of Alternative 3A is therefore also low.

The thin-layer sand and AquaBlok alternatives (Alternatives 3B, 3C, 4A and 4B) are more effective over the long-term: they permanently reduce fish tissue concentrations in Reach 3, the most contaminated reach, and in all downstream reaches; the model further predicts that these gains will be sustained over the long term. It is possible that severe storms could compromise the effectiveness of the thin-layer sand or AquaBlok cap. Further studies would be undertaken during Remedial Design which would contemplate possible effects from storms and develop measures to try to ensure the performance of these alternatives. For Alternatives 4A and 4B, an institutional control would also need to be considered to protect the AquaBlok cap from disturbances by recreational uses (e.g., no anchoring by boats). As discussed above, institutional controls are less effective and reliable over the long term. An additional consideration is that fish in Reach 8 are not expected to be safe for consumption under these alternatives, so in this reach the effectiveness of Alternatives 3B, 3C, 4A and 4B would rely on institutional controls (which may be more effective in this reach than elsewhere, because the reach is managed by the Fish and Wildlife Service). In any event, reliance on ICs in Reach 8 is a common feature of all alternatives considered. In summary, Alternatives 3B, 3C, 4A, and 4B have a reasonable level of long-term effectiveness and permanence.

The dredge and removal alternatives (Alternatives 5A - 5D) are still more effective and reliable over the long-term, insofar as they physically remove contamination from the river permanently.

Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion addresses the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume.

Alternatives 1, 2 and 3A do not reduce toxicity, mobility or volume through treatment, as no treatment is involved in those alternatives. The thin-layer sand cap and AquaBlok cap alternatives (3B - 3C and 4A - 4B) reduce mobility but do not reduce toxicity, mobility or volume through treatment. Depending upon levels of contamination in sediment, some treatment of sediment may be required under the dredging alternatives prior to disposal. The more comprehensive alternatives – i.e., the alternatives involving remedial action in Reaches 3, 4 and 6 (3C, 4B, 5B, 5D) -- reduce more contaminant mobility than do those that are limited to Reach 3.

Short-term Effectiveness

This criterion focuses on the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup goals are achieved.

Because no active remediation is proposed for Alternative 1, this alternative would not result in any short-term risks to on-site workers or adverse effects to the environment or community during implementation. Cleanup goals throughout the river, except for Reach 8, would be reached in approximately 70 years.

As no active remediation is proposed for Alternative 2, this alternative would not result in any short-term risks to on-site workers or adverse effects to the environment or community during implementation. The time required to implement Alternative 2 would be minimal. Cleanup goals throughout the river, except for Reach 8, would be reached in approximately 70 years.

The evaluation of the short-term effectiveness of Alternative 3A (MNR) is similar. The monitoring component of Alternative 3A would pose few short-term risks to workers during implementation as sampling techniques employed would be traditional and would not harm the environment or surrounding community.

The remaining active alternatives all have fairly similar short-term impacts. The alternatives that limit active remediation to Reach 3 (namely Alternatives 3B, 4A, 5A and 5C) would have somewhat fewer short-term impacts than the alternatives that propose remediation across several reaches (Alternatives 3C, 4B, 5B, and 5D).

All of the active remediation alternatives are largely similar in terms of the amount of the time to attain cleanup goals (across all modeled reaches, excluding Reach 8). According to the WASP model, all of these alternatives are projected to attain the fish tissue cleanup level in the modeled reaches of the river (except Reach 8) within approximately ten years. Reaches 2, 9 and 10 were not modeled but are expected to recover within a similar amount of time.

Implementability

This criterion addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

There are no implementability issues under Alternative 1 as no actions are taken to address the contamination. Alternative 2 (Limited Action) presents very few implementability issues as well as only institutional controls are required under this alternative and these should not be difficult to implement although institutional controls can, in some cases, be difficult to monitor and enforce. MNR proposed under Alternative 3A will require access agreements. These are not anticipated to be difficult to obtain. No unconventional monitoring techniques are proposed for use and impact to the Sudbury River is anticipated to be negligible

Of the active alternatives (3B-C, 4A-B, 5A-D), thin-layer sand capping (under 3B and 3C) is somewhat easier to implement than sediment removal via dredging, since sediment removal requires dewatering sediment, water treatment, and material handling operations. Implementing the AquaBlok alternatives (4A and 4B) may also be marginally more complex, because the properties of AquaBlok cause it to expand when hydrated. Although this is a benefit to its performance, it will require additional provisions and effort during project execution because it must remain dry prior to placement. On-site manufacturing of AquaBlok would provide a means for limiting the amount of material requiring staging prior to placement. Both the AquaBlok and thin-layer sand caps would require some additional evaluation during remedial design, so as to optimize the permanence and effectiveness of the caps and to maximize restoration of the aquatic environment, particularly for the AquaBlok alternatives.

The alternatives that involve a thin layer of sand or AquaBlok in Reaches 4 and 6 (Alternatives 3C and 4B) would also be somewhat more difficult to implement than those limited to Reach 3 (Alternatives 3B and 4A). In particular, remediation in Reach 6 may involve sediment removal to accommodate the shallower depths observed in Reach 6 and potential restoration activities along the river banks. Additionally, as a larger area would be disturbed under Alternatives 3C and 4B, more access agreements and coordination with local officials would be required.

The sediment removal alternatives (Alternatives 5A - 5D), while somewhat more difficult to implement, involve basic construction techniques that are not difficult to implement. Sediment removal has been implemented at several sites without significant technical or administrative problems.

Overall, Alternative 3B is the least complicated and least geographically extensive of the active remediation alternatives, and thus is the active alternative most easily implemented. The AquaBlok alternatives (4A-B) are somewhat more complicated because of the nature of the material and issues related to aquatic restoration. The dredging and removal alternatives (5A-D) are also somewhat more complicated, but have been implemented at other sites without significant implementation problems. Similarly, the more comprehensive capping alternatives

(3C and 4B) are more complicated due to the larger geographical area that would be affected. However, all of the active remediation alternatives are capable of being implemented.

Cost
This criterion includes estimated capital and Operation Maintenance (O&M) costs, as well as present-worth costs.

As shown on the detailed cost estimated provided in Section 12 of the FS, Alternative 1 (No Action) is the least costly of proposed alternative to implement. Alternative 2 (Limited Action) requires little cost to complete compared to monitoring and/or active remediation. Alternative 3A (MNR) is less costly ($1.1 million) than active remediation, but slightly more costly than implementing administrative controls under Alternative 2 ($0.2 million). Comparing the active remedial alternatives, Alternative 3B is the least costly ($8.5 million), followed by 3C ($20.8 million), 4A ($24.3 million), 4B ($48.9 million), 5A ($59.7 million), 5B ($88.5 million), 5C ($99.8 million) and 5D ($213.5 million) in ascending order.

3. Modifying Criteria

The modifying criteria are used as the final evaluation of remedial alternatives, generally after EPA has received public comment on the RI/FS and Proposed Plan. There are two: state acceptance and community acceptance.

State Acceptance
This criterion addresses the State's position and key concerns related to the preferred alternative and other alternatives, and the State's comments on ARARs or the proposed use of waivers. The Commonwealth of Massachusetts, through its lead agency, the Massachusetts Department of Environmental Protection, has expressed its support for the preferred alternative presented in the Proposed Plan and concurs with the selected remedy outlined in this ROD. See Appendix E for the state concurrence letter.

Community Acceptance
This criterion addresses the public's general response to the alternatives described in the Proposed Plan and RI/FS reports, and in particular to the public's response to EPA's proposed plan to select Alternative 3B.

EPA's attempts to engage the public, including the publication of a proposed plan and the holding of multiple public meetings, are described in Section C. A Public Hearing was held on July 19, 2010, also at the Framingham Public Library. A transcript was created for the July 19, 2010 hearing and has been made part of the Administrative Record for this Record of Decision. Based upon a request by the Metrowest Growth Management Committee, the Public Comment Period was extended until August 26, 2010. In addition to the oral comments, a number of written comments were provided on the Proposed Plan. EPA's responses to comments are included in the Responsiveness Summary, which is part of this Record of Decision.

Comments were numerous, but most were of several basic types. First, some commenters expressed support for EPA's plan to select Alternative 3B. Second, a number of others said that EPA's proposed remedy was too extensive, too expensive, and unnecessary based on the magnitude of the risks and the limited number of people (i.e., recreational anglers) it may benefit. These parties favored the "No Action" or "Limited Action" alternatives. A third group expressed support for the dredging alternatives (5A-5D). A fourth group supported different exposure assumptions (e.g., number of fish consumed by recreational anglers), or suggested that additional investigation or explanation was merited (e.g., questions about other chemicals of concern, other sources of contamination, and the derivation of the sediment contamination levels that define the areas to be covered by a thin sand layer). A fifth group suggested measures to be incorporated into any selected active remedy, to ensure minimal impact on neighbors and on plants and animals in and around the river. Finally, a sixth group suggested altogether different remedies from those considered by EPA in the FS.

Overall, putting aside the comments that were neither for nor against a particular remedy, the comments seem to indicate that the community is divided about which alternative is best. Some favor Alternative 3B, others favor no action or limited action, and still others favor the more extensive dredging alternatives or other ambitious plans not evaluated in the FS.

L. THE SELECTED REMEDY

1. Summary of the Rationale for the Selected Remedy

The selected remedy is a comprehensive remedy which utilizes a combination of technologies to address the only unacceptable risk (consumption of mercury-contaminated fish) in Operable Unit 4. The major components of the remedy are as follows:

- Enhanced Natural Recovery (ENR) in a portion of Reach 3 (i.e., Framingham Reservoir 2).
- Monitored Natural Recovery (MNR) in Reaches 2, 4, 6, 9, and 10.
- Limited Action for Reach 8. This includes monitoring of contamination levels in fish, to determine the impact of the selected remedy and of ongoing atmospheric deposition on fish tissue. However, fish tissue contamination levels in Reach 8 are not expected to decline to levels that would permit consumption in quantities assumed for a recreational angler.
- "Institutional Controls" throughout the river – i.e., community outreach as well as posting and maintenance of signs advising against the consumption of fish where they are unsafe for regular consumption.
- No Action for Reaches 5 and 7 since there are no unacceptable risks to either a child or an adult recreational angler in these reaches.
- Periodic Five-year Reviews.

2. Description of Remedial Components

The selected remedy is consistent with EPA's preferred alternative outlined in the June 2010 Proposed Plan, and is consistent with Alternative 3B as described in the June 2010 Public Comment Draft Feasibility Study. Following is a detailed description of each of the components of the selected Remedial Alternative.

Enhanced Natural Recovery (ENR)

Enhanced Natural Recovery consists of the placement of a thin layer of sand (or any similar material determined to be more effective at sequestering mercury and/or re-colonization of benthic habitat) over existing contaminated river bottom sediment that uniformly exceeds a mercury concentration of 10 mg/kg (or ppm) in surface sediment. This area is an approximately 84-acre section of Reservoir 2, located in Reach 3 between Fountain Street and the Reservoir No. 2 Dam (referred to previously and included as Figure J-2). This is the only part of the river, other than Reach 8, where natural processes alone are not expected to be adequate over a reasonable period of time (i.e., less than 30 years) to eliminate unacceptable risks from the consumption of mercury-contaminated fish.

The 10 ppm sediment concentration indicates areas that are targeted for the thin sand layer but it is not a "cleanup level"; the cleanup levels for the selected remedy are based solely on fish tissue concentrations of mercury (see below). The placement of sand in this quantity is anticipated to be equal to approximately 400 years of natural sedimentation and should result in a dilution of mercury concentrations in sediment and ultimately in lower fish tissue concentrations.

A variety of potential staging and work areas were evaluated in the FS. One area looks to be the most favorable. This area is approximately 2.5 acres and is located just south of the Sudbury River and Fountain Street (near the Fountain Street Bridge). A conceptual layout of the staging area is shown in Figure L-1. Materials could be delivered to this area by road or possibly by rail. Sand delivery by rail may be both cost effective as well as reduce impacts to local traffic patterns. The use of rail or trucking and the final selection of staging and work locations will be developed during the remedial design phase of the cleanup.

In light of the complexity of the river environment, and consistent with a number of comments from the public urging EPA to embrace "adaptive management" principles (i.e., adjusting plans as new information comes to light), EPA has decided to use the remedial design to make the final determination about a number of features of the thin layer cap. These include:

- The specific makeup and characteristics of the thin-layer cap materials (e.g., grain size, density).
- The need for a "habitat layer" as part of the thin-layer cap to help promote re-colonization of benthic organisms.
- Other materials which, if added to sand, might help sequester mercury.
- Certain locations within the area to receive the thin sand layer may be subject to scouring. They may therefore require a more stable, erosion-resistant material in the thin layer to ensure long-term performance.

Sediment stability testing may also be performed (among other hydrological measurements described in the draft Monitoring Plan) during the remedial design phase. The selected remedy may include limited use of other materials, and could involve very limited excavation of certain areas if needed to ensure the long-term performance and protectiveness of the remedy or to preserve benthic, aquatic, or littoral habitat.

It is also important to note that the proposed depth of the thin sand layer – six inches – is approximate, and may be modified during remedial design. In addition, mixing of the newly introduced material with the underlying sediment is expected to occur and would not be considered to be inconsistent with the goals of the selected remedy. Furthermore, it may be determined during remedial design that certain areas within the 84-acre target areas need not be capped (either based upon underlying sediment concentrations in a particular spot, concerns regarding erosion of capping materials, or other factors) without compromising the overall protectiveness or performance of the remedy.

While the specific methods of construction will be determined during remedial design, conceptually, the staging area is expected to consist of a large dock on piers and will be used to store and transfer sand to the actual placement equipment (refer to Figure L-2). Depending on the location of the waterfront staging area as well as method of sand delivery (rail versus truck), a conveyor system may be used to move material from the primary staging area (south of Fountain Street) to the waterfront staging area to limit adverse impacts to traffic on Fountain Street (or adjacent to any other selected staging area). It is likely that sand from the waterfront staging area will be transferred to a mobile (floating) barge. The placement of the sand will be completed using one of a variety of methods to be determined during remedial design.

Since some intrusive work would be required, best work practices would be utilized to protect surrounding environmental receptors from eroding soil and/or sediment as well as stormwater run-off from staged materials. Engineering controls such as hay bales or silt curtain will be implemented as a means of reducing the transport of contaminated sediments adjacent to the work areas, to the extent necessary. Traffic control plans will be developed in coordination with local police and noise will be minimized to the extent possible. As appropriate, air monitoring will be conducted during the work and engineering controls such as misting will be used if necessary for dust suppression.

At the conclusion of construction activities, construction equipment will be demobilized from the Site and restoration of any wetland or other resource areas disturbed during implementation of the remedy will be restored.

It is estimated that construction of the selected remedy, inclusive of remedial design studies, will require 3 years.

Monitored Natural Recovery (MNR)

EPA has selected Monitored Natural Recovery as the remedy for Reaches 2, 4, 6, 9 and 10. Based on EPA's computer model, based on evidence that sedimentation is burying mercury in the lower-methylating reaches, and based on the trend analysis for a subset of these reaches (see the CSM model in Section E.4 for more details), fish tissue contamination is projected to attenuate such that the target fish tissue concentration of mercury (0.48 ppm) should be achieved in these reaches in less than 30 years.[14] This is unlike Reach 3, where MNR alone is not expected to achieve the target fish tissue concentration without the enhancements identified above.

Limited Action in Reach 8

The Great Meadows National Wildlife Refuge is a unique hydrological environment encompassing 3,600 total acres, of which approximately 1,100 acres are routinely (annually) flooded. As discussed in Section E of this ROD, wetlands, like those in GMNWR, have a

[14] As noted above (Section E), Reaches 2, 9, and 10 were not part of the computer model evaluation. However, the rate of recovery in these reaches is anticipated to be similar to the modeled reaches, and should attain remedial goals over similar timeframes (i.e., less than 30 years). To the extent required to adequately monitor the progress of MNR, the computer model may be expanded to include data from any pre-design studies as well as data generated post-construction to evaluate these other river reaches.

significantly higher rate of methylation than other river environments. The wetlands are efficient at converting mercury contamination into methylmercury, where it is much more readily absorbed into the food chain. Concentrations of mercury in fish in Reach 8 are elevated even though the sediment concentration of mercury is relatively low (between 1 and 3 ppm). Because of this efficient methylation, and because of on-going atmospheric deposition of mercury, the WASP computer model predicts that even a very extensive attempt to excavate contaminated sediments would result in only a marginal reduction in fish tissue concentrations. In addition, it would be difficult, if not impossible to separate the Nyanza-related contamination from non-Site related contamination for response in this section of the river. In light of these features of the reach, and in light of the marginal nature of the overall risk to human health attributable to fish consumption in this reach, EPA's selected remedy for Reach 8 relies on institutional controls (fishing advisories, signs and public outreach discouraging consumption of contaminated fish from the Sudbury River). Because Reach 8 is a national wildlife refuge managed by the U.S. Fish and Wildlife Service, EPA believes it will be easier to implement, monitor and maintain/enforce institutional controls including maintaining fish advisory signs and performing outreach on a nearly continual basis in that area (e.g., warnings in brochures or elsewhere at the visitors' center and informal reminders by FWS staff). EPA will continue to monitor Reach 8, to verify the impact of the selected remedy and of ongoing atmospheric deposition on fish tissue concentrations. EPA believes that, over time, risks in Reach 8 from Nyanza-related contamination will attenuate but that fish may continue to be contaminated at unsafe levels, due to the interaction between atmospheric pollution and conditions in the reach that tend to favor mercury accumulation in fish tissue.

Long-term Monitoring Program
A baseline of fish tissue concentrations was established during previous Site investigations (specifically the 2006 HHRA). Depending on when the Remedial Action is set to begin, EPA may consider conducting additional fish tissue sampling to update the "pre-remedial" fish tissue concentration data. Once the remedy is underway, and after construction is completed, periodic fish tissue sampling will be conducted. Periodic surface water and sediment sampling as well as sampling of benthic organisms in the restored sand layer may also be conducted to assist in the evaluation of overall river conditions and progress towards meeting Remedial Action Objectives. EPA will consult with the Massachusetts Department of Public Health (MassDPH), members of EPA's National Contaminated Sediments Technical Advisory Group (CSTAG), and/or other technical experts to design and implement the Final Monitoring Plan. The timing, frequency, and target species will all be determined during remedial design and will be included in the Final Monitoring Plan.

While the specific details will be established during Remedial Design, primary components of monitoring under this alternative would likely include:

- Sediment Monitoring – Periodic sediment sampling and analysis for mercury and methylmercury;

- Surface Water Monitoring – Periodic surface water sampling and analysis for total and filtered mercury and methylmercury;
- Fish Tissue Monitoring – Periodic single-species fish tissue sampling would be performed to evaluate changes in fish tissue concentrations over time. Although the frequency and number of species collected would be determined during the Remedial Design, EPA may seek to make more frequent collections of smaller (younger) species that may be a better indicator of remedy performance. Additionally, at a less frequent interval, tri-species (large mouth bass, brown bullhead, and yellow perch) sampling would be performed to recalculate the risk to Human Health and to evaluate changes over time.
- As noted above, additional monitoring may also be conducted if deemed appropriate.

Institutional Controls
The selected remedy requires a fishing advisory, installation of signs, public outreach and implementation of a plan to gauge the effectiveness of these measures

To ensure that information is received by the target fishing population, EPA would undertake public outreach and education. While the Sudbury River does not traverse an environmental justice area (e.g., low-income communities exposed to an disproportionate level of contamination), EPA understands that many of the more-intensive users of the river (i.e., those potentially eating the most fish caught from the river) are likely from minority and lower-income groups. EPA will take extra steps to ensure that any outreach activity is also targeted specifically to these groups. This will likely include continued posting of signs using pictograms and in multiple languages, such as English, Spanish, Portuguese, Cambodian, and Vietnamese. EPA may also prepare outreach materials, such as public service announcements and internet postings targeted to these specific groups.

In addition, EPA will coordinate as needed with DCR or other state and local authorities to ensure necessary upkeep of dams on the river, to the extent necessary to maintain the thin sand layer and to maintain other relevant hydrological conditions.

Five-Year Reviews
Since wastes will be left in place as part of the selected remedy, the NCP requires periodic reviews of the remedy. A comprehensive review will be conducted at least every five years to evaluate the protectiveness of the remedy. The purpose of these five-year reviews is to evaluate the implementation and performance of the remedy in order to determine if the remedy is or will be protective of human health and the environment. Such five-year reviews are already statutorily required at the Nyanza Site based on cleanup decisions made at the Site's other Operable Units. Future five-year reviews will evaluate the entire Site inclusive of remedial decisions made for the Sudbury River. The five-year review will document recommendations and follow-up actions as necessary to ensure long-term protectiveness of the remedy or bring about protectiveness of a remedy that is not protective. These recommendations could include

providing additional response actions, improving monitoring activities, optimizing the remedy, enhancing institutional controls and conducting additional studies and investigations.

Remedial Design and Pre-Design Studies
As described in some detail above, a number of additional investigations are necessary to reduce project uncertainty and maximize remedy effectiveness. These investigations collectively are referred to as "Pre-Design Studies" and will provide additional detailed information that is required to complete the Remedial Design. The Draft Monitoring Plan (provided in the Draft FS) described a number of hydrologic investigations which will be conducted prior to completing the final Remedial Design. The studies include, but are not limited to: grain size analysis; bathymetric surveys; velocity and flow determinations; and measurements of groundwater influence on the Sudbury River (i.e., the degree to which the river is fed in part by groundwater).[15] In addition, sediment stability may be evaluated (if warranted); this evaluation may cause EPA to modify the composition or design of the sand layer, either to aid in the sequestration of mercury or to encourage benthic re-colonization. If determined to be necessary, pre-design studies may also include further testing to delineate surface sediment concentrations in the 84-acre segment of Framingham Reservoir 2 slated to be capped.

The final Remedial Design of the selected remedial alternative outlined in this ROD will depend on the results of the various pre-design investigations outlined above.

3. Summary of the Estimated Remedy Costs
The total estimated cost of the selected remedy is approximately $8.5 million. A summary table of the major capital and annual operation, maintenance, and monitoring cost elements for each component of the selected remedy is shown in Table J-1. The discount rate used for calculating total present worth costs was 7%.

The information in these cost estimate summary tables are based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data which may be obtained during the pre-design phase. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

4. Expected Outcomes of the Selected Remedy
The primary expected outcome of the selected remedy is that the river outside of Reach 8 will no

15 EPA believes there is a very low likelihood that inputs from groundwater could cause recontamination of sediment. The predominant method by which mercury from the Nyanza facility contaminated the river was not through groundwater, but by overland flow and direct discharges from the brooks and creeks constituting OU3. Groundwater samples from 2009 from around historic source areas show low and non-detected results for mercury. However, in response to public comments and to assure the maximum effectiveness of the thin layer of sand, EPA proposes to conduct additional hydrological studies including measurements of groundwater flux and groundwater quality closer to the area to be capped.

longer present an unacceptable risk to recreational anglers who consume fish from the river. In Reach 8 fish are likely to remain contaminated at unacceptable levels; however institutional controls will be used to reduce/prevent consumption of contaminated fish in this section of the river so that the selected remedy is protective. EPA believes that it will take approximately ten years to reach the cleanup goal of 0.48 ppm mercury in fish tissue in Reaches 3, 4 and 6. Reaches 2, 9 and 10 were not modeled but are expected to recover within a similar amount of time. Fish in Reach 8 are not expected to reach the cleanup level anytime in the foreseeable future (as discussed above, the cleanup level does not actually apply to fish from Reach 8). Table L-1 shows the fish tissue concentrations at 5 and 30 years predicted by EPA's computer model.[16]

a. Cleanup Levels

The consumption of fish from the river presents a threat to human health. As previously discussed in Section G, fish from the river are contaminated by methylmercury. There is no unacceptable ecological risk, but the fish contamination is at levels that result in a hazard quotient above 1 for both children and adults who consume fish in quantities associated with recreational angling. The cleanup goal for the river is to reduce fish tissue concentrations to 0.48 ppm in each reach of the river, except for Reach 8. This 0.48 ppm value is to be calculated as the average fish tissue concentration of total mercury in large-mouth bass, yellow perch, and bullhead from each reach. This cleanup level applies to Reaches 2, 3, 4, 6, 9, and 10. As noted elsewhere, Reaches 5 and 7 are currently below this level. It also does not apply in Reach 8, where Limited Action has been selected as the remedy.

The National Recommended Water Quality Criteria (NRWQC) for mercury is typically also a requirement that is "relevant and appropriate" to cleaning up a river, and one would expect to see it listed as a chemical-specific ARAR. However, in this case, the NRWQC for mercury is lower than the local background concentration of mercury. Specifically, the NRWQC (which is expressed as concentration of mercury in fish tissue) is 0.3 milligram of mercury per kilogram of fish tissue, whereas the background concentration of mercury in fish, as determined by measuring concentrations in fish from reference water bodies including upstream portions of the Sudbury River, is 0.4 ppm. This means that even if all Nyanza-related mercury were removed from the river (which is the only contamination EPA has jurisdiction under CERCLA to clean up), then mercury concentrations would still be above the NRWQC, presumably due to ongoing atmospheric deposition. The NRWQC is also below the concentration of mercury in fish found to present no unacceptable risk under the Site-specific risk analysis performed by EPA. Under these circumstances, and consistent with EPA guidance that advises against cleaning up to levels below background concentrations, EPA has determined that the NRWQC is not relevant and appropriate. However, EPA may in the future re-evaluate the relevance of the NRWQC to the

[16] Although Table L-1 shows that the cleanup level will be achieved in most of the river in five years under the selected remedy, EPA has said in this ROD that it expects to achieve the cleanup level in most of the river in "approximately 10 years" after construction of the thin sand layer. This was done to be cautious and to try to account for uncertainties in the modeling that produced the table.

Site, for example if background contamination drops significantly.

Over time, EPA may re-evaluate fish consumption assumptions that serve as the basis for this cleanup level and adjust the cleanup level as appropriate. This cleanup goal is consistent with ARARs, attains EPA's risk management goals for remedial action, and is protective of human health.

b. Performance Standard for Thin Layer Cap

The Performance Standard for the enhanced natural recovery component of the remedy (i.e., the thin-layer capping) is to apply thin layer capping material to that portion of Reach 3 which uniformly exceeds 10 parts per million (on average) of mercury in the surficial (top 6 inches) sediment. This area is referred to as Segment 5 in the WASP computer model evaluation and is the area between the Fountain Street bridge and the Framingham Reservoir No. 2 dam. As noted above, the six-inch layer is an approximate measure; some mixing of the newly introduced material with the underlying sediment is expected to occur and would not be considered to be inconsistent with the goals of the Selected Remedy. Materials will be selected during remedial design based on evaluation of sediment stability, velocity, stream flow and other factors described above (refer to the section above on "Remedial Design and Pre-Design Studies").

M. STATUTORY DETERMINATION

The remedial action selected for implementation at OU4 is consistent with CERCLA and, to the extent practicable, the NCP. The selected remedy is protective of human health and the environment, will comply with ARARs, and is cost-effective. In addition, the selected remedy utilizes permanent solutions and alternate treatment technologies or resource recovery technologies to the maximum extent practicable, and satisfies the statutory preference for treatment that permanently and significantly reduces the mobility, toxicity or volume of hazardous substances as a principal element.

1. The Selected Remedy is Protective of Human Health and the Environment

The remedy at OU4 will adequately protect human health and the environment by eliminating, reducing or controlling exposures to human and environmental receptors through engineering controls and institutional controls. More specifically, the selected remedy will have the following components:

- Enhanced natural recovery (ENR) in Reach 3. The portions of Reach 3 with the most-contaminated sediments will be covered with a 6-inch layer of sand. The addition of a sand layer accelerates natural recovery processes by which contaminated sediment is normally buried and diluted. This burying and dilution of sediment are expected to help reduce fish tissue contamination in Reach 3 and in downstream reaches, thereby helping make fish safe for regular consumption in most reaches within a reasonable timeframe.
- Monitored natural recovery in Reaches 2, 4, 6, 9, and 10. Natural recovery processes (e.g., volatilization of dissolved mercury, dilution of contaminated sediment) are also expected to reduce fish tissue concentrations of mercury in most reaches within a reasonable timeframe, thereby helping make these fish safe for regular consumption within a reasonable timeframe. EPA will continue to take samples to monitor confirm this progress.
- Institutional controls in all reaches where fish are unsafe for recreational anglers to consume (i.e., Reaches 2 through 4, 6, and 8 through 10). These institutional controls may include community outreach as well as posting and maintenance of signs advising against fish consumption where fish are unsafe for regular consumption. These signs and the outreach should help prevent regular consumption of fish for so long as fish have unacceptably high levels of contamination (or indefinitely in Reach 8).
- Limited action in Reach 8. EPA will monitor fish contamination in Reach 8 to determine the impact of the selected remedy and of future atmospheric deposition on fish tissue there. Fish in Reach 8 are not expected to be safe to consume on a recreational basis within a reasonable timeframe.
- No action for reaches 5 and 7, since there are no unacceptable risks to either a child or an adult recreational angler in these reaches.
- Five year reviews. To the extent required by law, EPA will review the remedy every five

years for as long mercury contamination is present in OU4 in concentrations that do not allow for regular consumption of fish. This will ensure that the remedy is operating as intended – e.g., that fish tissue concentrations are going down as expected and that all necessary fish advisories are maintained.

The selected remedy will reduce potential human health risk levels such that they do not exceed EPA's acceptable hazard index of 1. The remedy will comply with ARARs and To Be Considered criteria. Implementation of the selected remedy will not pose any unacceptable short-term risks or cause any cross-media impacts.

When fish tissue concentrations do reach acceptable levels throughout OU4, as determined by comparison to the clean-up level (0.48 ppm of mercury in fish) promulgated in this ROD and to any newly promulgated ARARs and modified ARARs that call into question the protectiveness of the remedy, a risk assessment may be performed on fish tissue contamination to determine whether the remedy is protective.[17] This risk assessment will follow EPA procedures and will assess the cumulative non-carcinogenic risks posed by consumption of fish. If, after review of the risk assessment, the remedy is not determined to be protective by EPA, the remedial action will continue until protective levels are achieved and have not been exceeded for a period of three consecutive years, or until the remedy is otherwise deemed protective. These protective residual levels shall constitute the final cleanup levels for this Record of Decision and shall be considered performance standards for any remedial action. If EPA decides not to perform further risk assessment or its risk assessment determines that the remedy is protective, 0.48 ppm mercury in fish will be the final cleanup level for this Record of Decision and shall be considered a performance standard for this remedial action.

2. The Selected Remedy Complies with ARARs

The selected remedy will comply with all federal and any more stringent state ARARs that pertain to the Site. The ARARs for the selected remedy are listed and discussed in detail in the tables in Appendix D to this ROD. The following is a discussion of some of the more significant federal and State ARARs for this Site:[18]

- Clean Water Act § 404, 40 CFR Part 230. These regulations limit discharges of dredged or fill material into any navigable waterway, including by forbidding such discharges where there is a practical alternative. These rules are applicable, because the thin sand

[17] The National Recommend Water Quality Criterion for methylmercury was determined to be not relevant and appropriate for OU4, because background concentrations of methylmercury are higher than the NRWQC and the state surface water quality standard, making compliance with these standards impractical. In the event that EPA determines at any point over the course of the remedy that the relevant background concentrations of methylmercury in fish tissue have declined below these standards for methylmercury, or that achieving these standards is practical in all of part of the river, then EPA may elect to continue remedial actions until such time as these standards are achieved in all or part of OU4.

[18] The ARARs tables list the rules applicable to identification of hazardous waste. EPA expects that sediment from the river will not be hazardous. But if after testing, sediment removed from the river is determined to be hazardous, EPA would expect to have to comply with additional hazardous waste requirements.

layer constitutes a discharge of dredged or fill material. There is no practical alternative to conducting work within wetlands, as this is where the contamination is located. EPA has determined that the selected remedy is the least damaging practical alternative.

- Wild and Scenic Rivers Act, 16 U.S.C. § 1271 et seq. Under this rule, "wild, scenic or recreational" rivers must be preserved in a free-flowing condition. By statute, reaches 7 through 10 of the river have been designated as "recreational," so this requirement is applicable. No impacts to the river that would affect its free-flowing condition are planned as part of the selected remedy in these reaches.
- Fish and Wildlife Coordination Act, 16 U.S.C. § 661, 50 CFR Part 81. These regulations require consultation with the Fish and Wildlife Service and the analogous state agency prior to modification of any body of water. It is applicable because the thin sand layer may constitute a modification of the water body.

In addition, the selected remedy will comply with the following more stringent state ARARs:

- Wetlands Protection Act, 310 CMR 10.56, 10.54, and 10.58. These rules are the performance standards for riverbeds, riverfronts, and river banks. They are applicable because the selected remedy involves activities in and impacts to these areas in the Sudbury River. EPA has determined that the impacts to the shore areas are temporary, not significant, and practically unavoidable; the addition of the thin sand layer is not expected to significantly degrade water quality over the short term, and is expected to improve water quality over the long term.
- Water Quality Certification for Discharge of Dredged or Fill Material, 314 CMR 9.00. This requirement is similar to CWA § 404, described above. It is applicable, because the selected remedy's thin sand deposits should constitute a discharge subject to the rule. The selected remedy meets the requirement because it constitutes the least damaging practical alternative.
- Wetlands Rare Species Rules, 310 CMR 10.37. This rule forbids adverse impacts to habitats of state-listed species. Reaches 1, 8 and 10 are rare species habitats, so this rule is applicable. No impacts are expected in the relevant reaches.

The following policies, advisories, criteria, and guidances will also be considered during the implementation of the remedial action:

- Reference Dose. This is a guidance used to compute health hazards from exposure to non-carcinogens. The methylmercury reference dose was used to calculate the clean-up goal (0.48 mg/kg mercury in fish tissue) in OU4. These are not laws or regulations and are therefore TBC.
- Wetlands and Floodplains Executive Orders, EO 11990 and 11988. These requirements forbid activities that impair wetlands and floodplains, unless there is no practicable alternative.

- State and/or local fish advisories. The Massachusetts Department of Public Health currently advises against consumption of any fish in the Sudbury River between Ashland and Concord due to mercury contamination. This advisory and the signs posted to enforce it will be taken into consideration in developing of institutional controls under the selected remedy. They are not laws or regulations and are therefore TBCs.

3. The Selected Remedy is Cost-Effective

In EPA's judgment, the selected remedy is cost-effective because the remedy costs are proportional to its overall effectiveness (see 40 CFR 300.430(f)(1)(ii)(D)). This determination was made by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria (i.e., that are protective of human health and the environment and comply with all federal and any more stringent ARARs, or as appropriate, waive ARARs). Overall effectiveness was evaluated by assessing three of the five balancing criteria -- long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness, in combination. The effectiveness of each alternative then was compared to the alternative's costs to determine cost-effectiveness. The relationship of the overall effectiveness of the selected remedy was determined to be proportional to its costs and hence represents a reasonable value for the money to be spent.

The selected remedy is expected to reduce the concentration of methylmercury in fish tissue to acceptable levels in almost all reaches of the river (i.e., except in Reach 8, which is essentially impervious to active remediation because of the efficiency with which wetlands in this reach methylate mercury from Nyanza and non-Nyanza sources). It is expected to do this within approximately ten years. It accomplishes this goal by reducing the mobility of the most-contaminated sediments in Reach 3, which will be buried by a thin sand layer. It has the smallest footprint in the river of any of the active remediation alternatives. And it has a net present worth (total cost in today's dollars) of $8.5 million, the lowest cost of any the proposal involving active remediation.

A survey of the costs and benefits of the other alternatives considered illustrates the cost-effectiveness of the selected remedy. The only alternatives that are less expensive than the selected remedy are Alternatives 1 (no action, no cost), 2 (institutional controls, $0.2 million) and 3A (MNR, $1.1 million). Alternative 1 is not protective of human health; it was therefore eliminated from consideration. Under Alternatives 2 and 3A, the model predicts that natural recovery processes would reduce fish tissue concentrations to acceptable levels in Reaches 4 and 6, but that fish tissue concentrations would remain at unacceptable levels in Reaches 3 and 8 for at least decades.[19] In these reaches (and possibly in some of the other reaches not modeled), protectiveness would depend wholly on institutional controls, which would have to be obeyed

[19] As discussed previously, the model does not generate predictions for Reaches 2, 9 and 10, but these reaches are similar to modeled reaches and are expected to see analogous fish tissue concentration reductions. Fish from Reaches 5 and 7 already exhibit mercury contamination at levels acceptable for consumption by recreational anglers.

across a large area over many decades. In addition, these alternatives would not meet all of the Remedial Action Objectives in a reasonable timeframe. EPA believes the greater cost ($8.5 million) of the selected remedy is worth the added benefits of permanently reducing contaminant levels in fish to acceptable levels in most of the river in a significantly shorter period of time.

The selected remedy is also more cost-effective than the other active alternatives considered. These alternatives range in cost from $20.8 million to $213.5 million – i.e., from about 2.5x the cost of the selected remedy to more than 20x the cost of the selected remedy. But according to EPA's model, these remedies are not significantly more effective than the selected remedy. All the active remediation remedies considered in the FS reduce fish tissue concentrations in Reaches 3, 4 and 6 to levels allowing for consumption by recreational anglers. None of the alternatives considered is predicted to be capable of bringing fish tissue concentrations in Reach 8 down to acceptable levels. The only advantage of the more expensive remedies is that some of them reduce fish tissue concentrations to concentrations between 0.43 and 0.45 mg/kg in Reach 3, whereas the selected remedy is expected to achieve concentrations of 0.47 mg/kg over the same timeframe – a gap of between 0.02 mg/kg and 0.04 mg/kg. This is a very marginal advantage, particularly since (a) the baseline risk in OU4 is marginal (the maximum hazard index, under conservative exposure assumptions and in only one part of the river, is only 2.1), and (b) there is a large difference in cost between the selected remedy and the other active remediation alternatives. As a result these other active alternatives are not cost-effective.

In sum, EPA believes that the selected remedy is cost-effective and that its costs are proportional to its benefits. Additional information comparing the effectiveness of the remedial alternatives is shown in Figures 12-10, 12-11, 13-1A and 13-1B of the FS. Additional discussion of the effectiveness of the selected remedy under the NCP criteria is also part of the next section.

4. The Selected Remedy Utilizes Permanent Solutions and Alternative Treatment or Resource Recovery Technologies to the Maximum Extent Practicable

Once EPA identified those alternatives that would attain ARARs (or that are eligible for a waiver of ARARs), and that would be protective of human health and the environment, EPA identified which alternatives utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. This determination was made by deciding which one of the identified alternatives provides the best balance of trade-offs in terms of: 1) long-term effectiveness and permanence; 2) reduction of toxicity, mobility or volume through treatment; 3) short-term effectiveness; 4) implementability; and 5) cost. The balancing test emphasized long-term effectiveness and permanence and the reduction of toxicity, mobility and volume through treatment and also considered the preference for treatment as a principal element, the bias against off-site land disposal of untreated waste, and community and state acceptance.

The selected remedy provides the best balance of trade-offs among the alternatives. Compared to the MNR and limited action alternatives, the selected remedy is superior, because unlike these alternatives, it is expected to achieve the clean-up goal in Reach 3 (a measure of long-term effectiveness) and it reduces the mobility of contaminants significantly by diluting the most contaminated sediment in the river. EPA believes these advantages over MNR and limited action are decisive.

The comparison to the active alternatives is more complex. The selected remedy is inferior to the dredging alternatives in terms of long-term effectiveness and permanence, because the dredging alternatives would permanently remove contamination from the river, instead of merely covering it. It is also inferior to most of the active remediation alternatives, both dredging and AquaBlok, because these alternatives clean up a larger area of the river than the selected remedy. But these alternatives are not likely to achieve the cleanup level significantly faster in any reach than the selected remedy, and the selected remedy, though it does not remove mercury permanently, is expected to achieve fish tissue contaminant reductions over the long-term by burying the most contaminated sediments.

Given this near-parity on the major criteria, the other criteria become significant, particularly cost. The selected remedy has fewer short-term impacts than the alternatives that address a much larger area – including impacts on wetlands – and is somewhat more easily implemented than the AquaBlok and dredge alternatives. But probably the most significant factor weighing against the other active alternatives, given their approximately identical long-term effectiveness is cost. The selected remedy is expected to cost $8.5 million, compared to $20.8 million to $213.5 million for the other active remediation alternatives – i.e., the other active alternatives range from about 2.5x the cost of the selected remedy to more than 20x the cost of the selected remedy. Weighing these factors, the marginal risk presented at this Site (HI<2) ,and also the state's acceptance and the apparent lack of any clear favorite in the community, EPA believes the balance of factors favors the selected remedy.

5. The Selected Remedy Does Not Satisfy the Preference for Treatment Which Permanently and Significantly Reduces the Toxicity, Mobility or Volume of the Hazardous Substances as a Principal Element

The selected remedy does not satisfy the preference for treatment as no treatment is required. The sediment that is addressed in this ROD has been classified as a low-level threat.

6. Five-Year Reviews of the Selected Remedy Are Required

Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, a review will be conducted within five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

N. DOCUMENTATION OF NO SIGNIFICANT CHANGES

EPA unveiled its proposed plan for the remediation of OU4 (the Sudbury River) at multiple informational meetings in June 2010. The selected remedy documented in this ROD includes all the features of the preferred remedy described in the Proposed Plan: enhanced natural recovery (i.e., depositing a thin sand layer) in Reach 3, limited action (i.e., sampling to confirm the impact of the selected remedy and of ongoing atmospheric deposition) in Reach 8, monitored natural recovery in Reaches 2, 4, 6, 9 and 10, institutional controls and five-year reviews. EPA reviewed all written and verbal comments submitted during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the proposed plan, were necessary. While not a significant change, a number of commenters recommended that EPA adopt "adaptive management" techniques (i.e., adjusting plans as new information comes to light). In response, EPA has added various studies to be conduct as Pre-Design, over and above those originally outlined in the FS. These studies include: sediment stability testing and evaluation of certain amendments to the capping material that would either enhance sequestration of mercury or provide more favorable conditions for benthic re-colonization.

O. STATE ROLE

The Commonwealth of Massachusetts, acting through the Massachusetts Department of Environmental Protection, has reviewed the various alternatives and has indicated its support for the selected remedy. The Commonwealth has also reviewed the Risk Assessments and Feasibility Study to determine if the selected remedy is in compliance with applicable or relevant and appropriate State environmental and facility siting laws and regulations. The Commonwealth of Massachusetts concurs with the selected remedy. A copy of the declaration of concurrence is attached as Appendix E.

PART 3: THE RESPONSIVENESS SUMMARY

EPA published notices of availability of the draft Proposed Plan and Administrative Record in the Metrowest Daily News on June 19, 2010 and released the final Proposed Plan to the public on June 21, 2010. EPA also held multiple public information sessions, including June 21, 2010 at the Great Meadows National Wildlife Refuge headquarters in Sudbury, June 22, 2010 at the Framingham Public Library, and a special session regarding the computer model used for the project, held on June 24, 2010 at Great Meadows. A Public Hearing was held on July 19, 2010, also at the Framingham Public Library. A transcript was created for the July 19, 2010 hearing and has been made part of the Administrative Record for this Record of Decision. Based upon a request by the Metrowest Growth Management Committee, the Public Comment Period was extended until August 26, 2010. In addition to the oral comments, a number of written comments were provided on the Proposed Plan. Outlined below is a summary of comments received from the public and other interested parties during the public comment period and EPA's response to those comments. Similar comments have been summarized and grouped together. The full text of all written and oral comments received during the comment period has been included in the Administrative Record.

Comment #1:
Several commenters expressed support of EPA's proposed remedy.

<u>EPA Response:</u>
EPA appreciates the commenters' support for EPA's proposed remedy.

Comment #2:
A number of commenters stated their view that EPA's proposed remedy was too extensive, too expensive, and unnecessary based on the magnitude of the remaining risks and what they believed to be the limited number of people it may benefit. Many of these commenters instead favored the "No Action" or "Limited Action" alternatives.

<u>EPA Response:</u>
EPA disagrees with this comment. EPA has determined that the selected remedy (Alternative 3B) is a more appropriate cleanup approach than the commenters' suggested No Action and Limited Action alternatives. Under the No Action and Limited Action Alternatives, Reach 3 would remain contaminated at unacceptable levels for the foreseeable future. Under the No Action alternative, there would be no monitoring to confirm decreases in contamination throughout the rest of the river and there would be no Superfund role in ensuring the proper maintenance of fish advisories and associated outreach in areas where the fish are too contaminated to eat. EPA has determined that the remedy is cost effective, despite its $8.5 million price tag.

Comment #3:
Many commenters expressed concern over the long-term performance and permanence of the proposed remedy. A number of these commenters, including the Town of Framingham, suggested that EPA drain Framingham Reservoir #2 and remove sediments utilizing conventional "dry excavation" techniques. These commenters believed that this type of excavation, unlike the wet dredging techniques evaluated in the FS, would alleviate concerns about re-suspension of contamination during wet dredging and/or would be easier to implement. One commenter noted that the Framingham reservoirs were designed to be periodically drained and dredged to maintain certain volumes for water supply purposes which, in their opinion, would ease implementation of a dry excavation remedy.

EPA Response:
EPA evaluated dry excavation of contamination early on in the development of the Feasibility Study, but it was screened out of the evaluation at that time, for Site-specific reasons. However, based upon questions received during the public comment period, EPA conducted further evaluation of this concept, as summarized in a technical memorandum prepared by EPA's contractor, which has been included in the Administrative Record. The key point in this evaluation is that dry excavation would provide slightly greater protection and greater reliability than the selected remedy but at a significantly greater cost. It therefore would not be cost-effective under the circumstances found at this Site. Specifically, the selected remedy is expected to reduce fish tissue contamination to acceptable levels in the reservoir in only a few years; fish contamination is already very close to levels deemed safe. Any benefit dry excavation might have would be (at most) to marginally reduce fish tissue concentrations further below this threshold. Second, according to a cost estimate prepared by EPA's contractor, dry excavation would cost approximately $58 million – approximately seven times more expensive than the selected remedy. EPA believes that, under these circumstances including the marginal risk being addressed, the vastly greater cost of dry excavation is not worth the marginal human health benefit (if any) dry excavation may have over the selected remedy.

Additionally, it is unclear whether the Framingham Reservoir No. 2 was "designed to be drained," as asserted in some comments. EPA was informed by the Massachusetts Department of Conservation and Recreation (DCR, the owner of the reservoir) that it is unaware of any engineering plans indicating that the reservoir was designed to be drained. DCR also informed EPA that it is unaware of any standard procedures for such a drainage operation. It appears that the existing control structures can lower the reservoir only six feet below the spillway elevation; to drain the remaining ten feet would require pumps, bypass pipes, and dewatering of incoming groundwater flow (which would be expected due to the hydraulic gradient shift induced by lowering the water level in the reservoir).

Comment #4:
In expressing its support for EPA's preferred alternative, the National Oceanic and Atmospheric Administration (NOAA) noted that Reservoir 2 is NOAA's primary area of concern due to its

higher concentrations and higher risks than other reaches. NOAA requested clarification of the relationship at the Site between particle grain size, dissolved organic carbon, and wetlands in Reach 8.

EPA Response:
EPA also believes that the area of greatest concern for remediation is Reservoir 2 (Reach 3). This area is the focus of the active remediation (i.e., a thin sand layer) set forth under the selected remedy.

In general, dissolved organic carbon (DOC) in the water column helps make mercury available for methylation, and fine grain size sediment acts in a countervailing way to make mercury less available for methylation. In Reach 8, the only grain size data available was from the central channel of the river, because the wetland sediments are comprised almost entirely of peat, with a layer of coarse organic matter (e.g., decomposing leaf litter) on top. The river channel sediments represent a relatively small proportion of the surface area within Reach 8, with the reach being dominated by bordering wetlands. So, it is difficult to relate DOC to grain size in Reach 8, because while there is in fact high DOC in the water column in this reach, there are few fine-grained sediments except in portions of the channel.

Comment #5:
An entity called the Sediment Management Work Group stated its opposition to the "dry excavation" approach suggested by others during the comment period. The Sediment Management Work Group had concerns about the implementability, reliability, and cost effectiveness of dry excavation.

EPA Response:
Dredging and dry excavation have proven to be protective, implementable, highly reliable and cost-effective solutions to sediment contamination at Superfund sites across the country. EPA also believes dredging or dry excavation alternatives could be implemented and would be a reliable means of removing contamination from the Sudbury River. But because of the Site-specific circumstances discussed above (e.g., low overall levels of contamination, nature of the contamination, and the existence of a lower cost alternative that would reduce fish contamination in Reach 3 to acceptable levels), dry excavation is less cost-effective than the selected remedy.

Comment #6:
The U.S. Fish and Wildlife Service (USFWS) expressed support for Alternative 3C rather than EPA's preferred Alternative 3B. USFWS also suggested thin-layer capping or sediment removal in Reach 2 and consideration of the need to conduct localized sediment removal in shallow portions (where water is less than four feet deep) of other reaches to ensure that adequate water depths remain for habitat considerations. USFWS indicated its support for EPA's selected remedy in Reach 8, i.e., continued monitoring and ICs.

EPA Response:
The ROD states that the selected remedy may include very limited excavation of certain areas if needed to ensure the long-term performance and protectiveness of the remedy or to preserve benthic, aquatic, or littoral habitat. EPA has not selected a remedy that would implement thin layer capping in Reaches 4 and 6, as contemplated under Alternative 3C from the Feasibility Study. Alternative 3C is more than twice as expensive as the selected remedy and covers a larger portion of the river, yet the addition of a thin layer cap in these areas is not markedly better at reducing fish contamination to acceptable levels. (See Figures 12-2 and 12-3 of the FS.) EPA also disagrees that thin-layer capping and sediment removal in Reach 2 are warranted based upon the evidence now available. Mean levels of contamination in Reach 2 sediments are an order of magnitude lower than in Reach 3, suggesting that the effect of capping Reach 2 sediments would be more limited. EPA believes that Reach 2 will naturally recover in a timeframe similar to the approximately ten-year timeframe anticipated for Reaches 3, 4 and 6 under the selected remedy.

Comment #7:
One commenter supported the incorporation of monitored natural recovery in the remedy and supported its use in Reach 3 as well. This commenter questioned whether the remediation goal (0.48 parts per million in fish tissue) was statistically different from the levels currently found at the Site (and in the "No Action" alternative) and questioned whether the benefits from the proposed cleanup could be distinguishable from natural recovery based on recent data, background concentrations, model uncertainty, and the relatively low Hazard Index. This commenter suggested that EPA delay remedy decision making until additional evaluations were completed.

EPA Response:
The Hazard Index from the river is lower than the HI commonly found at other Superfund sites contaminated by mercury. It is also true that the average background concentration is only 0.05 ppm lower than the cleanup level of 0.48 ppm. However, according to EPA's Site-specific risk assessment, the fish in Reach 3 are contaminated at levels that are almost twice (0.94 ppm) the maximum safe concentration for the most sensitive part of the population (i.e., fish consumption by a child at a frequency associated with recreational angling). The National Recommended Water Quality Criterion of 0.30 ppm is lower than the risk-based figure of 0.48 ppm, providing some indication that the risk-based value is not unduly conservative. On this basis, on the basis of erring on the side of caution with respect to risks to human health, and for all the other reasons cited in the main body of the ROD, EPA believes that its remedy decision is appropriate.

Comment #8:
Some commenters, including the Town of Framingham, expressed concerns over the performance of prior remedial actions conducted under Operable Units 1, 2, and 3 at the Nyanza Site in Ashland and whether there is the potential for continued contamination in the river from the source areas or from groundwater contamination underlying the Site.

EPA Response: There is no evidence of any significant ongoing contamination in the river from the prior operable units. Since the completion of remedial actions at OU1 (landfill) and OU3 (brooks and wetlands near the Nyanza facility), groundwater and surface water samples have been periodically collected as part of the long-term operation and maintenance of these remedies. According to the most recent (2009) annual monitoring reports, mercury was detected in 4 out of 13 groundwater samples from wells around the landfill. But the maximum concentration detected was only 1.6 parts per billion (ppb), below both the State groundwater cleanup (GW-1) goal and the maximum contaminant level (MCL) for mercury (2 ppb) allowed under the Safe Drinking Water Act. Surface water samples were collected from both the western and eastern side of the landfill; the eastern side includes the OU3 remediation areas (Eastern Wetland /Trolley Brook). Mercury was detected in one out of four samples, but at a relatively low concentration (0.7 parts per billion) that is unlikely to have a significant impact on the river. With all that said, EPA plans to collect additional groundwater data from areas that are closer to the Sudbury River as part of Pre-Design and Remedial Design studies.

Comment #9:
One commenter suggested that EPA's study area should not have stopped at the confluence of the Sudbury and Assabet Rivers, but should have included the Concord River and the Merrimack River further downstream from the Nyanza Site.

EPA Response:
According to the 1992 Remedial Investigation and subsequent studies, there is no indication that mercury from the Nyanza facility is affecting water or sediment quality downstream of the confluence of the Assabet and Sudbury Rivers.

Comment #10:
Comments on behalf of the Town of Framingham questioned EPA's determination that mercury was the only contaminant of concern, citing a number of other chemicals they believe would be attributable to Nyanza. The Town also requested information on mercury contamination "hot spots" and data on historic depositional areas in Reservoir 2.

EPA Response:
The 1992 Remedial Investigation for OU3 investigated the possibility that other contaminants presented an unacceptable risk to human health, and determined that the only unacceptable risk was attributable to mercury. Although numerous contaminants are attributable to the Nyanza facility and are the focus of remedial action in other operable units (e.g., volatile organic compounds in groundwater), these contaminants generally do not persist in surface water (they volatilize to the air) and also do not bioaccumulate in fish, as mercury does.

Although it is unclear what the Town means by "hot spot," the selected remedy is expected to address all surface sediments in the reservoir uniformly contaminated above 10 ppm. The most recent analytical data regarding the concentration of mercury in different media in Reservoir 2 is readily available in Appendix A to the Feasibility Study as well as the 2006 HHRA and the 2008 SBERA, all three of which are available on-line. In addition, all older (historic) information is available at EPA's public information repositories in Boston and at the Ashland Public Library

Comment #11:
One commenter asked about historical sediment sampling and whether EPA had changed its sampling protocol over time on sample depth and whether any changes in sampling methodology could bias the results and evaluation of historical trends.

EPA Response:
EPA's sampling techniques have varied over the approximately 20 years it has spent characterizing the river, depending on the purpose of the sampling event and as a result of improved analytical procedures. EPA has made every effort to take these different techniques into account when it analyzes sediment and other data -- see, for example, the trend analysis memo in Appendix B to the Feasibility Study. Nonetheless, the variation is a source of uncertainty in EPA's analysis. Looking ahead, EPA will seek to use more consistent methods of data collection, so as to reduce uncertainty to the extent possible.

Comment #12:
Comments on behalf of the MetroWest Regional Collaborative and the Town of Framingham noted their agreement with EPA's description of and accuracy of the fate and transport of mercury in the Sudbury River watershed. The SuAsCo Watershed Community Council also endorsed and supported these comments.

EPA Response:
EPA appreciates the comments in support of its analysis and selected remedy.

Comment #13:
One commenter asked for information on the specific types of mercury found in the river, asking for information on mercury isotopes and half-lives. Another commenter asked whether the relative percentage of methylmercury versus total mercury was of particular concern at this Site compared to other Superfund sites.

EPA Response:
Mercury is not radioactive and has no half-life; it is stable and is not expected to decay into any other element.

The proportion of mercury to methylmercury in the river is consistent with the proportion observed at comparable mercury-contaminated sites, allowing for the fact that different hydrological conditions (such as those present in Reach 8 of the Sudbury River) are more conducive to the conversion of mercury into methylmercury. Methylmercury also tends to be the form of mercury that accumulates in fish. Additional information on methylmercury is provided in Section E.2 of the main body of the ROD.

Comment #14:
Some commenters questioned the validity of EPA's fish consumption assumptions for the recreational adult and child angler. Some commenters thought that the number of fish meals per year that EPA assumed was too high, while others believed it was too low. Others noted that certain people are more apt to eat the entire fish and not just the fillet.

EPA Response:
There are no Site-specific fish consumption data and no data on fish consumption from rivers in the vicinity of the Sudbury River. The fish assumption rates were obtained from a "creel" survey of recreational angling in Maine and the amount of fish consumed by these anglers from freshwater bodies of different types (flowing versus standing). EPA applied the results of this survey to the Sudbury River – i.e., assuming so many grams of fish consumed per day from each reach of the river, depending on whether the river was flowing, standing or a mixture of the two. In the absence of Site-specific data, EPA believes the Maine survey is the best way to estimate fish consumption rates from the Sudbury River.

EPA also considered the possibility that some people might eat the whole fish instead of just the fillet. If one assumes that a person who consumes the whole fish is apt to substitute consumption of meat from other parts of the fish for fillet meat, then that person's overall exposure to mercury will be lower, because the fillet is the most contaminated part of the fish. EPA assumed all consumption was limited to the most contaminated portion of the fish, as part of EPA's attempt to be conservative in its estimate of risk. Put differently, the concentration of methylmercury as measured in a "whole fish" will always be lower than the corresponding concentration in the fillet since, unlike some other contaminants, mercury contamination would concentrate in the fillet rather than in other parts of the fish (e.g., the offal).

Comment #15:
Comments on behalf of the MetroWest Regional Collaborative and the Town of Framingham requested that EPA more clearly describe the derivation of the 0.48 ppm remediation goal used in the Feasibility Study. These comments also requested further analysis of the uncertainties and suitability of the calculated bioaccumulation factors (BAFs). The SuAsCo Watershed Community Council also endorsed and supported these comments.

EPA Response:
EPA has tried to clarify in the ROD how it has calculated the 0.48 ppm remediation goal and the calculation of the BAF. To summarize: the 0.48 ppm cleanup level was calculated as the fish tissue concentration that would lead to the maximum safe exposure to the most sensitive receptor (a child recreational angler). This is explained in Section G of the ROD, and additional details are available in the 2006 Human Health Risk Assessment, which is included in the administrative record.

For the BAF (used to convert predictions about surface water concentrations of mercury into predicted fish tissue concentrations), filtered surface water methylmercury concentrations were paired with bass and perch fish tissue mercury concentrations, collected at approximately the same time and from the same reach. The 2007/2008 data was used to perform initial BAF calculations for Reaches 3 and 8. As the reach-specific BAFs were similar, the BAF of 7.8×10^6 liters per kilogram for Reach 3 (highest BAF calculated) was selected to provide a conservative estimate of bioaccumulation. More information on the BAF calculation is available in Section E.5 of the main body of the ROD; still more details are in the paper on the computer model in Appendix C to the Feasibility Study.

Comment #16:
Comments on behalf of the MetroWest Regional Collaborative and the Town of Framingham suggested that EPA revise its description of the Remedial Action Objective (RAO) to better describe the underlying fish consumption rate assumptions. The SuAsCo Watershed Community Council also endorsed and supported these comments.

EPA Response:
EPA has added to the ROD details on the fish consumption rate assumptions. Please see Section G.1.b of the main body of the ROD.

Comment #17:
Comments on behalf of the MetroWest Regional Collaborative and the Town of Framingham questioned the use of the 2 ppm and 10 ppm target sediment concentrations in the Feasibility Study and requested more information on the technical basis for these values. The SuAsCo Watershed Community Council also expressed similar concerns.

EPA Response:
EPA has explained the basis of the target sediment concentrations in the ROD (see the footnote in section J.3). To summarize: The 2 ppm and 10 ppm target sediment concentrations were chosen because these concentrations identify distinct areas of the river with consistently elevated levels of mercury, and because, when tested by the model, it was determined that addressing such areas would generate acceptable fish tissue concentrations in most of the river. Targeting sediments within these ranges was also found to lead to a variety of distinct remedial alternatives (which became the alternatives evaluated in the Feasibility Study).

Comment #18:
One commenter questioned EPA's findings regarding the low level of risk in Heard Pond and asked if the risk there should be higher based on the commenter's view that it is surrounded by higher-methylating wetlands, similar to Reach 8.

EPA Response:
Heard Pond was sampled and the human health risk in the Pond was assessed separately from Reach 7; this was done to account for the fact that it is in direct contact with Sudbury River water for only a portion of the year (typically in spring during severe flooding events). The sampling in Heard Pond showed that fish contamination there was below the cleanup level of 0.48 ppm. This result is similar to the relatively low risk (below the cleanup level) attributed to the main stem of the Sudbury River along Reach 7.

EPA does not agree that Heard Pond has the same predisposition to methylation as Reach 8. While Heard Pond does flood, it does not flood as frequently or as extensively as the floodplains associated with GMNWR and the bordering wetlands are much less extensive.

Comment #19:
One commenter asked whether there might be other likely sources of mercury contamination in Reach 8 besides Nyanza and "background" sources.

EPA Response:
EPA is not aware of other sources of mercury beyond those outlined previously.

Comment #20:
Several commenters requested clarification on the risks from swimming and risks from direct contact to sediments if these sediments were to be displaced and/or transported to an exposed area. Others asked whether exposed soil or sediment contamination could pose an airborne risk from inhalation.

EPA Response:
The possibility of direct contact with surface water and sediment via ingestion and dermal contact was evaluated for recreational users (swimming, wading, and boating) and presented in the 1992 Remedial Investigation for OU3. This investigation determined that these activities do not present unacceptable risks to human health.

EPA does not believe that inhalation of air from exposed river soil or sediment is of concern. Exposure to mercury vapor can occur when elemental mercury or products that contain elemental mercury break and release mercury to the air, particularly in warm or poorly-ventilated indoor spaces. Since methylmercury has a low vapor pressure, and tends to bind tightly to organic and biochemical molecules, release of methylmercury from the river would not be expected to lead to significant inhalation exposures.

Comment #21:
Some commenters requested clarification of EPA's estimate for when fish would become safe to eat under the proposed cleanup.

EPA Response:
According to EPA's model, fish contamination levels will decline to acceptable levels (i.e., levels that would allow for fish consumption in quantities associated with recreational angling) in the modeled reaches, except Reach 8, in approximately 10 years following construction of the thin sand layer. Reaches 2, 9 and 10 were not modeled and so no precise answer can be given for these reaches, but fish there are expected to reach safe levels of contamination in a similar timeframe. Reach 8 fish will remain contaminated at unsafe levels for the foreseeable future. As discussed in the ROD and the Feasibility Study, there are uncertainties associated with the model which may affect it accuracy and thus the model prediction should not be considered absolute.

Comment #22:
A number of commenters expressed concerns about impacts on current or future drinking water wells located adjacent to the river and whether sediment contamination could contribute to contamination in these wells. Other commenters also expressed concerns about potential Nyanza Site-related impacts on the Town of Billerica's water supply, which is drawn from the Concord River approximately 30 downstream from the former Nyanza facility.

EPA Response:
The downstream reaches of the river pass through certain areas designated as "Zone II" areas. Zone II areas are areas from which certain municipal drinking water supplies might be drawn during drought conditions. And Billerica draws its drinking water directly from the Concord River, which is approximately 30 miles downstream from the Nyanza facility. However, the concentration of mercury in surface water (maximum 40 nanograms/liter or ng/L) is approximately fifty times lower than the Maximum Contaminant Level (2,000 ng/L) deemed safe under the Safe Drinking Water Act; the 1992 Remedial Investigation for OU3 confirmed that water taken directly from the most-contaminated part of the river would not present an unacceptable risk to human health if it were used as drinking water. It is therefore unlikely that surface water from the river is contributing to an unacceptable degradation of drinking water quality in Billerica or anywhere else.

EPA also believes mercury is highly unlikely to leach out of sediment into drinking water supplies in any significant quantity, for several reasons:

- the concentration of mercury in sediment is relatively low in the downstream reaches that are within the Zone II recharge areas;
- Groundwater from other, uncontaminated areas within each Zone II is expected to mix with any contaminated water from the Sudbury River;
- Nyanza mercury (i.e. old mercury) is tightly bound to particulates and migrates very little; and
- EPA has reviewed analytical data from the municipal water systems where the relevant Zone II recharge area includes a portion of the Sudbury River. These data correspond to

wells which provide water for the residents of Sudbury, Wayland and Concord. Of the 177 samples dating to 1993, there were 6 reported detections of mercury – all attributable to a singular sampling event in 1997 from various Sudbury municipal water supply wells. None of the wells exceeded the MCL for mercury and there were no detections of mercury in subsequent sampling events.

Comment #23:
One commenter suggested that the Framingham reservoirs be returned to use as drinking water supplies. Other questions were raised regarding whether the contamination affects the ability of the reservoir water to be used for drinking water. The Town of Framingham and others also submitted comments expressing concern over a possible connection between portions of the Sudbury River and the Massachusetts Water Resources Authority water supply (including backup supplies), suggesting the river has the potential to contaminate MWRA's water supply.

EPA Response:
DCR has confirmed that the Sudbury River Reservoirs are not part of any public water distribution system. There are no plans to return them to any drinking water system. According to DCR, the reservoirs are of insufficient size and have water quality problems unrelated to Nyanza, such as high turbidity, that would preclude their being used as drinking water sources in the future. EPA also does not believe the Sudbury River has the potential to contaminate water supplies that are upgradient form the river (i.e., Sudbury Reservoir, Framingham Reservoir No.3 or the MWRA aqueduct). The maximum measured mercury in surface water from the river (40 ng/L) is substantially below the Maximum Contaminant Level (MCL) set for public drinking water supplies (2,000 ng/L) by the Safe Drinking Water Act.

Comment #24:
In its comment letter, the Massachusetts Department of Conservation and Recreation (DCR), the state agency that owns the property in and around Reservoir 2, wrote to clarify what it believed was the public's misconception regarding Reservoir 2. DCR clarified that Reservoir 2 is not a public water supply and has not been designated as such in many years.

EPA Response:
EPA appreciates the DCR's clarification.

Comment #25:
In its comments, the Massachusetts Department of Conservation and Recreation (DCR), the state agency that owns the property in and around Reservoir 2, stated its willingness to provide EPA access to its property at the reservoir to implement the remedy. DCR also noted its willingness to transfer control or management of its land to another entity should someone wish to open up this resource for recreational use, as public access to the reservoir property is currently restricted under DCR policy.

EPA Response:
EPA appreciates the offer to provide access. EPA expects to ask DCR to sign a written access agreement so as to allow EPA and others to enter DCR's property to perform the remedy. The second comment regarding transfer of control/management is not a comment related to the cleanup of the Sudbury River. That being said, we have no objection to recreational uses of the river (apart from the consumption of fish in areas subject to a fish advisory) that do not interfere with implementation of the selected remedy.

Comment #26:
A number of comments focused on the design of the proposed thin-layer cap. Questions raised included whether enhancements were needed to ensure successful repopulation by benthic organisms (e.g., the U.S. Fish and Wildlife Service submitted a comment suggesting a four-inch "habitat layer" be incorporated into the cap); whether a thicker layer of sand might be more resistant to breeding habits of certain fin fish or other organisms; and whether the cap should be designed with certain additives or "amendments" to increase performance and/or stability. USFWS also suggested that any planned restoration of staging areas be done with bioengineering materials rather than stone (rip-rap) armoring wherever possible.

EPA Response:
In light of these comments, EPA will evaluate a number of features of the thin layer cap during the remedial design phase. These features include:

- The specific makeup and characteristics of the thin-layer cap materials (e.g., grain size, density).
- The need for a "habitat layer" as part of the thin-layer cap to help promote re-colonization of benthic organisms.
- Other materials which, if added to sand, might help sequester mercury.
- Additional evaluation of areas that may be subject to scouring. They may therefore require a more stable, erosion-resistant material in the thin layer to ensure long-term performance.

Sediment stability testing may also be performed (among other hydrological measurements described in the draft Monitoring Plan) during the remedial design phase. The selected remedy may include the limited use of other materials and could involve very limited excavation of certain areas if needed to ensure the long-term performance and protectiveness of the remedy or to preserve/restore benthic, aquatic, or littoral habitat. See Section L of the ROD for more detailed information. EPA expects to use standard practices to restore any staging and shore areas disturbed as part of the cleanup.

Comment #27:
A number of comments focused on the impacts of the proposed remedy on aquatic plants and/or vegetation on the edges of Reservoir No. 2. Commenters asked whether the proposed plan

would kill this vegetation and whether dead vegetation would create a risk if it were deposited on the cap or the floodplain, or transported downstream.

EPA Response:
The slopes of Reservoir No. 2 are relatively steep around the majority of the Reservoir and are armored with stone. As a result there is a limited amount of vegetation along the edges. Where sand is placed along the edges of the reservoir there will likely be a temporary loss in vegetation, however new vegetation will emerge within a short time. Due to the relatively low flow rate of the reservoir (generally less than 1 ft/second), transport of vegetation downstream is not likely. EPA believes that any dead vegetation transported to the thin sand layer, floodplain or downstream would not be problematic. This vegetation would not contain any significant amount of mercury.

Comment #28:
Several commenters raised questions about the potential impacts of the proposed remedy on flood storage capacity within Reservoir 2 (where EPA plans to add a thin sand layer to part of the river bottom) and whether the proposed remedy would exacerbate flooding problems in the area.

EPA Response:
EPA has determined that there will be no loss of flood storage capacity in Reservoir No. 2. If the thin sand layer were to cause the water level in the reservoir to rise permanently, this would indicate a loss of flood storage. But this is not the case, because even in non-flood conditions, water spills over the dam at the bottom of the reservoir. The thin sand layer will send additional volumes of water over the dam at the time the sand is deposited, as reservoir water is effectively replaced by an equal volume of sand. But this effect will be momentary; once this displaced water is discharged over the dam, the reservoir will return to the same surface water level it had before, and there will thus be no loss of flood storage capacity in the land around the reservoir.

Comment #29:
Several questions were raised regarding the Reservoir No. 2 dam and the impacts on the remedy if floodgates were opened and potential impacts of future dam removal or dam failure on the proposed remedy.

EPA Response:
EPA will coordinate as needed with the state Department of Conservation and Recreation and/or other state and local authorities to ensure necessary upkeep of the Framingham Reservoir No. 2 dam on the river, to the extent necessary to maintain the thin sand layer and to maintain other relevant hydrological conditions. The dam is classified as a high hazard dam, indicating that the absence or removal of such a dam would result in significant loss of property. It is therefore highly unlikely that the dam would be purposely removed.

Comment #30:
One comment regarding the persistence of contamination within the floodplain areas of the Great Meadows National Wildlife Refuge (Reach 8) inquired whether removal of dams downstream (in Billerica) could serve to change the mercury methylation potential in Reach 8.

EPA Response:
Although EPA has not studied the question specifically, EPA believes that the removal of downstream dams could affect the present-day features of GMNWR. The commenter's supposition is therefore correct, but this would result not only in the elimination of a high-methylating area, but also in the elimination of the wetland environment that comprises a national wildlife refuge. Given the intrinsic and substantial natural resource value of the refuge and given the marginal risk present in Reach 8, EPA does not consider downstream dam removal an appropriate remedy for Reach 8 or any other reach.

Comment #31:
A number of commenters asked for information on thin-layer capping performance and stability over time and asked about case studies and long-term performance data from other sites. A number of questions were raised about the long-term stability of the proposed sand layer over time, especially during storm events.

EPA Response:
Case studies on thin-layer capping
Additional sites where a thin sand layer or similar "enhanced natural recovery" have been implemented include: Wyckoff/Eagle Harbor Site, Ketchikan Pulp Co. Site, Bremerton Naval Complex Site, Saguenay Fjord Site (Canada), and Whatcom Waterway Site. Each of these sites has employed enhanced natural recovery as an element of the cleanup at these sites. Because no two sites have identical conditions, it is difficult to compare one site to the other in terms of performance, but generally the thin sand layer has shown some success.

Sediment Stability During Storms
EPA did consider sediment stability in various reports used to develop the FS. Specifically, historical flood data was included in a study of critical shear stress and sediment stability within the reservoirs in 2001. This study evaluated sediment migration due to storms of the following frequency: 3-, 14-, 100- and 1,000- year floods. Measurements made indicated that there was negligible movement attributable to the 3- and 14- year flood and some movement of sediment during the 100- year storm -- particular in locations near constrictions, or which were narrow and shallow (such at the uppermost reaches of Reservoir 2). As one could predict the 1,000 years storm resulted in significant re-suspension and migration.

In 2010, the U.S. Geological Survey measured the flow velocity associated with the most recent 100-year storm. It was concluded that generally the majority of the reservoir (including the portion subject to thin layer capping) had flow of less than 1 ft/second. As described in the ROD, additional studies relative to flow velocity and/or sediment stability may be collected in support of the Remedial Design. In certain limited areas (such as under and downstream of Fountain Street) it may be necessary to make this area more resistant to erosion. However, erosion of the sand cap in the majority of the area proposed for thin layer capping is not anticipated.

Comment #32:
Some commenters suggested that EPA evaluate innovative treatment technologies for dealing with sediment contamination, citing specific examples from elsewhere in the country.

EPA Response:
EPA encourages the evaluation and use, where appropriate, of innovative technologies. During the initial screening evaluation, a wide variety of remedial alternatives, including innovative technologies, were considered. These included, among others, phytoremediation, chemical immobilization and electrochemical oxidation. While most of these technologies were eliminated based on the initial screening evaluation, electrochemical oxidation was retained and carried through to the FS. In the FS it was eliminated based on reliability of this technology and the limited number of contractors/vendors familiar with this technology.

Comment #33:
One commenter questioned EPA's determination that dredging alternatives evaluated in the Feasibility Study did not achieve cleanup levels more quickly than the enhanced natural recovery or capping alternatives. This commenter expressed a belief that dredging should reap more benefits more quickly than other options.

EPA Response:
All active remediation alternatives considered in the Feasibility Study, including the selected remedy and all the dredging alternatives, are expected to achieve cleanup levels (0.48 ppm mercury in fish tissue) in all reaches except Reach 8. Each of the alternatives is expected to achieve this reduction relatively soon after completion of the active remediation measures (e.g., deposition of the thin sand layer, or completion of the dredging). It is true that, in certain reaches, the dredging alternatives would be expected to achieve marginally greater reductions in fish contamination – i.e., they are expected to get further below the 0.48 ppm cleanup level than the selected remedy and to theoretically provide more reliable protection in the long term than the selected remedy. However, given the protectiveness of the selective remedy and the fact that the risk in the river under baseline conditions is only marginally above acceptable levels to begin with, EPA believes this advantage of the dredging alternative is not worth the additional cost. The dredging alternatives were estimated to cost anywhere from $59.7 million to $213 million, versus $8.5 million for the selected remedy.

Comment #34:
One commenter suggested that cost should not be a consideration in making this remedy decision and that dredging is the only viable option, no matter what it costs.

EPA Response:
The National Contingency Plan (40 CFR Part 300) requires EPA to consider cost as one of the "primary balancing criteria" used to evaluate remedial alternatives.

Comment #35:
Several commenters raised other planned or ongoing dredging projects at other sites (including U.S. Army Natick Labs Lake Cochituate dredging in Natick, MA and General Electric's Hudson River dredging in New York) as a basis for preferring sediment removal over EPA's proposed remedy. Other commenters noted that these examples often focus on polychlorinated biphenyls and not mercury and, thus, may not be analogous.

EPA Response:
EPA believes the river is different from Lake Cochituate and the Hudson River site in several respects, over and above the fact that both of those sites are contaminated by PCBs instead of mercury. First, the risk attributable to mercury contamination in the Sudbury River is at unacceptable levels, but only marginally so, and based on conservative exposure assumptions. Given this marginal risk, reliability is not as great a concern at this Site as it is at other sites. Second, at this Site there is an alternative to dredging that appears to be effective at reducing fish contamination to acceptable levels in most of the river at a much lower cost. For more information on EPA's reasons for preferring the selected remedy to the dredging remedies, see sections K and M of the main body of the ROD.

Comment #36:
One commenter laid out a conceptual plan for how Reservoirs #1 and #2 could be drained and dredged.

EPA Response:
EPA appreciates the commenter's thoughts and input, but believes that the selected remedy is the appropriate cleanup approach for this Site, for all the reasons cited above and in Sections K and M of the ROD. See also the response to Comment #3 above.

Comment #37:
One comment (on behalf of the Wayland Conservation Commission) noted the need for any action to comply with state wetland protection regulations, noting that sediment removal alternatives could be more disruptive than less intrusive remedies. This comment also raised a question regarding jurisdiction of local commissions over the cleanup.

EPA Response:
EPA believes the selected remedy complies with state wetland regulations.; further details are in Section K.1 of the ROD. Although local commissions do not have jurisdiction over the cleanup, *see* 42 U.S.C. § 9621(e), EPA expects to coordinate the implementation of the selected remedy

with municipalities that may be affected by remedial activities in the Sudbury River.

Comment #38:
Comments on behalf of the MetroWest Regional Collaborative and the Town of Framingham suggested that EPA revisit the issue on the applicability of the National Recommended Water Quality Criteria (NRWQC) for mercury in the future if local background concentrations decline to levels below those criteria. The SuAsCo Watershed Community Council also endorsed and supported these comments prepared by a consultant for the MetroWest Regional Collaborative.

EPA Response:
As discussed in the main body of the ROD, if EPA determines at any point over the course of the remedy that the relevant background concentrations of methylmercury in fish tissue have declined below the NRWQC for methylmercury, or that achieving the NRWQC is practical in all or part of the river, then EPA may elect to continue remedial actions until such time as the NRWQC is achieved in all or part of OU4.

Comment #39:
Comments on behalf of the MetroWest Regional Collaborative and the Town of Framingham questioned the level of uncertainty in the computer model and requested more detailed information on predicted and observed fish tissue concentrations. These commenters also requested that EPA provide more information on other lines of evidence supporting EPA's evaluation of alternatives. The SuAsCo Watershed Community Council also endorsed and supported these comments.

EPA Response:
EPA is aware of the model uncertainties and have detailed them in the various volumes of the computer model report (Attachment C of the FS) and in the ROD. Notwithstanding this uncertainty, EPA believes it is appropriate to rely on the model to evaluate the relative effectiveness of different remedial alternatives. This is for several reasons: the model is based on (and was calibrated using) a significant amount of empirical data; the model was able to predict observed dissolved methylmercury concentrations with reasonable accuracy; assumptions used in the model all err on the side of protecting human health, consistent with basic CERCLA principles; and finally there is no other practical method to evaluate the effects of different remedial alternatives. For further details on the model, including more detailed information on the model's predictions about fish tissue concentrations, see section E.5 of the main body of the ROD.

Second, there are other lines of evidence supporting EPA's selected remedy, primarily in the form of a review of other sites where thin layer capping has been effective. See the response to comment #31 for a summary of this review.

Comment #40:
Several commenters suggested that EPA's remedy decision-making include provisions for "adaptive management" to adapt the cleanup plan to evolving conditions, new information, and lessons learned as work progresses.

EPA Response:
In crafting the selected remedy, EPA has incorporated "adaptive management" principles into the ROD. For example, as described in section L.2 of the main body of the ROD, EPA contemplates various "pre-design" studies. These studies will inform the Remedial Design as to certain features of the thin layer cap and sediment stability measures, rather than attempt to determine these features and measures in advance. More generally, EPA is aware that plans to implement the selected remedy may evolve somewhat as a result of the pre-design studies and potentially also during the construction phase, and has tried to allow for this possibility in the ROD.

Comment #41:
Numerous commenters expressed support for a robust, extensive, and long-term monitoring program, asking for more monitoring of sediment, surface water, and biota than was laid out in the Feasibility Study.

EPA Response:
EPA's monitoring plan is described in Section L.2 of the main body of the ROD, but the details (including the frequency of sampling) will be determined during remedial design. EPA expects to consult with the Massachusetts Department of Public Health, members of EPA's National Contaminated Sediments Technical Advisory Group (CSTAG), and/or other technical experts to design the Final Monitoring Plan. EPA will take under advisement the request for additional monitoring over and above that contemplated in the draft monitoring plan.

Comment #42:
Several commenters requested that additional technical information be included in the Feasibility Study and that some of the information presented in the Feasibility Study be modified.

EPA Response:
The Feasibility Study was written in accordance with EPA guidance and contained sufficient information and supporting data to support the remedial alternatives as outlined in this Record of Decision. The role of the FS is to collect sufficient information on each cleanup approach so that a fair comparison of the alternatives can be developed. EPA believes this FS fully and adequately summarized approximately 20 years of data collected from the river and other information regarding remedial alternatives, and that this data and other information were adequate to fairly evaluate and compare the different remedial alternatives in the FS. Even if certain data and information were not explicitly referenced in the FS, all data collected, comments submitted on the FS and other information that were considered or relied upon by

EPA are included as part of the Administrative Record for the Site. Additional information will be collected as part of during pre-design studies and incorporated, as appropriate, into the design documents that follow and these design documents will be made available to the public when completed.

Comment #43:
One commenter suggested that, instead of implementing the preferred alternative, EPA dedicate that proposed funding to programs to discourage consumption of fish from the river, including programs to purchase fish from anglers and/or payments to people to purchase fish from other sources.

EPA Response:
EPA intends to conduct periodic public outreach to discourage fish consumption. However, EPA believes it is more effective in the long-term to reduce the concentration of mercury in resident fish than to offer to purchase locally-caught fish.

Comment #44:
One commenter suggested that EPA look to remedy local problems of urban runoff and sediment loading from developed areas adjacent to the river and incorporate such efforts into the Selected Remedy.

EPA Response:
Urban runoff is considered a background source of contamination that is beyond the purview of a Superfund cleanup. The reasons EPA does not address background sources of contamination include cost-effectiveness, technical practicability, and the potential for recontamination of remediated areas by surrounding areas. See EPA's policy statement, "Role of Background in the CERCLA Cleanup Program," April 26, 2002, available at http://www.epa.gov/oswer/riskassessment/pdf/role.pdf. In any event, EPA believes that the selected remedy, though it does not include any component specifically addressed to urban runoff, should be able to reduce the risks in the river notwithstanding the possible degradation associated with urban runoff.

Comment #45:
Some commenters, including the Town of Framingham, raised environmental justice concerns and noted that many of those who fish and eat fish from the river may not speak or read English. These commenters stressed the importance of future outreach targeting non-English-speaking populations to educate them on the dangers of eating contaminated fish. Suggestions were made for pictograms to be used on warning signs as well as the need for outreach material written in Spanish, Portuguese, Vietnamese, Cambodian, Chinese, and Russian.

EPA Response:
While the Sudbury River does not flow through an Environmental Justice area as defined by

EPA guidance, EPA agrees that many of the more-intensive users of the river (i.e., those potentially eating the most fish caught from the river) are likely from minority and lower-income groups. EPA will take steps to ensure that all outreach materials give special consideration to these groups. This will likely include continued posting of signs in multiple languages as well as pictograms. EPA may also prepare outreach materials, such as public service announcements and internet postings, targeted to these specific groups.

Comment #46:
The MetroWest Regional Collaborative noted the need for a more robust program of institutional controls (in addition to sign posting), particularly multilingual public outreach and education programs. MetroWest noted its recent "Fishing for Health" campaign (which includes radio and print advertising, flyers, posters, and other outreach in English, Spanish, and Portuguese) and suggested that EPA and the Massachusetts Department of Public Health consider continuation of this program in the future. The SuAsCo Watershed Community Council also endorsed and supported these comments and added that this campaign should also be expanded to include Cambodian, Vietnamese, and Russian communities.

EPA Response:
As part of the selected remedy, EPA expects that signs will be posted to adequately to inform anglers of risks from consumption of fish from the river. EPA understands that many of the more-intensive users of the river (i.e., those potentially eating the most fish caught from the river) are likely from minority and lower-income groups. EPA will take extra steps to ensure that any outreach activity is also targeted specifically to these groups. This will likely include continued posting of signs using pictograms and in multiple languages, such as English, Spanish, Portuguese, Cambodian, Russian, and Vietnamese. EPA may also prepare outreach materials, such as public service announcements and internet postings targeted to these specific groups. EPA applauds MetroWest's community-based outreach efforts and may seek to model EPA's outreach effort on MetroWest's program.

Comment #47:
The Town of Framingham suggested that studies be done to examine the neurological effects that mercury contaminated Sudbury River fish may have had on those who consume them, also suggesting that a study should examine whether there is any correlation between childhood fish consumption and school performance.

EPA Response:
Epidemiological studies such as those suggested by the commenter are outside the scope of EPA's mission under the Superfund program. This comment and request have been referred to the U.S. Agency for Toxic Substances and Disease Registry and the Massachusetts Department of Public Health for their consideration

Appendix A

Figures

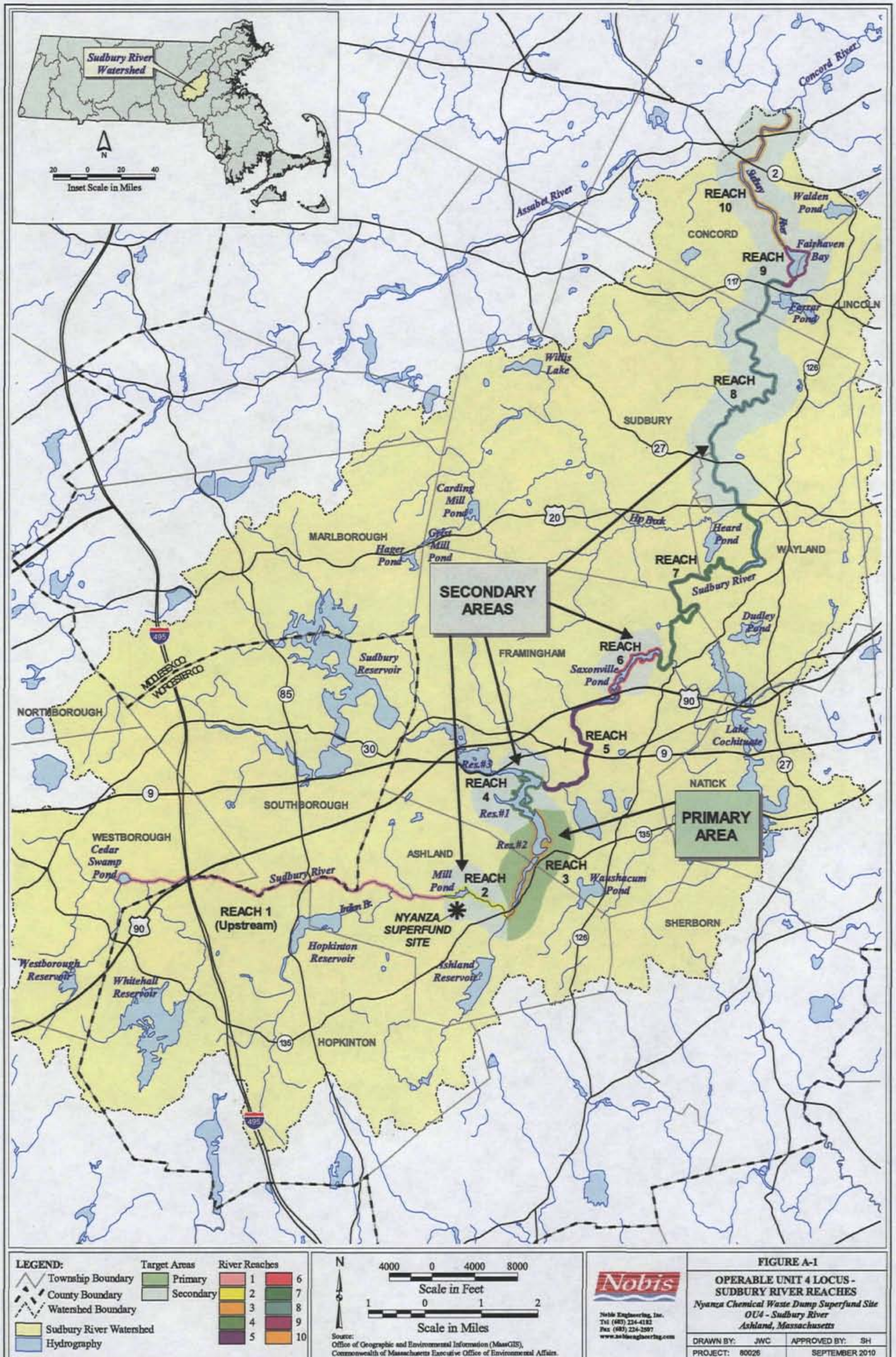

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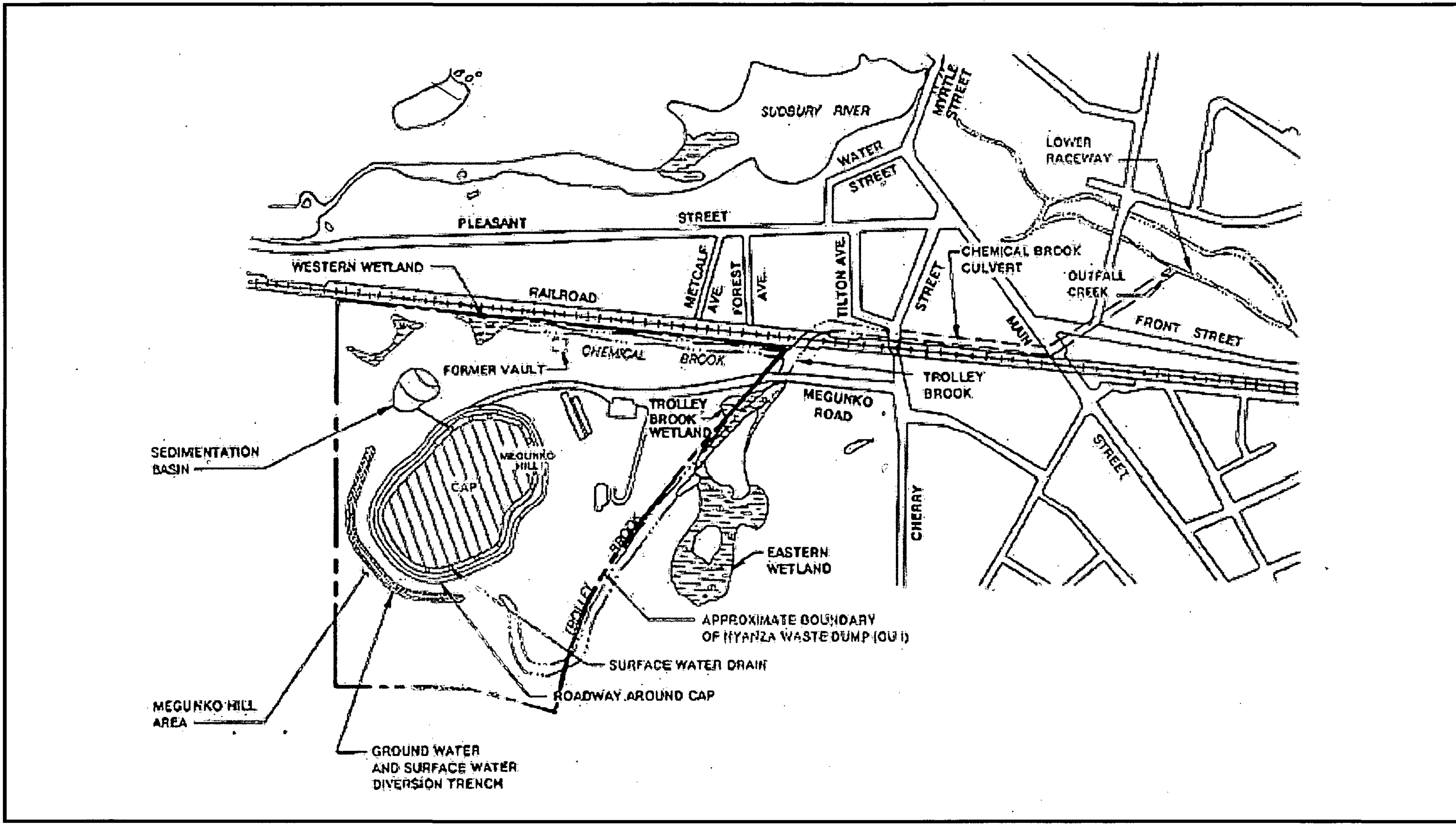
FIGURE A-1

OPERABLE UNIT 4 LOCUS - SUDBURY RIVER REACHES

Nyanza Chemical Waste Dump Superfund Site
OU4 - Sudbury River
Ashland, Massachusetts

DRAWN BY: JWC	APPROVED BY: SH
PROJECT: 80026	SEPTEMBER 2010

C:\Nyanza\APR\dfs_aquatic_maps_2010.apr | Reaches11x17 | c:\nyanza\exports\2010_maps\figa-1_reaches_091410.eps | 1:39 PM, 9/14/2010



Legend:

- Wetlands
- Brooks/Streams

N

Scale: 1" ≅ 700'

Nyanza Superfund Site OU IV
Sudbury River Mercury Contamination

Figure B-1
Nyanza Facility Map

Spatial Variation in Flux Magnitude
Due to Local Environmental Factors & Setting For Major Mercury Species

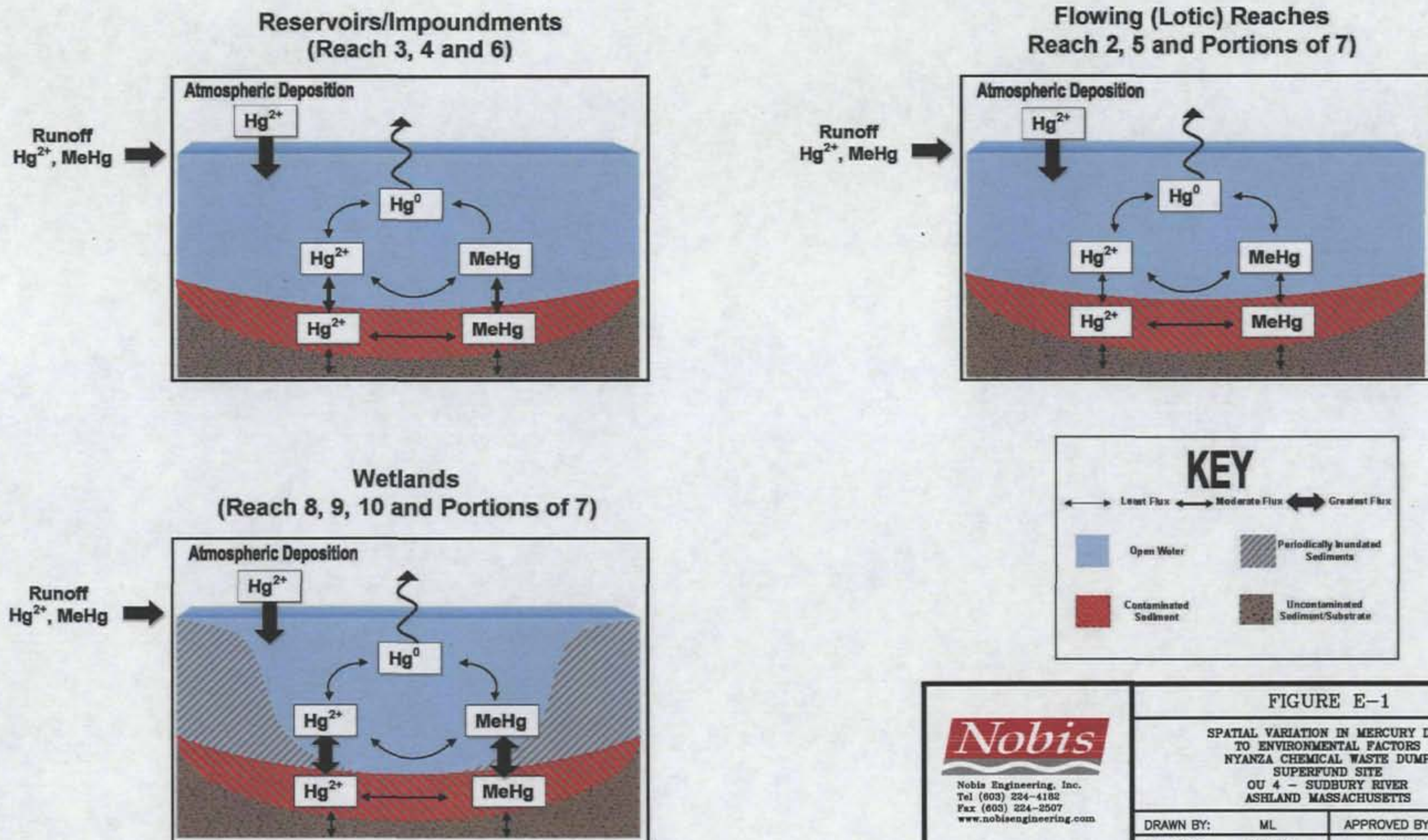


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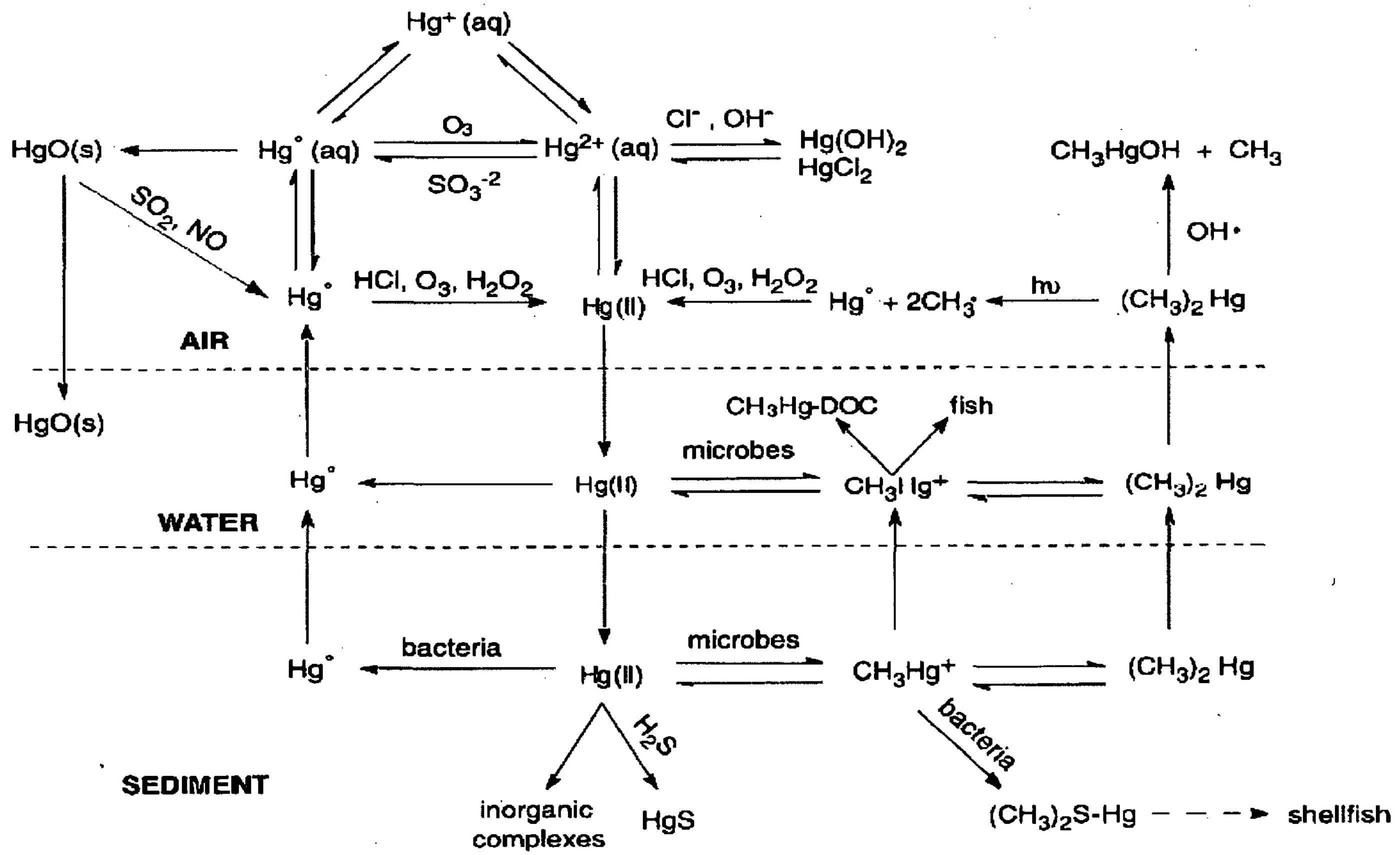
FIGURE E-1

SPATIAL VARIATION IN MERCURY DUE TO ENVIRONMENTAL FACTORS
NYANZA CHEMICAL WASTE DUMP SUPERFUND SITE
OU 4 – SUDBURY RIVER
ASHLAND MASSACHUSETTS

DRAWN BY:	ML	APPROVED BY:	SH
PROJECT:	80026	SEPTEMBER 2010	

R:\80000 Task Orders\80026 Nyanza OU4\Technical Data (TD)\CADD\dwg\80026.12-FIGURES.dwg

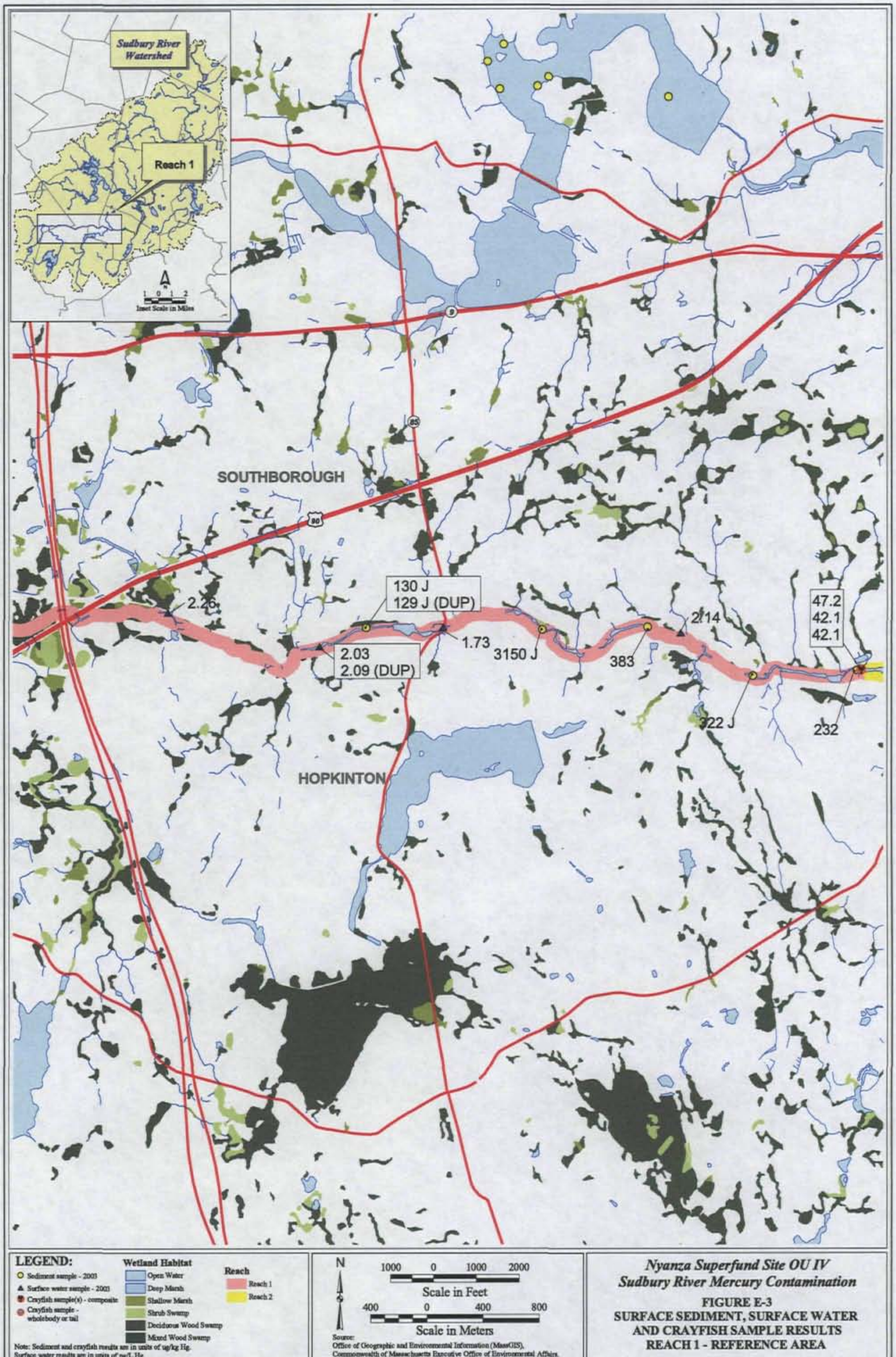
Figure E-2 Transformation of Mercury in Air, Water, and Sediment



Dashed lines represent the boundary between environmental compartments.

aq = associated with aqueous; DOC = dissolved organic carbon; s = solid

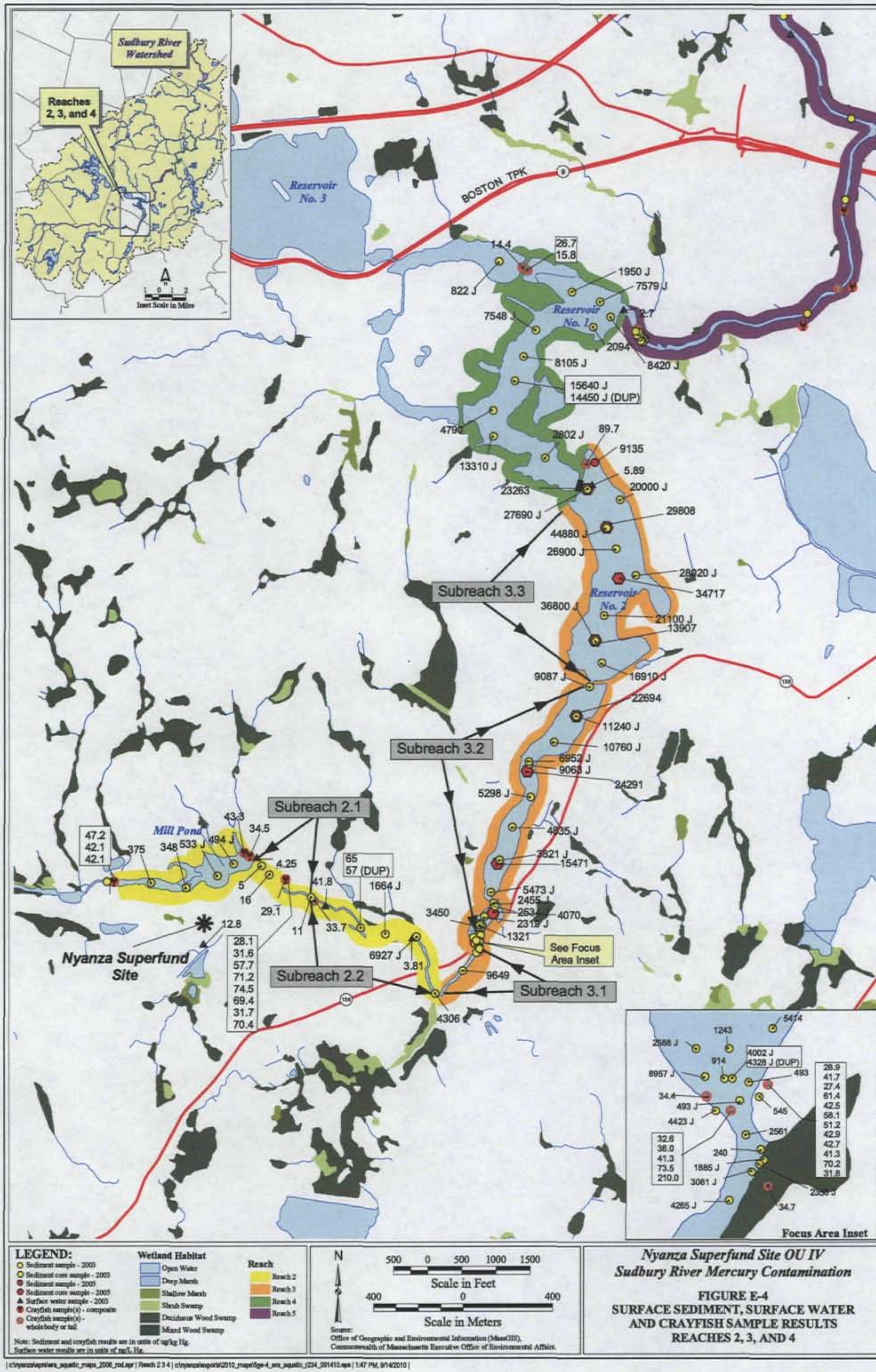
Source: Stem et al. 1996



Nyanza Superfund Site OU IV
Sudbury River Mercury Contamination

FIGURE E-3
SURFACE SEDIMENT, SURFACE WATER AND CRAYFISH SAMPLE RESULTS
REACH 1 - REFERENCE AREA

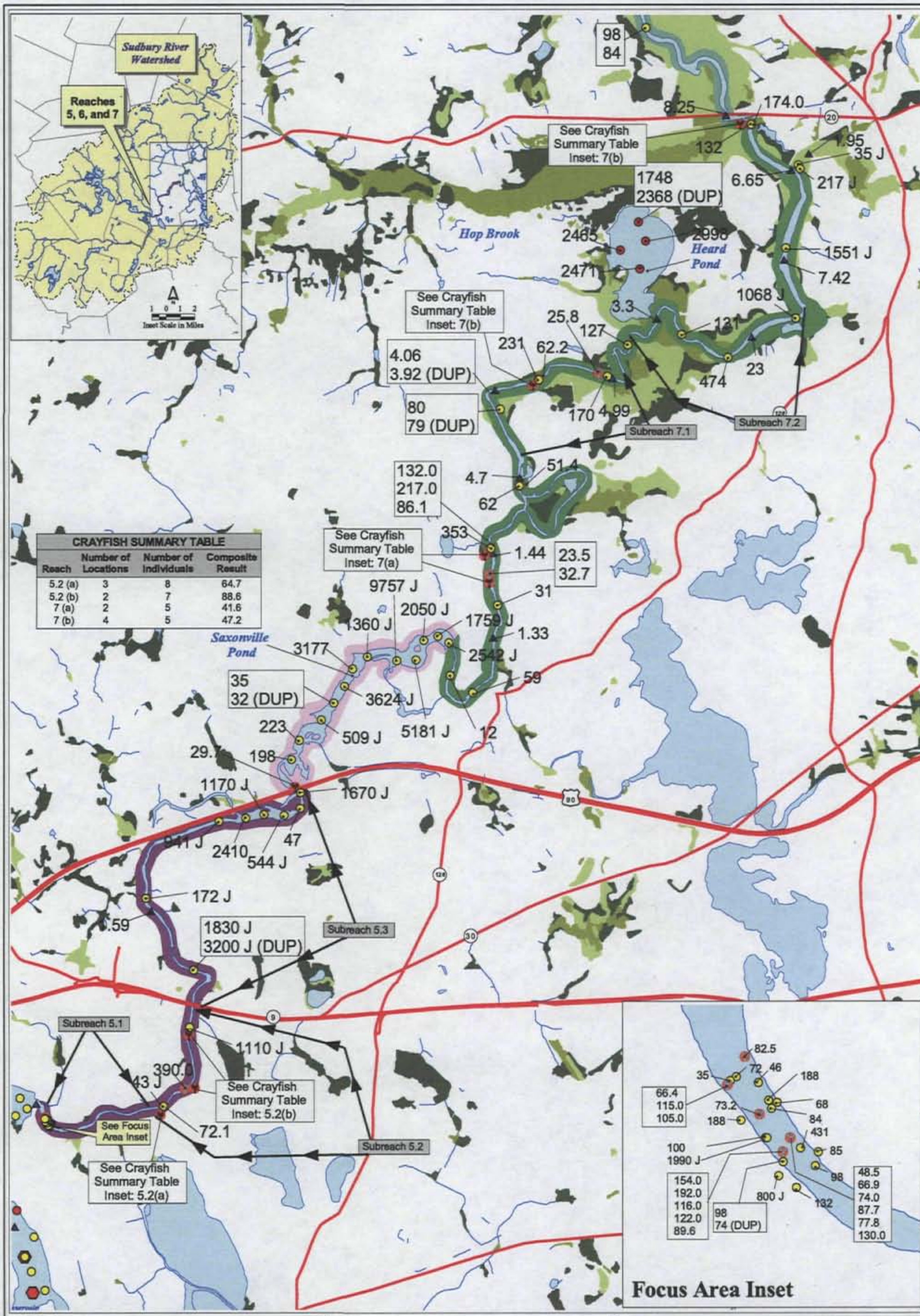
| c:\nyanza\apr\era_aquatic_maps_2006_rod.apr | Reach 1 | c:\nyanza\exports\2010_map\fig-3_era_aquatic_r1_091410.eps | 1:43 PM, 9/14/2010 |



Nyanza Superfund Site OU IV
Sudbury River Mercury Contamination

FIGURE E-4
SURFACE SEDIMENT, SURFACE WATER AND CRAYFISH SAMPLE RESULTS
REACHES 2, 3, AND 4

| c:\nyanza\apr\era_aquatic_maps_2008_rod.apr | Reach 2 3 4 | c:\nyanza\exports\2010_maps\figE-4_era_aquatic_r234_091410.eps | 1:47 PM, 9/14/2010 |



CRAYFISH SUMMARY TABLE			
Reach	Number of Locations	Number of Individuals	Composite Result
5.2 (a)	3	8	64.7
5.2 (b)	2	7	88.6
7 (a)	2	5	41.6
7 (b)	4	5	47.2

LEGEND:

- Sediment sample - 2003
- Sediment sample - 2005
- Sediment core sample - 2005
- Surface water sample - 2003
- Crayfish sample(s) - composite
- Crayfish sample(s) - wholebody or tail

Note: Sediment and crayfish results are in units of ug/kg Hg. Surface water results are in units of ng/L Hg.

Wetland Habitat

- Open Water
- Deep Marsh
- Shallow Marsh
- Shrub Swamp
- Deciduous Wood Swamp
- Mixed Wood Swamp

Reach

- Reach 5
- Reach 6
- Reach 7
- Reach 8

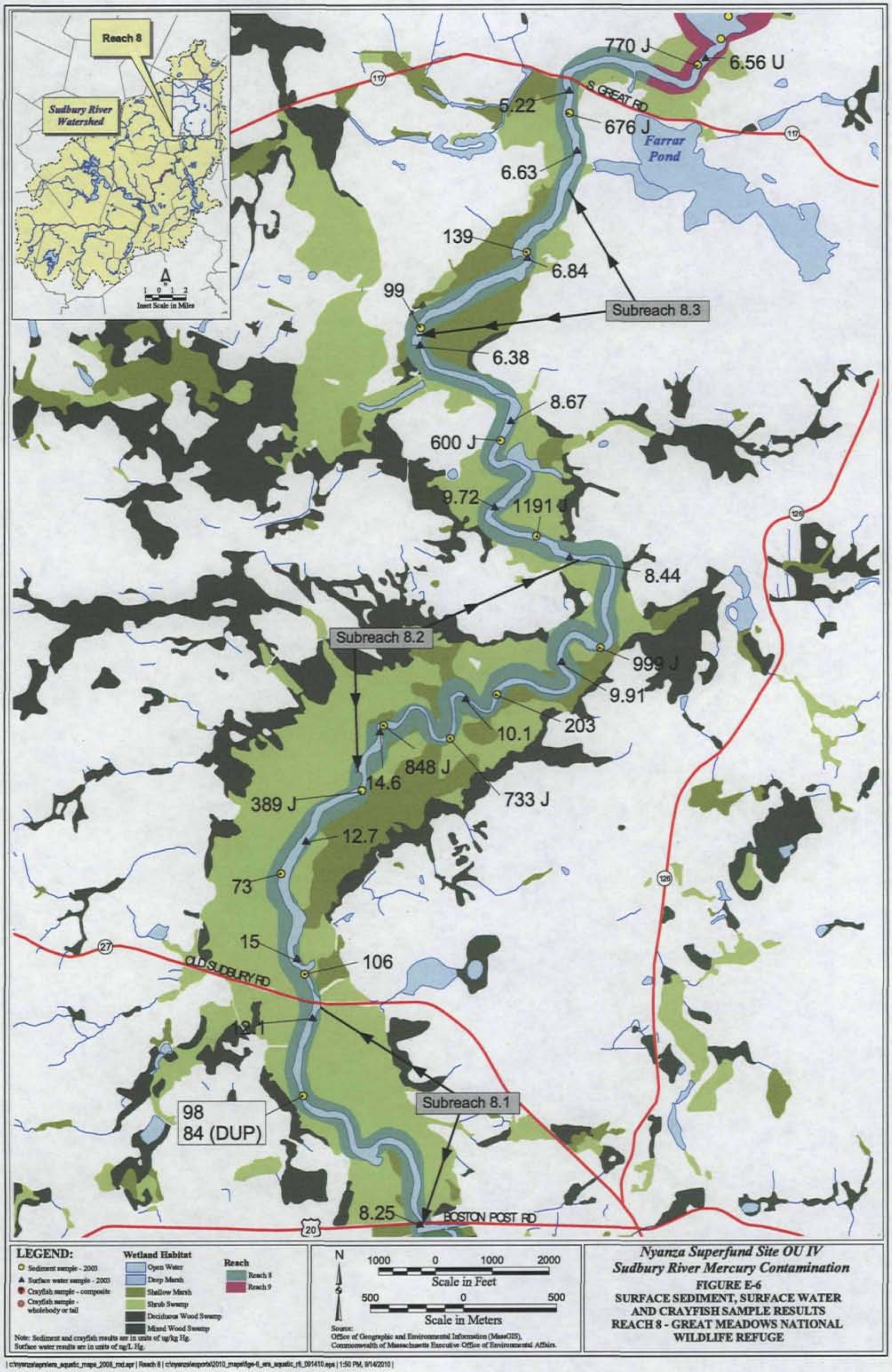
1000 0 1000 2000
Scale in Feet
400 0 400 800
Scale in Meters

Source:
Office of Geographic and Environmental Information (MassGIS),
Commonwealth of Massachusetts Executive Office of Environmental Affairs.

Nyanza Superfund Site OU IV
Sudbury River Mercury Contamination

FIGURE E-5
SURFACE SEDIMENT, SURFACE WATER AND CRAYFISH SAMPLE RESULTS REACHES 5, 6, AND 7

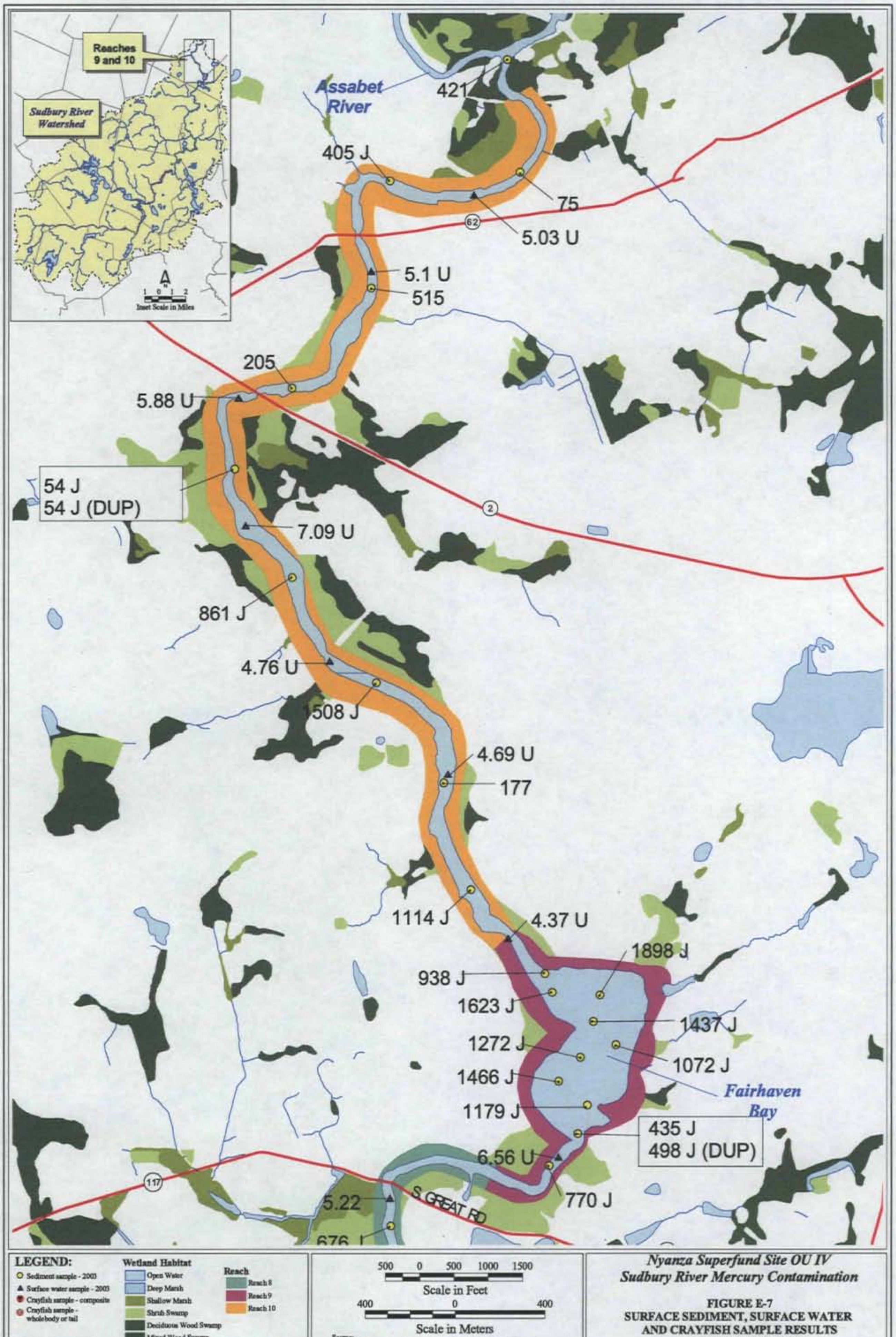
c:\nyanza\aprs\era_aquatic_maps_2008_rod.apr | Reach 5 6 7 | c:\nyanza\exports\2010_maps\fig e-5_era_aquatic_r567_091410.eps | 1:48 PM, 9/14/2010



Nyanza Superfund Site OU IV
Sudbury River Mercury Contamination

FIGURE E-6
SURFACE SEDIMENT, SURFACE WATER AND CRAYFISH SAMPLE RESULTS REACH 8 - GREAT MEADOWS NATIONAL WILDLIFE REFUGE

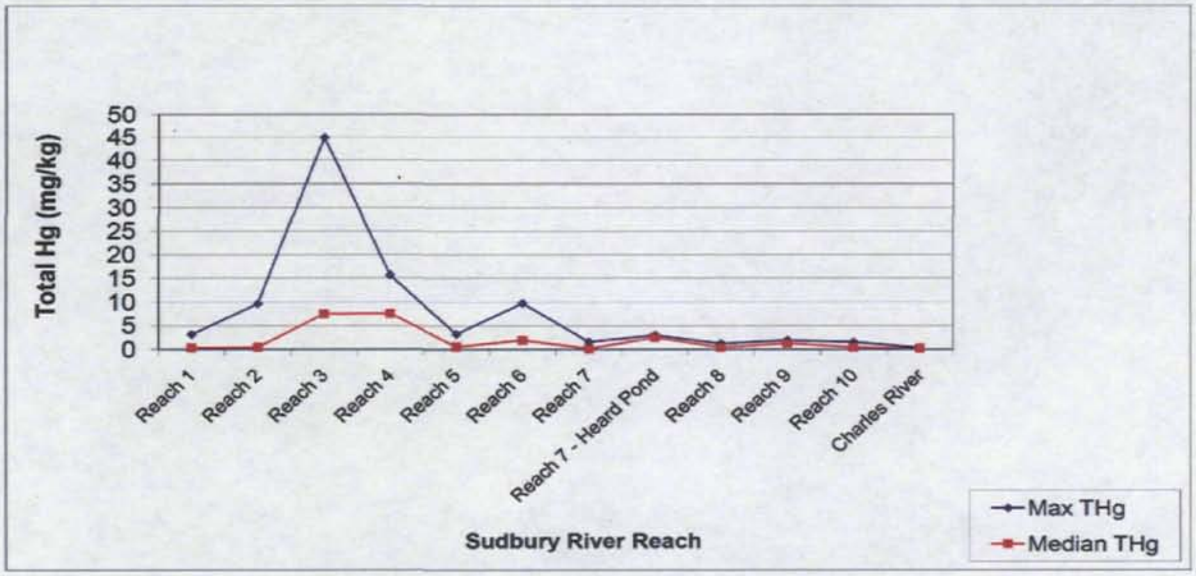
c:\nyanza\apr\era_aquatic_maps_2008_rod.apr | Reach 8 | c:\nyanza\export\2010_maps\figs-6_era_aquatic_r8_091410.eps | 1:50 PM, 9/14/2010 |



Nyanza Superfund Site OU IV
Sudbury River Mercury Contamination

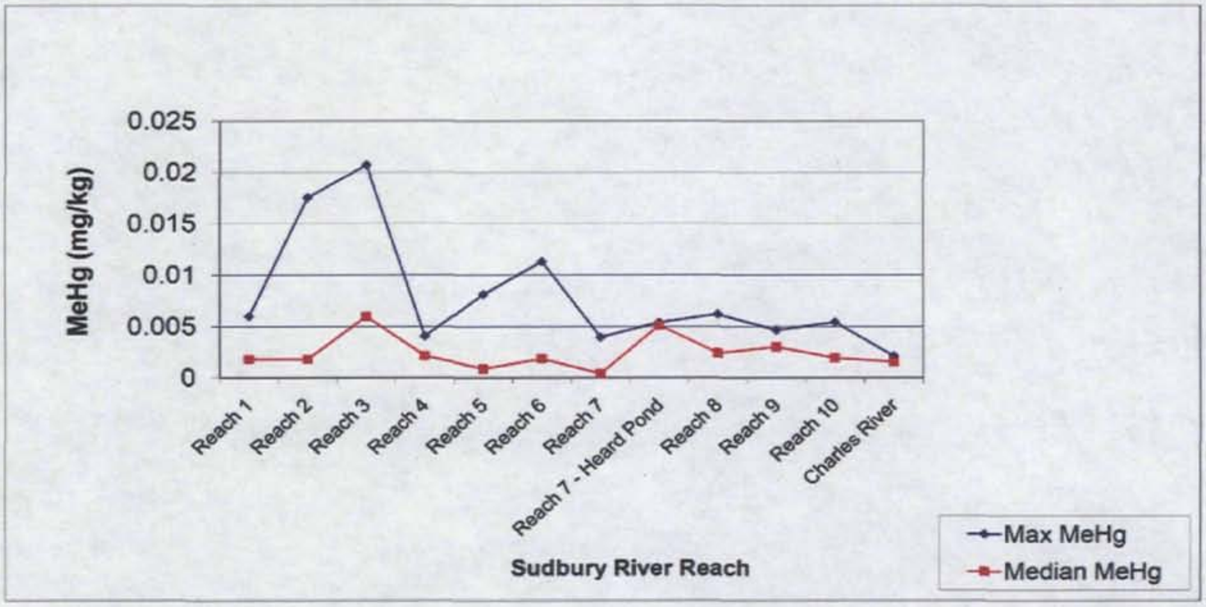
FIGURE E-7
SURFACE SEDIMENT, SURFACE WATER AND CRAYFISH SAMPLE RESULTS REACHES 9 AND 10

Figure E-8
2003 – 2005 Sediment Total Hg
Nyanza Chemical Waste Dump Superfund Site
Operable Unit 4 – Sudbury River
Ashland, Massachusetts



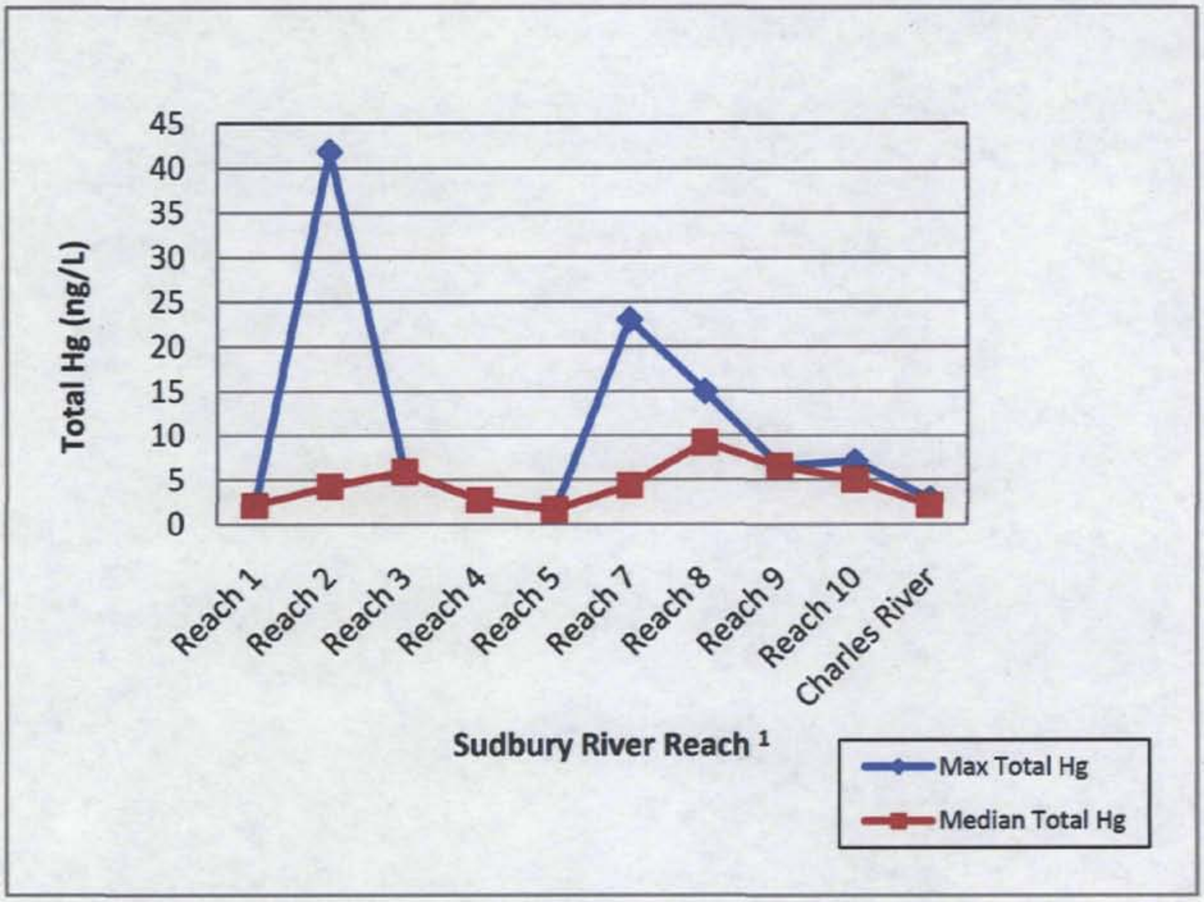
Notes:
mg/kg = milligrams per kilogram
Hg = mercury
MeHg = methylmercury
Max = maximum detection
Data adopted from: the *Supplemental Baseline and Ecological Risk Assessment* (Nobis, 2008)

Figure E-8
2003 – 2005 Sediment MeHg
Nyanza Chemical Waste Dump Superfund Site
Operable Unit 4 – Sudbury River
Ashland, Massachusetts



Notes:
mg/kg = milligrams per kilogram
Hg = mercury
MeHg = methylmercury
Max = maximum detection
Data adopted from: the *Supplemental Baseline and Ecological Risk Assessment* (Nobis, 2008)

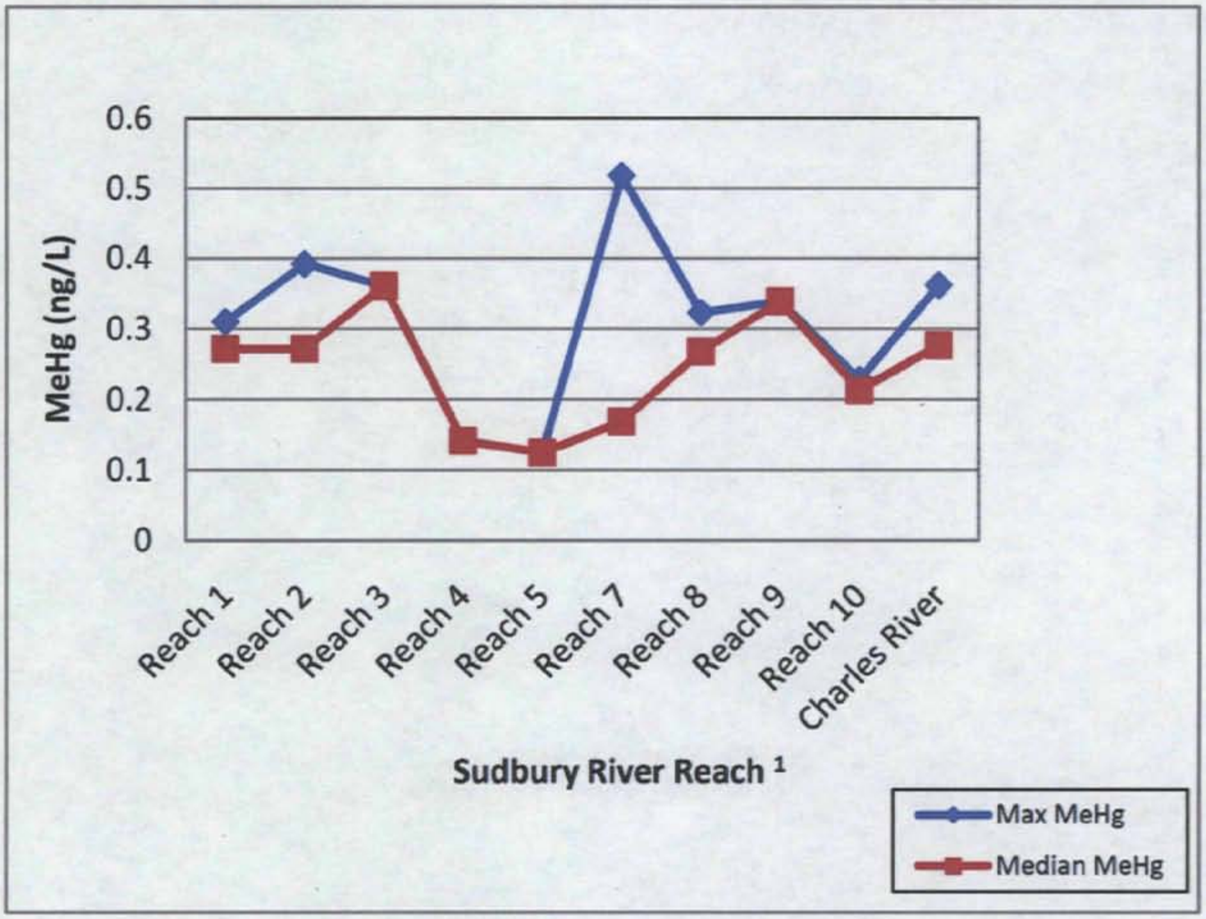
Figure E-9
2003 – 2005 Surface Water Total Hg
Nyanza Chemical Waste Dump Superfund Site
Operable Unit 4 – Sudbury River
Ashland, Massachusetts



Notes:
Results are unfiltered
ng/L = nanograms per liter
Hg = mercury
Max = maximum detection
Data adopted from: the *Supplemental Baseline and Ecological Risk Assessment* (Nobis, 2008); and, the *Report Summarizing Data Collected for the Nyanza Mercury Modeling Effort* (TechLaw, 2009).

1. No data was available for Reach 6 during 2003-2005; only one sample was collected from Reach 9 and non-detect results were obtained for all samples collected from Reaches 9 and 10 per laboratory methodology.

Figure E-9
2003 – 2005 Surface Water MeHg
Nyanza Chemical Waste Dump Superfund Site
Operable Unit 4 – Sudbury River
Ashland, Massachusetts



Notes:
Results are unfiltered
ng/L = nanograms per liter
MeHg = methylmercury
Max = maximum detection
Data adopted from: the *Supplemental Baseline and Ecological Risk Assessment* (Nobis, 2008); and, the *Report Summarizing Data Collected for the Nyanza Mercury Modeling Effort* (TechLaw, 2009).

1. No data was available for Reach 6 during 2003-2005; only one sample was collected from Reach 9 and non-detect results were obtained for all samples collected from Reaches 9 and 10 per laboratory methodology.

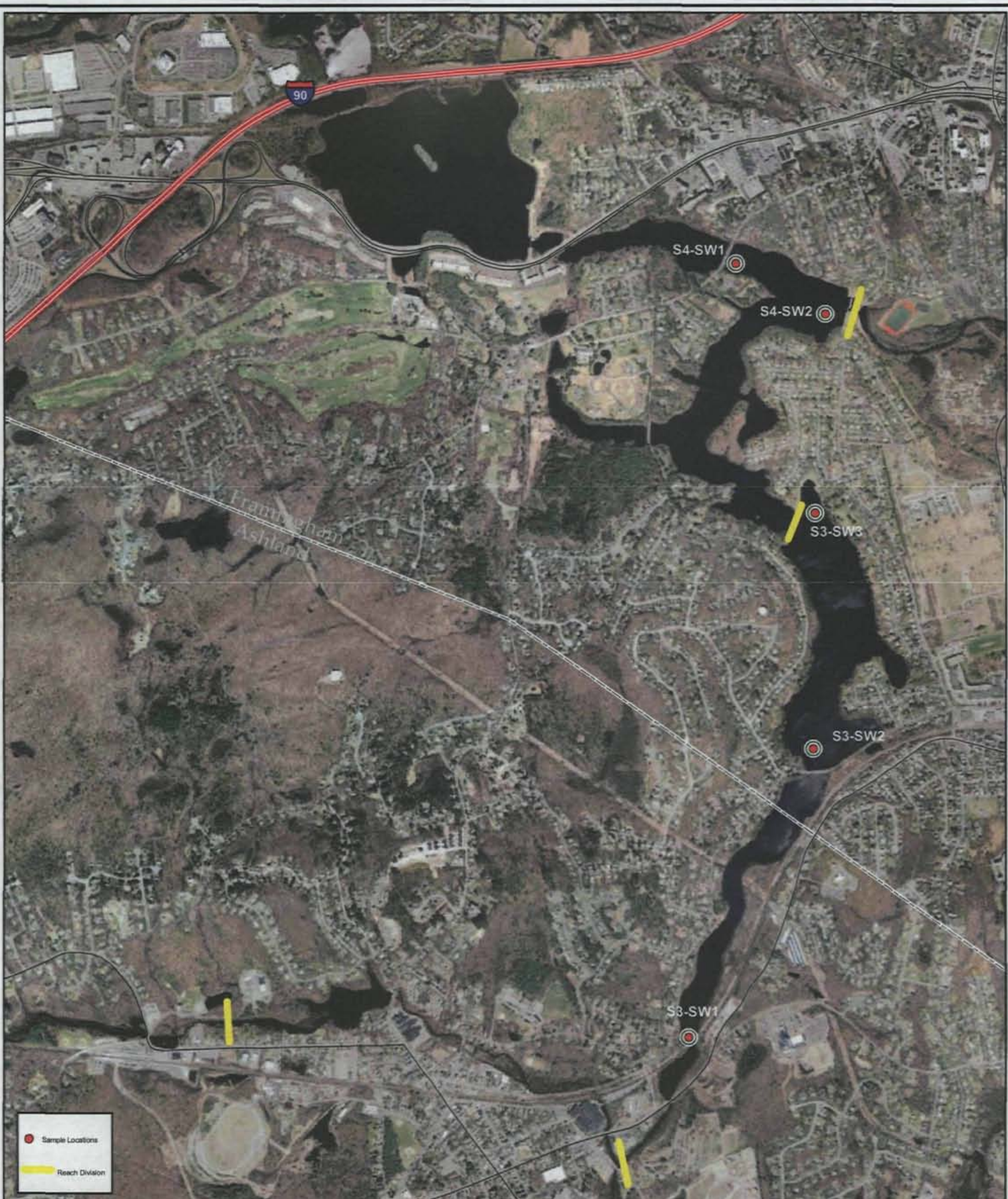


Figure E-10. Reaches 3 & 4 Low-Level Mercury Surface Water Sampling Locations

Produced By The EPA New England GIS Center
October 6, 2008
Map Tracker 4586

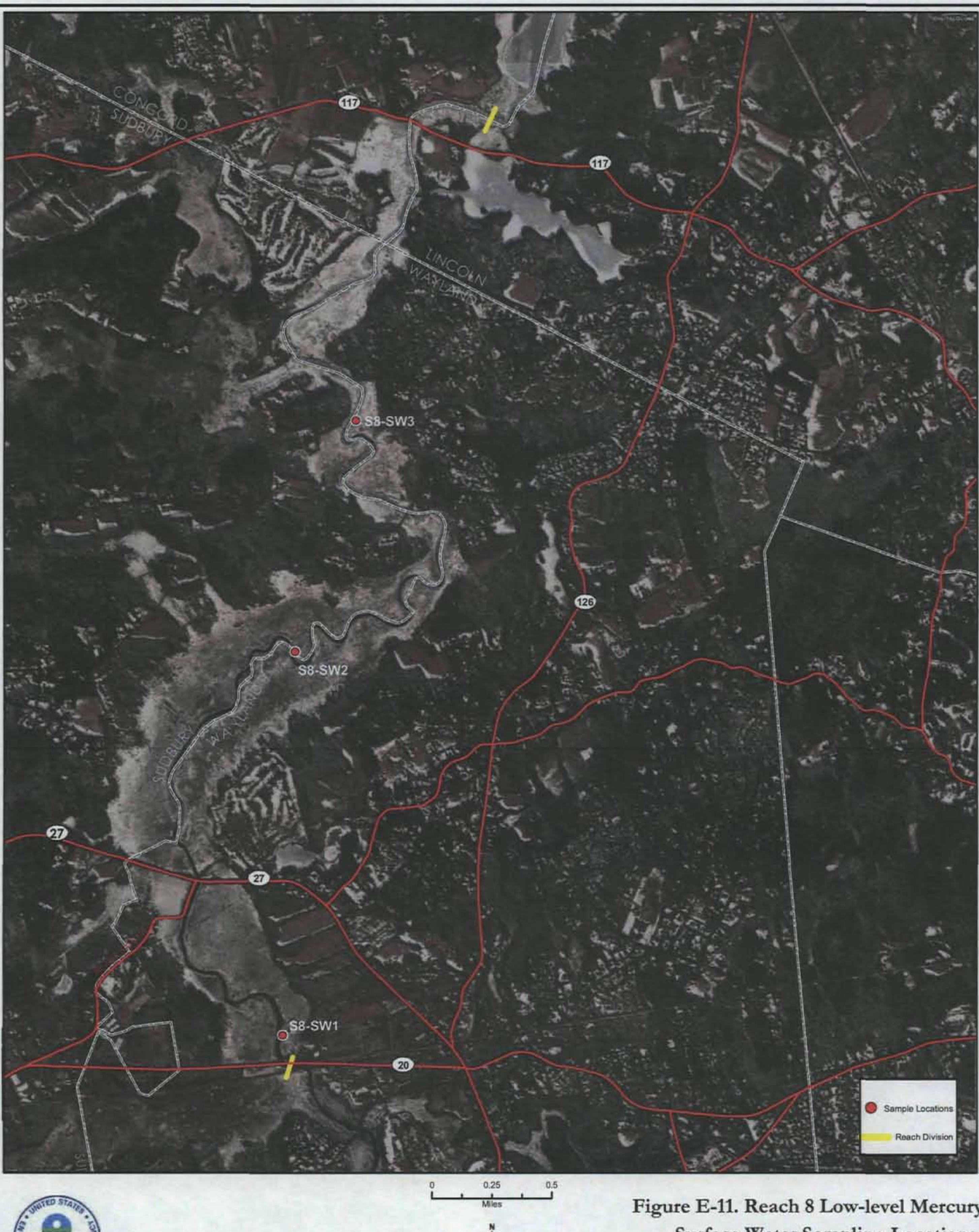


Figure E-11. Reach 8 Low-level Mercury Surface Water Sampling Locations

Produced By The EPA New England GIS Center
October 2, 2008
Map Tracker 4586

Figure E-12 Reach 3 - 2007/2008 Surface Water Data

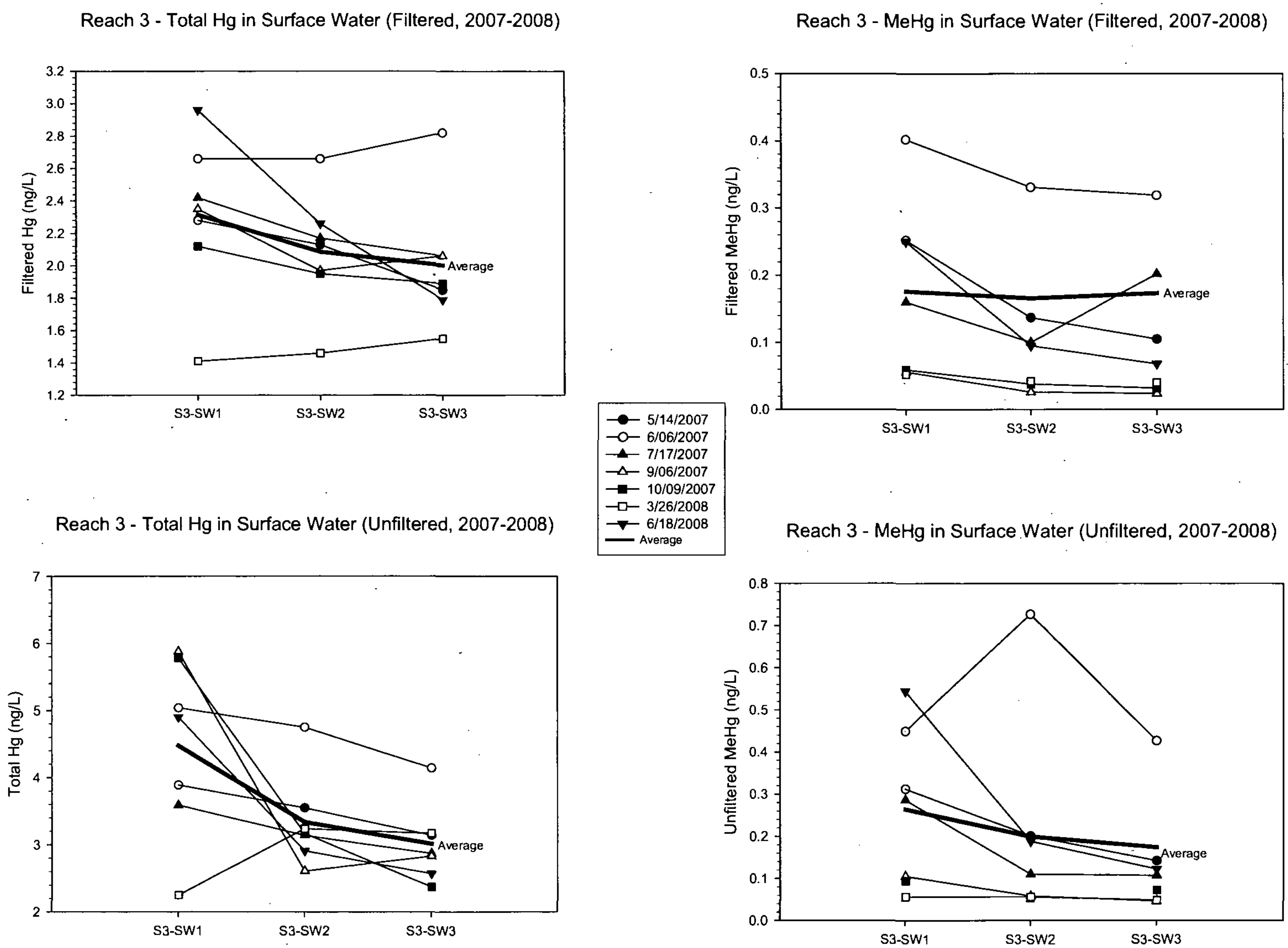
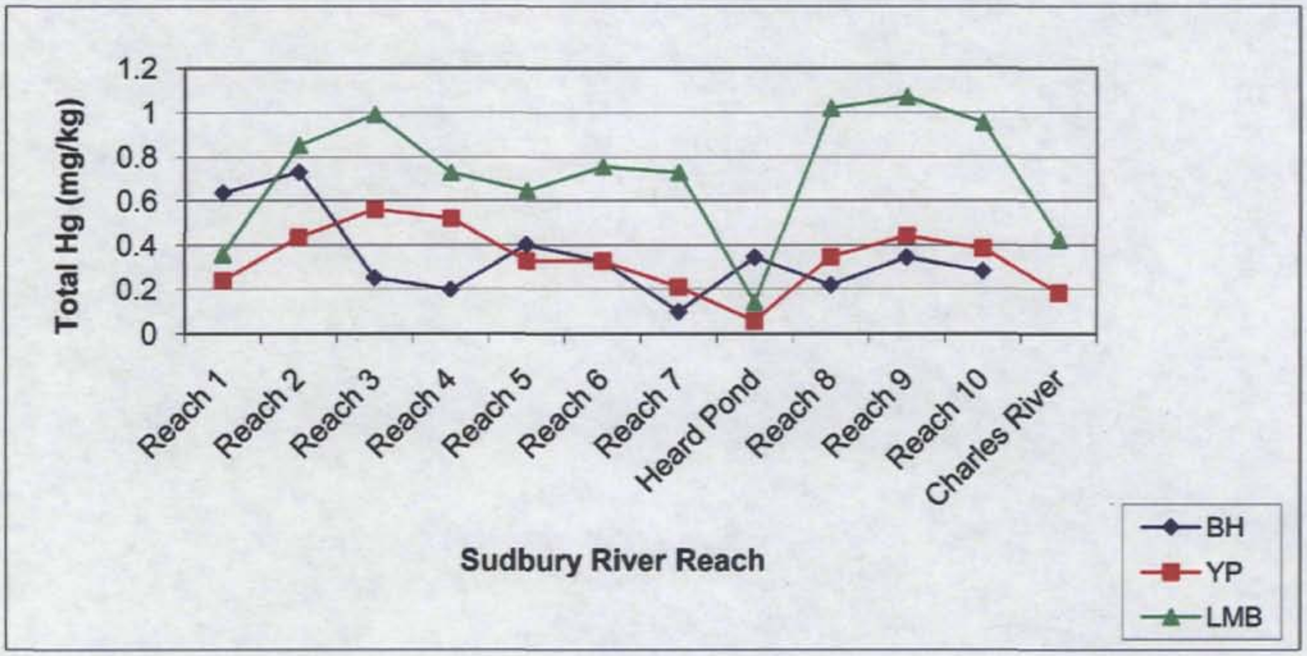
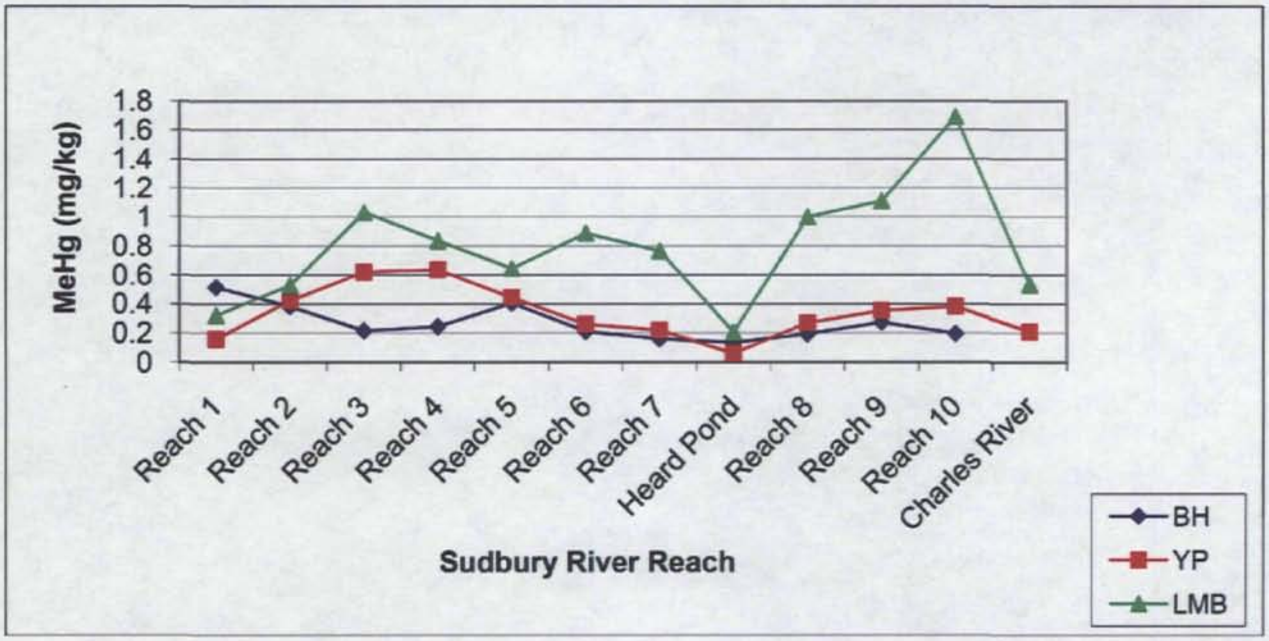


Figure E-13
2003 – 2005 Fish Tissue Total Hg
Nyanza Chemical Waste Dump Superfund Site
Operable Unit 4 – Sudbury River
Ashland, Massachusetts



Notes:
mg/kg = milligrams per kilogram
Hg = mercury
BH = bullhead
YP = yellow perch
LMB = large mouth bass
Data adopted from the *Supplemental Human Health Risk Assessment* (Avatar, 2006)

Figure E-13
2003 – 2005 Fish Tissue MeHg
Nyanza Chemical Waste Dump Superfund Site
Operable Unit 4 – Sudbury River
Ashland, Massachusetts



Notes:
mg/kg = milligrams per kilogram
MeHg = methylmercury
BH = bullhead
YP = yellow perch
LMB = large mouth bass
Data adopted from the *Supplemental Human Health Risk Assessment* (Avatar, 2006)

Figure E-14 Comparison of Predicted versus Observed (Filtered MeHg) for each Sampling Location for Final Model Design and Output: Annual Means and Standard Deviations

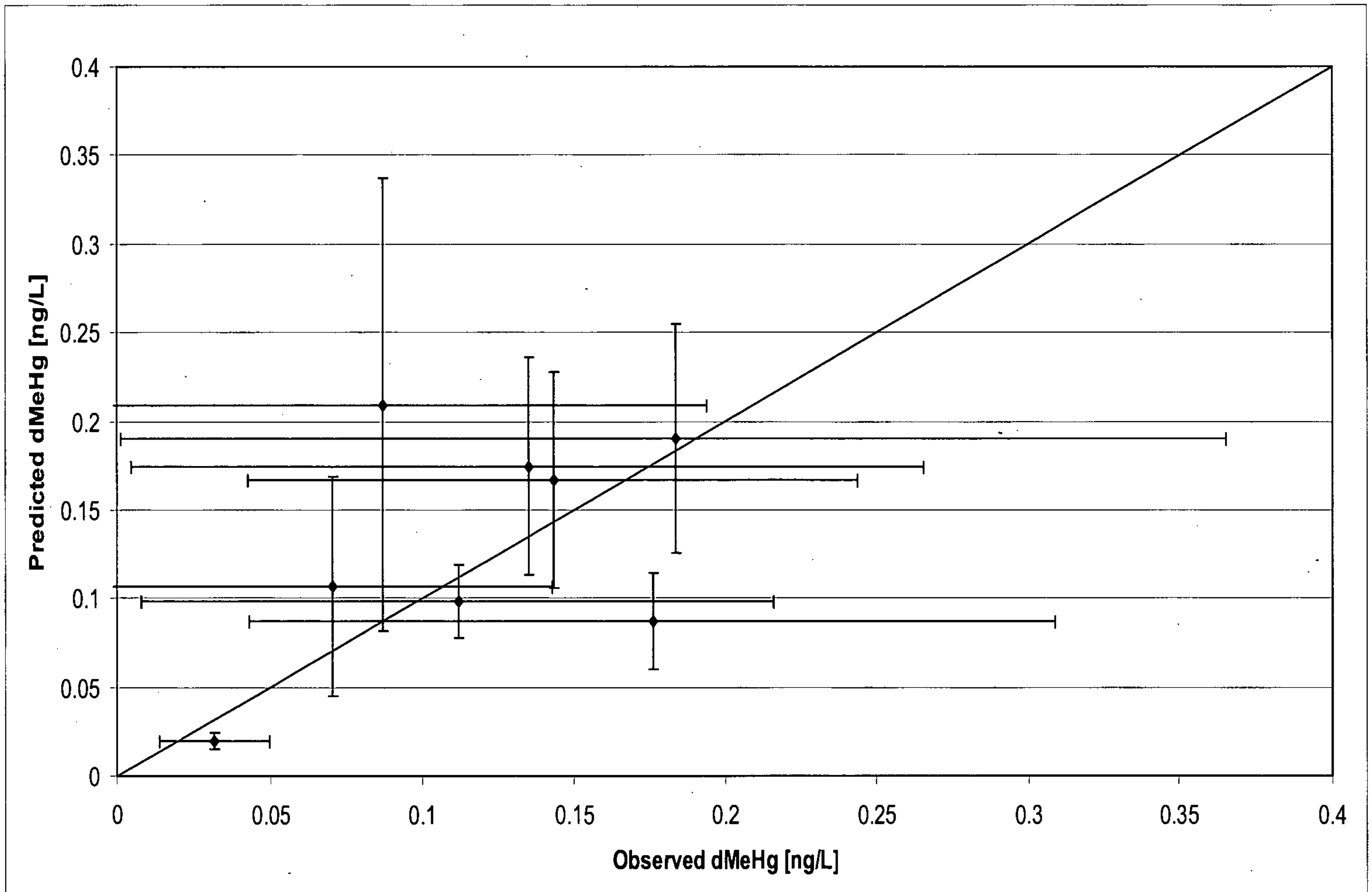


Figure E-15 Comparison of Predicted versus Observed (Unfiltered MeHg) for each Sampling Location for Final Model Design and Output: Annual Means and Standard Deviations

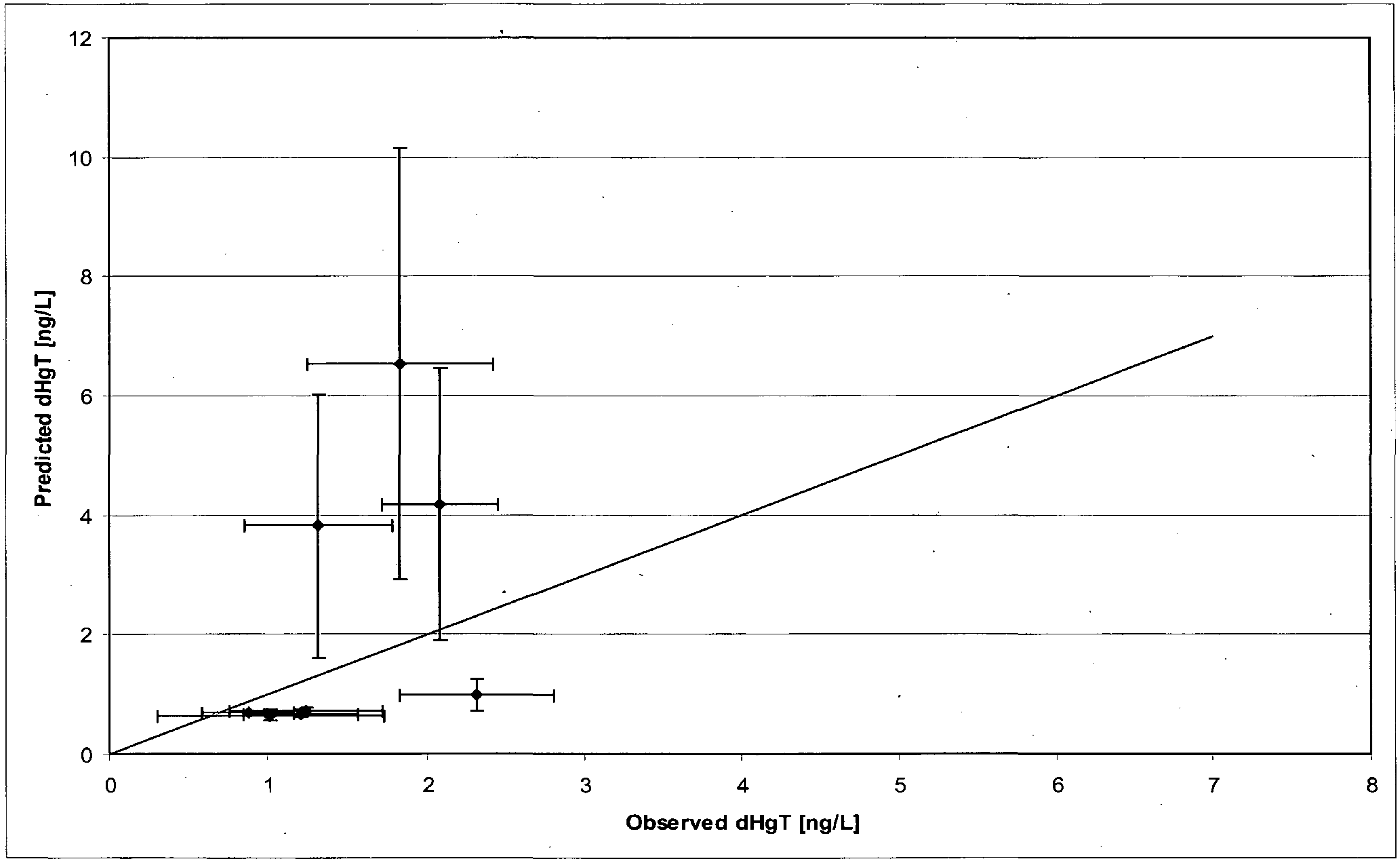


Figure J-1
Remedial Alternatives Summary
Nyanza Chemical Waste Dump Superfund Site
Operable Unit 4 - Sudbury River
Ashland, Massachusetts

Alternatives	Remedial Action	2	3	4	6	8	9	10
Alternative 1	No Action	NA	NA	NA	NA	NA	NA	NA
Alternative 2	Limited Action (LA)	LA	LA	LA	LA	LA	LA	LA
Alternative 3A	Monitored Natural Recovery (MNR)	MNR	MNR	MNR	MNR	LA	MNR	MNR
Alternative 3B	Enhanced Natural Recovery	MNR	Thin Layer Placement	MNR	MNR	LA	MNR	MNR
Alternative 3C	Enhanced Natural Recovery	MNR	Thin Layer Placement	Thin Layer Placement	Thin Layer Placement	LA	MNR	MNR
Alternative 4A	In Situ Containment of Reach 3 Sediment Where Hg > 2 mg/kg	MNR	Capping	MNR	MNR	LA	MNR	MNR
Alternative 4B	In Situ Containment of Reaches 3, 4, and 6 Sediment Where Hg > 2 mg/kg	MNR	Capping	Capping	Capping	LA	MNR	MNR
Alternative 5B	Sediment Removal within Reach 3 Where Hg > 10 mg/kg and In Situ Containment in Reaches 3, 4, and 6 Where Hg > 2 mg/kg in Sediment	MNR	Partial Removal/ Capping	Capping	Capping	LA	MNR	MNR
Alernative 5A	Sediment Removal in Reach 3 Where Hg > 10 mg/kg	MNR	Partial Removal	MNR	MNR	LA	MNR	MNR
Alternative 5C	Sediment Removal in Reach 3 Where Hg > 2 mg/kg	MNR	Removal	MNR	MNR	LA	MNR	MNR
Alternative 5D	Sediment Removal in Reaches 3, 4, and 6 Where Hg > 2 mg/kg	MNR	Removal	Removal	Removal	LA	MNR	MNR

Notes:

Hg = total mercury
MeHg = methylmercury
mg/kg = milligrams per kilogram
MNR = Monitored Natural Recovery

LEGEND:

Sediment Samples
- < 2000
- 2,000 - 10,000
- > 10,000

Sediment Cores Samples
- < 2000
- 2,000 - 10,000
- > 10,000
- Area > 10 mg/kg Hg

Wetland Habitat
- Open Water
- Deep Marsh
- Shallow Marsh
- Shrub Swamp
- Deciduous Wood Swamp
- Mixed Wood Swamp

Reach
- Reach 2
- Reach 3
- Reach 4

Note: Sediment results are in units of ug/kg Hg.

N

500 0 500 1000
Scale in Feet

200 0 200 400
Scale in Meters

Source:
Office of Geographic and Environmental Information (MassGIS),
Commonwealth of Massachusetts Executive Office of Environmental Affairs.

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FIGURE J-2

SURFACE SEDIMENT AREAS >10 mg/kg REACH 3

Nyanza Chemical Waste Dump Superfund Site
OU4 - Sudbury River
Ashland, Massachusetts

DRAWN BY: JWC	APPROVED BY: SH
PROJECT: 80026	SEPTEMBER 2010

| C:\Nyanza\APR\dfs_aquatic_maps_2010_091410.apr | Reach 3 Plus 10ppm | c:\nyanza\exports\rifig-2_fs_aquatic_r3_093010.eps | 10:14 AM, 9/30/2010 |

N

Drawn By: DWC	Checked By: SWH
Filename: FigL1-Reach 3 Base.091510.mxd	
Date: 09/15/10	Revision No. 00

APPROXIMATE SCALE

0 250 500 1,000 Feet

Legend

- Railroad
- County Bondary
- Municipal Boundary
- Highways/Major Roads
- Primary Road, Limited Access
- Primary Road, Not Limited Access
- Secondary Road
- Local Road, Access Ramp
- Vehicular Trail
- Segment Break
- Surface Water
- Reach 2
- Reach 3
- Reach 4

FIGURE L-1
POTENTIAL STAGING AREA DETAIL
REACH 3 SEGMENTS
NYANZA CHEMICAL WASTE DUMP
SUPERFUND SITE
OU4 - SUDBURY RIVER
ASHLAND, MASSACHUSETTS

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Concord, NH 03301
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fax (603) 224-2507
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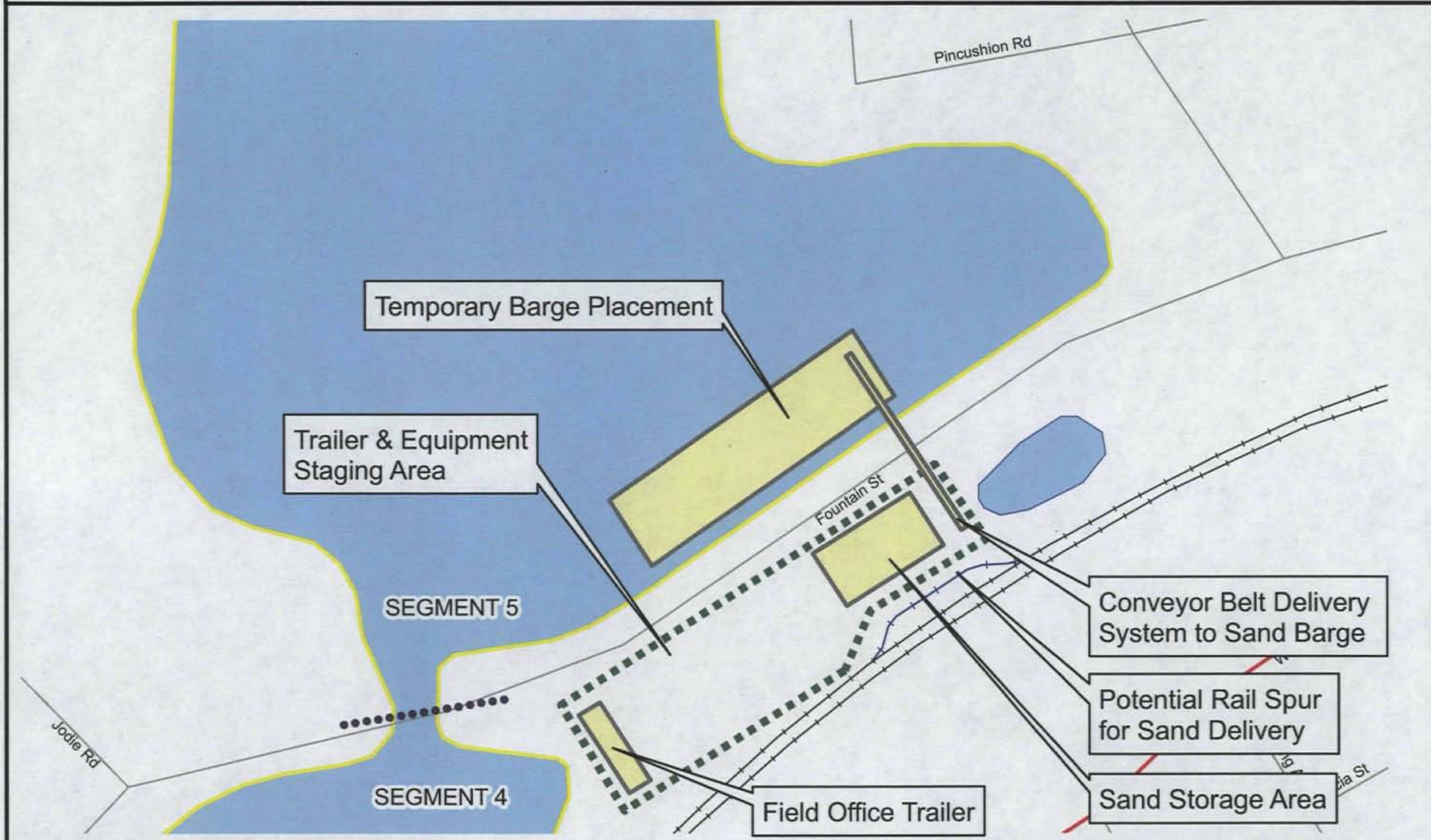
AREA OF DETAIL: POTENTIAL STAGING AREA



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Drawn By: DWC | Checked By: SWH

Filename: FigL2-Reach 3 Detail.091510.mxd

Date: 09/15/10 | Revision No. 00

APPROXIMATE SCALE
0 100 200 Feet

Legend

- Railroad
- County Bondary
- Municipal Boundary
- Highways/Major Roads
- Primary Road, Limited Access
- Primary Road, Not Limited Access
- Secondary Road
- Local Road, Access Ramp
- Vehicular Trail
- Segment Break
- Surface Water
- Reach 2
- Reach 3
- Reach 4

FIGURE L-2
POTENTIAL STAGING AREA DETAIL
REACH 3 SEGMENTS
NYANZA CHEMICAL WASTE DUMP
SUPERFUND SITE
OU4 - SUDBURY RIVER
ASHLAND, MASSACHUSETTS

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Appendix B

Tables

Table G-1: Summary of the receptor groups and measurement endpoints evaluated in the BERA by Sudbury River reach											
Receptor Group	measurement endpoint	R2	R3	R4	R5	R6	R7	R7(HP)	R8	R9	R10
BENTHIC INVERTEBRATES											
generic	compare [Hg] in sediment to benchmarks	•	•	•	•	•	•	•	•	•	•
mayfly test	sediment toxicity + bioaccumulation test		•						•	•	
freshwater mussel test	*in-situ* toxicity + bioaccumulation test	•	•	•		•				•	•
crayfish	compare [Hg] in crayfish to CBRs	•	•	•	•	•	•				
FISH											
generic	compare [Hg] in surface water to benchmarks	•	•	•	•		•		•		
sunfish	compare [Hg] in fish to CBRs	•	•	•	•	•	•		•	•	•
bullhead	compare [Hg] in fish to CBRs	•	•	•	•	•	•	•	•	•	•
yellow perch	compare [Hg] in fish to CBRs	•	•	•	•	•	•	•	•	•	•
largemouth bass	compare [Hg] in fish to CBRs	•	•	•	•	•	•	•	•	•	•
BIRDS											
tree swallow	compare estimated daily dose of Hg to TRVs	•	•	•	•	•	•		•	•	
	compare [Hg] in eggs to CBRs		•	•				•	•		
	compare [Hg] in nestling blood to CBRs		•	•							
	compare [Hg] in nestling feathers to CBRs		•	•							
	compare [Hg] in adult blood to CBRs		•	•			•	•	•		
	compare [Hg]in adult feathers to CBRs		•	•			•	•	•		
marsh birds*	compare [Hg] in eggs to CBRs						•			•	•
	compare [Hg] in adult blood to CBRs						•	•			
	compare [Hg]in adult feathers to CBRs						•				
redwing blackbird	compare [Hg] in adult blood to CBRs								•		
wood duck	compare [Hg] in eggs to CBRs								•		
	compare [Hg] in adult blood to CBRs						•		•		
	compare [Hg]in adult feathers to CBRs						•		•		
hooded merganser	compare [Hg] in eggs to CBRs			•					•		
	compare [Hg] in adult blood to CBRs								•		
	compare [Hg] in adult feathers to CBRs								•		
great blue heron	compare estimated daily dose of Hg to TRVs	•	•	•	•	•	•	•	•	•	•
belted kingfisher	compare estimated daily dose of Hg to TRVs	•	•	•	•	•	•	•	•	•	•
	compare [Hg] in eggs to CBRs								•		
	compare [Hg] in nestling blood to CBRs						•		•		
	compare [Hg] in nestling feathers to CBRs						•				
	compare [Hg] in adult blood to CBRs								•		
	compare [Hg]in adult feathers to CBRs								•		
MAMMALS											
mink	compare estimated daily dose of Hg to TRVs	•	•	•	•	•	•	•	•	•	•
	compare [Hg] in adult blood to CBRs			•			•				
	compare [Hg] in adult fur to CBRs			•	•		•				

CBR = critical body residue; HP = Heard Pond; R = reach; TRV = toxicity reference value

note: a measurement endpoint may not have been evaluated in a particular reach for one of the following reasons: (a) a receptor was absent from a reach (e.g., marsh birds in R3); (b) sampling was performed but no samples could be collected (e.g., crayfish in R10); (c) no sample was collected (e.g., surface water in R9); or (d) a test was not performed (e.g., *in-situ* mussel exposure in R8)

*marsh bird species consist of one or more of the following: eastern kingbird, song sparrow, swamp sparrow, water thrush, yellow throat, yellow warbler,

shaded blocks identify measurement endpoints summarized in Section G of the ROD

Table G-2: Common wildlife species associated with the Sudbury River					
Common Name	**Scientific Name**	**Seasonal Presence**			
		W	**Sp**	**Su**	**F**
BIRDS					
Blue-winged teal	*Anas discors*		X	X	X
American black duck	*Anas rubripes*		X	X	X
Mallard	*Anas platyrhynchos*	X	X	X	X
Wood duck	*Aix sponsa*		X	X	X
Ring-necked duck	*Aythya cottaris*		X		X
Common merganser	*Mergus merganser*			X	X
American bittern	*Botaurus lentiginosus*		X	X	X
Great blue heron	*Ardea herodias*		X	X	X
Black-crowned night heron	*Nycticorax nycticorax*		X	X	X
Green-backed heron	*Butorides striatus*		X	X	X
Killdeer	*Charadrius vociferus*		X	X	X
Osprey	*Pandion haliaetus*		X	X	X
Red-tailed hawk	*Buteo jamaicensis*	X	X	X	X
Northern harrier	*Circus cyaneus*	X	X	X	X
American kestrel	*Falco sparverius*	X	X	X	X
Belted kingfisher	*Ceryle alcyon*	X	X	X	X
Downy woodpecker	*Picoides pubescens*	X	X	X	X
Eastern kingbird	*Tyrannus tyrannus*		X	X	X
Barn swallow	*Hirundo rustica*		X	X	X
Tree swallow	*Tachycineta bicolor*		X	X	X
Tufted titmouse	*Parus bicolor*	X	X	X	X
Black-capped chickadee	*Parus atricapillus*	X	X	X	X
White-breasted nuthatch	*Sitta carolinensis*	X	X	X	X
Gray catbird	*Dumetella carolnensis*	X	X	X	X
Marsh wren	*Cistothorus palustris*		X	X	X

Table G-2: Common wildlife species associated with the Sudbury River					
Common Name	Scientific Name	Seasonal Presence			
		W	Sp	Su	F
Yellow warbler	*Dendroica petechia*		X	X	X
Common yellowthroat	*Geothylpis trichas*		X	X	X
Red-winged blackbird	*Agelaius phoeniceus*		X	X	X
Common grackle	*Quiscalus quiscula*	X	X	X	X
Song sparrow	*Melospiza melodia*	X	X	X	X
MAMMALS					
Virginia opossum	*Didelphis virginiana*	X	X	X	X
Raccoon	*Procyon lotor*	X	X	X	X
Long-tailed weasel	*Mustela frenata*	X	X	X	X
Mink	*Mustela vison*	X	X	X	X
River otter	*Lutra canadensis*	X	X	X	X
Striped skunk	*Mephitis mephitis*	X	X	X	X
Masked shrew	*Sorex cinereus*	X	X	X	X
Water shrew	*Sorex palustris*	X	X	X	X
Short-tailed shrew	*Blarina brevicauda*	X	X	X	X
Little brown myotis	*Myotis lucifugus*		X	X	X
Eastern pipistrelle	*Pipistrellus subflavus*		X	X	X
Beaver	*Castor canadenis*	X	X	X	X
Southern bog lemming	*Synaptomys cooperi*	X	X	X	X
Meadow vole	*Microtus pennsylvanicus*	X	X	X	X
Eastern cottontail	*Sylvilagus floridanus*	X	X	X	X
New England cottontail	*Sylvilagus transitionalis*	X	X	X	X
Eastern chipmunk	*Tamias striatus*	X	X	X	X
White-tailed deer	*Odocoileus virginianus*	X	X	X	X
REPTILES AND AMPHIBIANS					
Northern dusky salamander	*Desmognathus fuscus*		X	X	X
Northern two-lined salamander	*Eurycea bislineata*		X	X	X

Table G-2: Common wildlife species associated with the Sudbury River					
Common Name	Scientific Name	Seasonal Presence			
		W	Sp	Su	F
Red-spotted newt	*Notophthalmus viridescens*		X	X	X
Eastern pointed turtle	*Chrysmys picta*		X	X	X
Spotted turtle	*Clemmys guttata*		X	X	X
Blanding's turtle	*Emydoidea blandingi*		X	X	X
Common snapping turtle	*Chelydra serpentine*		X	X	X
Stinkpot	*Sternothacrus odoratus*		X	X	
Bullfrog	*Rana catesbeiana*		X	X	
Northern leopard frog	*Rana pipiens*		X	X	
Eastern American toad	*Bufo americanus*		X	X	
Northern spring peeper	*Hula crucifer*		X	X	
Green frog	*Rana clamitans*		X	X	
Wood frog	*Rana sylvatica*		X	X	
Pickerel frog	*Rana palustris*		X	X	
Eastern garter snake	*Thamnophis s. sirtalis*		X	X	
Eastern milk snake	*Tampropeltis treangulum*		X	X	X
Northern water snake	*Nerodia sipedon*		X	X	X
Eastern smooth green snake	*Opheodrys vernalis*		X	X	X
Northern ringneck snake	*Diadophis punctatus*		X	X	X
Northern brown snake	*Storeria dekayi*		X	X	X

source: Table 2.3 in the final SBERA report

W = Winter; Sp = Spring; Su = Summer; F = Fall

Note: All reptiles and amphibians listed are winter hibernators and are not considered active during the winter months.

Table G-3: Common aquatic species associated with the Sudbury River			
Fish		Invertebrates	
Common Name	Scientific Name	Common Name	Scientific Name
American eel	*Anguilla rostrata*	Crayfish	*Orconectes spp.*
Brook trout	*Salvelinus fontinalis*	Stoneflies	*Plecoptera*
Brown trout	*Salmo trutta*	Backswimmers	*Notonecta undulata*
Rainbow trout	*Oncorhynchus mykiss*	Water boatmen	*Corixa spp.*
Chain pickerel	*Esox niger*	Giant water bugs	*Belostoma spp.*
Redfin pickerel	*Esox americanus americanus*	Water striders	*Gerris remigis*
Carp	*Cyprinus carpio*	Whirligig beetles	*Dineutus spp; Gyrinus spp.*
Fallfish	*Semotilus corporalis*	Dragonflies	
Golden shiner	*Notemigonus crysoleucas*	Common Name	Scientific Name
Common shiner	*Notropis cornutus*	Green darner	*Anax junius*
Bridle shiner	*Notropis bifrenatus*	Cherry-faced meadowhawk	*Sympetrum internum*
White sucker	*Catostomus commersoni*	Twelve-spotted skimmer	*Libellula pulchella*
Lake chubsucker	*Erimyzon sucetta*	Whitetail	*Plathemis lydia*
Brown bullhead	*Ameuirus nebulosus*	Damselflies	
Yellow bullhead	*Ameuirus natalis*	Common Name	Scientific Name
White perch	*Morone americana*	Ebony jewelwing	*Calopteryx maculata*
Largemouth bass	*Micropterus salmoides*	Violet dancer	*Argia fumipennis*
Smallmouth bass	*Micropterus dolomieui*	Stream bluet	*Enallagma exulans*
Pumpkinseed	*Lepomis gibbosus*	Eastern forktail	*Ischnura verticalis*
Redbreast sunfish	*Lepomis auritus*		
Bluegill	*Lepomis macrochirus*		
Banded sunfish	*Enneacanthus obesus*		
Black crappie	*Pomoxis nigromaculatus*		
Yellow perch	*Perca flavescens*		
Tessellated darter	*Etheostoma olmstedi*		

Source: Table 2.4 in the final SBERA report

Table G-4: Presence of T&E species, and species of special concern, in the Sudbury River							
Common Name	Scientific Name	State Status	Reach Potentially Inhabiting				
			1	7	8	9	10
VERTEBRATES							
Amphibians							
Blue-spotted salamander	*Ambystoma laterale*	SC		√	√	√	√
Reptiles							
Blanding's turtle	*Emydoidea blandingii*	T					√
Eastern box turtle	*Terrapene carolina*	SC			√		
Birds							
American bittern	*Botaurus lentiginosus*	E		√	√		
Common moorhen	*Gallinula chloropus*	SC		√	√		
Least bittern	*Ixobrychus exilis*	E		√	√		
Pied-billed grebe	*Podilymbus podiceps*	E			√		
INVERTEBRATES							
Butterflies							
Hessel's hairstreak	*Callophrys hesseli*	SC	√				
Dragonflies							
Umber shadowdragon	*Neurocordulia obsoleta*	SC					√
Clubtail dragonfly	*Stylurus spiniceps*	T					√
PLANTS							
River Bulrush	*Bolboschoenus fluviatilis*	SC		√	√		
Long's Bulrush	*Scirpus longii*	T			√		
Britton's Violet	*Viola brittoniana*	T					√

Source: Table 2.5 in the final SBERA report
E–"Endangered" species are native species which are in danger of extinction throughout all or part of their range, or which are in danger of expiration from Massachusetts.
SC–"Special Concern" species are native species which have been documented to have suffered a decline that could threaten the species if allowed to continue unchecked, or which occur in such small numbers or with such restricted distribution or specialized habitat requirements that could easily become threatened within Massachusetts.
T–"Threatened" species are native species which are likely to become endangered in the foreseeable future, or which are declining or rare.

Table G-5: Exposure point concentrations for sediment							
Chemical	Maximum Detected Concentration (mg/kg, DW)	Arithmetic Mean Concentration (mg/kg, DW)	Data Distribution[a]	Calculation Method[a]	95 % UCL of the Mean[a] (mg/kg)	RME EPC (mg/kg, DW)	CTE EPC (mg/kg, DW)
Reach 2							
Total Mercury	9.65	2.03	NC	NC	NC	9.65	2.03
Reach 3							
Total Mercury	44.9	15.0	NC	NC	NC	44.9	15.0
Reach 3 - Focus Area							
Total Mercury	8.96	2.74	NC	NC	NC	8.96	2.74
Reach 4							
Total Mercury	15.6	6.59	NC	NC	NC	15.6	6.59
Reach 8							
Total Mercury	1.19	0.473	NC	NC	NC	1.19	0.473
Reach 9							
Total Mercury	1.90	1.21	NC	NC	NC	1.90	1.21
Reach 1							
Total Mercury	3.15	0.843	NC	NC	NC	3.15	0.843
Charles River							
Total Mercury	0.341	0.237	NC	NC	NC	0.341	0.237
Sudbury Reservoir							
Total Mercury	0.402	0.199	NC	NC	NC	0.402	0.199

Source: Total Mercury from Table 2-6 in the final SBERA report

CTE = central tendency exposure; DW = dry weight; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit

[a] Based on ProUCL recommendation.

mg/kg = Milligrams per kilogram.

Table G-6: Exposure point concentrations for surface water							
Chemical	Maximum Detected Concentration (ng/L)	Arithmetic Mean Concentration (ng/L)	Data Distribution[a]	Calculation Method[a]	95 % UCL of the Mean[a] (ng/L)	RME EPC (ng/L)	CTE EPC (ng/L)
Reach 2							
Total Mercury	41.8	16.6	NC	NC	NC	41.8	16.6
Reach 3							
Total Mercury	5.89	5.89	NC	NC	NC	5.89	5.89
Reach 4							
Total Mercury	2.70	2.70	NC	NC	NC	2.70	2.70
Reach 8							
Total Mercury	15.0	9.61	Normal	Student's-t UCL	11.052	11.1	9.61
Reach 9							
Total Mercury	no data available						
Reach 1							
Total Mercury	2.26	2.05	Normal	Student's-t UCL	2.31	2.26	2.05
Charles River							
Total Mercury	2.85	1.87	Normal	Student's-t UCL	2.19	2.19	1.87
Sudbury Reservoir							
Total Mercury	no data available						

Source: Table 3-5 in the SBERA

[a] Based on ProUCL recommendation.

ng/L = Nanograms per liter.

CTE = central tendency exposure; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit

Table G-7: Exposure point concentrations for emergent insects							
Chemical	Maximum Detected Concentration (mg/kg, WW)	Arithmetic Mean Concentration (mg/kg, WW)	Data Distribution[a]	Calculation Method[a]	95 % UCL of the Mean[a] (mg/kg)	RME EPC (mg/kg, WW)	CTE EPC (mg/kg, WW)
Reach 2							
Total Mercury	0.713	0.166	Lognormal	95% Chebyshev (MVUE) UCL	0.418	0.418	0.166
Methylmercury	NA	NA	NA	NA	NA	0.146	0.058
Reach 3							
Total Mercury	3.24	1.10	Gamma	Approximate Gamma UCL	1.39	1.39	1.10
Methylmercury	NA	NA	NA	NA	NA	0.485	0.384
Reach 4							
Total Mercury	1.14	0.493	Normal	Student's-t UCL	0.676	0.676	0.493
Methylmercury	NA	NA	NA	NA	NA	0.237	0.173
Reach 8							
Total Mercury	0.106	0.054	Normal	Student's-t UCL	0.068	0.068	0.054
Methylmercury	NA	NA	NA	NA	NA	0.024	0.019
Reach 9							
Total Mercury	0.156	0.107	Normal	Student's-t UCL	0.125	0.125	0.107
Methylmercury	NA	NA	NA	NA	NA	0.044	0.037
Reach 1							
Total Mercury	0.246	0.081	Non-Parametric	95% Chebyshev (Mean, Sd) UCL	0.262	0.246	0.081
Methylmercury	NA	NA	NA	NA	NA	0.086	0.028
Charles River							
Total Mercury	0.044	0.037	Normal	Student's-t UCL	0.041	0.041	0.037
Methylmercury	NA	NA	NA	NA	NA	0.014	0.013
Sudbury Reservoir							
Total Mercury	0.049	0.034	Normal	Student's-t UCL	0.042	0.042	0.034
Methylmercury	NA	NA	NA	NA	NA	0.015	0.012

Source: Table 3-2 in the final SBERA report

[a] Based on ProUCL recommendation.

mg/kg = Milligrams per kilogram.

methylmercury EPCs are based on 35% of total mercury EPCs.

CTE = central tendency exposure; EPC = exposure point concentration; NA = not available; RME = reasonable maximum exposure; UCL = upper confidence limit; WW = wet weight

Table G-8: Exposure point concentrations for whole crayfish							
Chemical	Maximum Detected Concentration (mg/kg, WW)	Arithmetic Mean Concentration (mg/kg, WW)	Data Distribution[a]	Calculation Method[a]	95 % UCL of the Mean[a] (mg/kg, WW)	RME EPCs (mg/kg, WW)	CTE EPCs (mg/kg, WW)
Reach 2							
Total Mercury	0.075	0.046	Non-Parametric	Mod-t UCL (Adjusted for skewness)	0.056	0.056	0.046
Reach 3							
Total Mercury	0.210	0.055	Non-Parametric	Mod-t UCL (Adjusted for skewness)	0.073	0.073	0.055
Reach 4							
Total Mercury	0.036	0.023	Normal	Student's-t UCL	0.035	0.035	0.023
Reach 8							
Total Mercury	no data available						
Reach 9							
Total Mercury	no data available						
Reach 1							
Total Mercury	0.047	0.044	NC	NC	NC	0.047	0.044
Charles River							
Total Mercury	0.046	0.040	NC	NC	NC	0.046	0.040
Sudbury Reservoir							
Total Mercury	0.013	0.010	NC	NC	NC	0.013	0.010

Source: Table 3-6 in the final SBERA report

[a]Based on ProUCL recommendation.

mg/kg = Milligrams per kilogram.

CTE = central tendency exposure; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit; WW = wet weight

Table G-9: Exposure point concentrations for size class A (> 5 cm to ≤ 10 cm) whole fish (species combined)							
Chemical	Maximum Detected Concentration (mg/kg, WW)	Arithmetic Mean Concentration (mg/kg, WW)	Data Distribution[a]	Calculation Method[a]	95 % UCL of the Mean[a] (mg/kg, WW)	RME EPC (mg/kg, WW)	CTE EPC (mg/kg, WW)
Reach 2							
Total Mercury	0.265	0.187	Normal	Student's-t UCL	0.209	0.209	0.187
Reach 3							
Total Mercury	0.477	0.219	Non-Parametric	Mod-t UCL (Adjusted for skewness)	0.264	0.264	0.219
Reach 4							
Total Mercury	0.353	0.220	Normal	Student's-t UCL	0.257	0.257	0.220
Reach 8							
Total Mercury	0.303	0.214	Normal	Student's-t UCL	0.223	0.223	0.214
Reach 9							
Total Mercury	0.219	0.172	Normal	Student's-t UCL	0.194	0.194	0.172
Reach 1							
Total Mercury	0.252	0.137	Normal	Student's-t UCL	0.162	0.162	0.137
Charles River							
Total Mercury	0.187	0.145	Normal	Student's-t UCL	0.156	0.156	0.145
Sudbury Reservoir							
Total Mercury	0.058	0.031	Non-Parametric	Mod-t UCL (Adjusted for skewness)	0.037	0.037	0.031

source: Table 3-7 in the final SBERA report

[a] Based on ProUCL recommendation.

mg/kg = Milligrams per kilogram.

CTE = central tendency exposure; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit; WW = wet weight

Table G-10: Exposure point concentrations for size class B (> 10 cm to ≤ 15 cm) whole fish (species combined)							
Chemical	Maximum Detected Concentration (mg/kg, WW)	Arithmetic Mean Concentration (mg/kg, WW)	Data Distribution[a]	Calculation Method[a]	95 % UCL of the Mean[a] (mg/kg, WW)	RME EPC (mg/kg, WW)	CTE EPC (mg/kg, WW)
Reach 2							
Total Mercury	0.363	0.221	Normal	Student's-t UCL	0.250	0.250	0.221
Reach 3							
Total Mercury	0.253	0.195	Normal	Student's-t UCL	0.209	0.209	0.195
Reach 4							
Total Mercury	0.215	0.143	Normal	Student's-t UCL	0.157	0.157	0.143
Reach 8							
Total Mercury	0.239	0.179	Normal	Student's-t UCL	0.185	0.185	0.179
Reach 9							
Total Mercury	0.274	0.210	Normal	Student's-t UCL	0.233	0.233	0.210
Reach 1							
Total Mercury	0.167	0.112	Normal	Student's-t UCL	0.129	0.129	0.112
Charles River							
Total Mercury	0.122	0.105	Normal	Student's-t UCL	0.111	0.111	0.105
Sudbury Reservoir							
Total Mercury	0.045	0.033	Normal	Student's-t UCL	0.036	0.036	0.033

source: Table 3-8 in the final SBERA report

[a] Based on ProUCL recommendation.

mg/kg = Milligrams per kilogram.

CTE = central tendency exposure; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit; WW = wet weight

Table G-11: Exposure point concentrations for size class C (> 15 cm to ≤ 20cm) whole fish (species combined)							
Chemical	Maximum Detected Concentration (mg/kg, WW)	Arithmetic Mean Concentration (mg/kg, WW)	Data Distribution[a]	Calculation Method[a]	95 % UCL of the Mean[a] (mg/kg, WW)	RME EPC (mg/kg, WW)	CTE EPC (mg/kg, WW)
Reach 2							
Total Mercury	0.324	0.180	Normal	Student's-t UCL	0.219	0.219	0.180
Reach 3							
Total Mercury	0.350	0.260	Normal	Student's-t UCL	0.294	0.294	0.260
Reach 4							
Total Mercury	0.200	0.156	Normal	Student's-t UCL	0.175	0.175	0.156
Reach 8							
Total Mercury	0.349	0.170	Gamma	Approximate Gamma UCL	0.186	0.186	0.170
Reach 9							
Total Mercury	0.229	0.170	Normal	Student's-t UCL	0.184	0.184	0.170
Reach 1							
Total Mercury	0.207	0.118	Normal	Student's-t UCL	0.151	0.151	0.118
Charles River							
Total Mercury	0.123	0.104	Normal	Student's-t UCL	0.109	0.109	0.104
Sudbury Reservoir							
Total Mercury	0.113	0.064	Normal	Student's-t UCL	0.074	0.074	0.064

source: Table 3-10 in the final SBERA report

[a]Based on ProUCL recommendation.

mg/kg = Milligrams per kilogram.

CTE = central tendency exposure; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit; WW = wet weight

Table G-12: Exposure point concentrations for Class D (≥ 20 cm long) whole fish (species combined)							
Chemical	Maximum Detected Concentration (mg/kg, WW)	Arithmetic Mean Concentration (mg/kg, WW)	Data Distribution[a]	Calculation Method[a]	95 % UCL of the Mean[a] (mg/kg, WW)	RME EPC (mg/kg, WW)	CTE EPC (mg/kg, WW)
Reach 2							
Total Mercury	0.584	0.309	Normal	Student's-t UCL	0.381	0.381	0.309
Reach 3							
Total Mercury	0.895	0.473	Normal	Student's-t UCL	0.592	0.592	0.473
Reach 4							
Total Mercury	0.617	0.367	Normal	Student's-t UCL	0.448	0.448	0.367
Reach 8							
Total Mercury	1.133	0.359	Gamma	Approximate Gamma UCL	0.471	0.471	0.359
Reach 9							
Total Mercury	1.275	0.482	Normal	Student's-t UCL	0.719	0.719	0.482
Reach 1							
Total Mercury	0.555	0.164	Gamma	Approximate Gamma UCL	0.227	0.227	0.164
Charles River							
Total Mercury	0.414	0.203	Normal	Student's-t UCL	0.272	0.272	0.203
Sudbury Reservoir							
Total Mercury	0.201	0.122	Normal	Student's-t UCL	0.156	0.156	0.122

Source: Table 3-11 in the final SBERA report

[a] Based on ProUCL recommendation.

mg/kg = Milligrams per kilogram.

CTE = central tendency exposure; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit; WW = wet weight

Table G-13: Exposure point concentrations for whole yellow perch (> 20 cm) and whole largemouth bass							
Chemical	Maximum Detected Concentration (mg/kg, WW)	Arithmetic Mean Concentration (mg/kg WW)	Data Distribution	Calculation Method	95% UCL of the Mean (mg/kg, WW)	RME EPC (mg/kg, WW)	CTE EPC (mg/kg WW)
Reach 2							
Largemouth Bass							
Total Mercury	0.565	0.392	NC	NC	NC	0.565	0.392
Yellow Perch (> 20 cm)							
Total Mercury	0.584	0.352	NC	NC	NC	0.584	0.352
Reach 3							
Largemouth Bass							
Total Mercury	0.895	0.658	NC	NC	NC	0.895	0.658
Yellow Perch (> 20 cm)							
Total Mercury	0.606	0.423	NC	NC	NC	0.606	0.423
Reach 4							
Largemouth Bass							
Total Mercury	0.617	0.506	NC	NC	NC	0.617	0.506
Yellow Perch (> 20 cm)							
Total Mercury	0.463	0.423	NC	NC	NC	0.463	0.423
Reach 8							
Largemouth Bass							
Total Mercury	1.130	0.751	NC	NC	NC	1.130	0.751
Yellow Perch (> 20 cm)							
Total Mercury	0.364	0.237	NC	NC	NC	0.364	0.237
Reach 9							
Largemouth Bass							
Total Mercury	1.270	0.935	NC	NC	NC	1.270	0.935
Yellow Perch (> 20 cm)							
Total Mercury	0.402	0.334	NC	NC	NC	0.402	0.334
Reach 1							
Largemouth Bass							
Total Mercury	0.255	0.224	NC	NC	NC	0.255	0.224
Yellow Perch (> 20 cm)							
Total Mercury	0.164	0.126	NC	NC	NC	0.164	0.126
Charles River							
Largemouth Bass							
Total Mercury	0.414	0.336	NC	NC	NC	0.414	0.336
Yellow Perch (> 20 cm)							
Total Mercury	0.169	0.160	NC	NC	NC	0.169	0.160
Sudbury Reservoir							
Largemouth Bass							
Total Mercury	0.201	0.178	NC	NC	NC	0.201	0.178
Yellow Perch (> 20 cm)							
Total Mercury	0.105	0.084	NC	NC	NC	0.105	0.084

source: Tables 2-16 (Reach 1), 2-17 (Reach 2), 2-18 (Reach 3), 2-19 (Reach 4), 2-24 (Reach 8), 2-25 (Reach 9), 2-27 (Charles R.) and 2-28 (Sudbury Res.) in the final SBERA report

CTE = central tendency exposure; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit; WW = wet weight

Table G-14: Exposure point concentrations for TotHg in tree swallow tissues (2003)							
Chemical	Maximum Detected Concentration (mg/kg, WW)	Arithmetic Mean Concentration (mg/kg, WW)	Data Distribution[a]	Calculation Method[a]	95 % UCL of the Mean[a] (mg/kg, WW)	RME EPC (mg/kg, WW)	CTE EPC (mg/kg, WW)
Reach 2							
Blood (adult)	no data available						
Blood (nestling)							
Feather (adult)							
Feather (nestling)							
Egg							
Reach 3							
Blood (adult)	0.512	0.258	NC	NC	NC	0.512	0.258
Blood (nestling)	0.048	0.035	NC	NC	NC	0.048	0.035
Feather (adult)	2.69	1.57	NC	NC	NC	2.69	1.57
Feather (nestling)	no data available						
Egg	0.060	0.036	NC	NC	NC	0.060	0.036
Reach 4							
Blood (adult)	0.191	0.191	NC	NC	NC	0.191	0.191
Blood (nestling)	0.034	0.026	NC	NC	NC	0.034	0.026
Feather (adult)	0.794	0.794	NC	NC	NC	0.794	0.794
Feather (nestling)	no data available						
Egg	0.049	0.049	NC	NC	NC	0.049	0.049
Reach 8							
Blood (adult)	0.917	0.416	NC	NC	NC	0.917	0.416
Blood (nestling)	no data available						
Feather (adult)	2.52	1.35	NC	NC	NC	2.52	1.35
Feather (nestling)	no data available						
Egg	0.212	0.128	NC	NC	NC	0.212	0.128
Reach 9							
Blood (adult)	no data available						
Blood (nestling)							
Feather (adult)							
Feather (nestling)							
Egg							
Reach 1							
Blood (adult)	no data available						
Blood (nestling)							
Feather (adult)							
Feather (nestling)							
Egg							
Charles River							
Blood (adult)	0.996	0.511	NC	NC	NC	0.996	0.511
Blood (nestling)	no data available						
Feather (adult)	1.56	1.07	NC	NC	NC	1.56	1.07
Feather (nestling)	no data available						
Egg	0.257	0.137	NC	NC	NC	0.257	0.137
Sudbury Reservoir							
Blood (adult)	0.171	0.120	NC	NC	NC	0.171	0.120
Blood (nestling)	0.046	0.016	NC	NC	NC	0.046	0.016
Feather (adult)	2.27	1.51	NC	NC	NC	2.27	1.51
Feather (nestling)	no data available						
Egg	0.157	0.061	NC	NC	NC	0.157	0.061

Source: Table 2-49 (Reach 3), Table 2-50 (Reach 4), Table 2-51 (Reaches 7 and 8), Table 2-52 (Charles River), and 2-53 (Sudbury Reservoir) in the final SBERA report

NC = not calculated

mg/kg = Milligrams per kilogram.

CTE = central tendency exposure; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit; WW = wet weight

Table G-15: Exposure point concentrations for TotHg in tree swallow tissues (2004)							
Chemical	Maximum Detected Concentration (mg/kg, WW)	Arithmetic Mean Concentration (mg/kg, WW)	Data Distribution[a]	Calculation Method[a]	95 % UCL of the Mean[a] (mg/kg, WW)	RME EPC (mg/kg,WW)	CTE EPC (mg/kg, WW)
Reach 2							
Blood (adult)	no data available						
Blood (nestling)							
Feather (adult)							
Feather (nestling)							
Egg							
Reach 3							
Blood (adult)	0.672	0.224	NC	NC	NC	0.672	0.224
Blood (nestling)	no data available						
Feather (adult)	8.56	2.76	NC	NC	NC	8.56	2.76
Feather (nestling)	no data available						
Egg	0.308	0.086	NC	NC	NC	0.308	0.086
Reach 4							
Blood (adult)	0.470	0.253	NC	NC	NC	0.470	0.253
Blood (nestling)	no data available						
Feather (adult)	4.39	2.00	NC	NC	NC	4.39	2.00
Feather (nestling)	no data available						
Egg	0.172	0.082	NC	NC	NC	0.172	0.082
Reach 8							
Blood (adult)	1.31	0.691	NC	NC	NC	1.31	0.691
Blood (nestling)	no data available						
Feather (adult)	3.53	2.22	NC	NC	NC	3.53	2.22
Feather (nestling)	no data available						
Egg	0.464	0.261	NC	NC	NC	0.464	0.261
Reach 9							
Blood (adult)	no data available						
Blood (nestling)							
Feather (adult)							
Feather (nestling)							
Egg							
Reach 1							
Blood (adult)	no data available						
Blood (nestling)							
Feather (adult)							
Feather (nestling)							
Egg							
Charles River							
Blood (adult)	0.549	0.405	NC	NC	NC	0.549	0.405
Blood (nestling)	no data available						
Feather (adult)	6.03	2.27	NC	NC	NC	6.03	2.27
Feather (nestling)	no data available						
Egg	0.151	0.114	NC	NC	NC	0.151	0.114
Sudbury Reservoir							
Blood (adult)	no data available						
Blood (nestling)							
Feather (adult)							
Feather (nestling)							
Egg							

Source: Tables 2.54 (Reach 3), 2-55 (Reach 4), 2-57 (Reach 8), and 2-58 (Charles River) in the final SBERA report

NC = not calculated

mg/kg = Milligrams per kilogram.

CTE = central tendency exposure; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit; WW = wet weight

Table G-16: Exposure point concentrations for TotHg in belted kingfisher tissues (2003)							
Chemical	Maximum Detected Concentration (mg/kg, WW)	Arithmetic Mean Concentration (mg/kg, WW)	Data Distribution[a]	Calculation Method[a]	95 % UCL of the Mean[a] (mg/kg, WW)	RME EPC (mg/kg, WW)	CTE EPC (mg/kg, WW)
Reach 2							
Blood (adult)	no data available						
Blood (nestling)							
Feather (adult)							
Feather (nestling)							
Egg							
Reach 3							
Blood (adult)	no data available						
Blood (nestling)							
Feather (adult)							
Feather (nestling)							
Egg							
Reach 4							
Blood (adult)	no data available						
Blood (nestling)							
Feather (adult)							
Feather (nestling)							
Egg							
Reach 8 (Transfer Station Pit)							
Blood (adult)	0.778	0.675	NC	NC	NC	0.778	0.675
Blood (nestling)	0.576	0.150	NC	NC	NC	0.576	0.150
Feather (adult)	12.4	12.4	NC	NC	NC	12.4	12.4
Feather (nestling)	no data available						
Egg							
Reach 8 (Macone's Pile)							
Blood (adult)	1.33	0.496	NC	NC	NC	1.33	0.496
Blood (nestling)	no data available						
Feather (adult)	6.98	5.40	NC	NC	NC	6.98	5.40
Feather (nestling)	no data available						
Egg							
Reach 8 (Route 117 Pit)							
Blood (adult)	1.01	0.766	NC	NC	NC	1.01	0.766
Blood (nestling)	0.246	0.104	NC	NC	NC	0.246	0.104
Feather (adult)	10.80	7.39	NC	NC	NC	10.80	7.39
Feather (nestling)	no data availabable						
Egg	0.152	0.152	NC	NC	NC	0.152	0.152
Reach 9							
Blood (adult)	no data available						
Blood (nestling)							
Feather (adult)							
Feather (nestling)							
Egg							
Reach 1							
Blood (adult)	no data available						
Blood (nestling)							
Feather (adult)							
Feather (nestling)							
Egg							
Charles River							
Blood (adult)	0.282	0.282	NC	NC	NC	0.282	0.282
Blood (nestling)	no data available						
Feather (adult)	7.18	7.18	NC	NC	NC	7.18	7.18
Feather (nestling)	no data available						
Egg							
Sudbury Reservoir							
Blood (adult)	no data available						
Blood (nestling)							
Feather (adult)							
Feather (nestling)							
Egg							

Source: Tables 2.45 (Transfer Station Pit), 2-46 (Macone's Pile), 2-47 (Route 117 Pit), and 2-48 (Charles River) in the final SBERA report

mg/kg = Milligrams per kilogram.

CTE = central tendency exposure; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit; WW = wet weight

Table G-17: Exposure point concentrations for TotHg in red wing blackbird tissues							
Chemical	Maximum Detected Concentration (mg/kg, WW)	Arithmetic Mean Concentration (mg/kg, WW)	Data Distribution[a]	Calculation Method[a]	95% UCL of the Mean[a] (mg/kg, WW)	RME EPC (mg/kg, WW)	CTE EPC (mg/kg, WW)
Reach 2							
Blood (adult)	no data available						
Reach 3							
Blood (adult)	no data available						
Reach 4							
Blood (adult)	no data available						
Reach 8							
Blood (adult)	9.42	4.06	NC	NC	NC	9.42	4.06
Reach 9							
Blood (adult)	no data available						
Reach 1							
Blood (adult)	no data available						
Charles River							
Blood (adult)	no data available						
Sudbury Reservoir							
Blood (adult)	no data available						

Source: Table 2-60 in the final SBERA report

mg/kg = Milligrams per kilogram.

CTE = central tendency exposure; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit; WW = wet weight

Table G-18: Exposure point concentrations for TotHg in hooded merganser tissues (2004)							
	Maximum Detected Conc. (mg.kg, WW)	Arithmetic Mean Conc. (mg/kg, WW)	Data Distribution	Calculation Method	95% UCL of the Mean (mg/kg, WW)	RME EPC (mg/kg, WW)	CTE EPC (mg/kg, WW)
Reach 2							
Egg	no data available						
Blood (adult)							
Feather (adult)							
Reach 3							
Egg	no data available						
Blood (adult)							
Feather (adult)							
Reach 4							
Egg	no data available						
Blood (adult)							
Feather (adult)							
Reach 8							
Egg	no data available						
Blood (adult)	0.021	0.021	NC	NC	NC	0.021	0.021
Feather (adult)	7.59	7.59	NC	NC	NC	7.59	7.59
Reach 9							
Egg	no data available						
Blood (adult)							
Feather (adult)							
Reach 1							
Egg	no data available						
Blood (adult)							
Feather (adult)							
Charles River							
Egg	no data available						
Blood (adult)							
Feather (adult)							
Sudbury Reservoir							
Egg	no data available						
Blood (adult)							
Feather (adult)							

Source: Table 2-37 in the final SBERA report

mg/kg = Milligrams per kilogram.

CTE = central tendency exposure; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit; WW = wet weight

Table G-19: Exposure point concentrations for TotHg in hooded merganser tissues (2005)							
	Maximum Detected Conc. (mg.kg, WW)	Arithmetic Mean Conc. (mg/kg, WW)	Data Distribution	Calculation Method	95% UCL of the Mean (mg/kg, WW)	RME EPC (mg/kg, WW)	CTE EPC (mg/kg, WW)
Reach 2							
Egg	no data available						
Blood (adult)							
Feather (adult)							
Reach 3							
Egg	no data available						
Blood (adult)							
Feather (adult)							
Reach 4							
Egg	0.816	0.657	NC	NC	NC	0.816	0.657
Blood (adult)	no data available						
Feather (adult)							
Reach 8							
Egg	1.95	0.71	NC	NC	NC	1.95	0.71
Blood (adult)	1.88	0.58	NC	NC	NC	1.88	0.58
Feather (adult)	7.48	4.87	NC	NC	NC	7.48	4.87
Reach 9							
Egg	no data available						
Blood (adult)							
Feather (adult)							
Reach 1							
Egg	no data available						
Blood (adult)							
Feather (adult)							
Charles River							
Egg	2.42	1.58	NC	NC	NC	2.42	1.58
Blood (adult)	4.27	2.44	NC	NC	NC	4.27	2.44
Feather (adult)	8.92	8.92	NC	NC	NC	8.92	8.92
Sudbury Reservoir							
Egg	0.56	0.42	NC	NC	NC	0.56	0.42
Blood (adult)	no data available						
Feather (adult)	6.44	6.44	NC	NC	NC	6.44	6.44

Source: Tables 2-39, 2-40, 2-41, and 2-42 in the final SBERA report

mg/kg = Milligrams per kilogram.

CTE = central tendency exposure; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit; WW = wet weight

Table G-20: Exposure point concentrations for TotHg in mink tissues							
Chemical	Maximum Detected Concentration (mg/kg, WW)	Arithmetic Mean Concentration (mg/kg, WW)	Data Distribution[a]	Calculation Method[a]	95% UCL of the Mean[a] (mg/kg, WW)	RME EPC (mg/kg, WW)	CTE EPC (mg/kg, WW)
Reach 2							
Blood (adult)	no data available						
Fur (adult)							
Reach 3							
Blood (adult)	0.177	0.177	NC	NC	NC	0.177	0.177
Fur (adult)	58.6	58.6	NC	NC	NC	58.6	58.6
Reach 4							
Blood (adult)	0.045	0.045	NC	NC	NC	0.045	0.045
Fur (adult)	1.23	1.23	NC	NC	NC	1.23	1.23
Reach 8							
Blood (adult)	no data available						
Fur (adult)							
Reach 9							
Blood (adult)	no data available						
Fur (adult)							
Reach 1							
Blood (adult)	no data available						
Fur (adult)							
Charles River							
Blood (adult)	no data available						
Fur (adult)							
Sudbury Reservoir							
Blood (adult)	no data available						
Fur (adult)							

Source: Table 2-67 in the final SBERA report

mg/kg = Milligrams per kilogram.

CTE = central tendency exposure; EPC = exposure point concentration; NC = not calculated; RME = reasonable maximum exposure; UCL = upper confidence limit; WW = wet weight

Table G-21: Wildlife exposure point concentrations derived from food chain modeling						
Chemical	RME (mg/kg BW-day)			CTE (mg/kg BW-day)		
	Tree Swallow	Belted Kingfisher	Mink	Tree Swallow	Belted Kingfisher	Mink
Reach 2						
Total Mercury	0.342	NA	NA	0.136	NA	NA
Methylmercury	0.120	0.108	0.022	0.048	0.096	0.018
Reach 3						
Total Mercury	1.137	NA	NA	0.901	NA	NA
Methylmercury	0.398	0.113	0.028	0.315	0.098	0.023
Reach 4						
Total Mercury	0.554	NA	NA	0.404	NA	NA
Methylmercury	0.194	0.096	0.020	0.142	0.084	0.016
Reach 8						
Total Mercury	0.056	NA	NA	0.044	NA	NA
Methylmercury	0.019	0.110	0.043	0.015	0.106	0.037
Reach 9						
Total Mercury	0.102	NA	NA	0.088	NA	NA
Methylmercury	0.036	0.115	0.053	0.031	0.103	0.041
Reach 1						
Total Mercury	0.202	NA	NA	0.066	NA	NA
Methylmercury	0.071	0.070	0.015	0.023	0.060	0.013
Charles River						
Total Mercury	0.033	NA	NA	0.030	NA	NA
Methylmercury	0.012	0.064	0.015	0.011	0.060	0.013
Sudbury Reservoir						
Total Mercury	0.035	NA	NA	0.028	NA	NA
Methylmercury	0.012	0.018	0.006	0.010	0.015	0.005

source: Table 3-19 in the final SBERA report

BW = body weight; CTE = central tendency exposure; NA = not available; RME = reasonable maximum exposure

Table G-22: Input parameters for calculating estimated daily doses using wildlife food chain modeling					
Input Parameter	Definition	Units	Tree Swallow	Belted Kingfisher	Mink
FT	foraging time in the exposure area	unitless	1.0	1.0	1.0
FIR	food ingestion rate	kg WW/kg BW-day	0.82	0.54	0.16
C_{EI}	conc. of COEC in emergent insects	mg/kg WW	reach-specific	NA	NA
C_{BI}	conc. of COEC in benthic invertebrates (i.e., crayfish)	mg/kg WW	NA	reach-specific	reach-specific
$C_{F\text{-}Class\ A}$	conc. of COEC in class A fish (≥ 5 to < 10 cm long)	mg/kg WW	NA	reach-specific	reach-specific
$C_{F\text{-}Class\ B}$	conc. of COEC in class B fish (≥ 10 to < 15 cm long)	mg/kg WW	NA	reach-specific	reach-specific
$C_{F\text{-}Class\ C}$	conc. of COEC in class C fish (≥ 15 to < 20 cm long)	mg/kg WW	NA	NA	reach-specific
$C_{F\text{-}Class\ D}$	conc. of COEC in class D fish (≥ 20 cm long)	mg/kg WW	NA	NA	reach-specific
P_{EI}	proportion of diet comprised of emergent insects	unitless	1.0	NA	NA
P_{BI}	proportion of diet comprised of benthic invertebrates	unitless	NA	0.17 (R2, R3, R4) & 0 (R8 and R9)	0.61 (R2, R3, R4) & 0 (R8 and R9)
$P_{F\text{-}Class\ A}$	proportion of diet comprised of Class A fish	unitless	NA	0.415 (R2, R3, R4) & 0.5 (R8 and R9)	0.0975 (R2, R3, R4) & 0.25 (R8 and R9)
$P_{F\text{-}Class\ B}$	proportion of diet comprised of Class B fish	unitless	NA	0.415 (R2, R3, R4) & 0.5 (R8 and R9)	0.0975 (R2, R3, R4) & 0.25 (R8 and R9)
$P_{F\text{-}Class\ C}$	proportion of diet comprised of Class C fish	unitless	NA	NA	0.0975 (R2, R3, R4) & 0.25 (R8 and R9)
$P_{F\text{-}Class\ D}$	proportion of diet comprised of Class D fish	unitless	NA	NA	0.0975 (R2, R3, R4) & 0.25 (R8 and R9)
SIR	sediment ingestion rate	kg DW/kg BW-day	NA	0.0045	0.0011
C_{Sed}	conc. of COEC in bed sediment	mg/kg DW	NA	reach-specific	reach-specific
WIR	water ingestion rate	L/kg BW-day	0.21	0.11	0.1
C_W	conc. of COEC in surface water	mg/L	reach-specific	reach-specific	reach-specific

source: Tables 3-15 (swallow exposure parameters), 3-16 (kingfisher exposure parameters) & 3-17 (mink exposure parameters) of the final SBERA report

BW = body weight; COEC = contaminant of ecological concern; DW = dry weight; NA = not applicable; R = reach; WW = wet weight

Table G-23: Summary of the no effect and effect CBRs		
Receptor	No effect CBR (mg TotHg/kg WW)	No effect CBR (mg TotHg/kg WW)
Crayfish	1.5	3.25
Fish	0.38	0.98
Bird eggs	0.5[a]	1.0[a]
	0.8[b]	1.6[b]
Bird blood	0.6	1.25
Feathers	1.21	9.1
Mammal blood	0.63[c]	1.5
Mammal fur	7.71[c]	19.03[c]

Source: Table 3-30 in the final SBERA report
CBR = critical body residue; WW = wet weight
[a] CBRs are for waterfowl and belted kingfisher
[b] CBRs derived from a tree swallow egg injection study
[c] CBRs derived from mink feeding studies

Table G-24: Assessment and measurement endpoints evaluated in the final SBERA		
Assessment Endpoint		**Measurement Endpoint**
Receptor	**Ecological Attribute**	
Benthic invertebrate community	Community structure, survival, and reproduction	Assess *in-situ* mussel bioaccumulation, growth and toxicity using the freshwater mussel.
		Compare Hg levels in sediment against sediment Hg benchmarks and values from other literature sources.
		Assess Hg bioaccumulation using *Hexagenia* mayflies exposed to reach-specific sediment samples
		Compare Hg levels in site-specific crayfish against reference area concentrations and literature-based Hg CBRs.
Fish population	Survival and reproduction	Compare Hg levels in surface water to surface water Hg benchmarks and values from the literature.
		Compare Hg levels in whole fish against reference area concentrations and literature-based fish Hg CBRs.
Insectivorous birds (tree swallows, eastern kingbirds, and marsh birds)	Survival, reproduction, and neurological effects	Compare site-specific egg, blood, and feather Hg levels in tree swallows against reference area concentrations, literature-based Hg CBRs, and Hg effect levels for eggs developed by USFWS.
		Use food chain modeling to estimate daily Hg intake by tree swallows feeding on emergent insects exposed to sediment from target reaches and compare results against literature-based Hg TRVs.
Piscivorous birds (belted kingfisher, great blue heron, and hooded merganser)	Survival, reproduction, and neurological effects	Use food chain modeling to estimate daily Hg intake by kingfishers feeding on fish collected from target reaches and compare results against literature-based bird Hg TRVs.
		Compare site-specific egg, blood, and feather Hg levels with reference area concentrations and literature-derived Hg CBRs.
Piscivorous mammals (as represented by the mink)	Survival, reproduction, and neurological effects	Compare site-specific blood and fur Hg levels against reference area concentrations literature-derived Hg CBRs.
		Use food chain modeling to estimate daily Hg intake by mink feeding on fish collected from target reaches and compare results against literature-based mammal Hg TRVs.

Source: 2-68 in the final SBERA report
CBR = critical body residue; TRV = toxicity reference value; USFWS = United States Fish and Wildlife Service

Table G-25: Risk summaries for targeted receptor groups in Reach 2 (Mills Pond) of the Sudbury River								
Receptor Group/ Target Receptor	Lifestage or size	Matrix	Measurement endpoint	Weight of Evidence[a]	Reach 2 "effect" HQs		Reference "effect" HQs	
					RME	CTE	RME	CTE
Benthic Invertebrates								
generic	NA	sediment	compare [sed] to benchmarks	L/M	**9.1**	**1.9**	**3.0**	**0.8**
mussel (*E. complanata*)	adult	whole mussel	*in-situ* toxicity testing	M/H	risk possible w/ mod CL		risk unlikely w/ mod CL	
crayfish (different species)	adult	whole crayfish	compare residues to CBRs	M	<1.0	<1.0	0.015	0.013
Fish								
generic	NA	surface water	compare [SW] to benchmarks	L/M	<1.0	<1.0	0.002	0.002
yellow perch (size class D)	> 20 cm	whole fish	compare residues to CBRs	M/H	<1.0	<1.0	0.2	0.1
largemouth bass (size class D)	> 20 cm	whole fish	compare residues to CBRs	M/H	<1.0	<1.0	0.3	0.2
Birds								
tree swallow	adult	SW, flies	food chain modeling	M	**3.7**	**1.5**	**2.2**	0.7
belted kingfisher	adult	sed, SW, fish	food chain modeling	M	**1.2**	**1.0**	0.8	0.6
Mammals								
mink	adult	sed, SW, fish	food chain modeling	M/H	<1.0	<1.0	0.4	0.4

CBR = critical body residue; CL = confidence level; CTE = central tendency exposure; HQ = hazard quotient; NA = not applicable; RME = reasonable maximum exposure; sed = sediment; SW = surface water

[a] L/M = low/moderate; M = moderate; M/H = moderate/high

Table G-26: Risk summaries for targeted receptor groups in Reach 3 (Reservoir 2) of the Sudbury River								
Receptor Group/ Target Receptor	Lifestage or size	Matrix	Measurement endpoint	Weight of Evidence[a]	Reach 3 "effect" HQs		Reference "effect" HQs	
					RME	CTE	RME	CTE
Benthic Invertebrates								
generic	NA	sediment	compare [sed] to benchmarks	L/M	**42.3**	**14.1**	0.4	0.2
mayfly test 1 (July 1994)	juvenile	whole flies	sed. tox + bioaccum. test	M/H	risk unlikely w/ mod CL		risk possible w/ low CL	
mayfly test 2 (Sept. 1994)	juvenile	whole flies	sed. tox + bioaccum. test	M/H	risk unlikely w/ mod CL		risk possible w/ low CL	
mussel (*E. complanata*)	adult	whole mussel	*in-situ* toxicity testing	M/H	risk possible w/ mod CL		risk unlikely w/ mod CL	
crayfish (different species)	adult	whole crayfish	compare residues to CBRs	M	<1.0	<1.0	0.004	0.003
Fish								
generic	NA	surface water	compare [SW] to benchmarks	L/M	<1.0	<1.0	no data available	
yellow perch (size class D)	> 20 cm	whole fish	compare residues to CBRs	M/H	<1.0	<1.0	0.1	0.1
largemouth bass (size class D)	> 20 cm	whole fish	compare residues to CBRs	M/H	<1.0	<1.0	0.2	0.2
Birds								
tree swallow	adult	SW, flies	food chain modeling	M	**12.2**	**9.7**	0.4	0.3
tree swallow (2003)	NA	egg	compare residues to CBRs	M/H	<1.0	<1.0	0.1	0.04
	nestling	blood	compare residues to CBRs	M/H	<1.0	<1.0	0.04	0.01
	nestling	feather	compare residues to CBRs	M/H	<1.0	<1.0	no data available	
	adult	blood	compare residues to CBRs	M/H	<1.0	<1.0	0.1	0.1
	adult	feather	compare residues to CBRs	M/H	<1.0	<1.0	0.3	0.2
tree swallow (2004)	NA	egg	compare residues to CBRs	M/H	<1.0	<1.0	no data available	
	adult	blood	compare residues to CBRs	M/H	<1.0	<1.0	no data available	
	adult	feather	compare residues to CBRs	M/H	<1.0	<1.0	no data available	
belted kingfisher	adult	sed, SW, fish	food chain modeling	M	**1.2**	**1.1**	0.2	0.2
Mammals								
mink	adult	sed, SW, fish	food chain modeling	M/H	<1.0	<1.0	0.2	0.1
	adult	fur	compare residues to CBRs	M	**3.1**	**3.1**	no data available	

CBR = critical body residue; CL = confidence level; CTE = central tendency exposure; HQ = hazard quotient; NA = not applicable; RME = reasonable maximum exposure; sed = sediment; SW = surface water

[a] L/M = low/moderate; M = moderate; M/H = moderate/high

Table G-27: Risk summaries for targeted receptor groups in Reach 4 (Reservoir 1) of the Sudbury River								
Receptor Group/ Target Receptor	Lifestage or size	Matrix	Measurement endpoint	Weight of Evidence[a]	Reach 4 "effect" HQs		Reference "effect" HQs	
					RME	CTE	RME	CTE
Benthic Invertebrates								
generic	NA	sediment	compare [sed] to benchmarks	L/M	**14.7**	**6.2**	0.4	0.2
mayfly test 1 (July 1994)	juvenile	whole flies	sed. tox + bioaccum. test	M/H	risk unlikely w/ mod CL		risk possible w/ low CL	
mayfly test 2 (Sept. 1994)	juvenile	whole flies	sed. tox + bioaccum. test	M/H	risk unlikely w/ mod CL		risk possible w/ low CL	
crayfish (different species)	adult	whole crayfish	compare residues to CBRs	M	<1.0	<1.0	0.004	0.003
Fish								
generic	NA	surface water	compare [SW] to benchmarks	L/M	<1.0	<1.0	no data available	
yellow perch (size class D)	> 20 cm	whole fish	compare residues to CBRs	M/H	<1.0	<1.0	0.1	0.1
largemouth bass (size class D)	> 20 cm	whole fish	compare residues to CBRs	M/H	<1.0	<1.0	0.2	0.2
Birds								
tree swallow	adult	SW, flies	food chain modeling	M	**6.0**	**4.3**	0.4	0.30
tree swallow (2003)	NA	egg	compare residues to CBRs	M/H	<1.0	<1.0	0.1	0.04
	nestling	blood	compare residues to CBRs	M/H	<1.0	<1.0	0.04	0.01
	adult	blood	compare residues to CBRs	M/H	<1.0	<1.0	0.1	0.1
	adult	feather	compare residues to CBRs	M/H	<1.0	<1.0	0.3	0.2
tree swallow (2004)	NA	egg	compare residues to CBRs	M/H	<1.0	<1.0	no data available	
	adult	blood	compare residues to CBRs	M/H	<1.0	<1.0	no data available	
	adult	feather	compare residues to CBRs	M/H	<1.0	<1.0	no data available	
hooded merganser (2005)	NA	egg	compare residues to CBRs	M/H	<1.0	<1.0	no data available	
belted kingfisher	adult	sed, SW, fish	food chain modeling	M	**1.0**	<1.0	0.2	0.2
Mammals								
mink	adult	sed, SW, fish	food chain modeling	M/H	<1.0	<1.0	0.2	0.1
	adult	blood	compare residues to CBRs	M	<1.0	<1.0	no data available	
	adult	fur	compare residues to CBRs	M	<1.0	<1.0	no data available	

CBR = critical body residue; CL = confidence level; CTE = central tendency exposure; HQ = hazard quotient; NA = not applicable; RME = reasonable maximum exposure; sed = sediment; SW = surface water

[a] L/M = low/moderate; M = moderate; M/H = moderate/high

Table G-28: Risk summaries for targeted receptor groups in Reach 8 (GMNWR) of the Sudbury River								
Receptor Group/ Target Receptor	Lifestage or size	Matrix	Measurement endpoint	Weight of Evidence[a]	Reach 8 "effect" HQs		Reference "effect" HQs	
					RME	CTE	RME	CTE
Benthic Invertebrates								
generic	NA	sediment	compare [sed] to benchmarks	L/M	**1.1**	<1.0	0.3	0.2
mayfly test 1 (July 1994)	juvenile	whole flies	sed. tox + bioaccum. test	M/H	risk unlikely w/ mod CL		risk possible w/ low CL	
mayfly test 2 (Sept. 1994)	juvenile	whole flies	sed. tox + bioaccum. test	M/H	risk unlikely w/ mod CL		risk possible w/ low CL	
mayfly test 3 (May 1995)	juvenile	whole flies	sed. tox + bioaccum. test	M/H	risk possible w/ low CL		risk possible w/ low CL	
mayfly test 4 (Sept. 1995)	juvenile	whole flies	sed. tox + bioaccum. test	M/H	risk possible w/ low CL		risk possible w/ low CL	
Fish								
generic	NA	surface water	compare [SW] to benchmarks	L/M	<1.0	<1.0	0.002	0.002
yellow perch (size class D)	> 20 cm	whole fish	compare residues to CBRs	M/H	<1.0	<1.0	0.2	0.2
largemouth bass (size class D)	> 20 cm	whole fish	compare residues to CBRs	M/H	**1.2**	<1.0	0.4	0.3
Birds								
tree swallow	adult	surf. wat., flies	food chain modeling	M	<1.0	<1.0	0.4	0.30
tree swallow (2003)	NA	egg	compare residues to CBRs	M/H	<1.0	<1.0	0.2	0.1
	adult	blood	compare residues to CBRs	M/H	<1.0	<1.0	0.8	0.4
	adult	feather	compare residues to CBRs	M/H	<1.0	<1.0	0.2	0.1
tree swallow (2004)	NA	egg	compare residues to CBRs	M/H	<1.0	<1.0	0.1	0.1
	adult	blood	compare residues to CBRs	M/H	**1.0**	<1.0	0.4	0.3
	adult	feather	compare residues to CBRs	M/H	<1.0	<1.0	0.7	0.3
belted kingfisher	adult	sed, SW, fish	food chain modeling	M	**1.2**	**1.1**	0.7	0.6
	NA	egg[b]	compare residues to CBRs	M	<1.0	<1.0	no data available	
	nestling	blood[b]	compare residues to CBRs	M	<1.0	<1.0	no data available	
	adult	blood[b]	compare residues to CBRs	M	**1.1**	<1.0	0.2	0.2
	adult	feather[b]	compare residues to CBRs	M	**1.4**	**1.4**	0.8	0.8
hooded merganser (2004)	adult	blood	compare residues to CBRs	M/H	<1.0	<1.0	no data available	
	adult	feather	compare residues to CBRs	M/H	<1.0	<1.0	no data available	
hooded merganser (2005)	NA	egg	compare residues to CBRs	M/H	**2.0**	<1.0	**2.4**	**1.6**
	adult	blood	compare residues to CBRs	M/H	<1.0	<1.0	**3.4**	**2.0**
	adult	feather	compare residues to CBRs	M/H	<1.0	<1.0	0.8	0.5
red wing black bird	adult	blood	compare residues to CBRs	M	**7.5**	**3.2**	no data available	
Mammals								
mink	adult	sed, SW, fish	food chain modeling	M/H	**1.2**	**1.1**	0.4	0.4

CBR = critical body residue; CL = confidence level; CTE = central tendency exposure; HQ = hazard quotient; NA = not applicable; RME = reasonable maximum exposure; sed = sediment; SW = surface water

[a] L/M = low/moderate; M = moderate; M/H = moderate/high

[b] values represent the highest risk measured at three locations on Reach 8 (i.e., Transfer Station Pit, Macone's Pile, and Route 117 Pit)

Table G-29: Risk summaries for targeted receptor groups in Reach 9 (Fairhaven Bay) of the Sudbury River								
Receptor Group/ Target Receptor	Lifestage or size	Matrix	Measurement endpoint	Weight of Evidence[a]	Reach 9 "effect" HQs		Reference "effect" HQs	
					RME	CTE	RME	CTE
Benthic Invertebrates								
generic	NA	sediment	compare [sed] to benchmarks	L/M	**1.8**	**1.1**	0.3	0.2
mayfly test 1 (July 1994)	juvenile	whole flies	sed. tox + bioaccum. test	M/H	risk unlikely w/ mod CL		risk unlikely w/ high CL	
mayfly test 2 (Sept. 1994)	juvenile	whole flies	sed. tox + bioaccum. test	M/H	risk unlikely w/ mod CL		risk unlikely w/ high CL	
mayfly test 3 (May 1995)	juvenile	whole flies	sed. tox + bioaccum. test	M/H	risk unlikely w/ mod CL		risk unlikely w/ high CL	
mayfly test 4 (Sept. 1995)	juvenile	whole flies	sed. tox + bioaccum. test	M/H	risk unlikely w/ mod CL		risk unlikely w/ high CL	
mussel (*E. complanata*)	adult	whole mussel	*in-situ* toxicity testing	M/H	risk unlikely w/ mod CL		risk unlikely w/ mod CL	
Fish								
yellow perch (size class D)	> 20 cm	whole fish	compare residues to CBRs	M/H	<1.0	<1.0	0.2	0.2
largemouth bass (size class D)	> 20 cm	whole fish	compare residues to CBRs	M/H	**1.3**	<1.0	0.4	0.3
Birds								
tree swallow	adult	surf. wat., flies	food chain modeling	M	**1.1**	<1.0	0.4	0.3
belted kingfisher	adult	sed, SW, fish	food chain modeling	M	**1.2**	**1.1**	0.7	0.6
Mammals								
mink	adult	sed, SW, fish	food chain modeling	M/H	**1.5**	**1.2**	0.4	0.4

CBR = critical body residue; CL = confidence level; CTE = central tendency exposure; HQ = hazard quotient; NA = not applicable; RME = reasonable maximum exposure; sed = sediment; SW = surface water

[a] L/M = low/moderate; M = moderate; M/H = moderate/high

Table J-1
Cost Analysis - Alternative 3B
Nyanza Chemical Waste Dump Superfund Site
Operable Unit 4 - Sudbury River
Ashland, Massachusetts

Alternative 3B - Enhanced Natural Recovery in Reach 3 of Hg > 10 mg/kg and MNR

A. CAPITAL COSTS

	Item	Rate	Amount	Units	Cost
1	**Remedial Construction/Installation**				
1-a	Site prep/mob/demob	$200,000	1	LS	$200,000
1-b	Construction Equipment and Materials				
	Materials				
	Clean Sand	$25	74,600	tons	$1,865,000
	Equipment Rental				
	GPS	$190	210	days	$39,900
	conveyor	$788	84	weeks	$66,192
	backhoe	$2,038	42	weeks	$85,596
	terrain loader	$736	42	weeks	$30,912
	front-end loader	$2,520	42	weeks	$105,840
	barges (2)	$5,250	42	weeks	$220,500
	work boat	$1,050	42	weeks	$44,100
	Equipment fuel/maintenance				
	conveyor	$1,200	84	weeks	$100,800
	backhoe	$1,600	42	weeks	$67,200
	terrain loader	$800	42	weeks	$33,600
	front-end loader	$1,800	42	weeks	$75,600
	work boat	$2,500	42	weeks	$105,000
	Subtotal (task 1-b)				$2,840,240
1-c	Construction Labor				
	conveyor operator	$3,098	84	weeks	$260,232
	backhoe operator	$2,113	42	weeks	$88,746
	terrain loader operator	$2,033	42	weeks	$85,386
	front-end loader operator	$2,112	42	weeks	$88,704
	work boat operator	$4,988	42	weeks	$209,496
	general laborers	$1,583	42	weeks	$66,486
	supervisor/foreman	$1,699	42	weeks	$71,358
	Subtotal (task 1-c)				$870,408
1-d	Construction Quality Control				
	QC Scientist/Field Engineer	$5,000	84	weeks	$420,000
1-e	Remedial Design				
	Pre-design and Design	$384,000	1	LS	$384,000
1-f	Restoration	$400,000	1	LS	$400,000
	Subtotal (Task 1)				**$5,114,648**

Alternative 3B - Enhanced Natural Recovery in Reach 3 of Hg > 10 mg/kg and MNR

A. CAPITAL COSTS

	Item	Rate	Amount	Units	Cost
2	Project management and administrative (including safety, permitting, field office and home office, reporting, regulatory approvals)		15%		$767,197
	Subtotal (Tasks 1, 2)				**$5,881,845**
	Contingency		20%		$1,176,369
	TOTAL CAPITAL COSTS (PRESENT WORTH)				**$7,058,214**

B. O&M COSTS

	Item	Rate	Amount	Units	Cost
1	**Remedial Construction, every 5 years** O&M (at Years 5, 10, 15, ..., 30)	$116,000	1	Event	$116,000
	Contigency	20%			

Table J-1
Cost Analysis - Alternative 3B
Nyanza Chemical Waste Dump Superfund Site
Operable Unit 4 - Sudbury River
Ashland, Massachusetts

Alternative 3B - Enhanced Natural Recovery in Reach 3 of Hg > 10 mg/kg and MNR

C. SUMMARY OF COSTS

	Item		Yearly Undiscounted Cost	Present Value
1	**Capital Costs**			
1-a	Enhanced Natural Recovery in Reach 3 of Hg >2 mg/kg;		$7,058,214	$7,058,214
1-b	MNR (from Alt 3A)		$503,224	$503,224
	TOTALCAPITAL PRESENT WORTH COST			**$7,561,438**
2	**O&M Costs**			
	Discount rate =	7%		
2-a	5-year Review, Institutional Controls, and Monitoring (from Alt 3A) at Discount rate = 7%			$476,001
2-b	Remedial Construction O&M			
	at Discount rate = 7%		$116,000	$ 267,828
	O&M present worth cost subtotal at Discount rate = 7%			$743,829
	Contingency	20%		
	TOTAL O&M PRESENT WORTH COST WITH CONTINGENCY at Discount rate = 7%			**$892,595**
3	**TOTAL PRESENT WORTH COST** at Discount rate = 7%			**$8,454,033**

Table L-1
Projected Fish Tissue Concentrations

	Remedial Approach	Current (2003) Exposure Point Concentration (mg/kg)	Current RME Risk Level (HI)	Fish Tissue Remediation Goal	Model-predicted Fish Tissue Concentration (5 years)*	Model-predicted Fish Tissue Concentration (30 years)*
Reach 2	MNR	0.83	1.8	0.48	NM**	NM**
Reach 3	ENR	0.94	2.1	0.48	0.47	0.47
Reach 4	MNR	0.58	1.3	0.48	0.19	0.19
Reach 5	NA	0.46	0.9	--	--	--
Reach 6	MNR	0.60	1.3	0.48	0.35	0.35
Reach 7	NA	0.50	1.0	--	--	--
Reach 8	LA	0.69	1.3	0.48	0.56	0.52
Reach 9	MNR	0.69	1.5	0.48	NM**	NM**
Reach 10	MNR	0.72	1.4	0.48	NM**	NM**

NM - Not Modeled
RME - Reasonably Maximally Exposed
MNR - Monitored Natural Recovery
ENR - Enhanced Natural Recovery
NA - Not applicable as these reaches did not trigger an unacceptable risk.
LA - Limited Action (as described in the ROD consisting of monitoring and institutional controls)
* - Timeframes measured post-construction
** - As described in Section E of the Nyanza OU4 ROD, the Computer Model was calibrated using data from Reach 3 through Reach 8 and thus used as a tool to predict the effectiveness of different remedial alternatives in meeting the remediation goals in those reaches. Reaches 2, 9 and 10 were not modeled. Based on the model's general evaluation of different alternatives as well as similarities between modeled and non-modeled reach (i.e. flow and standing water) EPA believes similar reductions will occur in Reach 2, 9 and 10, and that these reaches will achieve the cleanup goal (0.48 ppm). This will be confirmed with periodic monitoring.

Appendix C

Carcinogenic Risk Summary

TABLE 6-48
SUMMARY OF RISK RESULTS
NYANZA OPERABLE UNIT 3
MIDDLESEX COUNTY, MASSACHUSETTS

PARAMETER	RISK VALUES: FISH INGESTION															
	SUDBURY RESERVOIR								CEDAR SWAMP POND							
	SUBSISTENCE FISHERMAN				SPORT FISHERMAN				SUBSISTENCE FISHERMAN				SPORT FISHERMAN			
	HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK	
	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG
NAPHTHALENE*																
PHENOL*	1.3E-04	1.3E-04	0.0E+00	0.0E+00	1.7E-05	1.7E-05	0.0E+00	0.0E+00								
NITROBENZENE*																
ANTIMONY*									[2.8E+00]	[1.8E+00]	0.0E+00	0.0E+00	3.6E-01	2.6E-01	0.0E+00	0.0E+00
ARSENIC*	2.7E-01	2.7E-01	6.3E-05	6.3E-05	3.7E-02	3.7E-02	6.6E-06	6.6E-06								
CADMIUM*																
CHROMIUM*	3.0E-03	1.5E-03	0.0E+00	0.0E+00	6.3E-04	2.1E-04	0.0E+00	0.0E+00	8.7E-04	2.9E-04	0.0E+00	0.0E+00	1.2E-04	3.9E-05	0.0E+00	0.0E+00
LEAD*									0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
MERCURY*	[5.3E+00]	[4.0E+00]	0.0E+00	0.0E+00	7.3E-01	5.5E-01	0.0E+00	0.0E+00	[4.3E+01]	[3.3E+00]	0.0E+00	0.0E+00	[5.8E+00]	4.5E-01	0.0E+00	0.0E+00
METHYL MERCURY*	[2.9E+00]	[2.2E+00]	0.0E+00	0.0E+00	4.0E-01	3.0E-01	0.0E+00	0.0E+00								
3/4 METHYL PHENOL																
METHYLENE CHLORIDE																
ACETONE																
BEPH																
BENZO(B)FLUORANTHENE																
BENZO(A)PYRENE																
ENDOSULFAN I																
ENDOSULFAN II																
ENDOSULFAN SULFATE	1.2E-01	7.6E-02	0.0E+00	0.0E+00	1.7E-02	1.0E-02	0.0E+00	0.0E+00								
DIELDRIN	1.4E-02	1.4E-02	4.6E-06	4.6E-06	1.8E-03	1.6E-03	6.3E-07	6.3E-07								
4,4-DDD	0.0E+00	0.0E+00	6.6E-07	5.2E-07	0.0E+00	0.0E+00	1.3E-07	7.1E-08								
4,4-DDE	0.0E+00	0.0E+00	8.1E-06	3.9E-06	0.0E+00	0.0E+00	1.1E-06	5.3E-07								
4,4-DDT	0.0E+00	0.0E+00	4.0E-07	1.8E-07	0.0E+00	0.0E+00	5.4E-08	2.4E-08								
ALPHA-CHLORDANE	2.3E-02	2.3E-02	7.6E-07	7.6E-07	3.1E-03	3.1E-03	1.0E-07	1.0E-07								
GAMMA-CHLORDANE																
ALDRIN																
HEPTACLOR																
AROCHLOR 1248																
AROCLOR-1254																
AROCLOR-1260	0.0E+00	0.0E+00	4.3E-04	2.9E-04	0.0E+00	0.0E+00	5.8E-05	3.9E-05								
BARIUM																
COPPER																
MANGANESE	3.3E-02	1.4E-02	0.0E+00	0.0E+00	4.5E-03	2.0E-03	0.0E+00	0.0E+00								
NICKEL									4.1E-01	3.3E-02	0.0E+00	0.0E+00	5.5E-02	4.6E-03	0.0E+00	0.0E+00
SELENIUM	4.9E-01	1.2E-01	0.0E+00	0.0E+00	6.7E-02	1.7E-02	0.0E+00	0.0E+00	[1.1E+00]	6.5E-02	0.0E+00	0.0E+00	1.5E-01	1.2E-02	0.0E+00	0.0E+00
SILVER									9.8E-01	7.4E-02	0.0E+00	0.0E+00	1.4E-01	1.0E-02	0.0E+00	0.0E+00
THALLIUM									[1.5E+00]	9.6E-01	0.0E+00	0.0E+00	2.1E-01	1.3E-01	0.0E+00	0.0E+00
VANADIUM	1.5E-01	6.3E-02	0.0E+00	0.0E+00	2.0E-02	6.6E-03	0.0E+00	0.0E+00								
ZINC	4.2E-01	2.2E-01	0.0E+00	0.0E+00	5.7E-02	3.0E-02	0.0E+00	0.0E+00	3.9E-01	6.8E-02	0.0E+00	0.0E+00	5.3E-02	9.2E-03	0.0E+00	0.0E+00
SUM	[[illegible]]	[[illegible]]	8.0E-04	3.9E-04	9.3E-01	6.8E-01	9.9E-05	4.9E-05	[5.1E+01]	[6.4E+00]	0.0E+00	0.0E+00	[6.9E+00]	6.8E-01	0.0E+00	0.0E+00

BOXED VALUES ARE HAZARD QUOTIENTS WHICH EXCEED UNITY

FINAL

W92194F

TABLE 6
SUMMARY OF RISK RESULTS
NYANZA OPERABLE UNIT 3
MIDDLESEX COUNTY, MASSACHUSETTS
PAGE 2

PARAMETER	RISK VALUES · FISH INGESTION															
	SOUTHVILLE POND								MILL POND							
	SUBSISTENCE FISHERMAN				SPORT FISHERMAN				SUBSISTENCE FISHERMAN				SPORT FISHERMAN			
	HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK	
	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG
NAPHTHALENE*																
PHENOL*																
NITROBENZENE*																
ANTIMONY*																
ARSENIC*																
CADMIUM*																
CHROMIUM*	9.5E-04	3.4E-04	0.0E+00	0.0E+00	1.3E-04	4.7E-05	0.0E+00	0.0E+00								
LEAD*	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00								
MERCURY*	[4.0E+00]	[1.4E+00]	0.0E+00	0.0E+00	5.5E-01	1.9E-01	0.0E+00	0.0E+00	[9.0E+00]	[1.4E+00]	0.0E+00	0.0E+00	[1.2E+00]	1.9E-01	0.0E+00	0.0E+00
METHYL MERCURY*									3.3E+00	9.7E-01	0.0E+00	0.0E+00	4.5E-01	1.3E-01		
3/4 METHYL PHENOL																
METHYLENE CHLORIDE																
ACETONE																
BEPH																
BENZO(B)FLUORANTHENE																
BENZO(A)PYRENE																
ENDOSULFAN I																
ENDOSULFAN II																
ENDOSULFAN SULFATE																
DIELDRIN																
4,4-DDD																
4,4-DDE									0.0E+00	0.0E+00	5.9E-06	2.1E-06	0.0E+00	0.0E+00	8.1E-07	2.9E-07
4,4-DDT																
ALPHA-CHLORDANE																
GAMMA-CHLORDANE																
ALDRIN																
HEPTACLOR																
AROCHLOR 1248									0.0E+00	0.0E+00	2.2E-03	3.2E-04	0.0E+00	0.0E+00	3.1E-04	4.4E-05
AROCLOR-1254																
AROCLOR-1260																
BARIUM																
COPPER																
MANGANESE	5.2E-03	5.2E-03	0.0E+00	0.0E+00	7.0E-04	7.0E-04	0.0E+00	0.0E+00	4.2E-03	1.7E-03	0.0E+00	0.0E+00	5.8E-04	2.3E-04	0.0E+00	0.0E+00
NICKEL																
SELENIUM	4.1E-02	2.0E-02	0.0E+00	0.0E+00	5.5E-03	3.6E-03	0.0E+00	0.0E+00								
SILVER									1.1E-02	1.1E-02	0.0E+00	0.0E+00	1.5E-03	1.5E-03	0.0E+00	0.0E+00
THALLIUM																
VANADIUM									8.9E-03	6.8E-03	0.0E+00	0.0E+00	1.2E-03	9.2E-04	0.0E+00	0.0E+00
ZINC	1.5E-01	6.3E-02	0.0E+00	0.0E+00	2.0E-02	8.6E-03	0.0E+00	0.0E+00	2.7E-02	2.2E-02	0.0E+00	0.0E+00	3.8E-03	3.0E-03	0.0E+00	0.0E+00
SUM	[4.2E+00]	[1.5E+00]	0.0E+00	0.0E+00	5.8E-01	2.0E-01	0.0E+00	0.0E+00	[9.1E+00]	[1.4E+00]	2.2E-03	3.2E-04	[1.2E+00]	2.0E-01	3.1E-04	4.4E-05

BOXED VALUES ARE HAZARD QUOTIENTS WHICH EXCEED UNITY

FINAL

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TABLE 6-48
SUMMARY OF RISK RESULTS
NYANZA OPERABLE UNIT 3
MIDDLESEX COUNTY, MASSACHUSETTS
PAGE 3

RISK VALUES: FISH INGESTION — RESERVOIR NO. 2

PARAMETER	SUBSISTENCE FISHERMAN				SPORT FISHERMAN			
	HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK	
	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG
NAPHTHALENE*								
PHENOL*								
NITROBENZENE*								
ANTIMONY*	[5.2E+01]	[1.0E+00]	0.0E+00	0.0E+00	[7.1E+00]	2.6E-01	0.0E+00	0.0E+00
ARSENIC*	[7.8E+00]	4.7E-01	1.6E-03	1.1E-04	[1.1E+00]	6.5E-02	2.5E-04	1.5E-05
CADMIUM*	1.4E-01	8.1E-02	0.0E+00	0.0E+00	1.6E-02	1.1E-02	0.0E+00	0.0E+00
CHROMIUM*	7.7E-03	7.0E-04	0.0E+00	0.0E+00	1.1E-03	1.1E-04	0.0E+00	0.0E+00
LEAD*	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
MERCURY*	[3.4E+01]	[8.8E+00]	0.0E+00	0.0E+00	[4.7E+00]	[1.3E+00]	0.0E+00	0.0E+00
METHYL MERCURY*	[1.8E+01]	[7.6E+00]	0.0E+00	0.0E+00	[2.6E+00]	[1.1E+00]	0.0E+00	0.0E+00
3/4 METHYL PHENOL								
METHYLENE CHLORIDE								
ACETONE								
BEPH								
BENZO(B)FLUORANTHENE								
BENZO(A)PYRENE								
ENDOSULFAN I								
ENDOSULFAN II	2.7E-02	2.0E-02	0.0E+00	0.0E+00	3.7E-03	2.7E-03	0.0E+00	0.0E+00
ENDOSULFAN SULFATE								
DIELDRIN	1.4E-02	1.4E-02	4.6E-06	4.6E-06	1.6E-03	1.6E-03	6.3E-07	6.3E-07
4,4-DDD	0.0E+00	0.0E+00	8.6E-07	5.6E-07	0.0E+00	0.0E+00	1.3E-07	7.5E-08
4,4-DDE	0.0E+00	0.0E+00	1.3E-05	3.6E-06	0.0E+00	0.0E+00	1.8E-06	4.8E-07
4,4-DDT	0.0E+00	0.0E+00	4.0E-07	2.4E-07	0.0E+00	0.0E+00	5.4E-08	3.2E-08
ALPHA-CHLORDANE	2.3E-02	1.8E-02	7.8E-07	6.3E-07	3.1E-03	2.6E-03	1.0E-07	8.6E-08
GAMMA-CHLORDANE	4.5E-02	2.4E-02	1.5E-06	8.0E-07	6.2E-03	3.3E-03	2.1E-07	1.1E-07
ALDRIN	4.5E-02	1.5E-02	9.6E-06	3.2E-06	6.2E-03	2.0E-03	1.3E-06	4.4E-07
HEPTACLOR								
AROCHLOR 1248								
AROCLOR-1254	0.0E+00	0.0E+00	3.3E-03	4.1E-04	0.0E+00	0.0E+00	4.5E-04	5.6E-05
AROCLOR-1260	0.0E+00	0.0E+00	4.2E-04	3.4E-04	0.0E+00	0.0E+00	5.7E-05	4.7E-05
BARIUM								
COPPER								
MANGANESE	1.6E-01	1.1E-02	0.0E+00	0.0E+00	2.6E-02	1.6E-03	0.0E+00	0.0E+00
NICKEL								
SELENIUM								
SILVER	2.0E-01	2.7E-02	0.0E+00	0.0E+00	2.7E-02	3.7E-03	0.0E+00	0.0E+00
THALLIUM	[2.6E+01]	[1.6E+00]	0.0E+00	0.0E+00	[3.6E+00]	2.1E-01	0.0E+00	0.0E+00
VANADIUM	2.2E-01	6.2E-02	0.0E+00	0.0E+00	3.1E-02	6.8E-03	0.0E+00	0.0E+00
ZINC	[1.2E+00]	1.3E-01	0.0E+00	0.0E+00	1.7E-01	1.7E-02	0.0E+00	0.0E+00
SUM	[1.2E+02]*	[1.4E+01]**	5.5E-03*	6.6E-04	[1.7E+01]*	[1.8E+00]**	7.6E-04*	1.2E-04

RISK VALUES: FISH INGESTION — RESERVOIR 1

PARAMETER	SUBSISTENCE FISHERMAN				SPORT FISHERMAN			
	HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK	
	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG
NAPHTHALENE*								
PHENOL*	5.2E-03	9.3E-04	0.0E+00	0.0E+00	7.1E-04	1.3E-04	0.0E+00	0.0E+00
NITROBENZENE*								
ANTIMONY*								
ARSENIC*	5.2E-03	9.3E-04	0.0E+00	0.0E+00	7.1E-04	1.3E-04	0.0E+00	0.0E+00
CADMIUM*	5.2E-01	3.6E-01	1.2E-04	8.4E-05	7.0E-02	4.9E-02	1.6E-05	1.1E-05
CHROMIUM*								
LEAD*	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
MERCURY*	[1.9E+01]	[3.4E+00]	0.0E+00	0.0E+00	[2.6E+00]	4.6E-01	0.0E+00	0.0E+00
METHYL MERCURY*	[1.7E+01]	[4.5E+00]	0.0E+00	0.0E+00	[2.3E+00]	6.1E-01	0.0E+00	0.0E+00
3/4 METHYL PHENOL								
METHYLENE CHLORIDE								
ACETONE								
BEPH	2.2E-01	4.5E-02	2.7E-05	5.4E-06	3.1E-02	6.1E-03	3.7E-06	7.3E-07
BENZO(B)FLUORANTHENE								
BENZO(A)PYRENE								
ENDOSULFAN I								
ENDOSULFAN II								
ENDOSULFAN SULFATE								
DIELDRIN								
4,4-DDD	0.0E+00	0.0E+00	2.8E-06	1.8E-07	0.0E+00	0.0E+00	3.8E-07	2.5E-08
4,4-DDE	0.0E+00	0.0E+00	6.3E-06	3.5E-06	0.0E+00	0.0E+00	6.6E-07	4.8E-07
4,4-DDT	0.0E+00	0.0E+00	2.0E-07	1.5E-07	0.0E+00	0.0E+00	2.7E-08	2.0E-08
ALPHA-CHLORDANE	5.7E-02	3.7E-02	1.9E-06	1.2E-06	7.7E-03	5.1E-03	2.6E-07	1.7E-07
GAMMA-CHLORDANE	3.4E-02	2.3E-02	1.1E-06	7.6E-07	4.6E-03	3.1E-03	1.5E-07	1.0E-07
ALDRIN								
HEPTACLOR								
AROCHLOR 1248								
AROCLOR-1254	0.0E+00	0.0E+00	1.7E-04	3.6E-05	0.0E+00	0.0E+00	2.4E-05	5.1E-06
AROCLOR-1260	0.0E+00	0.0E+00	3.1E-04	3.0E-05	0.0E+00	0.0E+00	4.2E-05	4.1E-06
BARIUM	4.5E-03	1.6E-03	0.0E+00	0.0E+00	6.2E-04	2.1E-04	0.0E+00	0.0E+00
COPPER								
MANGANESE	1.4E-01	3.1E-02	0.0E+00	0.0E+00	2.0E-02	4.2E-03	0.0E+00	0.0E+00
NICKEL								
SELENIUM								
SILVER								
THALLIUM								
VANADIUM	3.0E-01	9.6E-02	0.0E+00	0.0E+00	4.2E-02	1.3E-02	0.0E+00	0.0E+00
ZINC	[1.8E+00]	2.2E-01	0.0E+00	0.0E+00	2.4E-01	2.9E-02	0.0E+00	0.0E+00
SUM	[2.2E+01]*	[4.2E+00]**	6.4E-04*	1.6E-04	[3.0E+00]*	5.7E-01**	6.8E-05*	2.2E-05

BOXED VALUES ARE HAZARD QUOTIENTS WHICH EXCEED UNITY

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SUMMARY OF RISK RESULTS
NYANZA OPERABLE UNIT 3
MIDDLESEX COUNTY, MASSACHUSETTS
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PARAMETER	RISK VALUES: FISH INGESTION															
	SAXONVILLE RESERVOIR								FAIRHAVEN BAY							
	SUBSISTENCE FISHERMAN				SPORT FISHERMAN				SUBSISTENCE FISHERMAN				SPORT FISHERMAN			
	HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK	
	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG
NAPHTHALENE*	6.4E-01	4.4E-02	0.0E+00	0.0E+00	8.8E-02	6.0E-03	0.0E+00	0.0E+00								
PHENOL*	2.7E-04	1.0E-04	0.0E+00	0.0E+00	3.7E-05	1.4E-05	0.0E+00	0.0E+00	1.9E-02	2.4E-03	0.0E+00	0.0E+00	2.5E-03	3.3E-04	0.0E+00	0.0E+00
NITROBENZENE*									6.5E-02	6.5E-02	0.0E+00	0.0E+00	8.9E-03	8.9E-03	0.0E+00	0.0E+00
ANTIMONY*	4.7E-01	4.7E-01	0.0E+00	0.0E+00	6.5E-02	6.5E-02	0.0E+00	0.0E+00								
ARSENIC*	2.1E-01	1.8E-01	4.8E-05	4.2E-05	2.9E-02	2.5E-02	6.6E-06	5.7E-06								
CADMIUM*																
CHROMIUM*	5.9E-03	8.9E-04	0.0E+00	0.0E+00	7.9E-04	1.2E-04	0.0E+00	0.0E+00	4.6E-03	6.1E-04	0.0E+00	0.0E+00	6.3E-04	8.4E-05	0.0E+00	0.0E+00
LEAD*	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
MERCURY*	[6.1E+00]	[2.6E+00]	0.0E+00	0.0E+00	[1.1E+00]	3.9E-01	0.0E+00	0.0E+00	[1.4E+01]	[4.6E+00]	0.0E+00	0.0E+00	[2.0E+00]	6.5E-01	0.0E+00	0.0E+00
METHYL MERCURY*	[6.2E+00]	[1.6E+00]	0.0E+00	0.0E+00	8.4E-01	2.5E-01	0.0E+00	0.0E+00	[5.4E+00]	[2.5E+00]	0.0E+00	0.0E+00	7.4E-01	3.5E-01	0.0E+00	0.0E+00
3/4 METHYL PHENOL									5.2E-02	3.8E-03	0.0E+00	0.0E+00	7.0E-03	5.1E-04	0.0E+00	0.0E+00
METHYLENE CHLORIDE									3.2E-01	1.1E-02	6.1E-05	2.2E-06	4.3E-02	1.6E-03	8.3E-08	3.0E-07
ACETONE									2.2E-02	5.4E-03	0.0E+00	0.0E+00	3.0E-03	7.4E-04	0.0E+00	0.0E+00
BEPH	4.6E-02	1.1E-02	5.5E-06	1.4E-06	6.3E-03	1.6E-03	7.5E-07	1.9E-07	2.5E-03	2.2E-03	3.0E-07	2.6E-07	3.4E-04	3.0E-04	4.1E-08	3.6E-08
BENZO(B)FLUORANTHENE									0.0E+00	0.0E+00	2.9E-04	2.6E-04	0.0E+00	0.0E+00	4.0E-05	3.6E-05
BENZO(A)PYRENE									0.0E+00	0.0E+00	8.8E-05	8.8E-05	0.0E+00	0.0E+00	1.2E-05	1.2E-05
ENDOSULFAN I	4.1E-02	3.4E-02	0.0E+00	0.0E+00	5.5E-03	4.6E-03	0.0E+00	0.0E+00								
ENDOSULFAN II																
ENDOSULFAN SULFATE	2.7E-02	2.7E-02	0.0E+00	0.0E+00	3.7E-03	3.7E-03	0.0E+00	0.0E+00								
DIELDRIN	1.4E-02	6.6E-03	4.8E-06	2.3E-06	1.8E-03	9.2E-04	6.3E-07	3.2E-07								
4,4-DDD	0.0E+00	0.0E+00	2.0E-06	6.5E-07	0.0E+00	0.0E+00	2.7E-07	8.9E-08								
4,4-DDE	0.0E+00	0.0E+00	4.0E-06	1.5E-06	0.0E+00	0.0E+00	5.4E-07	2.0E-07	0.0E+00	0.0E+00	7.1E-08	3.5E-08	0.0E+00	0.0E+00	9.7E-07	4.8E-07
4,4-DDT	0.0E+00	0.0E+00	4.0E-07	2.8E-07	0.0E+00	0.0E+00	5.4E-08	3.8E-08								
ALPHA-CHLORDANE	4.5E-02	4.5E-02	1.5E-06	1.5E-06	6.2E-03	6.2E-03	2.1E-07	2.1E-07								
GAMMA-CHLORDANE	2.3E-02	1.6E-02	7.6E-07	6.3E-07	3.1E-03	2.6E-03	1.0E-07	8.6E-08								
ALDRIN																
HEPTACLOR	1.6E-02	4.6E-03	1.6E-05	4.4E-06	2.2E-03	6.2E-04	2.1E-06	6.0E-07								
AROCHLOR 1248																
AROCLOR-1254	0.0E+00	0.0E+00	1.8E-04	8.0E-05	0.0E+00	0.0E+00	2.4E-05	1.2E-05	0.0E+00	0.0E+00	2.1E-03	9.6E-04	0.0E+00	0.0E+00	2.8E-04	1.2E-04
AROCLOR-1260	0.0E+00	0.0E+00	4.9E-04	2.1E-04	0.0E+00	0.0E+00	6.7E-05	2.8E-05	0.0E+00	0.0E+00	1.3E-04	4.6E-05	0.0E+00	0.0E+00	1.8E-05	6.2E-06
BARIUM									3.0E-02	1.7E-02	0.0E+00	0.0E+00	4.1E-03	2.4E-03	0.0E+00	0.0E+00
COPPER *																
MANGANESE	2.7E-01	2.9E-02	0.0E+00	0.0E+00	3.9E-02	3.9E-03	0.0E+00	0.0E+00	4.5E-01	3.9E-02	0.0E+00	0.0E+00	6.1E-02	5.3E-03	0.0E+00	0.0E+00
NICKEL	8.4E-02	1.6E-02	0.0E+00	0.0E+00	1.1E-02	2.1E-03	0.0E+00	0.0E+00	1.4E-01	2.2E-02	0.0E+00	0.0E+00	1.6E-02	3.0E-03	0.0E+00	0.0E+00
SELENIUM	1.7E-01	4.4E-02	0.0E+00	0.0E+00	2.3E-02	6.1E-03	0.0E+00	0.0E+00	7.3E-02	2.5E-02	0.0E+00	0.0E+00	1.0E-02	3.5E-03	0.0E+00	0.0E+00
SILVER	1.1E-01	2.4E-02	0.0E+00	0.0E+00	1.6E-02	3.2E-03	0.0E+00	0.0E+00								
THALLIUM	[2.3E+01]	[1.1E+00]	0.0E+00	0.0E+00	[3.1E+00]	1.6E-01	0.0E+00	0.0E+00								
VANADIUM	2.4E-01	6.3E-02	0.0E+00	0.0E+00	3.2E-02	1.1E-02	0.0E+00	0.0E+00								
ZINC	6.4E-01	1.2E-01	0.0E+00	0.0E+00	8.8E-02	1.7E-02	0.0E+00	0.0E+00	1.4E-01	6.1E-02	0.0E+00	0.0E+00	2.0E-02	8.3E-03	0.0E+00	0.0E+00
SUM	[3.4E+01]	[9.1E+00] **	7.9E-04 *	3.8E-04	[4.7E+00]	9.9E-01 **	1.0E-04 *	4.8E-05	[1.6E+01]	[5.0E+00] **	2.8E-03 *	1.3E-03	[2.2E+00]	6.8E-01 **	3.6E-04 *	1.8E-04

BOXED VALUES ARE HAZARD QUOTIENTS WHICH EXCEED UNITY

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SUMMARY OF RISK RESULTS
NYANZA OPERABLE UNIT 3
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PARAMETER	RISK VALUES: SEDIMENT EXPOSURE															
	REACH 1 AND BACKGROUND				REACH 2				EASTERN WETLANDS				EASTERN WETLANDS DRILLING			
	HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME	
	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG
TRICHLOROETHENE									0.0E+00	0.0E+00	2.1E-09	1.1E-09	0.0E+00	0.0E+00	4.2E-08	2.7E-08
12DICHLOROETHENE					1.3E-05	3.0E-06	0.0E+00	0.0E+00	5.3E-05	3.0E-05	0.0E+00	0.0E+00	2.3E-03	1.1E-04	0.0E+00	0.0E+00
CHLOROBENZENE*					6.5E-06	1.9E-06	0.0E+00	0.0E+00	3.3E-04	1.7E-04	0.0E+00	0.0E+00	7.0E-03	5.4E-04	0.0E+00	0.0E+00
NITROBENZENE*									3.0E-03	3.0E-03	0.0E+00	0.0E+00	6.4E-04	4.6E-04	0.0E+00	0.0E+00
1,2-DICHLOROBENZENE					4.6E-05	2.2E-05	0.0E+00	0.0E+00	1.6E-04	1.0E-04	0.0E+00	0.0E+00	3.3E-04	4.6E-05	0.0E+00	0.0E+00
1,3-DCB*													2.2E-05	2.1E-05	0.0E+00	0.0E+00
1,4-DCB*					0.0E+00	0.0E+00	1.4E-08	7.9E-09	0.0E+00	0.0E+00	2.0E-08	1.5E-08	0.0E+00	0.0E+00	3.8E-09	7.2E-09
1,2,4-TRICHLOROBENZENE*					1.3E-03	1.1E-03	0.0E+00	0.0E+00	6.4E-03	3.4E-03	0.0E+00	0.0E+00	6.6E-04	5.3E-04	0.0E+00	0.0E+00
NAPHTHALENE*					6.1E-04	3.1E-04	0.0E+00	0.0E+00	1.2E-03	6.0E-04	0.0E+00	0.0E+00	4.2E-05	4.2E-05	0.0E+00	0.0E+00
PHENOL*																
ARSENIC*	1.3E-01	6.3E-02	1.4E-05	5.7E-06	9.1E-02	4.2E-02	9.8E-06	4.6E-06	7.7E-02	4.0E-02	8.3E-06	4.3E-06	4.3E-02	1.0E-02	4.6E-06	1.1E-06
ANTIMONY*	3.7E-02	2.6E-02	0.0E+00	0.0E+00												
CADMIUM*													1.2E-02	2.4E-03	0.0E+00	0.0E+00
*CHROMIUM**	*1.0E-04*	*4.1E-05*	*0.0E+00*	*0.0E+00*	*3.8E-04*	*8.2E-05*	*0.0E+00*	*0.0E+00*	*8.4E-04*	*2.3E-04*	*0.0E+00*	*0.0E+00*	*7.7E-04*	*7.8E-05*	*0.0E+00*	*0.0E+00*
LEAD*	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
MERCURY*	9.6E-03	1.7E-03	0.0E+00	0.0E+00	1.9E-01	2.4E-02	0.0E+00	0.0E+00	6.6E-01	2.2E-01	0.0E+00	0.0E+00	5.7E-01	3.8E-02	0.0E+00	0.0E+00
MONOMETHYLHG*					5.9E-03	1.9E-03	0.0E+00	0.0E+00	4.1E-03	1.2E-03	0.0E+00	0.0E+00				
DIMETHYLHG*																
VINYL CHLORIDE																
BENZENE													0.0E+00	0.0E+00	1.3E-10	1.3E-10
DICHLOROMETHANE					6.6E-07	4.1E-07	6.7E-11	6.0E-11					1.1E-04	9.6E-06	1.3E-08	1.2E-09
ACETONE	4.1E-07	4.1E-07	0.0E+00	0.0E+00	1.3E-05	5.0E-06	0.0E+00	0.0E+00	6.6E-05	3.7E-05	0.0E+00	0.0E+00	4.5E-06	1.4E-06	0.0E+00	0.0E+00
BEHP					2.3E-04	7.4E-05	1.4E-08	4.7E-09					4.1E-06	2.6E-06	2.6E-10	1.6E-10
3/4-METHYLPHENOL									1.2E-05	1.2E-05	0.0E+00	0.0E+00	3.4E-06	3.4E-06	0.0E+00	0.0E+00
2-METHYLNAPH																
ACENAPTHYLENE					2.6E-04	2.5E-04	0.0E+00	0.0E+00					2.3E-05	1.6E-05	0.0E+00	0.0E+00
PHENANTHRENE	6.2E-06	7.7E-06	0.0E+00	0.0E+00	6.5E-03	6.4E-04	0.0E+00	0.0E+00	3.2E-04	3.2E-04	0.0E+00	0.0E+00	1.4E-04	4.0E-05	0.0E+00	0.0E+00
FLUORANTHENE	1.6E-05	1.1E-05	0.0E+00	0.0E+00	4.6E-04	1.0E-04	0.0E+00	0.0E+00	6.2E-05	6.2E-05	0.0E+00	0.0E+00	1.3E-05	6.7E-06	0.0E+00	0.0E+00
PYRENE	1.6E-05	1.2E-05	0.0E+00	0.0E+00	6.1E-04	1.1E-04	0.0E+00	0.0E+00	1.2E-04	6.6E-05	0.0E+00	0.0E+00	1.7E-06	1.7E-06	0.0E+00	0.0E+00
BENZO(A)ANTH					0.0E+00	0.0E+00	1.1E-05	2.6E-06					0.0E+00	0.0E+00	4.6E-07	3.2E-07
CHRYSENE	0.0E+00	0.0E+00	4.6E-07	4.1E-07	0.0E+00	0.0E+00	1.1E-05	2.6E-06	0.0E+00	0.0E+00	3.1E-06	2.6E-06	0.0E+00	0.0E+00	2.5E-07	2.0E-07
BENZO(B)FLUOR	0.0E+00	0.0E+00	5.1E-07	4.7E-07	0.0E+00	0.0E+00	9.0E-06	2.6E-06	0.0E+00	0.0E+00	6.4E-06	7.1E-06				
BENZO(K)FLUOR					0.0E+00	0.0E+00	9.7E-06	2.5E-06					0.0E+00	0.0E+00	2.2E-06	7.1E-07
BENZO(A)PYRENE	0.0E+00	0.0E+00	2.3E-07	2.3E-07	0.0E+00	0.0E+00	9.6E-06	2.6E-06	0.0E+00	0.0E+00	2.2E-06	2.1E-06	0.0E+00	0.0E+00	3.1E-07	3.1E-07
IN(123-CD)PYRENE					0.0E+00	0.0E+00	2.3E-06	1.6E-06								
DIBENZ(AH)ANTH					0.0E+00	0.0E+00	2.4E-07	2.2E-07					0.0E+00	0.0E+00	3.1E-07	3.1E-07
BENZO(GHI)PERYL					3.3E-04	3.0E-04	0.0E+00	0.0E+00								
BARIUM	6.6E-03	2.4E-03	0.0E+00	0.0E+00	7.6E-03	2.6E-03	0.0E+00	0.0E+00	2.1E-03	1.2E-03	0.0E+00	0.0E+00	2.4E-03	1.2E-03	0.0E+00	0.0E+00
BERYLLIUM	6.6E-04	3.1E-04	2.6E-06	1.3E-06	6.6E-04	3.2E-04	3.0E-06	1.4E-06	1.5E-03	6.1E-04	6.3E-06	3.5E-06	3.0E-03	6.6E-04	1.3E-05	2.6E-06
COPPER																
MANGANESE	3.0E-02	7.0E-03	0.0E+00	0.0E+00	7.6E-02	1.6E-02	0.0E+00	0.0E+00	2.4E-02	5.3E-03	0.0E+00	0.0E+00	8.7E-03	1.8E-03	0.0E+00	0.0E+00
NICKEL	4.7E-03	1.0E-03	0.0E+00	0.0E+00	1.7E-03	6.6E-04	0.0E+00	0.0E+00	3.7E-03	9.3E-04	0.0E+00	0.0E+00	2.1E-03	6.6E-04	0.0E+00	0.0E+00
SILVER																
SELENIUM	1.1E-03	3.8E-04	0.0E+00	0.0E+00					2.4E-03	5.2E-04	0.0E+00	0.0E+00				
THALLIUM													3.7E-02	1.2E-02	0.0E+00	0.0E+00
VANADIUM	1.3E-02	5.3E-03	0.0E+00	0.0E+00	1.2E-02	5.2E-03	0.0E+00	0.0E+00	9.6E-03	4.6E-03	0.0E+00	0.0E+00	6.9E-03	3.6E-03	0.0E+00	0.0E+00
ZINC	5.7E-03	1.9E-03	0.0E+00	0.0E+00	3.0E-03	1.2E-03	0.0E+00	0.0E+00	1.5E-03	6.0E-04	0.0E+00	0.0E+00	2.6E-03	3.9E-04	0.0E+00	0.0E+00
4,4-DDE					0.0E+00	0.0E+00	3.6E-09	2.5E-09								
4,4-DDD					0.0E+00	0.0E+00	1.4E-09	1.4E-09	0.0E+00	0.0E+00	7.8E-09	3.3E-09				
4,4-DDT					0.0E+00	0.0E+00	6.6E-09	1.1E-08								
CHLORDANE																
AROCLOR 1254																
SUM	2.3E-01	1.0E-01	1.9E-05	9.2E-06	3.9E-01	9.5E-02	9.9E-05	2.1E-05	1.1E+00	2.9E-01	2.8E-05	2.0E-05	7.0E-01	7.3E-02	2.1E-05	5.8E-06

BOXED VALUES ARE HAZARD QUOTIENTS WHICH EXCEED UNITY

FINAL

W92194F

PARAMETER	RISK VALUES: SEDIMENT EXPOSURE															
	CULVERT				OUTFALL CREEK				RACEWAY				COLD SPRING BROOK			
	HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME	
	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG
TRICHLOROETHENE	0.0E+00	0.0E+00	8.8E-10	4.8E-10	0.0E+00	0.0E+00	4.8E-11	3.2E-08	0.0E+00	0.0E+00	6.5E-07	2.1E-07				
12DICHLOROETHENE	1.8E-06	1.0E-06	0.0E+00	0.0E+00	4.1E-07	4.1E-04	0.0E+00	0.0E+00	5.3E-04	2.3E-04	0.0E+00	0.0E+00				
CHLOROBENZENE*	1.8E-06	1.1E-06	0.0E+00	0.0E+00					4.0E-03	1.2E-03	0.0E+00	0.0E+00				
NITROBENZENE*	1.4E-03	1.4E-03	0.0E+00	0.0E+00	2.3E-03	1.6E-03	0.0E+00	0.0E+00								
1,2-DICHLOROBENZENE	4.8E-06	4.2E-06	0.0E+00	0.0E+00	7.4E-08	6.3E-08	0.0E+00	0.0E+00	1.6E-04	1.1E-04	0.0E+00	0.0E+00				
1,3-DCB*	7.8E-08	7.8E-08	0.0E+00	0.0E+00												
1,4-DCB*	0.0E+00	0.0E+00	7.3E-08	5.7E-08												
1,2,4-TRICHLOROBENZENE*	1.8E-03	1.6E-03	0.0E+00	0.0E+00	2.3E-03	1.4E-03	0.0E+00	0.0E+00								
NAPHTHALENE*	3.1E-04	2.0E-04	0.0E+00	0.0E+00	1.7E-04	1.1E-04	0.0E+00	0.0E+00	3.4E-03	2.1E-03	0.0E+00	0.0E+00				
PHENOL*																
ARSENIC*	4.0E-02	2.8E-02	4.3E-08	2.8E-08	2.6E-02	1.8E-02	2.7E-08	1.9E-08	2.3E-01	1.5E-01	2.4E-05	1.6E-05	2.6E-02	2.1E-02	2.8E-08	2.3E-08
ANTIMONY*																
CADMIUM*									2.0E-02	8.3E-03	0.0E+00	0.0E+00				
CHROMIUM*	2.9E-04	1.8E-04	0.0E+00	0.0E+00	1.8E-03	8.2E-04	0.0E+00	0.0E+00	3.8E-04	2.8E-04	0.0E+00	0.0E+00	3.1E-05	2.8E-05	0.0E+00	0.0E+00
LEAD*	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
MERCURY*	4.4E-08	4.2E-08	0.0E+00	0.0E+00	8.2E-01	2.2E-01	0.0E+00	0.0E+00	6.1E-03	4.4E-03	0.0E+00	0.0E+00				
MONOMETHYLHG*																
DIMETHYLHG*																
VINYL CHLORIDE																
BENZENE	0.0E+00	0.0E+00	6.5E-11	6.6E-11												
DICHLOROMETHANE					3.8E-08	1.5E-08	4.6E-10	1.9E-10	4.2E-08	4.2E-08	5.2E-10	5.2E-10				
ACETONE					1.4E-08	9.5E-07	0.0E+00	0.0E+00	3.1E-05	2.0E-05	0.0E+00	0.0E+00				
BEHP	2.3E-06	1.7E-06	1.4E-08	1.1E-08	2.3E-04	1.1E-04	1.4E-08	8.9E-09	2.9E-04	2 [illegible]-04	1.8E-08	1.8E-08				
3/4-METHYLPHENOL																
2-METHYLNAPH																
ACENAPTHYLENE	7.2E-06	7.2E-06	0.0E+00	0.0E+00	1.8E-04	1.4E-04	0.0E+00	0.0E+00								
PHENANTHRENE	4.1E-04	3.8E-04	0.0E+00	0.0E+00	4.8E-04	3.2E-04	0.0E+00	0.0E+00	8.2E-03	6.2E-03	0.0E+00	0.0E+00				
FLUORANTHENE	7.2E-06	6.7E-06	0.0E+00	0.0E+00	8.2E-05	6.7E-05	0.0E+00	0.0E+00	1.0E-03	7.3E-04	0.0E+00	0.0E+00				
PYRENE	8.2E-06	8.2E-06	0.0E+00	0.0E+00	1.7E-04	1.2E-04	0.0E+00	0.0E+00	8.9E-04	6.4E-04	0.0E+00	0.0E+00				
BENZO(A)ANTH	0.0E+00	0.0E+00	2.1E-08	1.8E-08	0.0E+00	0.0E+00	2.7E-08	2.0E-08	0.0E+00	0.0E+00	2.6E-05	1.5E-05				
CHRYSENE	0.0E+00	0.0E+00	1.6E-08	1.6E-08	0.0E+00	0.0E+00	3.6E-08	2.7E-08	0.0E+00	0.0E+00	2.2E-05	1.5E-05				
BENZO(B)FLUOR	0.0E+00	0.0E+00	2.1E-08	2.1E-08	0.0E+00	0.0E+00	4.5E-08	3.1E-08	0.0E+00	0.0E+00	1.3E-05	1.1E-05				
BENZO(K)FLUOR	0.0E+00	0.0E+00	2.0E-08	1.7E-08	0.0E+00	0.0E+00	2.5E-08	1.2E-08	0.0E+00	0.0E+00	1.6E-05	1.1E-05				
BENZO(A)PYRENE	0.0E+00	0.0E+00	2.0E-08	1.8E-08	0.0E+00	0.0E+00	3.1E-08	2.3E-08	0.0E+00	0.0E+00	1.2E-05	9.9E-06				
IN(123-CD)PYRENE	0.0E+00	0.0E+00	6.4E-07	6.4E-07	0.0E+00	0.0E+00	1.8E-08	1.2E-08								
DIBENZ(AH)ANTH																
BENZO(GHI)PERYL	1.4E-04	1.4E-04	0.0E+00	0.0E+00	3.8E-04	2.5E-04	0.0E+00	0.0E+00								
BARIUM	8.6E-04	6.6E-04	0.0E+00	0.0E+00	2.1E-03	1.2E-03	0.0E+00	0.0E+00	2.6E-03	1.8E-03	0.0E+00	0.0E+00	2.4E-03	2.2E-03	0.0E+00	0.0E+00
BERYLLIUM	2.0E-04	1.8E-04	8.8E-07	7.0E-07	8.0E-04	3.8E-04	3.4E-08	1.7E-08	3.7E-03	2.8E-03	1.8E-05	1.1E-05	6.9E-04	3.7E-04	3.0E-06	1.6E-06
COPPER																
MANGANESE	2.8E-03	1.7E-03	0.0E+00	0.0E+00	6.8E-03	3.0E-03	0.0E+00	0.0E+00	1.6E-02	8.3E-03	0.0E+00	0.0E+00	1.6E-02	1.2E-02	0.0E+00	0.0E+00
NICKEL									1.7E-02	8.2E-03	0.0E+00	0.0E+00				
SILVER																
SELENIUM																
THALLIUM																
VANADIUM	4.7E-03	3.1E-03	0.0E+00	0.0E+00	9.4E-03	4.8E-03	0.0E+00	0.0E+00	1.3E-02	1.2E-02	0.0E+00	0.0E+00	1.1E-02	8.1E-03	0.0E+00	0.0E+00
ZINC	6.4E-04	6.5E-04	0.0E+00	0.0E+00	3.8E-03	1.8E-03	0.0E+00	0.0E+00	4.9E-03	3.3E-03	0.0E+00	0.0E+00	1.5E-03	1.4E-03	0.0E+00	0.0E+00
4,4-DDE									0.0E+00	0.0E+00	1.3E-09	1.6E-09				
4,4-DDD									0.0E+00	0.0E+00	4.8E-09	1.4E-09				
4,4-DDT																
CHLORDANE																
AROCLOR 1254									0.0E+00	0.0E+00	4.9E-07	2.8E-07				
SUM	9.8E-02	7.8E-02	1.8E-06	1.4E-06	6.7E-01	2.8E-01	2.4E-06	1.6E-06	3.3E-01	2.1E-01	1.3E-04	8.9E-05	5.7E-02	4.5E-02	5.8E-06	3.9E-06

BOXED VALUES ARE HAZARD QUOTIENTS WHICH EXCEED UNITY

FINAL

SUMMARY OF RISK RESULTS
NYANZA OPERABLE UNIT 3
MIDDLESEX COUNTY, MASSACHUSETTS
PAGE 7

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PARAMETER	RISK VALUES: SEDIMENT EXPOSURE															
	REACH 3				REACH 4				REACH 5				REACH 6			
	HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME	
	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG
TRICHLOROETHENE																
12DICHLOROETHENE																
CHLOROBENZENE*																
NITROBENZENE*																
1,2-DICHLOROBENZENE																
1,3-DCB*																
1,4-DCB*	0.0E+00	0.0E+00	1.6E-08	1.6E-08												
1,2,4-TRICHLOROBENZENE*	2.8E-04	2.2E-04	0.0E+00	0.0E+00												
NAPHTHALENE*	6.2E-05	6.2E-05	0.0E+00	0.0E+00												
PHENOL*																
ARSENIC*	1.3E-01	4.6E-02	1.4E-05	5.0E-06	2.0E-01	6.6E-02	2.1E-05	7.0E-06	5.6E-02	2.3E-02	6.0E-06	2.5E-06	1.5E-01	6.8E-02	1.6E-05	7.3E-06
ANTIMONY*	8.2E-02	1.6E-02	0.0E+00	0.0E+00												
CADMIUM*	7.3E-02	1.6E-02	0.0E+00	0.0E+00	5.4E-02	1.6E-02	0.0E+00	0.0E+00					6.0E-02	1.4E-02	0.0E+00	0.0E+00
CHROMIUM*	4.6E-03	8.3E-04	0.0E+00	0.0E+00	4.1E-04	1.3E-04	0.0E+00	0.0E+00	1.1E-04	3.3E-05	0.0E+00	0.0E+00	5.1E-04	1.2E-04	0.0E+00	0.0E+00
LEAD*	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
MERCURY*	3.4E-01	1.0E-01	0.0E+00	0.0E+00	4.6E-02	2.1E-02	0.0E+00	0.0E+00	2.6E-02	8.1E-03	0.0E+00	0.0E+00	1.1E-01	2.1E-02	0.0E+00	0.0E+00
MONOMETHYLHG*	4.7E-04	4.7E-04	0.0E+00	0.0E+00	1.4E-03	4.6E-04	0.0E+00	0.0E+00								
DIMETHYLHG*	3.4E-04	1.3E-04	0.0E+00	0.0E+00												
VINYL CHLORIDE																
BENZENE																
DICHLOROMETHANE																
ACETONE	1.3E-05	5.4E-06	0.0E+00	0.0E+00	1.1E-04	8.6E-05	0.0E+00	0.0E+00					2.3E-05	1.6E-05	0.0E+00	0.0E+00
BEHP	1.0E-04	9.0E-05	8.6E-09	5.7E-09					3.6E-05	3.6E-05	2.4E-09	2.4E-09	2.2E-04	1.6E-04	1.4E-08	1.0E-08
3/4-METHYLPHENOL									5.9E-06	5.9E-06	0.0E+00	0.0E+00				
2-METHYLNAPH																
ACENAPTHYLENE	4.9E-04	4.2E-04	0.0E+00	0.0E+00					8.2E-05	8.2E-05	0.0E+00	0.0E+00				
PHENANTHRENE	3.6E-03	7.0E-04	0.0E+00	0.0E+00	8.7E-05	8.7E-05	0.0E+00	0.0E+00	2.8E-04	2.8E-04	0.0E+00	0.0E+00	8.2E-04	6.0E-04	0.0E+00	0.0E+00
FLUORANTHENE	8.2E-04	1.2E-04	0.0E+00	0.0E+00	1.4E-05	1.3E-05	0.0E+00	0.0E+00	5.7E-05	5.7E-05	0.0E+00	0.0E+00	1.3E-04	1.0E-04	0.0E+00	0.0E+00
PYRENE	7.6E-04	1.7E-04	0.0E+00	0.0E+00	1.8E-05	1.7E-05	0.0E+00	0.0E+00	7.5E-05	7.5E-05	0.0E+00	0.0E+00	2.0E-04	1.4E-04	0.0E+00	0.0E+00
BENZO(A)ANTH	0.0E+00	0.0E+00	1.1E-08	3.4E-08	0.0E+00	0.0E+00	2.6E-07	2.6E-07	0.0E+00	0.0E+00	1.2E-08	1.2E-08	0.0E+00	0.0E+00	3.6E-08	2.6E-08
CHRYSENE	0.0E+00	0.0E+00	2.0E-08	4.4E-08	0.0E+00	0.0E+00	5.6E-07	8.2E-07	0.0E+00	0.0E+00	1.8E-08	1.8E-08	0.0E+00	0.0E+00	3.8E-08	3.3E-08
BENZO(B)FLUOR	0.0E+00	0.0E+00	1.1E-08	3.6E-08	0.0E+00	0.0E+00	1.0E-06	7.0E-07	0.0E+00	0.0E+00	3.6E-08	3.6E-08	0.0E+00	0.0E+00	6.7E-08	4.1E-08
BENZO(K)FLUOR	0.0E+00	0.0E+00	8.6E-08	3.6E-08	0.0E+00	0.0E+00	3.6E-07	3.6E-07					0.0E+00	0.0E+00	2.5E-08	2.3E-08
BENZO(A)PYRENE	0.0E+00	0.0E+00	1.1E-08	3.1E-08	0.0E+00	0.0E+00	3.6E-07	3.6E-07	0.0E+00	0.0E+00	8.2E-07	8.2E-07	0.0E+00	0.0E+00	2.6E-08	2.0E-08
IN(123-CD)PYRENE	0.0E+00	0.0E+00	4.6E-08	2.0E-08	0.0E+00	0.0E+00	2.4E-07	2.4E-07	0.0E+00	0.0E+00	8.1E-07	8.1E-07	0.0E+00	0.0E+00	1.9E-08	1.4E-08
DIBENZ(AH)ANTH	0.0E+00	0.0E+00	7.6E-07	5.6E-07												
BENZO(GHI)PERYL	8.3E-04	4.0E-04	0.0E+00	0.0E+00	4.7E-05	4.7E-05	0.0E+00	0.0E+00	[illegible]	1.4E-04	0.0E+00	0.0E+00	4.2E-04	3.0E-04	0.0E+00	0.0E+00
BARIUM	4.8E-03	2.6E-03	0.0E+00	0.0E+00	4.6E-03	2.6E-03	0.0E+00	0.0E+00	[illegible]	2.7E-03	0.0E+00	0.0E+00	5.2E-03	3.1E-03	0.0E+00	0.0E+00
BERYLLIUM	1.6E-03	6.6E-04	6.7E-08	2.4E-08	1.3E-03	2.6E-04	6.6E-08	1.3E-08	[illegible]	8.1E-05	3.9E-07	3.9E-07	7.3E-04	1.6E-04	3.1E-08	7.7E-07
COPPER																
MANGANESE	1.8E-02	7.1E-03	0.0E+00	0.0E+00					3.5E-02	1.3E-02	0.0E+00	0.0E+00	2.6E-02	1.1E-02	0.0E+00	0.0E+00
NICKEL	8.1E-03	2.6E-03	0.0E+00	0.0E+00	8.8E-03	2.6E-03	0.0E+00	0.0E+00	1.5E-03	6.2E-04	0.0E+00	0.0E+00	7.2E-03	1.9E-03	0.0E+00	0.0E+00
SILVER									3.9E-03	1.2E-03	0.0E+00	0.0E+00				
SELENIUM	1.8E-03	3.0E-04	0.0E+00	0.0E+00	1.6E-03	8.4E-04	0.0E+00	0.0E+00	1.6E-04	1.6E-04	0.0E+00	0.0E+00	2.2E-03	5.0E-04	0.0E+00	0.0E+00
THALLIUM																
VANADIUM	1.6E-02	9.1E-03	0.0E+00	0.0E+00	1.6E-02	9.0E-03	0.0E+00	0.0E+00	9.0E-03	4.4E-03	0.0E+00	0.0E+00	2.2E-02	1.5E-02	0.0E+00	0.0E+00
ZINC	4.0E-03	1.6E-03	0.0E+00	0.0E+00					7.0E-03	1.6E-03	0.0E+00	0.0E+00	6.2E-03	2.7E-03	0.0E+00	0.0E+00
4,4-DDE	0.0E+00	0.0E+00	3.8E-08	4.8E-08												
4,4-DDD	0.0E+00	0.0E+00	1.0E-08	3.8E-08									0.0E+00	0.0E+00	3.1E-08	1.6E-08
4,4-DDT																
CHLORDANE																
AROCLOR 1254																
SUM	8.8E-01	2.1E-01	9.0E-06	2.8E-06	3.3E-01	1.2E-01	3.0E-05	1.1E-05	1.5E-01	5.4E-02	1.4E-05	1.1E-05	3.6E-01	1.4E-01	4.2E-05	2.4E-05

BOXED VALUES ARE HAZARD QUOTIENTS WHICH EXCEED UNITY

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FINAL

SUMMARY OF RISK RESULTS
N ZA OPERABLE UNIT 3
M .ESEX COUNTY, MASSACHUSETTS
PAGE 8

W92194F

PARAMETER	RISK VALUES: SEDIMENT EXPOSURE															
	REACH 7				REACH 8				REACH 9				REACH 10			
	HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME	
	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG
TRICHLOROETHENE																
12DICHLOROETHENE																
CHLOROBENZENE*																
NITROBENZENE*																
1,2-DICHLOROBENZENE																
1,3-DCB*																
1,4-DCB*																
1,2,4-TRICHLOROBENZENE*																
NAPHTHALENE*																
PHENOL*																
ARSENIC*	2.8E-01	6.2E-02	2.7E-05	6.6E-06	1.9E-01	7.4E-02	2.0E-05	7.9E-06	3.9E-01	1.9E-01	4.2E-05	2.1E-05	7.4E-02	3.6E-02	8.0E-06	3.9E-06
ANTIMONY*																
CADMIUM*	6.5E-02	6.1E-03	0.0E+00	0.0E+00	1.8E-02	7.6E-03	0.0E+00	0.0E+00	3.1E-02	2.6E-02	0.0E+00	0.0E+00				
CHROMIUM*	3.8E-04	8.8E-05	0.0E+00	0.0E+00	6.6E-05	4.0E-05	0.0E+00	0.0E+00	1.4E-04	9.2E-05	0.0E+00	0.0E+00	3.1E-05	2.1E-05	0.0E+00	0.0E+00
LEAD*	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
MERCURY*	3.4E-02	8.5E-03	0.0E+00	0.0E+00	1.3E-02	1.0E-02	0.0E+00	0.0E+00	2.4E-02	2.0E-02	0.0E+00	0.0E+00	3.3E-03	1.0E-03	0.0E+00	0.0E+00
MONOMETHYLHG*																
DIMETHYLHG*																
VINYL CHLORIDE																
BENZENE																
DICHLOROMETHANE																
ACETONE	6.6E-05	3.6E-05	1.3E-09	7.3E-09												
BEHP	1.3E-04	6.7E-05	7.6E-09	6.1E-09												
3/4-METHYLPHENOL																
2-METHYLNAPH																
ACENAPTHYLENE																
PHENANTHRENE	6.2E-04	3.0E-04	0.0E+00	0.0E+00												
FLUORANTHENE	[illegible]	4.9E-05	0.0E+00	0.0E+00												
PYRENE	[illegible]	6.0E-05	0.0E+00	0.0E+00												
BENZO(A)ANTH	0.0E+00	0.0E+00	2.2E-08	1.1E-08												
CHRYSENE	0.0E+00	0.0E+00	3.1E-08	1.6E-08												
BENZO(B)FLUOR	0.0E+00	0.0E+00	2.3E-08	1.3E-08												
BENZO(K)FLUOR	0.0E+00	0.0E+00	1.3E-09	6.6E-07												
BENZO(A)PYRENE	0.0E+00	0.0E+00	2.2E-08	1.6E-08												
IN(123-CD)PYRENE	0.0E+00	0.0E+00	1.4E-08	1.4E-08												
DIBENZ(AH)ANTH																
BENZO(GHI)PERYL	3.1E-04	3.1E-04	0.0E+00	0.0E+00												
BARIUM	6.6E-03	3.4E-03	0.0E+00	0.0E+00	8.1E-03	4.1E-03	0.0E+00	0.0E+00	8.6E-03	4.2E-03	0.0E+00	0.0E+00	2.3E-03	1.2E-03	0.0E+00	0.0E+00
BERYLLIUM	2.2E-04	2.1E-04	6.5E-07	6.6E-07												
COPPER																
MANGANESE	2.6E-02	6.7E-03	0.0E+00	0.0E+00	1.1E-01	3.1E-02	0.0E+00	0.0E+00	9.4E-03	7.6E-03	0.0E+00	0.0E+00	8.1E-03	3.3E-03	0.0E+00	0.0E+00
NICKEL	4.0E-03	1.0E-03	0.0E+00	0.0E+00	1.2E-03	6.6E-04	0.0E+00	0.0E+00	2.6E-03	2.3E-03	0.0E+00	0.0E+00	1.0E-03	6.7E-04	0.0E+00	0.0E+00
SILVER																
SELENIUM	2.6E-03	4.2E-04	0.0E+00	0.0E+00	6.6E-04	2.7E-04	0.0E+00	0.0E+00								
THALLIUM																
VANADIUM	1.2E-02	6.1E-03	0.0E+00	0.0E+00	3.3E-03	2.6E-03	0.0E+00	0.0E+00	6.0E-03	4.6E-03	0.0E+00	0.0E+00	4.1E-03	2.4E-03	0.0E+00	0.0E+00
ZINC	6.6E-03	1.6E-03	0.0E+00	0.0E+00	3.0E-03	1.7E-03	0.0E+00	0.0E+00	2.9E-03	1.6E-03	0.0E+00	0.0E+00	4.9E-04	3.5E-04	0.0E+00	0.0E+00
4,4-DDE																
4,4-DDD																
4,4-DDT																
CHLORDANE	2.3E-04	2.3E-04	4.3E-09	4.3E-09												
AROCLOR 1254	0.0E+00	0.0E+00	4.3E-07	7.3E-07												
SUM	4.1E-01	9.9E-02	4.1E-05	1.9E-05	3.3E-01	1.3E-01	2.0E-05	7.9E-06	4.6E-01	2.6E-01	4.2E-05	2.1E-05	9.2E-02	4.6E-02	8.0E-06	3.9E-06

BOXED VALUES ARE HAZARD QUOTIENTS WHICH EXCEED UNITY

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FINAL

W92194F

PARAMETER	RISK VALUES: SEDIMENT EXPOSURE												RISK SUMMARIES: SEDIMENT EXPOSURE			
	BORDERING WETLANDS RECREATIONAL				BORDERING WETLANDS RECREATIONAL (270 DAYS PER YEAR)				BORDERING WETLANDS RESIDENTIAL				HEARD POND			
	HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME		HAZARD QUOTIENT CHILD		CANCER RISK LIFETIME	
	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG
TRICHLOROETHENE																
12DICHLOROETHENE																
CHLOROBENZENE*																
NITROBENZENE*																
1,2-DICHLOROBENZENE																
1,3-DCB*																
1,4-DCB*																
1,2,4-TRICHLOROBENZENE*																
NAPHTHALENE*																
PHENOL*																
ARSENIC*	7.8E-02	3.8E-02	7.6E-06	4.1E-06	3.9E-01	2.0E-01	2.7E-05	1.4E-05	5.1E-01	2.7E-01	3.6E-05	1.9E-05	6.6E-02	6.6E-02	7.1E-06	7.1E-06
ANTIMONY*																
CADMIUM*																
CHROMIUM*	1.6E-04	4.4E-05	0.0E+00	0.0E+00	1.0E-03	2.4E-04	0.0E+00	0.0E+00	1.3E-03	3.1E-04	0.0E+00	0.0E+00	7.3E-05	7.3E-05	0.0E+00	0.0E+00
LEAD*	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
MERCURY*	4.7E-02	6.7E-03	0.0E+00	0.0E+00	2.6E-01	3.6E-02	0.0E+00	0.0E+00	3.3E-01	4.7E-02	0.0E+00	0.0E+00	2.2E-02	2.2E-02	0.0E+00	0.0E+00
MONOMETHYLHG*																
DIMETHYLHG*																
VINYL CHLORIDE																
BENZENE																
DICHLOROMETHANE																
ACETONE																
BEHP																
3/4-METHYLPHENOL																
2-METHYLNAPH																
ACENAPTHYLENE																
PHENANTHRENE																
FLUORANTHENE																
PYRENE																
BENZO(A)ANTH																
CHRYSENE																
BENZO(B)FLUOR																
BENZO(K)FLUOR																
BENZO(A)PYRENE																
IN(123-CD)PYRENE																
DIBENZ(AH)ANTH																
BENZO(GHI)PERYL																
BARIUM	2.6E-03	1.4E-03	0.0E+00	0.0E+00	1.3E-02	7.6E-03	0.0E+00	0.0E+00	1.7E-02	8.7E-03	0.0E+00	0.0E+00	3.3E-03	3.3E-03	0.0E+00	0.0E+00
BERYLLIUM	8.6E-04	3.0E-04	3.0E-06	1.3E-06	3.7E-03	1.6E-03	1.0E-05	4.6E-06	4.9E-03	2.1E-03	1.4E-05	5.8E-06				
COPPER																
MANGANESE	2.0E-02	8.4E-03	0.0E+00	0.0E+00	1.1E-01	2.9E-02	0.0E+00	0.0E+00	1.4E-01	3.8E-02	0.0E+00	0.0E+00	6.1E-03	6.1E-03	0.0E+00	0.0E+00
NICKEL	2.0E-03	6.6E-04	0.0E+00	0.0E+00	1.1E-02	3.6E-03	0.0E+00	0.0E+00	1.4E-02	4.6E-03	0.0E+00	0.0E+00	1.0E-03	1.0E-03	0.0E+00	0.0E+00
SILVER																
SELENIUM	4.4E-04	2.6E-05	0.0E+00	0.0E+00	2.4E-03	1.4E-04	0.0E+00	0.0E+00	3.1E-03	1.8E-04	0.0E+00	0.0E+00				
THALLIUM																
VANADIUM	1.0E-02	7.2E-03	0.0E+00	0.0E+00	8.1E-02	4.0E-02	0.0E+00	0.0E+00	1.1E-01	5.1E-02	0.0E+00	0.0E+00	5.7E-03	5.7E-03	0.0E+00	0.0E+00
ZINC	1.2E-03	3.6E-04	0.0E+00	0.0E+00	6.3E-03	2.0E-03	0.0E+00	0.0E+00	8.1E-03	2.6E-03	0.0E+00	0.0E+00	2.6E-03	2.6E-03	0.0E+00	0.0E+00
4,4-DDE																
4,4-DDD																
4,4-DDT																
CHLORDANE																
AROCLOR 1254																
SUM	1.6E-01	6.0E-02	1.1E-05	5.4E-06	8.7E-01	3.2E-01	3.8E-05	1.9E-05	1.1E+00	4.2E-01	4.9E-05	2.4E-05	1.1E-01	1.1E-01	7.1E-06	7.1E-06

BOXED VALUES ARE HAZARD QUOTIENTS WHICH EXCEED UNITY

FINAL

W92194F

PARAMETER	RISK VALUES: SURFACE WATER															
	REACH 1 AND BACKGROUND				REACH 2				Eastern Wetlands				OUTFALL CREEK			
	HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK	
	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG
TCE*									0.0E+00	0.[illegible]00	6.9E-08	4.8E-08	0.0E+00	0.0E+00	1.4E-07	1.4E-07
1,2-DCE*					1.9E-04	1.9E-04	0.0E+00	0.0E+00	1.5E-03	9.9E-04	0.0E+00	0.0E+00	2.2E-03	2.2E-03	0.0E+00	0.0E+00
1,4-DCB*													0.0E+00	0.0E+00	9.0E-08	9.0E-08
1,2-DCB*									2.0E-04	2.0E-04	0.0E+00	0.0E+00	2.7E-04	2.7E-04	0.0E+00	0.0E+00
ARSENIC*					9.8E-03	9.8E-03	1.9E-08	1.9E-08								
CADMIUM*					1.4E-02	5.5E-03	0.0E+00	0.0E+00								
CHROMIUM*					8.8E-06	5.2E-06	0.0E+00	0.0E+00	7.7E-05	7.7E-05	0.0E+00	0.0E+00	5.5E-06	5.5E-06	0.0E+00	0.0E+00
LEAD*	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
MERCURY*									1.2E-02	6.8E-03	0.0E+00	0.0E+00	1.6E-03	1.6E-03	0.0E+00	0.0E+00
1,1-DCE	6.4E-04	5.6E-04	1.7E-08	1.5E-08												
BEHP													4.8E-05	4.8E-05	4.7E-09	4.7E-09
BARIUM	4.5E-04	3.1E-04	0.0E+00	0.0E+00	2.6E-03	6.8E-04	0.0E+00	0.0E+00	1.8E-04	1.7E-04	0.0E+00	0.0E+00	2.1E-04	2.1E-04	0.0E+00	0.0E+00
BERYLLIUM					1.5E-03	5.1E-04	1.1E-05	3.9E-06								
COPPER																
MANGANESE	1.1E-03	7.9E-04	0.0E+00	0.0E+00	9.6E-02	1.5E-02	0.0E+00	0.0E+00	1.1E-03	9.8E-04	0.0E+00	0.0E+00	1.4E-03	1.4E-03	0.0E+00	0.0E+00
NICKEL	8.6E-04	2.5E-04	0.0E+00	0.0E+00	3.8E-03	1.1E-03	0.0E+00	0.0E+00								
SELENIUM																
SILVER	5.5E-03	1.5E-03	0.0E+00	0.0E+00	2.2E-02	3.1E-03	0.0E+00	0.0E+00								
VANADIUM					2.2E-03	2.0E-03	0.0E+00	0.0E+00								
ZINC	3.0E-05	3.0E-05	0.0E+00	0.0E+00	6.1E-04	1.2E-04	0.0E+00	0.0E+00					2.3E-04	2.3E-04	0.0E+00	0.0E+00
SUM HAZARD QUOTIENTS	8.6E-03	3.5E-03	1.7E-08	1.5E-08	1.5E-01	3.8E-02	1.3E-05	5.7E-06	1.5E-02	9.3E-03	6.9E-08	4.8E-08	5.9E-03	5.9E-03	2.3E-07	2.3E-07

BOXED VALUES ARE HAZARD QUOTIENTS WHICH EXCEED UNITY

FINAL

W92194F

SUMMARY OF RISK RESULTS
NYANZA OPERABLE UNIT 3
MIDDLESEX COUNTY, MASSACHUSETTS

PARAMETER	RISK VALUES: SURFACE WATER															
	RACEWAY				COLD SPRING BROOK				REACH 3				REACH 4			
	HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK	
	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG
TCE*	0.0E+00	0.0E+00	2.1E-08	2.1E-08												
1,2-DCE*	3.7E-04	3.7E-04	0.0E+00	0.0E+00												
1,4-DCB*																
1,2-DCB*																
ARSENIC*																
CADMIUM*																
CHROMIUM*													5.9E-06	4.4E-06	0.0E+00	0.0E+00
LEAD*									0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
MERCURY*																
1,1-DCE																
BEHP					2.8E-03	2.8E-03	2.7E-07	2.7E-07	4.8E-05	4.8E-05	4.7E-09	4.7E-09				
BARIUM	3.2E-04	3.2E-04	0.0E+00	0.0E+00					2.5E-04	1.1E-05	0.0E+00	0.0E+00	4.8E-04	2.5E-04	0.0E+00	0.0E+00
BERYLLIUM																
COPPER																
MANGANESE	2.6E-03	2.6E-03	0.0E+00	0.0E+00	1.1E-03	1.1E-03	0.0E+00	0.0E+00	6.2E-04	6.2E-04	0.0E+00	0.0E+00	2.0E-03	1.3E-03	0.0E+00	0.0E+00
NICKEL																
SELENIUM									3.8E+00	7.5E-01	0.0E+00	0.0E+00				
SILVER					4.5E-03	4.5E-03	0.0E+00	0.0E+00	3.9E-03	2.3E-03	0.0E+00	0.0E+00				
VANADIUM																
ZINC									3.9E-05	3.9E-05	0.0E+00	0.0E+00				
SUM HAZARD QUOTIENTS	3.3E-03	3.3E-03	2.1E-08	2.1E-08	8.4E-03	8.4E-03	2.7E-07	2.7E-07	3.8E+00	7.6E-01	4.7E-09	4.7E-09	2.5E-03	1.5E-03	0.0E+00	0.0E+00

BOXED VALUES ARE HAZARD QUOTIENTS WHICH EXCEED UNITY

FINAL

W92194F

PARAMETER	RISK VALUES: SURFACE WATER											
	REACH 5				REACH 6				REACH 7			
	HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK		HAZARD QUOTIENT		CANCER RISK	
	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG
TCE*												
1,2-DCE*												
1,4-DCB*												
1,2-DCB*												
ARSENIC*	3.6E-03	3.4E-03	6.8E-07	6.5E-07								
CADMIUM*												
CHROMIUM*												
LEAD*					0.0E+00	0.0E+00	0.0E+00	0.0E+00				
MERCURY*												
1,1-DCE												
BEHP												
BARIUM	2.5E-04	2.5E-04	0.0E+00	0.0E+00	3.2E-04	9.4E-05	0.0E+00	0.0E+00	4.2E-04	1.4E-04	0.0E+00	0.0E+00
BERYLLIUM												
COPPER												
MANGANESE	1.0E-03	8.8E-04	0.0E+00	0.0E+00	1.6E-03	9.4E-04	0.0E+00	0.0E+00	1.2E-03	7.3E-04	0.0E+00	0.0E+00
NICKEL												
SELENIUM												
SILVER									2.1E-03	1.1E-03	0.0E+00	0.0E+00
VANADIUM												
ZINC												
SUM HAZARD QUOTIENTS	4.9E-03	4.3E-03	6.8E-07	6.5E-07	1.9E-03	1.0E-03	0.0E+00	0.0E+00	3.7E-03	2.0E-03	0.0E+00	0.0E+00

BOXED VALUES ARE HAZARD QUOTIENTS WHICH EXCEED UNITY

FINAL

Appendix D

ARARs Tables

Chemical-Specific ARARs

Requirement	Synopsis	Status	Action to be Taken to Attain Requirement
Federal ARARs			
EPA Risk Reference Doses (RfDs)	RfDs are estimates of a daily exposure concentration that is likely to be without appreciable risk of deleterious effects during a lifetime exposure.	TBC.	RfDs were used to characterize human health risks due to non-carcinogens in site media.
State ARARs			
None			

Location-Specific ARARs

Requirement	Requirement Synopsis	Determination of Applicability	Action to be Taken to Attain Requirement
Federal ARARs			
Fish and Wildlife Coordination Act (16 U.S.C. § 661), Fish and Wildlife Protection (40 CFR 6.302(g)).	Requires that a federal agency take action to prevent, mitigate or compensate for project-related losses of fish and wildlife resources. Encourages any federal agency proposing to modify a body of water to consult with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and other related state agencies.	Applicable.	Construction activities in the river are subject to these requirements. The selected remedy will be implemented in accordance with these requirements.
Clean Water Act, Section 404 Guidelines for discharge of dredged or fill material into waters of US (40 CFR Parts 230 and 231, 33 CFR Parts 320-23, and 33 CFR Part 332)	Outlines requirements for the discharge of dredged or fill materials into surface waters, including wetlands. Such discharges are not allowed if there are practicable alternatives with less adverse impact. Sets standards for restoration and mitigation required as a result of unavoidable impacts to aquatic resources.	Applicable.	The thin sand layer is subject to these requirements. The selected remedy will conform to these requirements, including mitigation and/or restoration. EPA has determined that the selected remedy is the least damaging practicable alternative.
Rivers and Harbors Act Section 10 (33 U.S.C. § 403)	Sets forth criteria for placing dams/structures in navigable waters of the U.S.	Applicable.	The thin layer capping will be performed in accordance with these requirements.

Requirement	Requirement Synopsis	Determination of Applicability	Action to be Taken to Attain Requirement
Protection of Wetlands (Executive Order 11990)	Federal agencies are required to avoid adversely impacting wetlands unless there is no practicable alternative and the proposed action includes all measures to minimize harm to wetlands that may result from such use.	TBC.	The selected remedy will comply with the EO. EPA has determined that there is no practicable alternative to the selected remedy. All measures to minimize harm will be taken.
Floodplain Management (EO 11988)	Federal agencies are required to avoid impacts associated with the occupancy and modification of a floodplain and avoid support of floodplain development whenever there is a practicable alternative.	TBC.	The selected remedy will comply with the EO. EPA has determined that there is no practicable alternative to occupancy and modification of the floodplain.
State ARARs			
Waterways Regulations (310 CMR 9.32, 9.35 and 9.36)	These standards forbid fill above the high-water mark (310 CMR 9.32), and forbid fill that would limit public navigation (9.35) or limit traditional water-dependent uses of the river (9.36).	Applicable.	The selected remedy will comply with these requirements. The selected remedy is not expected to result in fill above the high water mark or that would interfere with navigation or other uses of the river.
Water Quality Certification for Discharge of Dredged or Fill Material (314 CMR 9.00)	Limits discharges of dredged or fill material into any navigable waterway, including by forbidding such discharges where there is a practicable alternative that would have less adverse impact on the aquatic ecosystem.	Applicable.	The selected remedy will comply with these requirements. See discussion of CWA s.404, which imposes similar requirements.

Requirement	Requirement Synopsis	Determination of Applicability	Action to be Taken to Attain Requirement
Wetlands Protection Act -- performance standards for bordering vegetated wetlands (310 CMR 10.55)	Applies to freshwater wetlands (i.e., inundated soils supporting traditional wetland plants) bordering the river. Forbids destruction or impairment of such areas, unless certain presumptions can be rebutted.	Applicable.	The selected remedy will comply with these regulations. Activity on land bordering the river, e.g., in Reach 3, is not expected to impair or destroy a vegetated wetland.
Wetlands Protection Act - riverbed performance standards (310 CMR 10.56)	There can be no diminution in water-carrying capacity, surface water quality, and the riverbed's habitat.	Applicable.	Work will be conducted in accordance with these requirements. The addition of 6 inches of clean sand is not anticipated to significantly degrade water-carrying capacity or habitat in the riverbed. Surface water quality will be improved as a result of actions taken to address mercury concentrations in sediments.
Wetlands Protection Act -- performance standards for land subject to flooding (310 CMR 10.57)	Prohibits (a) net loss of flood storage in bordering land subject to flooding (defined to include areas bordering a river), (b) work in bordering lands that would restrict certain water flows in the river, and (c) work in bordering lands that would impair its capacity to provide important wildlife habitat functions.	Applicable.	Work will be conducted in accordance with these requirements. No loss of flood storage or restriction in water flow is anticipated as a result of the selected remedy. Work on portions of the riverbank is not expected to impair the area's important habitat functions.

Requirement	Requirement Synopsis	Determination of Applicability	Action to be Taken to Attain Requirement
Wetlands Protection Act -- riverfront and bank performance standards (310 CMR 10.54 and 10.58)	In riverfront areas (area within 200 feet of high-water line), there must be no practicable and substantially equivalent economic alternatives to the proposed project with less adverse effects on the wetland interests, and there must be no significant adverse impact. In river bank areas (the land between the river and an upland/wetland/ floodplain), occupancy shall not impair the stability of the bank, water carrying capacity of the river, water quality, and habitat functions.	Applicable.	Work will be conducted in accordance with these requirements. The impacts on riverfront areas are temporary impacts from construction of staging areas, haul roads, etc.; these are not significant and there is no practicable and substantially equivalent economic alternative with lower impacts. This can be accomplished without impairing the stability, water carrying capacity, or habitat functions of the bank.
Wetlands Protection Program Policy 90-2: Adverse Impacts to Rare Species; 310 CMR 10.37 (related wetlands regulations)	Forbids actions that have short-term or long-term adverse impacts to the habitat(s) of state-listed species. Reaches 1, 8 and 10 appear to be rare species habitats.	Applicable to rare species habitat(s) in or proximate to reaches undergoing remediation.	Work will be conducted in accordance with these requirements. No impacts in relevant reaches.
State and/or local fish advisories	The Massachusetts Department of Public Health currently advises against consumption of any fish from the Sudbury River between Ashland and Concord, due to mercury contamination.	TBC.	EPA will consider these advisories in implementing institutional controls under the selected remedy.

Requirement	Requirement Synopsis	Determination of Applicability	Action to be Taken to Attain Requirement
Antiquities Act and Regulations (MGL ch. 9, §§ 26-27); Massachusetts Historical Commission (950 CMR 70.00); Antiquities Act and Regulations (MGL ch. 9, §§ 26-27); Protection of Properties Included in the State Register of Historic Places (950 CMR 71.00); Massachusetts Underwater Archaeological Resources (312 CMR 2.00).	Projects which are state-funded or state-licensed or which are on state property must eliminate, minimize, or mitigate adverse effects to properties listed in the register of historic places. Establishes state register of historic places. The Underwater Archaeological Resources regulation limits disturbances of certain underwater items of "historic value."	Potentially applicable. No areas of concern have been identified to date, but a review of currently listed historical places will be undertaken prior to conducting any remedial or support activities.	Work will be conducted in accordance with these requirements if historic /archeological resources are encounted. However, the thin sand layer included in the selected remedy is not anticipated to impact any historically sensitive areas.

Action-Specific ARARs

Requirement	Requirement Synopsis	Determination of Applicability	Action to be Taken to Attain Requirement
Federal ARARs			
Invasive Species (Executive Order 13112)	When undertaking actions that impact the environment, federal agencies are directed to prevent the introduction of invasive species and to provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause.	TBC.	Steps will be taken to address invasive species consistent with the EO.
State ARARs			
Ambient Air Quality Standards; Air Pollution Control Regulations (310 CMR 6.04 & 7.09)	Regulates emissions of particulates and dust.	Applicable.	The selected remedy will be conducted in accordance with these requirements.
Hazardous Waste Rules, Identification and Listing of Hazardous Wastes (310 CMR 30.100).	These rules establish requirements for determining whether wastes are hazardous.	Applicable.	These standards would apply to characterization of sampling-related waste. EPA believes this waste is unlikely to be hazardous but sampling and analysis will be performed to confirm.

Appendix E

State Concurrence Letter

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY & ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
ONE WINTER STREET, BOSTON, MA 02108 617-292-5500

DEVAL L. PATRICK
Governor

TIMOTHY P. MURRAY
Lieutenant Governor

IAN A. BOWLES
Secretary

LAURIE BURT
Commissioner

September 29, 2010

James T. Owens III, Director
Office of Site Remediation and Restoration
US Environmental Protection Agency Region 1
5 Post Office Square, Suite 100 (OSRR07-2)
Boston, MA 02109-3912

Re: State Concurrence, Operable Unit 4 Record of Decision
Nyanza Chemical Waste Dump Superfund Site, Ashland, Massachusetts

Dear Mr. Owens:

The Massachusetts Department of Environmental Protection (MassDEP) has reviewed the Record of Decision for Operable Unit Four (ROD) dated September 2010 for the Nyanza Chemical Waste Dump Superfund Site in Ashland, Massachusetts. The ROD selects a series of remedial activities for mercury impacted stretches of the Sudbury River from Ashland to Concord. Based on review of the ROD and associated documents, MassDEP concurs with the selected remedy, namely Alternative 3B (Enhanced Natural Recovery in Sediments with Mercury >10 ppm).

Alternative 3B consists of placing a 6 inch sand layer on sediments in Reach 3 that exceed 10 ppm mercury. This enhancement will replicate the natural sedimentation processes ongoing within the river and will eventually result in fish tissue concentrations reaching the target remedial goal. Alternative 3B also includes monitored natural attenuation for Reaches 2, 4, 6, 9, and 10, monitoring for Reach 8, and institutional controls for all reaches.

MassDEP concurs with the selected remedy. If you have any questions regarding this concurrence, please have your staff contact David Buckley, MassDEP Project Manager, at 617-556-1184.

Very Truly Yours,

Laurie Burt
Commissioner
Massachusetts Department of Environmental Protection

Appendix F

Administrative Record Index

Nyanza Chemical Waste Dump

NPL Site Administrative Record File
Record of Decision (ROD)
Operable Unit 4

Index

ROD Signed: September 30, 2010
Released: October 2010

Prepared by
EPA New England
Office of Site Remediation & Restoration

With Assistance from
ASRC Management Services
6301 Ivy Lane, Suite 300
Greenbelt, MD 20770

Introduction to the Collection

This is the Administrative Record Index for the Nyanza Chemical Waste Dump Superfund Site, Ashland, Massachusetts, Operable Unit 4 (Sudbury River), Record of Decision (ROD) was released October 2010. The file contains site-specific documents and a list of guidance documents used by EPA staff in selecting a response remedial action at the site.

This file includes, by reference, the Administrative Record for the Nyanza Chemical Waste Dump, OU1 Record of Decision (ROD), issued on September 04, 1985, the Administrative Record, OU2 Record of Decision (ROD), issued on September 23, 1991, the Administrative Record, OU3 Record of Decision (ROD), issued on March 30, 1993, and the Explanation of Significant Differences, OU2, issued on September 29, 2006

The administrative record file is available for review at:

5 Post Office Square
Suite 100 (LIBO1 – 2)
Boston, MA 02109 - 3912
(By appointment)
(617) 918-1440 (phone)
(617) 918-0440 (fax)
http://www.epa.gov/region01/superfund/resource/records.html

Ashland, Public Library
66 Front Street
Ashland, MA 01721
(508) 881-0134 (phone)
(508) 881-0135 (fax)
library@ashlandmass.com

An administrative record file is required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA).

Please note that the compact disc(s) (CD) containing this Administrative Record may include index data and other metadata (hereinafter collectively referred to as metadata) to allow the user to conduct index searches and key word searches across all the files contained on the CD. All the information that appears in the metadata, including any dates associated with creation of the indexing data, is not part of the Administrative Record for the Site under CERCLA and shall not be construed as relevant to the documents that comprise the Administrative Record. This metadata is provided as a convenience for the user and is not part of the Administrative Record.

Questions about this administrative record file should be directed to the EPA New England Remedial Project Manager.

03: REMEDIAL INVESTIGATION (RI)

File Break: 03.01

466637 **2007 FISH AND WILDLIFE COMMENTS ON BASELINE ECOLOGICAL RISK ASSESSMENT (BERA)**

Author: KENNETH MUNNEY US DOI/US FISH & WILDLIFE SERVICE
Doc Date: 10/14/2007 **# of Pages:** 6
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: LETTER
CORRESPONDENCE

466638 **MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION (MADEP) COMMENTS ON DRAFT SUPPLEMENTAL BASELINE ECOLOGICAL RISK ASSESSMENT (SBERA) 2007**

Author: JENNIFER MCWEENEY MA DEP
Doc Date: 09/20/2007 **# of Pages:** 1
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: LETTER
CORRESPONDENCE

466647 **CRABBENHOFT 2009 PHONE CONVERSATION WITH MR ARTHUR C CUNNINGHAM**

Author: ARTHUR C CUNNINGHAM WESTON SOLUTIONS INC
Doc Date: 04/22/2009 **# of Pages:** 1
Addressee: MARIE-SWIECH LAFLAMME WESTON SOLUTIONS INC
Weston Number:
Doc Type: MEMO
CORRESPONDENCE

466773 **FIELD RECONNAISSANCE OF HYDROLOGIC CONDITIONS IN BRACKET RESERVOIR (4/21/2010 TRANSMITTAL ATTACHED)**

Author: KEITH W ROBINSON US DEPT OF INTERIOR - GEOLOGICAL
Doc Date: 04/05/2010 **# of Pages:** 976
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: REPORT

03: REMEDIAL INVESTIGATION (RI)

File Break: 03.02

466642 MASSACHUSETTS FISH TISSUE MERCURY STUDIES: LONG-TERM MONITORING RESULTS 1999-2004

Author: MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PR
Doc Date: 01/01/2006 **# of Pages:** 48
Addressee: WALL EXPERIMENT STATION
Weston Number:
Doc Type: SAMPLING DATA

466776 RAINFALL DATA FOR 2007 - 2008

Author:
Doc Date: 01/01/1111 **# of Pages:** 1
Addressee:
Weston Number:
Doc Type: SAMPLING DATA

466819 DATA VALIDATION MEMO, TO NO. 25, TASK NO. 1, TDF NO. 1201A, CASE NO: NYANZA 2009, SDG NO: GSA004, TOTAL MERCURY: 103/FISH TISSUE

Author: LOUIS MACRI TECHLAW INC
Doc Date: 02/10/2009 **# of Pages:** 11
Addressee: ROBERT PEARY TECHLAW INC
CHRISTINE CLARK US EPA REGION 1
Weston Number:
Doc Type: REPORT
DATA VALIDATION REPORT
SAMPLING DATA
MEMO
CORRESPONDENCE

03: REMEDIAL INVESTIGATION (RI)

File Break: 03.02

466820 **CALCULATION OF FISH INGESTION HAZARD QUOTIENT FOR REACHES 2 AND 9 OF THE NYANZA SITE WITH "FLOWING" AND "STANDING" FISH INGESTION RATES**

Author: CHAU VU US EPA REGION 1
Addressee: DANIEL KEEFE US EPA REGION 1
Doc Type: MEMO
SAMPLING DATA
CORRESPONDENCE
Doc Date: 10/29/2008 **# of Pages:** 3
Weston Number:

File Break: 03.04

466614 **EMERGENCY ACTION PLAN FOR THE SUDBURY AND FRAMINGHAM RESERVOIRS N0S. 1, 2, AND 3**

Author: GZA GEO ENVIRONMENTAL INC
Addressee: COMMONWEALTH OF MASSACHUSETTS
Doc Type: REPORT
Doc Date: 05/01/1995 **# of Pages:** 262
Weston Number:

466651 **TECHNICAL MEMORANDUM: DEVELOPMENT OF BIOACCUMULATION FACTORS (BAFS) FOR METHYLMERCURY TO SUPPORT CLEANUP GOALS**

Author: US EPA REGION 1
Addressee:
Doc Type: MEMO
CORRESPONDENCE
Doc Date: 06/16/2010 **# of Pages:** 22
Weston Number:

03: REMEDIAL INVESTIGATION (RI)

File Break: 03.04

466774 **INSPECTION AND MONITORING REPORT, FALL 2009**

Author: CORPORATE ENVIRONMENTAL ADVISORS INC
Addressee: MA DEPT OF ENVIRONMENTAL PROTECTION
Doc Type: REPORT
Doc Date: 01/01/2010 **# of Pages:** 194
Weston Number:

466775 **NORTHEAST REGIONAL MERCURY TOTAL MAXIMUM DAILY LOAD**

Author: CT DEPT OF ENVIRONMENTAL PROTECTION
Addressee: MA DEPT OF ENVIRONMENTAL PROTECTION
ME DEPT OF ENVIRONMENTAL PROTECTION
NEW ENGLAND INTERSTATE WATER POLLUTION CONTR(
NH DEPT OF ENVIRONMENTAL SERVICES
NY DEPT OF ENVIRONMENTAL CONSERVATION
RI DEPT OF ENVIRONMENTAL MANAGEMENT
VT DEPT OF ENVIRONMENTAL CONSERVATION
Doc Type: REPORT
Doc Date: 10/24/2007 **# of Pages:** 113
Weston Number:

File Break: 03.06

466634 **FINAL REPORT, HYDRODYNAMIC AND SEDIMENT TRANSPORT STUDY OF SUDBURY RIVER, MASSACHUSETTS**

Author: COASTAL AND HYDRAULICS LABORATORY
Addressee: US ARMY CORP ENGINEERS
Doc Type: REPORT
Doc Date: 08/01/2001 **# of Pages:** 51
Weston Number:

03: REMEDIAL INVESTIGATION (RI)

File Break: 03.06

466639 **PARTICLE-SCALE INVESTIGATION OF PAH DESORPTION KINETICS AND THERMODYNAMICS FROM SEDIMENT**

Author: UPAL GHOSH ENVIRONMENTAL SCIENCE AND TECHNOLO
Addressee: RICHARD G LUTHY ENVIRONMENTAL SCIENCE AND TECH
JEFFREY W TALLEY ENVIRONMENTAL SCIENCE AND TECH
AMERICAN CHEMICAL SOCIETY
Doc Type: REPORT

Doc Date: 07/28/2001 **# of Pages:** 9
Weston Number:

03: REMEDIAL INVESTIGATION (RI)

File Break: 03.06

466640 **WHOLE-ECOSYSTEM STUDY SHOWS RAPID FISH-MERCURY RESPONSE TO CHANGES IN MERCURY DEPOSITION**

Author: CHRISTOPHER L BABIARZ UNIVERSITY OF WISCONSIN

Doc Date: 10/16/2007 **# of Pages:** 6

Addressee: KEN G BEATY UNIVERSITY OF CRESCENT

Weston Number:

PAUL J BLANCHFIELD UNIVERSITY OF CRESCENT
BRIAN A BRANFIREUN UNIVERSITY OF TORONTO/DEPT OF
CYNTHIA C GILMOUR SMITHSONIAN ENVIRONMENTAL RE
JENNIFER A GRAYDON UNIVERSITY OF ALBERTA
REED HARRIS TETRA TECH INC
ANDREW HEYES UNIVERSITY OF MARYLAND
HOLGER HINTELMANN SMITHSONIAN ENVIRONMENTAL F
JAMES P HURLEY UNIVERSITY OF WISCONSIN - WATER RE
DAVID P KRABBENOHFT US GEOLOGICAL SURVEY
STEVE LINDBERG OAK RIDGE NATIONAL LABORATORY
ROBERT P MASON UNIVERSITY OF CONNECTICUT
MICHAEL J PATERSON UNIVERSITY OF CRESCENT
CHERYL L PODEMSKI UNIVERSITY OF CRESCENT
ART ROBINSON CANADIAN FOREST SERVICE
JOHN W M RUDD R & K RESEARCH INC
KEN A SANDILANDS UNIVERSITY OF CRESCENT
GEORGE R SOUTHWORTH OAK RIDGE NATIONAL LABORA
VINCENT L ST LOUIS UNIVERSITY OF ALBERTA
MICHAEL T TATE US GEOLOGICAL SURVEY

Doc Type: REPORT

03: REMEDIAL INVESTIGATION (RI)

File Break: 03.06

466641 **REACTIVITY AND MOBILITY OF NEW AND OLD MERCURY DEPOSITION IN BOREAL FOREST ECOSYSTEM DURING THE FIRST YEAR OF THE METAALICUS STUDY**

Author: REED HARRIS TETRA TECH INC
Doc Date: 11/06/2002 **# of Pages:** 7
Addressee: ANDREW HEYES UNIVERSITY OF MARYLAND
HOLGER HINTELMANN TRENT UNIVERSITY
JAMES P HURLEY UNIVERSITY OF WISCONSIN - WATER RE
CAROL A KELLY FRESHWATER INSTITUTE
DAVID P KRABBENOHFT US GEOLOGICAL SURVEY
STEVE LINDBERG OAK RIDGE NATIONAL LABORATORY
JOHN W M RUDD FRESHWATER INSTITUTE
KAREN J SCOTT UNIVERSITY OF MANITOBA
VINCENT L ST LOUIS UNIVERSITY OF ALBERTA
Weston Number:
Doc Type: REPORT

File Break: 03.07

449087 **TECHNICAL MEMORANDUM: REVIEW OF HUMAN HEALTH RISK ASSESSMENT NYANZA SUPERFUND SITE OPERABLE UNIT FOUR (OU4) SUDBURY RIVER MERCURY CONTAMINATION**

Author: EXPONENT
Doc Date: 12/05/2008 **# of Pages:** 21
Addressee:
Weston Number:
Doc Type: MEMO
CORRESPONDENCE

03: REMEDIAL INVESTIGATION (RI)

File Break: 03.09

466635 DRAFT HUMAN HEALTH RISK ASSESSMENT (HHRA) SYNTHESIS, OPERABLE UNIT 4 (OU4)

Author: AVATAR ENVIRONMENTAL
Addressee: US ENVIRONMENTAL PROTECTION AGENCY
Doc Type: REPORT
Doc Date: 05/01/2006 **# of Pages:** 102
Weston Number:

File Break: 03.10

256912 SUPPLEMENTAL BASELINE HUMAN HEALTH RISK ASSESSMENT, FINAL VOLUME 1 OF 2 - TEXT AND APPENDIX B

Author: ROY F WESTON INC
Addressee: US EPA REGION 1
Doc Type: REPORT
RISK/HEALTH ASSESSMENT
Doc Date: 11/01/1999 **# of Pages:** 149
Weston Number:

256913 SUPPLEMENTAL BASELINE HUMAN HEALTH RISK ASSESSMENT, FINAL VOLUME 2 OF 2 - APPENDIX A

Author: ROY F WESTON INC
Addressee: US EPA REGION 1
Doc Type: REPORT
RISK/HEALTH ASSESSMENT
Doc Date: 11/01/1999 **# of Pages:** 488
Weston Number:

03: REMEDIAL INVESTIGATION (RI)

File Break: 03.10

256978 **FINAL HUMAN HEALTH RISK ASSESSMENT, OPERABLE UNIT 4 (OU04)**

Author: AVATAR ENVIRONMENTAL
Doc Date: 05/01/2006 **# of Pages:** 220
Addressee: US EPA REGION 1
Weston Number:
Doc Type: REPORT
RISK/HEALTH ASSESSMENT

287317 **DRAFT, SUPPLEMENTAL BASELINE ECOLOGICAL RISK ASSESSMENT(SBERA), NYANZA SUPERFUND SITE, SUDBURY RIVER MERCURY CONTAMINATION, MASSACHUSETTS**

Author: AVATAR ENVIRONMENTAL
Doc Date: 04/01/2007 **# of Pages:** 1308
Addressee:
Weston Number:
Doc Type: REPORT

443220 **FINAL SUPPLEMENTAL BASELINE ECOLOGICAL RISK ASSESSMENT(SBERA), NYANZA, SUDBURY RIVER, ASHLAND, MASSACHUSETTS**

Author: AVATAR ENVIRONMENTAL
Doc Date: 12/01/2008 **# of Pages:** 1524
Addressee: NOBIS ENGINEERING INC
Weston Number:
Doc Type: REPORT

449085 **EPA RESPONSES TO THE TECHNICAL MEMORANDUM BY EXPONENT ON THE REVIEW OF THE HUMAN HEALTH RISK ASSESSMENT (HHRA), OPERABLE UNIT FOUR (OU4)**

Author: CHAU VU US EPA REGION 1
Doc Date: 01/21/2009 **# of Pages:** 2
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: MEMO
CORRESPONDENCE

03: REMEDIAL INVESTIGATION (RI)

File Break: 03.10

449086 **EPA RESPONSES TO COMMENTS FROM THE METRO WEST GROWTH MANAGEMENT COMMITTEE ON THE SUPPLEMENTAL BASELINE ECOLOGICAL RISK ASSESSMENT (SBERA), OPERABLE UNIT FOUR (OU4)**

Author: BART HOSKINS US EPA REGION 1 - OFFICE OF ENVIRO ME/ **Doc Date:** 10/27/2009 **# of Pages:** 6
Addressee: **Weston Number:**
Doc Type: MEMO
CORRESPONDENCE

449088 **COMMENTS ON THE SUBURY RIVER SUPPLEMENTAL BASELINE ECOLOGICAL RISK ASSESSMENT (SBERA)**

Author: MARTIN PILLSBURY METRO WEST GROWTH MANAGEMEN **Doc Date:** 09/30/2009 **# of Pages:** 3
Addressee: DANIEL KEEFE US EPA REGION 1 **Weston Number:**

466620 **DRAFT SUPPLEMENTAL BASELINE ECOLOGICAL RISK ASSESSMENT (SBERA) VOLUME 1 OF 3 - TEXT, FIGURES, AND TABLES**

Author: ROY F WESTON INC **Doc Date:** 05/01/1999 **# of Pages:** 256
Addressee: US EPA REGION 1 **Weston Number:**
Doc Type: REPORT
RISK/HEALTH ASSESSMENT

466621 **DRAFT SUPPLEMENTAL BASELINE ECOLOGICAL RISK ASSESSMENT (SBERA) VOLUME 2 OF 3 - APPENDIX A**

Author: ROY F WESTON INC **Doc Date:** 05/01/1999 **# of Pages:** 616
Addressee: US EPA REGION 1 **Weston Number:**
Doc Type: REPORT
RISK/HEALTH ASSESSMENT

03: REMEDIAL INVESTIGATION (RI)

File Break: 03.10

466622 DRAFT SUPPLEMENTAL BASELINE ECOLOGICAL RISK ASSESSMENT (SBERA) VOLUME 3 OF 3 - APPENDICES B THROUGH F

Author: ROY F WESTON INC
Doc Date: 05/01/1999
\# of Pages: 348
Addressee: US EPA REGION 1
Weston Number:
Doc Type: REPORT
RISK/HEALTH ASSESSMENT

466636 1999 NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) COMMENTS ON ECOLOGICAL RISK ASSESSMENT (ERA) [MARGINALIA]

Author: KENNETH FINKELSTEIN US NATIONAL OCEANIC AND ATM
Doc Date: 06/23/1999
\# of Pages: 6
Addressee: CHERYL SPRAGUE US EPA REGION 1
Weston Number:
Doc Type: LETTER
CORRESPONDENCE

471197 MEMO REGARDING FISH MOVEMENT BETWEEN REACHES

Author: BART HOSKINS US EPA REGION 1 - OFFICE OF ENVIRO ME/
Doc Date: 01/01/1111
\# of Pages: 2
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: MEMO

04: FEASIBILITY STUDY (FS)

File Break: 04.01

449095 **SUITABILITY OF THE SUDBURY RESERVOIR AS A REFERENCE AREA FOR OPERABLE UNIT FOUR (OU4) SUDBURY RIVER STUDIES**

Author: BART HOSKINS US EPA REGION 1 - OFFICE OF ENVIRO ME/ **Doc Date:** 12/04/2009 **# of Pages:** 2
Addressee: **Weston Number:**
Doc Type: MEMO
CORRESPONDENCE

466626 **CONTAMINATED SEDIMENTS TECHNICAL ADVISORY GROUP (CSTAG) RECOMMENDATIONS FOR NYANZA CHEMICAL WASTE DUMP, OPERABLE UNIT 4 (OU4)**

Author: STEPHEN J ELLS CONTAMINATED SEDIMENTS TECHNICAL **Doc Date:** 07/12/2006 **# of Pages:** 6
Addressee: LEAH H EVISON CONTAMINATED SEDIMENTS TECHNICAL **Weston Number:**
CHERYL SPRAGUE US EPA REGION 1
Doc Type: MEMO
CORRESPONDENCE

466627 **RESPONSE TO CONTAMINATED SEDIMENTS TECHNICAL ADVISORY GROUP (CSTAG) RECOMMENDATIONS FOR NYANZA CHEMICAL WASTE DUMP, OPERABLE UNIT 4 (OU4)**

Author: DANIEL KEEFE US EPA REGION 1 **Doc Date:** 06/21/2007 **# of Pages:** 18
Addressee: STEPHEN J ELLS CONTAMINATED SEDIMENTS TECHNICAL ADVISORY GROUP (CSTAG) **Weston Number:**
LEAH H EVISON CONTAMINATED SEDIMENTS TECHNICAL ADVISORY GROUP (CSTAG)
Doc Type: MEMO
CORRESPONDENCE

04: FEASIBILITY STUDY (FS)

File Break: 04.01

466629 **CONSIDERATIONS MEMO FOR THE PROPOSED REMEDY, OPERABLE UNIT 4 (OU4)**

Author: DANIEL KEEFE US EPA REGION 1
Doc Date: 04/15/2010 **# of Pages:** 56
Addressee: STEPHEN ELLS US EPA REGION 1
Weston Number:
Doc Type: CORRESPONDENCE
MEMO

466630 **2006 SEDIMENT MANAGEMENT PRINCIPLE CONSIDERATION MEMORANDUM**

Author: US EPA REGION 1
Doc Date: 01/01/2006 **# of Pages:** 82
Addressee:
Weston Number:
Doc Type: MEMO
CORRESPONDENCE

466631 **CONTAMINATED SEDIMENTS TECHNICAL ADVISORY GROUP (CSTAG) UPDATE RECOMMENDATIONS FOR NYANZA CHEMICAL WASTE DUMP, OPERABLE UNIT 4 (OU4)**

Author: STEPHEN J ELLS CONTAMINATED SEDIMENTS TECHNICAL
Doc Date: 06/07/2010 **# of Pages:** 4
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: MEMO
CORRESPONDENCE

466632 **ASHLAND 2009 PILOT NOTICE REGARDING SURPLUS STATUS OF THE RESERVOIR**

Author: JONATHAN L YEO MASSACHUSETTS DEPARTMENT OF COI
Doc Date: 03/16/2009 **# of Pages:** 2
Addressee: BOARD OF SELECTMEN ASHLAND (MA) TOWN OF
Weston Number:
Doc Type: LETTER
CORRESPONDENCE

04: FEASIBILITY STUDY (FS)

File Break: 04.01

466633 FRAMINGHAM 2009 PILOT NOTICE REGARDING SURPLUS STATUS OF THE RESERVOIR

Author: JONATHAN L YEO MASSACHUSETTS DEPARTMENT OF CO

Doc Date: 03/16/2009 # of Pages: 2

Addressee: BOARD OF SELECTMEN FRAMINGHAM (MA) TOWN OF

Weston Number:

Doc Type: LETTER
CORRESPONDENCE

466649 TREATMENT AND DREDGING OF MERCURY PLAGUED MATERIAL

Author: BEN WEINRIB TORNADO MOTION TECHNOLOGIES LLC

Doc Date: 01/28/2009 # of Pages: 1

Addressee: WESTON SOLUTIONS INC

Weston Number:

Doc Type: LETTER
CORRESPONDENCE

471165 TECHNICAL MEMORANDUM: DRY EXCAVATION OF CONTAMINATED SEDIMENT IN RESERVOIR NO.2 (REACH 3), WHERE MERCURY IN SEDIMENT EXCEEDS 10MG/KG

Author: NOBIS ENGINEERING INC

Doc Date: 09/14/2010 # of Pages: 3

Addressee: WESTON SOLUTIONS INC
DANIEL KEEFE US EPA REGION 1

Weston Number:

Doc Type: MEMO

04: FEASIBILITY STUDY (FS)

File Break: 04.02

462834 **REPORT SUMMARIZING DATA COLLECTED FOR THE NYANZA MERCURY MODELING EFFORT, OPERABLE UNIT FOUR (OU4)**

Author: TECHLAW
Doc Date: 03/24/2009 **# of Pages:** 50
Addressee:
Weston Number:
Doc Type: SAMPLING DATA

466628 **FINAL TREND ANALYSIS OF SEDIMENT, SURFACE WATER, AND FISH MERCURY DATA**

Author: TECHLAW
Doc Date: 05/20/2009 **# of Pages:** 50
Addressee: US EPA REGION 1
Weston Number:
Doc Type: SAMPLING DATA

466648 **CALCULATION OF FISH MEALS PER YEAR FOR NYANZA SUPERFUND SITE - RME SCENARIO FOR RECREATIONAL CHILD AND ADULT ANGLER**

Author: CHAU VU US EPA REGION 1
Doc Date: 05/20/2009 **# of Pages:** 3
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: MEMO
CORRESPONDENCE

File Break: 04.04

466609 **TECHNICAL MEMORANDUM: DEVELOPMENT OF MERCURY BIOACCUMULATION FACTORS (BAFS) FROM AVAILABLE SURFACE WATER AND FISH TISSUE DATA**

Author: AVATAR ENVIRONMENTAL
Doc Date: 12/22/2009 **# of Pages:** 9
Addressee: SCOTT HARDING NOBIS ENGINEERING INC
Weston Number:
Doc Type: MEMO
CORRESPONDENCE

04: FEASIBILITY STUDY (FS)

File Break: **04.04**

466610 TECHNICAL MEMORANDUM: BIOTA TO SEDIMENT ACCUMULATION FACTORS (BSAFS) DEVELOPMENT

Author: AVATAR ENVIRONMENTAL
Doc Date: 09/02/2009 **# of Pages:** 38
Addressee: SCOTT HARDING NOBIS ENGINEERING INC
Weston Number:
Doc Type: MEMO
CORRESPONDENCE

466612 EFFECTS OF CAPPING MATERIALS ON RECOLONIZATION OF BENTHIC ORGANISM NYANZA CHEMICAL WASTE DUMP SUPERFUND SITE, OPERABLE UNIT 4 (OU4) - SUDBURY RIVER

Author: SCOTT HARDING NOBIS ENGINEERING INC
Doc Date: 05/28/2010 **# of Pages:** 2
Addressee: *DANIEL KEEFE US EPA REGION 1*
Weston Number:
Doc Type: MEMO
CORRESPONDENCE

466613 DRAFT TECHNICAL MEMORANDUM FOR REMEDIAL ATLTERNATIVE SCREENING, OPERABLE UNIT 4 - SUDBURY RIVER (02/09/2009 TRANSMITTAL LETTER IS ATTACHED)

Author: NOBIS ENGINEERING INC
Doc Date: 02/01/2009 **# of Pages:** 102
Addressee: US EPA REGION 1
Weston Number:
Doc Type: MEMO
CORRESPONDENCE

471164 ADDENDUM: SENSITIVITY ANALYSIS - MODELING MERCURY TRANSPORT AND TRANSFORMATION ALONG THE SUDBURY RIVER

Author: CHRISTOPHER D KNIGHTES US EPA - OFFICE OF RESEARCH
Doc Date: 01/01/1111 **# of Pages:** 20
Addressee: US EPA REGION 1
Weston Number:
Doc Type: REPORT

04: FEASIBILITY STUDY (FS)

File Break: 04.06

466615 UNDERWATER ENGINEERING INSPECTION OF BRACKETT RESERVOIR DAM

Author: PARE ENGINEERING CORPORATION
Addressee: METROPOLITAN DISTRICT COMMISSION
Doc Type: REPORT
Doc Date: 04/01/2002
# of Pages: 16
Weston Number:

466616 UNDERWATER ENGINEERING INSPECTION OF STEARNS RESERVOIR DAM

Author: PARE ENGINEERING CORPORATION
Addressee: METROPOLITAN DISTRICT COMMISSION
Doc Type: REPORT
Doc Date: 04/01/2002
# of Pages: 14
Weston Number:

466617 PHASE 1 INSPECTION/EVALUATION REPORT - FRAMINGHAM RESERVOIR # 1 DAM

Author: GZA GEO ENVIRONMENTAL INC
Addressee:
Doc Type: REPORT
Doc Date: 05/16/2007
# of Pages: 57
Weston Number:

466618 PHASE 1 INSPECTION/EVALUATION REPORT - FRAMINGHAM RESERVOIR # 2 DAM

Author: GZA GEO ENVIRONMENTAL INC
Addressee:
Doc Type: REPORT
Doc Date: 05/16/2007
# of Pages: 56
Weston Number:

04: FEASIBILITY STUDY (FS)

File Break: 04.06

466619 REPORT SUMMARIZING DATA COLLECTED FOR THE NYANZA OU4 MODELING EFFORT, 2003 THROUGH 2008, PREPARED BY TECHLAW INC, UNDER ENVIRONMENTAL SERVICES ASSISSTANCE TEAM (ESAT) CONTRACT

Author: TECHLAW INC
Doc Date: 03/24/2009 **# of Pages:** 50
Addressee:
Weston Number:
Doc Type: REPORT

466646 PUBLIC COMMENT DRAFT FEASIBILITY STUDY (FS) FOR NYANZA CHEMICAL WASTE DUMP, OPERABLE UNIT 4 (OU4) (06/16/2010 TRANSMITTAL LETTER IS ATTACHED)

Author: NOBIS ENGINEERING INC
Doc Date: 06/01/2010 **# of Pages:** 529
Addressee: US EPA REGION 1
Weston Number:
Doc Type: REPORT
FEASIBILITY STUDY (FS)

File Break: 04.07

466608 REDUCING MERCURY IN THE NORTHEAST UNITED STATES

Author: TERRI GOLDBERG AIR & WASTE MANAGEMENT ASSOC
Doc Date: 05/01/2008 **# of Pages:** 5
Addressee: JOHN GRAHAM AIR & WASTE MANAGEMENT ASSOC
STEPHEN HOCHBRUNN AIR & WASTE MANAGEMENT ASSC
SUSANNAH KING AIR & WASTE MANAGEMENT ASSOC
PAUL MILLER AIR & WASTE MANAGEMENT ASSOC
ADAM WIENERT AIR & WASTE MANAGEMENT ASSOC
MEG WILCOX AIR & WASTE MANAGEMENT ASSOC
Weston Number:
Doc Type: REPORT

04: FEASIBILITY STUDY (FS)

File Break: 04.09

466645 REMEDIAL PROPOSED PLAN FOR NYANZA CHEMICAL WASTE DUMP, OPERABLE UNIT 4 (OU4)

Author: US EPA REGION 1
Doc Date: 06/01/2010 **# of Pages:** 15
Addressee:
Weston Number:
Doc Type: PUBLIC INFORMATION
REPORT
PROPOSED PLAN

05: RECORD OF DECISION (ROD)

File Break: 05.01

472030 STATE CONCURRENCE LETTER FOR RECORD OF DECISION (ROD) OPERABLE UNIT 04

Author: LAURIE BURT MA DEPARTMENT OF ENVIRONMENTAL PR(
Doc Date: 09/29/2010 **# of Pages:** 1
Addressee: JAMES T OWENS III US EPA REGION 1
Weston Number:
Doc Type: LETTER

File Break: 05.03

471145 RESPONSIVENESS SUMMARY FOR RECORD OF DECISION (ROD) OPERABLE UNIT 04

Author: US EPA REGION 1
Doc Date: 09/30/2010 **# of Pages:** 20
Addressee:
Weston Number:
Doc Type: REPORT

05: RECORD OF DECISION (ROD)

File Break: **05.03**

471163 **MEMO REGARDING UPDATED RESPONSE TO CONTAMINATED SEDIMENT TECHNICAL ADVISORY GROUP (CSTAG) RECOMMENDATIONS DATED 6/07/2010**

Author: DANIEL KEEFE US EPA REGION 1
Doc Date: 09/10/2010 **# of Pages:** 27
Addressee: STEPHEN J ELLS CONTAMINATED SEDIMENTS TECHNICAL ADVISORY GROUP (CSTAG)
Weston Number:
Doc Type: MEMO

471166 **LETTER REGARDING COMMENTS ON PUBLIC COMMENT DRAFT FEASIBILITY STUDY (FS) FOR SITE**

Author: KENNETH FINKELSTEIN US NATIONAL OCEANIC AND ATM
Doc Date: 08/10/2010 **# of Pages:** 2
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: PUBLIC (AND OTHER) COMMENTS
CORRESPONDENCE
LETTER

471167 **LETTER REGARDING COMMENTS ON PUBLIC COMMENT DRAFT FEASIBILITY STUDY (FS) AND PROPOSED PLAN FOR SITE**

Author: THOMAS R CHAPMAN US DEPT OF INTERIOR - FISH & WILI
Doc Date: 08/20/2010 **# of Pages:** 4
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS

05: RECORD OF DECISION (ROD)

File Break: 05.03

471168 LETTER REGARDING COMMENTS ON PROPOSED CLEANUP PLAN FOR SITE

Author: JAMIE FOSBURGH US DEPT OF INTERIOR - NATIONAL PARI
Doc Date: 08/12/2010 # of Pages: 2
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS

471169 LETTER REGARDING COMMENTS ON REMEDIATION PLAN FOR SITE

Author: JOHN M SCANNELL COMMONWEALTH OF MASSACHUSETT
Doc Date: 08/26/2010 # of Pages: 1
Addressee: US EPA REGION 1
Weston Number:
Doc Type: LETTER
CORRESPONDENCE
PUBLIC (AND OTHER) COMMENTS

471170 COMMENTS ON PROPOSED CLEANUP PLAN FOR SITE (LIST OF MEMBERSHIP IN THE SEDIMENT MANAGEMENT WORK GROUP ATTACHED)

Author: STEVEN C NADEAU SEDIMENT MANAGEMENT WORK GRO
Doc Date: 08/25/2010 # of Pages: 8
Addressee: US EPA REGION 1
Weston Number:
Doc Type: CORRESPONDENCE
PUBLIC (AND OTHER) COMMENTS
MEMO

05: RECORD OF DECISION (ROD)

File Break: 05.03

471171 LETTER REGARDING COMMENTS ON PROPOSED REMEDY FOR SITE

Author: DAVID GLASER ANCHOR QEA
Addressee: DANIEL KEEFE US EPA REGION 1
Doc Date: 08/26/2010 **# of Pages:** 6
Weston Number:
Doc Type: PUBLIC (AND OTHER) COMMENTS
CORRESPONDENCE
LETTER

471172 LETTER REGARDING COMMENTS ON FEASIBILITY STUDY (FS) FOR SITE (SUPPORTING DOCUMENTATION ATTACHED)

Author: MARTIN PILLSBURY METROWEST REGIONAL COLLABORA
Addressee: DANIEL KEEFE US EPA REGION 1
Doc Date: 08/25/2010 **# of Pages:** 46
Weston Number:
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS

05: RECORD OF DECISION (ROD)

File Break: 05.03

471173 LETTER REGARDING COMMENTS ON FEASIBILITY STUDY (FS) FOR SITE (REVIEW OF PUBLIC COMMENT DRAFT FEASIBILITY STUDY (FS) FOR SITE ATTACHED)

Author: GINGER ESTY FRAMINGHAM (MA) TOWN OF
Doc Date: 08/23/2010 **# of Pages:** 35
Addressee: DENNIS GIOMBETTI FRAMINGHAM (MA) TOWN OF
LAURIE LEE FRAMINGHAM (MA) TOWN OF
ETHAN MASCOOP FRAMINGHAM (MA) TOWN OF
CHARLES J SISITSKY FRAMINGHAM (MA) TOWN OF
JASON SMITH FRAMINGHAM (MA) TOWN OF
JULIAN SUSO FRAMINGHAM (MA) TOWN OF
DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: LETTER
CORRESPONDENCE
PUBLIC (AND OTHER) COMMENTS

471175 LETTER REGARDING COMMENTS ON PROPOSED CLEANUP PLAN FOR SITE

Author: NANCY A BRYANT SUASCO WATERSHED COMMUNITY CO
Doc Date: 08/26/2010 **# of Pages:** 1
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: PUBLIC (AND OTHER) COMMENTS
LETTER
CORRESPONDENCE

05: RECORD OF DECISION (ROD)

File Break: 05.03

471176 LETTER REGARDING COMMENTS ON FEASIBILITY STUDY (FS) FOR SITE

Author: J ANDREW IRWIN WAYLAND (MA) TOWN OF
Doc Date: 08/20/2010 **# of Pages:** 2
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: LETTER
PUBLIC (AND OTHER) COMMENTS
CORRESPONDENCE

471177 LETTER REGARDING RESPONSE TO PUBLIC COMMENT PERIOD, SUDBURY RIVER PROJECT

Author: LESLIE GITHENS ASHLAND (MA) BOARD OF HEALTH
Doc Date: 08/23/2010 **# of Pages:** 1
Addressee: DIMITRI KARPOUZIS ASHLAND (MA) BOARD OF HEALTH
MARY MORTENSEN ASHLAND (MA) BOARD OF HEALTH
JOHN REAP ASHLAND (MA) BOARD OF HEALTH
MALCOLM SMART ASHLAND (MA) BOARD OF HEALTH
DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: CORRESPONDENCE
PUBLIC (AND OTHER) COMMENTS
LETTER

471178 LETTER REGARDING SUDBURY RIVER - COMMENTS ON EPA PLAN

Author: JOHN A COLLINS AQUABLOK
Doc Date: 07/23/2010 **# of Pages:** 2
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS

05: RECORD OF DECISION (ROD)

File Break: 05.03

471179 EMAIL REGARDING NYANZA WASTE CLEANUP, COMMENT ON PROPOSED PLAN FOR SITE

Author: ROBERT SANTONE FRAMINGHAM (MA) RESIDENT
Doc Date: 07/15/2010
# of Pages: 1
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: PUBLIC (AND OTHER) COMMENTS
CORRESPONDENCE
EMAIL

471180 EMAIL REQUEST FOR EXTENSION OF PUBLIC COMMENT PERIOD FOR SUDBURY RIVER DRAFT FEASIBILITY STUDY (FS)

Author: MARTIN PILLSBURY METROPOLITAN AREA PLANNING CO
Doc Date: 06/25/2010
# of Pages: 1
Addressee: MARTIN PILLSBURY METROWEST REGIONAL COLLABORA
DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: PUBLIC (AND OTHER) COMMENTS
EMAIL
CORRESPONDENCE

471181 EMAIL REGARDING COMMENT ON NYANZA/SUDBURY RIVER REMEDIATION PLAN

Author: JILL A MILLER MILLER MICROCOMPUTER SERVICES
Doc Date: 07/27/2010
# of Pages: 1
Addressee: A RICHARD MILLER MILLER MICROCOMPUTER SERVICES
DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: CORRESPONDENCE
EMAIL
PUBLIC (AND OTHER) COMMENTS

05: RECORD OF DECISION (ROD)

File Break: 05.03

471182 EMAIL REGARDING NYANZA SUPERFUND CLEAN-UP, COMMENT ON PRPOSED PLAN (WITH EMAIL CONVERSATION ATTACHED)

Author: JILL A MILLER MILLER MICROCOMPUTER SERVICES
Doc Date: 06/30/2010 # of Pages: 5
Addressee: A RICHARD MILLER COCHITUATE STATE PARK ADVISORY
A RICHARD MILLER MILLER MICROCOMPUTER SERVICES
DANIEL KEEFE US EPA REGION 1
CHRISTOPHER D KNIGHTES US EPA - OFFICE OF RESEARCH AND DEVELOPMENT
Weston Number:
Doc Type: PUBLIC (AND OTHER) COMMENTS
EMAIL
CORRESPONDENCE

471183 EMAIL REGARDING QUESTION ON NYANZA SITE SAND LAYERING PROPOSAL

Author: MALCOLM SMART ASHLAND (MA) BOARD OF HEALTH
Doc Date: 07/23/2010 # of Pages: 1
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: EMAIL
PUBLIC (AND OTHER) COMMENTS
CORRESPONDENCE

471184 EMAIL REGARDING EPA PLAN FOR SUDBURY RIVER - COMMENT ON PROPOSED PLAN

Author: NANCY WILSON FRAMINGHAM (MA) RESIDENT
Doc Date: 08/02/2010 # of Pages: 1
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: EMAIL
PUBLIC (AND OTHER) COMMENTS
CORRESPONDENCE

05: RECORD OF DECISION (ROD)

File Break: 05.03

471185 EMAIL REGARDING COMMENT ON PROPOSED PLAN

Author: STEVEN WILSON FRAMINGHAM (MA) RESIDENT
Doc Date: 06/23/2010 # of Pages: 1
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: PUBLIC (AND OTHER) COMMENTS
CORRESPONDENCE
EMAIL

471186 LETTER REGARDING COMMENT ON PROPOSED SUDBURY RIVER CLEANUP AT RESERVOIR #2

Author: MICHAEL P MANNING AVSG
Doc Date: 08/25/2010 # of Pages: 2
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: CORRESPONDENCE
PUBLIC (AND OTHER) COMMENTS
LETTER

471187 EMAIL REGARDING SUDBURY RIVER/RESERVOIR - COMMENT ON PROPOSED PLAN

Author: CARALINE LEVY FRAMINGHAM (MA) RESIDENT
Doc Date: 07/01/2010 # of Pages: 1
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: EMAIL
PUBLIC (AND OTHER) COMMENTS
CORRESPONDENCE

05: RECORD OF DECISION (ROD)

File Break: 05.03

471188 EMAIL REGARDING COMMENT ON PROPOSED PLAN FOR SITE

Author: JUDITH HOWELL NONE
Doc Date: 07/05/2010 # of Pages: 1
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: PUBLIC (AND OTHER) COMMENTS
CORRESPONDENCE
EMAIL

471189 EMAIL REGARDING COMMENT ON PROPOSED PLAN FOR SUDBURY RIVER

Author: AL CARBONNEAU MARLBORO (MA) RESIDENT
Doc Date: 07/20/2010 # of Pages: 1
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: PUBLIC (AND OTHER) COMMENTS
EMAIL
CORRESPONDENCE

471190 EMAIL REGARDING SUDBURY RIVER CLEAN-UP - COMMENT ON PROPOSED PLAN

Author: MATT ELLIOTT FRAMINGHAM (MA) RESIDENT
Doc Date: 08/23/2010 # of Pages: 1
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: CORRESPONDENCE
PUBLIC (AND OTHER) COMMENTS
EMAIL

05: RECORD OF DECISION (ROD)

File Break: 05.03

471191 EMAIL REGARDING SUDBURY RIVER - COMMENT ON PROPOSED PLAN

Author: WENDY JOSLIN NONE
Addressee: DANIEL KEEFE US EPA REGION 1
Doc Type: CORRESPONDENCE
EMAIL
PUBLIC (AND OTHER) COMMENTS
Doc Date: 07/22/2010 **# of Pages:** 1
Weston Number:

471192 EMAIL REGARDING COMMENT ON PROPOSED PLAN

Author: BOB COLLINI FRAMINGHAM (MA) RESIDENT
Addressee: DANIEL KEEFE US EPA REGION 1
Doc Type: PUBLIC (AND OTHER) COMMENTS
EMAIL
CORRESPONDENCE
Doc Date: 07/22/2010 **# of Pages:** 2
Weston Number:

471193 EMAIL REGARDING PUBLIC COMMENT ON SUDBURY RIVER CLEAN UP

Author: JIM PILLSBURY FRAMINGHAM (MA) RESIDENT
Addressee: DANIEL KEEFE US EPA REGION 1
Doc Type: PUBLIC (AND OTHER) COMMENTS
EMAIL
CORRESPONDENCE
Doc Date: 08/26/2010 **# of Pages:** 2
Weston Number:

05: RECORD OF DECISION (ROD)

File Break: 05.03

471194 LETTER REGARDING PUBLIC COMMENT ON PROPOSED PLAN FOR SITE

Author: JANET DRAKE NONE
Doc Date: 01/01/1111 # of Pages: 1
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: PUBLIC (AND OTHER) COMMENTS
CORRESPONDENCE
LETTER

471195 LETTER REGARDING PUBLIC COMMENT ON PROPOSED PLAN FOR SITE

Author: H I SILVERMAN FRAMINGHAM (MA) RESIDENT
Doc Date: 08/20/2010 # of Pages: 2
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: PUBLIC (AND OTHER) COMMENTS
LETTER
CORRESPONDENCE

471196 LETTER REGARDING PUBLIC COMMENT ON PROPOSED PLAN FOR SITE

Author: PARKER L CODDINGTON SUDBURY (MA) RESIDENT
Doc Date: 06/23/2010 # of Pages: 1
Addressee: DANIEL KEEFE US EPA REGION 1
Weston Number:
Doc Type: LETTER
CORRESPONDENCE
PUBLIC (AND OTHER) COMMENTS

05: RECORD OF DECISION (ROD)

File Break: 05.04

471144 **RECORD OF DECISION (ROD) FOR OPERABLE UNIT 04 SUDBURY RIVER SIGNED 09/30/2010**

Author US EPA REGION 1
Doc Date: 09/30/2010 # of Pages: 256
Addressee:
Weston Number:
Doc Type: REPORT
RECORD OF DECISION (ROD)

File Break: 05.05

460491 **MODELING MERCURY TRANSPORT AND TRANSFORMATION ALONG THE SUDBURY RIVER, MASSACHUSETTS (USA) WITH IMPLICATIONS FOR REGULATORY ACTION, VOLUME 1: MERCURY FATE AND TRANSPORT**

Author: CHRISTOPHER D KNIGHTES US EPA - OFFICE OF RESEARCH
Doc Date: 03/24/2010 # of Pages: 116
Addressee: US EPA REGION 1
Weston Number:
Doc Type: REPORT

460492 **MODELING MERCURY TRANSPORT AND TRANSFORMATION ALONG THE SUDBURY RIVER, MASSACHUSETTS (USA) WITH IMPLICATIONS FOR REGULATORY ACTION, VOLUME 2: EVALUATING THE EFFECTIVENESS OF DIFFERENT REMEDIAL ALTERNATIVES TO REDUCE MERCURY CONCENTRATIONS IN FISH**

Author: CHRISTOPHER D KNIGHTES US EPA - OFFICE OF RESEARCH
Doc Date: 03/24/2010 # of Pages: 81
Addressee: US EPA REGION 1
Weston Number:
Doc Type: REPORT

13: COMMUNITY RELATIONS

File Break: 13.03

466625 FINAL SIGN PHOTO SHEET: FISH CONSUMPTION ADVISORY SIGNS ALONG SUDBURY RIVER, OPERABLE UNIT 4 (OU4)

Author: NOBIS ENGINEERING INC
Doc Date: 06/15/2009 **# of Pages:** 1
Addressee:
Weston Number:
Doc Type: NEWS CLIPPING

466892 NEWS RELEASE: EPA EXTENDS PUBLIC COMMENT PERIOD FOR PROPOSED CLEAN UP FOR NAYNZA CHEMICAL WASTE DUMP

Author: US EPA REGION 1
Doc Date: 07/01/2010 **# of Pages:** 3
Addressee:
Weston Number:
Doc Type: PUBLIC INFORMATION
PRESS RELEASE

File Break: 13.04

466644 REVIEW OF ENHANCED MONITORED NATURAL RECOVERY AT CONTAMINATED SEDIMENT SITES (DECEMBER 2-4, 2008 WORKSHOP)

Author: BART D CHADWICK US NAVY
Doc Date: 12/02/2008 **# of Pages:** 1
Addressee: JASON M CONDER ENVIRON CORP
J GERMANO GERMANO & ASSOCIATES INC
MARC GREENBERG EPA
VICTORIA KIRTAY SPAWAR SYSTEMS CENTER PACIFIC (SS
GUI LOTUFO US ARMY ENGINEER RESEARCH & DEVELOPI
VICTOR MAGAR ENVIRON CORP
Weston Number:
Doc Type: MEETING RECORD

13: COMMUNITY RELATIONS

File Break: 13.04

466664 NYANZA OPERABLE UNIT 4 (OU4) PUBLIC MEETING SIGNING SHEET - GREAT MEADOWS

Author: US EPA REGION 1
Addressee:
Doc Type: MEETING RECORD
Doc Date: 06/21/2010 **# of Pages:** 1
Weston Number:

466665 NYANZA OPERABLE UNIT 4 (OU4) PUBLIC MEETING SIGNING SHEETS - FRAMINGHAM

Author: US EPA REGION 1
Addressee:
Doc Type: MEETING RECORD
Doc Date: 06/22/2010 **# of Pages:** 2
Weston Number:

471174 PUBLIC HEARING

Author: US EPA REGION 1
Addressee:
Doc Type: REPORT
PUBLIC (AND OTHER) COMMENTS
PUBLIC INFORMATION
Doc Date: 07/19/2010 **# of Pages:** 71
Weston Number:

File Break: 13.05

278823 FACT SHEET - EPA UPDATE REGARDING NYANZA SUDBURY RIVER STUDY, OPERABLE UNIT FOUR (OU4)

Author: US EPA REGION 1
Addressee:
Doc Type: FACT SHEET
Doc Date: 10/01/2007 **# of Pages:** 4
Weston Number:

13: COMMUNITY RELATIONS

File Break: 13.05

278824 **FACT SHEET - EPA UPDATE REGARDING NYANZA SUDBURY RIVER STUDY, OPERABLE UNIT FOUR (OU4) (SPANISH VERSION)**

Author: US EPA REGION 1
Doc Date: 10/01/2007 **# of Pages:** 3
Addressee:
Weston Number:
Doc Type: FACT SHEET

466650 **FACT SHEET: 2005/2006 NATIONAL LISTING OF FISH ADVISORIES**

Author: US ENVIRONMENTAL PROTECTION AGENCY
Doc Date: 07/01/2007 **# of Pages:** 7
Addressee:
Weston Number:
Doc Type: FACT SHEET

16: NATURAL RESOURCE TRUSTEE

File Break: 16.01

466623 **FISH AND WILDLIFE SERVICE COMMENTS TO EPA'S CONTAMINATED SEDIMENTS TECHNICAL ADVISORY GROUP (CSTAG)**

Author: KENNETH MUNNEY US DOI/US FISH & WILDLIFE SERVICE
Doc Date: 05/29/2006 **# of Pages:** 5
Addressee: KYMBERLEE KECKLER US EPA REGION 1
Weston Number:
Doc Type: LETTER
CORRESPONDENCE

16: NATURAL RESOURCE TRUSTEE

File Break: 16.01

466624 **NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) COMMENTS TO 2006 SEDIMENT INVESTIGATION**

Author: KENNETH FINKELSTEIN US NATIONAL OCEANIC AND ATM
Doc Date: 05/11/2006 **# of Pages:** 5
Addressee: KYMBERLEE KECKLER US EPA REGION 1
Weston Number:
Doc Type: LETTER
CORRESPONDENCE

File Break: 16.05

466611 **WATER DEPTH AND THICKNESS OF SEDIMENT IN RESERVOIRS 1 AND 2 FRAMINGHAM AND ASHLAND, MASSACHUSETTS**

Author: US EPA REGION 1
Doc Date: 01/01/1991 **# of Pages:** 23
Addressee: US GEOLOGICAL SURVEY
Weston Number:
Doc Type: REPORT

17: SITE MANAGEMENT RECORDS

File Break: 17.07

466600 **TECHNICAL REPORT 1983: ENHANCED MONITORED NATURAL RECOVERY (EMNR) CASE STUDIES REVIEW**

Author: ENVIRON CORP
Doc Date: 05/01/2009 **# of Pages:** 55
Addressee: SPAWAR SYSTEMS CENTER PACIFIC (SSC PACIFIC)
Weston Number:
Doc Type: REPORT

17: SITE MANAGEMENT RECORDS

File Break: 17.07

466601 **DEMONSTRATION OF THE AQUABLOCK SEDIMENT CAPPING TECHNOLOGY - INNOVATIVE TECHNOLOGY EVALUATION REPORT**

Author: US ENVIRONMENTAL PROTECTION AGENCY
Doc Date: 09/01/2007 # of Pages: 145
Addressee:
Weston Number:
Doc Type: REPORT

466602 **CANADIAN JOURNAL OF FISHERIES AND AQUATIC SCIENCES: MERCURY IN THE SUDBURY RIVER (MASSACHUSETTS U.S.A.) POLLUTION HISTORY AND SYNTHESIS OF RECENT RESEARCH**

Author: PAMELA J SHIELDS US EPA REGION 1
Doc Date: 05/05/2000 # of Pages: 9
Addressee: JAMES WIENER UPPER MISSISSIPPI SCIENCE CENTER
Weston Number:

466603 **CANADIAN JOURNAL OF FISHERIES AND AQUATIC SCIENCES: STRATIGRAPHY AND HISTORIC ACCUMULATION OF MERCURY IN RECENT DEPOSITIONAL SEDIMENTS IN THE SUDBURY RIVER, MASSACHUSETTS, U.S.A.**

Author: D R ENGSTROM SCIENCE MUSEUM OF MINNESOTA
Doc Date: 05/05/2000 # of Pages: 11
Addressee: BRADLEY FRAZIER UNIVERSITY OF WISCONSIN-LA CROSS
Weston Number:
RONALD RADA UNIVERSITY OF WISCONSIN-LA CROSSE
JAMES WIENER UPPER MISSISSIPPI SCIENCE CENTER

466604 **CANADIAN JOURNAL OF FISHERIES AND AQUATIC SCIENCES: SAMPLING FOR MERCURY AT SUBNANOGRAM PER LITRE CONCENTRATIONS FOR LOAD ESTIMATION IN RIVERS**

Author: ROBERT F BREAULT US GEOLOGICAL SURVEY
Doc Date: 05/05/2000 # of Pages: 7
Addressee: JOHN A COLMAN US DOI/US GEOLOGICAL SURVEY
Weston Number:

17: SITE MANAGEMENT RECORDS

File Break: 17.07

466605 **CANADIAN JOURNAL OF FISHERIES AND AQUATIC SCIENCES: DISTRIBUTION, HYDROLOGIC TRANSPORT, AND CYCLING OF TOTAL MERCURY AND METHYL MERCURY IN CONTAMINATED RIVER-RESERVOIR-WETLAND SYSTEM (SUDBURY RIVER, EASTERN MASSACHUSETTS)**

Author: ROBERT F BREAULT US GEOLOGICAL SURVEY
Addressee: JOHN A COLMAN US DOI/US GEOLOGICAL SURVEY
M.C. WALDRON US GEOLOGICAL SURVEY
Doc Date: 05/05/2000 **# of Pages:** 12
Weston Number:

466606 **CANADIAN JOURNAL OF FISHERIES AND AQUATIC SCIENCES: BIOAVAILABILITY OF SEDIMENT-ASSOCIATED MERCURY TO HEXAGENIA MAYFLIES IN CONTAMINATED FLOODPLAIN RIVER**

Author: NICOLAS S BLOOM FRONTIER GEOSCIENCES
Addressee: GREGORY COPE UPPER MISSISSIPPI SCIENCE CENTER
TERESA NAIMO UPPER MISSISSIPPI SCIENCE CENTER
JAMES WIENER UPPER MISSISSIPPI SCIENCE CENTER
Doc Date: 05/05/2000 **# of Pages:** 11
Weston Number:

466607 **CANADIAN JOURNAL OF FISHERIES AND AQUATIC SCIENCES: IN SITU ASSESSMENT OF MERCURY CONTAMINATION IN THE SUDBURY RIVER, MASSACHUSETTS, USING TRANSPLANTED FRESHWATER MUSSELS (ELLIPITIO COMPLANATA)**

Author: NANCY BECKVAR US NATIONAL OCEANIC ATMOSPHERIC
Addressee: KENNETH FINKELSTEIN US NATIONAL OCEANIC AND ATM
Doc Date: 05/05/2000 **# of Pages:** 10
Weston Number:

17: SITE MANAGEMENT RECORDS

File Break: **17.07**

466643 **MERCURY CYCLING IN STREAM ECOSYSTEMS. 2. BENTHIC METHYLMERCURY PRODUCTION AND BED SEDIMENT-PORE WATER PARTITIONING**

Author: GEORGE R AIKEN US GEOLOGICAL SURVEY
Addressee: MARK E BRIGHAM US GEOLOGICAL SURVEY
BRITT D HALL ENVIRONMENTAL SCIENCE & TECHNOLOG'
DAVID P KRABBENHOFT ENVIRONMENTAL SCIENCE & TE(
MICHELLE A LUTZ ENVIRONMENTAL SCIENCE & TECHNO
MARK MARVIN-DIPASQUALE ENVIRONMENTAL SCIENCE ‹
WILLIAM H OREM ENVIRONMENTAL SCIENCE & TECHNOL
Doc Type: REPORT

Doc Date: 03/11/2009 **# of Pages:** 8
Weston Number:

466652 **APPENDIX 2B-3: MESOCOSM STUDIES TO QUANTIFY HOW METHYLMERCURY IN THE EVERGLADES RESPONDS TO CHANGES IN MERCURY, SULFUR, AND NUTRIENT LOADING**

Author: CYNTHIA C GILMOUR ACADEMY OF NATURAL SCIENCES (
Addressee: DAVID P KRABBENOHFT US GEOLOGICAL SURVEY
WILLIAM O OREM US GEOLOGICAL SURVEY
Doc Type: REPORT

Doc Date: 01/01/2004 **# of Pages:** 15
Weston Number:

466653 **PARTITION COEFFICIENTS FOR METALS IN SURFACE WATER, SOIL, AND WASTE**

Author: TERRY L ALLISON ALLISON GEOSCIENCE CONSULTANT IN
Addressee: JERRY D ALLISON HYDROGEOLOGIC INC
Doc Type: REPORT

Doc Date: 07/01/2005 **# of Pages:** 93
Weston Number:

17: SITE MANAGEMENT RECORDS

File Break: 17.07

466654 **PATTERNS OF HG BIOACCUMULATION AND TRANSFER IN AQUATIC FOOD WEBS ACROSS MULTI-LAKE STUDIES IN THE NORTHEAST US**

Author: CELIA Y CHEN DARTMOUTH COLLEGE
Addressee: CAROL L FOLT DARTMOUTH COLLEGE
NEIL C KAMMAN VERMONT DEPARTMENT OF ENVIRONMI
BRANDON M MAYES DARTMOUTH COLLEGE
RICHARD S STEMBERGER DARTMOUTH COLLEGE
Doc Type: REPORT
Doc Date: 01/01/2005 # of Pages: 13
Weston Number:

466655 **MERCURY BIOAVAILABILITY AND BIOACCUMULATION IN ESTUARINE FOOD WEBS IN THE GULF OF MAINE**

Author: CELIA Y CHEN DARTMOUTH COLLEGE
Addressee: MICHELLE DIONNE WELLS NATIONAL ESTUARINE RESEA
BRANDON M MAYES LONG TRAIL BREWERY
STEFAN STURUP UNIVERSITY OF COPENHAGEN
DARREN M WARD UNIVERSITY OF COPENHAGEN
Doc Type: REPORT
Doc Date: 03/15/2009 # of Pages: 18
Weston Number:

17: SITE MANAGEMENT RECORDS

File Break: 17.07

466656 MERCURY CONTAMINATION IN FOREST AND FRESHWATER ECOSYSTEMS IN THE NORTHEASTERN UNITED STATES

Author: CELIA Y CHEN DARTMOUTH COLLEGE
Doc Date: 01/01/2007 # of Pages: 12
Addressee: CHARLES T DRISCOLL SYRACUSE UNIVERSITY
DAVID C EVERS BIODIVERSITY RESEARCH INSTITUTE
YOUNG-JI HAN HUBBARD BROOK RESEARCH FOUNDATIOI
THOMAS M HOLSEN CLARKSON UNIVERSITY
NEIL C KAMMAN VERMONT DEPARTMENT OF ENVIRONMI
KATHLEEN FALLON LAMBERT HUBBARD BROOK RESEAR(
RONALD K MUNSON TETRA TECH INC
Weston Number:
Doc Type: REPORT

466657 ELECTROCHEMICAL REMEDIATION TECHNOLOGIES (ECRTS) IN-SITU REMEDIATION OF CONTAMINATED MARINE SEDIMENTS

Author: US ENVIRONMENTAL PROTECTION AGENCY
Doc Date: 06/01/2007 # of Pages: 74
Addressee:
Weston Number:
Doc Type: REPORT

466658 SILT CURTAINS AS A DREDGING PROJECT MANAGEMENT PRACTICE

Author: NORMAN R FRANCINGUES US ARMY CORPS OF ENGINEER:
Doc Date: 09/01/2005 # of Pages: 18
Addressee: MICHAEL R PALERMO US ARMY CORPS OF ENGINEERS
Weston Number:
Doc Type: REPORT

17: SITE MANAGEMENT RECORDS

File Break: 17.07

466659 IN-SITU CAPPING OF CONTAMINATED SEDIMENTS: COMPARING THE RELATIVE EFFICTIVENESS OF SAND VERSUS CLAY MINERAL-BASED SEDIMENT CAPS

Author: J H HULL HULL & ASSOCIATES INC
Addressee: J M JERSAK HULL & ASSOCIATES INC
C A KASPER HULL & ASSOCIATES INC
Doc Type: REPORT
Doc Date: 01/01/1999 **# of Pages:** 26
Weston Number:

466660 ROLE OF MICROORGANISMS IN ELEMENTAL MERCURY FORMATION IN NATURAL WATERS

Author: HAROLD F HEMOND MASSACHUSETTS INSTITUTE OF TECI
Addressee: R P MASON MASSACHUSETTS INSTITUTE OF TECHNOLOG\
F M M MOREL PRINCETON UNIVERSITY
Doc Type: REPORT
Doc Date: 01/01/1995 **# of Pages:** 13
Weston Number:

466661 DEVELOPMENT AND PLACEMENT OF A SORBENT-AMENDED THIN LAYER SEDIMENT CAP IN THE ANACOSTIA RIVER

Author: GREGORY V LOWRY CARNEGIE MELLON UNIVERSITY
Addressee: KATHLEEN M MCDONOUGH CARNEGIE MELLON UNIVERS
JIM OLSTA CETCO
DANNY REIBLE UNIVERSITY OF TEXAS AUSTIN
YUEWEI ZHU HORNE ENGINEERING SERVICES INC
Doc Type: REPORT
Doc Date: 08/22/2006 **# of Pages:** 24
Weston Number:

17: SITE MANAGEMENT RECORDS

File Break: 17.07

466662 **MERCURY CYCLING IN STREAM ECOSYSTEMS. 1. WATER COLUMN CHEMISTRY AND TRANSPORT**

Author: GEORGE R AIKEN US GEOLOGICAL SURVEY
Addressee: MARK E BRIGHAM US GEOLOGICAL SURVEY
DAVID P KRABBENOHFT US GEOLOGICAL SURVEY
DENNIS A WENTZ US GEOLOGICAL SURVEY
Doc Type: REPORT
Doc Date: 03/11/2009 # of Pages: 7
Weston Number:

466663 **MERCURY CYCLING IN STREAM ECOSYSTEMS. 3. TROPHIC DYNAMICS AND METHYLMERCURY BIOACCUMULATION**

Author: GEORGE R AIKEN US GEOLOGICAL SURVEY
Addressee: AMANDA H BELL US GEOLOGICAL SURVEY
LIA C CHASAR US GEOLOGICAL SURVEY
BARBARA C SCUDDER US GEOLOGICAL SURVEY
ROBIN A STEWART US GEOLOGICAL SURVEY
Doc Type: REPORT
Doc Date: 03/11/2009 # of Pages: 8
Weston Number:

466770 **EVALUATION OF BIOACCUMULATION FACTORS AND TRANSLATORS FOR METHYLMERCURY**

Author: ROBERT K BRODBERG CALIFORNIA ENVIRONMENTAL PR(
Addressee: JAMES R SANBORN CALIFORNIA ENVIRONMENTAL PROTE
Doc Type: REPORT
Doc Date: 03/01/2006 # of Pages: 92
Weston Number:

17: SITE MANAGEMENT RECORDS

File Break: **17.07**

466771 NATIONAL PILOT STUDY OF MERCURY CONTAMINATION OF AQUATIC ECOSYSTEMS ALONG MULTIPLE GRADIENTS: BIOACCUMULATION IN FISH

Author: WILLIAM G BRUMBAUGH COLUMBIA ENVIRONMENTAL R
Addressee: KATHY ECHOLS COLUMBIA ENVIRONMENTAL RESEARCH
DENNIS R HELSEL OFFICE OF REGIONAL GEOLOGIST CENT
DAVID P KRABBENHOFT WISCONSIN DISTRICT MERCURY
JAMES G WIENER UNIVERSITY OF WISCONSIN-LA CROSSE
Doc Type: REPORT
Doc Date: 09/01/2001 **# of Pages:** 30
Weston Number:

466772 DEVELOPMENT OF BIOACCUMULATION FACTORS FOR PROTECTION OF FISH AND WILDLIFE IN THE GREAT LAKES

Author: LAWRENCE P BURKHARD US EPA - OFFICE OF RESEARCH /
Addressee: PHILIP M COOK US EPA
Doc Type: REPORT
Doc Date: 01/01/1111 **# of Pages:** 9
Weston Number:

466788 TOXICOLOGICAL PROFILE FOR MERCURY

Author: US DEPT OF HEALTH AND HUMAN SERVICES - AGENCY F(
Addressee:
Doc Type: REPORT
Doc Date: 03/01/1999 **# of Pages:** 668
Weston Number:

466789 EPA'S CONTAMINATED SEDIMENT MANAGEMENT STRATEGY

Author: US EPA
Addressee:
Doc Type: REPORT
Doc Date: 04/01/1998 **# of Pages:** 129
Weston Number:

17: SITE MANAGEMENT RECORDS

File Break: 17.07

466790 FINAL WATER QUALITY CRITERION FOR PROTECTION OF HUMAN HEALTH: METHYLMERCURY

Author: US EPA
Doc Date: 01/01/2001 # of Pages: 303
Addressee:
Weston Number:
Doc Type: REPORT

466791 CONTAMINANTS IN AQUATIC HABITATS AT HAZARDOUS WASTE SITES: MERCURY

Author: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATI
Doc Date: 12/01/1996 # of Pages: 80
Addressee:
Weston Number:
Doc Type: REPORT

466792 MERCURY IN FISH, BED SEDIMENT, AND WATER FROM STREAMS ACROSS UNITED STATES, 1998 - 2005

Author: US DEPT OF INTERIOR - GEOLOGICAL SURVEY
Doc Date: 01/01/2009 # of Pages: 86
Addressee:
Weston Number:
Doc Type: REPORT

466793 NATIONAL RECOMMENDED WATER QUALITY CRITERIA

Author: US EPA
Doc Date: 01/01/2009 # of Pages: 22
Addressee:
Weston Number:
Doc Type: REPORT

Number of Documents in Administrative Record: 135

Selected Key Guidance Documents

EPA Guidance Documents may be reviewed at the OSRR Records and Information Center in Boston, MA

DOCNUMBER	DOCDATE	TITLE	OSWEREPAID
	01-Jan-94	METHODS FOR MEASURING THE TOXICITY AND BIOACCUMULATION OF SEDIMENT-ASSOICATED CONTAMINANTS WITH FRESHWATER INVERTEBRATES	
1001	01-Jan-81	COSTS OF REMEDIAL RESPONSE ACTIONS AT UNCONTROLLED HAZARDOUS WASTE SITES	
2001	01-Jun-85	EPA GUIDE FOR MINIMIZING ADVERSE ENVIRONMENTAL EFFECTS OF CLEANUP OF UNCONTROLLED HAZARDOUS-WASTE SITES	EPA/600/8-85/008
2002	01-Oct-88	INTERIM FINAL GUIDANCE FOR CONDUCTING REMEDIAL INVESTIGATIONS AND FEASIBILITY STUDIES UNDER CERCLA.	OSWER #9355.3-01
2005	01-Aug-85	POLICY ON FLOOD PLAINS AND WETLAND ASSESSMENTS FOR CERCLA ACTIONS	OSWER #9280.0-02
2018	01-Nov-89	FEASIBILITY STUDY - DEVELOPMENT AND SCREENING OF REMEDIAL ACTION ALTERNATIVES [QUICK REFERENCE FACT SHEET]	OSWER #9355.3-01FS3
2019	01-Mar-90	FEASIBILITY STUDY: DETAILED ANALYSIS OF REMEDIAL ACTION ALTERNATIVES [QUICK REFERENCE FACT SHEET]	OSWER #9355.3-01FS4
2113	01-Jul-88	LABORATORY DATA VALIDATION FUNCTIONAL GUIDELINES FOR EVALUATING INORGANICS ANALYSES (DRAFT)	
2114	01-Feb-88	LABORATORY DATA VALIDATION FUNCTIONAL GUIDELINES FOR EVALUATING ORGANICS ANALYSES (DRAFT)	
2116	01-Jul-85	SEDIMENT SAMPLING QUALITY ASSURANCE USER'S GUIDE	EPA/600/4-85/048
5001	27-Sep-85	CHEMICAL, PHYSICAL & BIOLOGICAL PROPERTIES OF COMPOUNDS PRESENT AT HAZARDOUS WASTE SITES	OSWER #9850.3
5009		INTEGRATED RISK INFORMATION SYSTEM (IRIS) [A COMPUTER-BASED HEALTH RISK INFORMATION SYSTEM AVAILABLE THROUGH E-MAIL--BROCHURE ON ACCESS IS INCLUDED]	
5013	01-Apr-88	SUPERFUND EXPOSURE ASSESSMENT MANUAL	OSWER #9285.5-1
5016	01-Dec-88	AIR/SUPERFUND NATIONAL TECHNICAL GUIDANCE STUDY SERIES VOLUME I - APPLICATION OF AIR PATHWAY ANALYSES FOR SUPERFUND ACTIVITIES	
5020	01-Jul-89	EXPOSURE FACTORS HANDBOOK	EPA/600/8-89/043
5021	27-Jan-89	GUIDANCE FOR SOIL INGESTION RATES	OSWER #9850.4
5023	29-Sep-89	RISK ASSESSMENT GUIDANCE FOR SUPERFUND, VOLUME I, HUMAN HEALTH EVALUATION MANUAL	OSWER #9285.7-01a

Selected Key Guidance Documents

EPA Guidance Documents may be reviewed at the OSRR Records and Information Center in Boston, MA

DOCNUMBER	DOCDATE	TITLE	OSWEREPAID
5024	01-Mar-89	RISK ASSESSMENT GUIDANCE FOR SUPERFUND, VOLUME II, ENVIRONMENTAL EVALUATION MANUAL	EPA/540/1-89/001
6000	01-Oct-87	REMEDIAL ACTION COSTING PROCEDURES MANUAL	
9000	24-Dec-86	INTERIM GUIDANCE ON SUPERFUND SELECTION OF REMEDY	OSWER #9355.0-19
9002	01-Apr-90	GUIDE TO SELECTING SUPERFUND REMEDIAL ACTIONS	OSWER #9355.0-27FS
C003	24-May-77	PROTECTION OF WETLANDS: EXECUTIVE ORDER 11990. 42 FED. REG. 26961 (1977).	
C006	28-Feb-87	STATIONARY SOURCE SAMPLING REPORT. EEI REF. NO. 5448. BENZENE, MERCURY, TOLUENE, TRIETHYLAMINE AND XYLENE EMISSIONS TESTING.	
C018	17-Oct-86	COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980. AMENDED BY PL 99-499, 10/17/86.	
C026	08-Jan-87	ESTIMATED SOIL INGESTION RATES FOR USE IN RISK ASSESSMENT. TAKEN FROM RISK ANALYSIS, VOL. 7, NO. 3, 1987.	
C034	01-Jun-85	GUIDANCE ON FEASIBILITY STUDIES UNDER CERCLA.	EPA 540/G-85-003
C035	01-Jun-85	GUIDANCE ON REMEDIAL INVESTIGATIONS UNDER CERCLA.	EPA 540/G-85/002
C044	21-May-87	EPA IMPLEMENTATION OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 (SARA). DUPLICATE OF 3003.	
C055	09-Jul-87	INTERIM GUIDANCE ON COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS.	OSWER 9234.0-05
C063	01-Jan-92	NATIONAL OIL AND HAZARDOUS SUBSTANCES POLLUTION CONTINGENCY PLAN.	OSWER 9200.2-14
C065	01-Oct-85	OCCUPATIONAL SAFETY AND HEALTH GUIDANCE MANUAL FOR HAZARDOUS WASTE SITE ACTIVITIES.	01A0006857
C129	01-Jul-89	CODE OF FEDERAL REGULATIONS. TITLE 40. PARTS 190 TO 299. PROTECTION OF ENVIRONMENT. REVISED AS OF JULY 1, 1989.	OLD 40 CFRs
C174	01-Dec-89	RISK ASSESSMENT GUIDANCE FOR SUPERFUND. VOLUME I. HUMAN HEALTH EVALUATION MANUAL (PART A). INTERIM FINAL.	EPA 540/1-89/002
C178	25-Nov-87	DRAFT GUIDANCE ON CERCLA COMPLIANCE WITH OTHER LAWS MANUAL.	OSWER 9234.1-01
C220	29-May-92	FINAL GUIDELINES FOR EXPOSURE ASSESSMENT. PGS. 22888 - 22938.	57 FR 22888
C235	01-Apr-91	RISK ASSESSMENT IN SUPERFUND: A PRIMER. FIRST EDITION. SEPTEMBER 1990.	EPA 540/X-91/002
C251	01-Mar-89	ECOLOGICAL ASSESSMENT OF HAZARDOUS WASTE SITES: A FIELD AND LABORATORY REFERENCE.	EPA 600/3-89/013

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DOCNUMBER	DOCDATE	TITLE	OSWEREPAID
C253	01-May-89	RAPID BIOASSESSMENT PROTOCOLS FOR USE IN STREAMS AND RIVERS. BENTHIC MACROINVERTEBRATES AND FISH.	EPA 444/4-89-001
C260	01-Mar-86	COMMUNITY RELATIONS IN SUPERFUND: A HANDBOOK.	OSWER 9230.0-3A
C268	01-Jan-96	ECO UPDATE. ECOLOGICAL SIGNIFICANCE AND SELECTION OF CANDIDATE ASSESSMENT ENDPOINTS. INTERMITTENT BULLETIN VOLUME 3, NUMBER 1	OSWER 9345.0-11FSI
C269	01-Jan-96	ECO UPDATE. ECOTOX THRESHOLDS. INTERMITTENT BULLETIN VOLUME 3, NUMBER 2	OSWER 9345.0-12FSI
C276	22-Apr-91	ROLE OF THE BASELINE RISK ASSESSMENT IN SUPERFUND REMEDY SELECTION DECISIONS	OSWER 9355.0-30
C277	11-Jul-94	RISK-BASED CONCENTRATION TABLE, THIRD QUARTER 1994	
C288	01-Aug-94	RISK UPDATE ISSUE NO. 2	
C361	02-Jun-97	ECOLOGICAL RISK ASSESSMENT GUIDANCE FOR SUPERFUND PROCESS FOR DESIGNING AND CONDUCTING ECOLOGICAL RISK ASSESSMENTS (EPA 540-R-97-006)	
C366	18-Jul-97	DRAFT FINAL GUIDELINES FOR ECOLOGICAL RISK ASSESSMENT	
C368	01-Jun-96	TOXICOLOGICAL BENCHMARKS FOR WILDLIFE: 1996 REVISION	
C373	01-May-92	SUPPLEMENTAL GUIDANCE TO RAGS: CALCULATING THE CONCENTRATION TERM (PUBLICATION 9285 7-081 VOL. I, NUMBER 1)	
C374	01-Sep-94	ECO UPDATE: FIELD STUDIES FOR ECOLOGICAL RISK ASSESMENT (VOL. 2, NUMBER 2)	
C375	01-May-84	BODY WEIGHTS OF 686 SPECIES OF NORTH AMERICAN BIRDS	
C376	01-Jul-94	TOXICOLOGICAL BENCHMARKS FOR SCREENING POTENTIAL CONTAMINANTS OF CONCERN FOR EFFECTS ON AQUATIC BIOTA: 1994 REVISION	
C377	22-Mar-96	EVALUATION OF BIOMARKERS IN BROWN BULLHEAD	
C382	01-Nov-97	EPA'S CONTAMINATED SEDIMENT MANAGEMENT STRATEGY	
C384	01-Sep-94	ESTIMATING EXPOSURE OF TERRESTRIAL WILDLIFE TO CONTAMINANTS	01A0008399
C396	01-Jan-92	FRAMEWORK FOR ECOLOGICAL RISK ASSESSMENT AT THE EPA	
C398	01-Sep-93	GUIDELINES FOR DERIVING SITE-SPECIFIC SEDIMENT QUALITY CRITERIA FOR THE PROTECTION OF BENTHIC ORGANISMS (EPA-822-R-93-017)	
C416	01-Sep-91	ROLE OF BTAG'S IN ECOLOGICAL ASSESSMENT -ECO UPDATE - VOL. 1, NO. 1	OSWER 9345.0-05I

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DOCNUMBER	DOCDATE	TITLE	OSWEREPAID
C447	01-Jan-85	GUIDELINES FOR DERIVING NUMERICAL NATIONAL WATER QUALITY FOR THE PROTECTION OF AQUATIC ORGANISMS AND THEIR USES	TD370 G946
C449	09-Nov-97	SUMMARY OF EPA SEDIMENT POLICY GOALS	
C450	26-Nov-97	INITIATION OF FINAL AGENCY REVIEW FOR CONTAMINATED SEDIMENT MANAGEMENT STRATEGY	
C462	01-Apr-98	EPA'S CONTAMINATED SEDIMENT MANAGEMENT STRATEGY	
C471	24-May-77	EXECUTIVE ORDER 11988 - FLOODPLAIN MANAGEMENT	
C472	24-May-77	EXECUTIVE ORDER 11990 - PROTECTION OF WETLANDS	
C473	01-Aug-97	RULES OF THUMB FOR SUPERFUND REMEDY SELECTION (EPA 540-R-97-013)	OSWER 9355.0-69
C474	01-Dec-97	DRAFT INTERIM FINAL OSWER MONITORED NATURAL ATTENUATION POLICY	OSWER 9200.4-17
C486	14-Oct-98	MANAGEMENT OF REMEDIATION WASTE UNDER RCRA	EPA 530-F-98-026
C503	01-Jul-98	NATIONAL OIL AND HAZARDOUS SUBSTANCES POLLUTION CONTIGENCY PLAN; CODE OF FEDERAL REGULATIONS (TITLE 40, PART 300)	
C512	21-Apr-99	FINAL OSWER DIRECTIVE "USE OF MONITORED NATURAL ATTENUATION AT SUPERFUND, RCRA CORRECTIVE ACTION, AND UNDERGROUND STORAGE TANK SITES"	OSWER 9200.4-17P
C513	01-Jun-96	TOXICOLOGICAL BENCHMARKS FOR SCREENING POTENTIAL CONTAMINANTS OF CONCERN FOR EFFECTS ON AQUATIC BIOTA: 1996 REVISION, ES/ER/TMN-96/R2	
C515	21-Apr-99	USE OF MONITORED NATURAL ATTENTUATION AT SUPERFUND, RCRA CORRECTIVE ACTION, AND UNDERGROUND STORAGE TANK SITES	OSWER 9200.4-17P
C525	01-Jul-99	GUIDE TO PREPARING SUPERFUND PROPOSED PLANS RECORDS OF DECISION AND OTHER REMEDY SELECTION DECISION DOCUMENTS	OSWER 9200.1-23P
C530	01-Jan-98	RISK ASSESSMENT GUIDANCE FOR SUPERFUND, VOLUME 1, HUMAN HEALTH EVALUATION MANUAL, INTERIM	OSWER 9285.7-01D
C531	01-Sep-00	INSTITUTIONAL CONTROLS: A SITE MANAGER'S GUIDE TO IDENTIFYING, EVALUATING AND SELECTING INSTITUTIONAL CONTROLS AT SUPERFUND AND RCRA CORRECTIVE ACTION CLEANUPS.	OSWER 9355.0-74 FS-P

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DOCNUMBER	DOCDATE	TITLE	OSWEREPAID
C539	01-Jun-03	COMPREHENSIVE FIVE-YEAR REVIEW GUIDANCE	OSWER 9355.7-03B-P
C542	01-Aug-93	GUIDE FOR CONDUCTING TREATABILITY STUDIES UNDER CERCLA, BIODEGRADATION REMEDY SELECTION, INTERIM GUIDANCE	EPA 540/R-93/519A
C548	01-Feb-93	QUALITY ASSURANCE FOR SUPERFUND ENVIRONMENTAL DATA COLLECTION ACTIVITIES, QUICK REFERENCE FACT SHEET	OSWER 9200.2-16FS
C549	01-Apr-90	QUALITY ASSURANCE/QUALITY CONTROL GUIDANCE FOR REMOVAL ACTIVITIES, SAMPLING QA/QC PLAN AND DATA VALIDATION PROCEDURES, INTERIM FINAL	OSWER 9360.4-01
C561	01-Jan-04	GUIDANCE FOR MONITORING AT HAZARDOUS WASTE SITES: FRAMEWORK FOR MONITORING PLAN DEVELOPMENT AND IMPLEMENTATION	OSWER 9355.4-28
C563	07-Oct-99	ECOLOGICAL RISK ASSESSMENT AND RISK MANAGEMENT PRINCIPLES FOR SUPERFUND SITES	OSWER 9285.7-28 P
C564	12-Aug-94	ROLE OF THE ECOLOGICAL RISK ASSESSMENT IN THE BASELINE RISK ASSESSMENT	OSWER 9285.7-17
C565	12-Feb-02	PRINCIPLES FOR MANAGING CONTAMINATED SEDIMENT RISKS AT HAZARDOUS WASTE SITES	OSWER 9285.6-08
C578	24-May-77	EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT	EO 11988
C583	01-Jan-94	METHODS FOR MEASURING THE MEASURING THE TOXICITY AND BIOACCUMULATION OF SEDIMENT-ASSOCIATED CONTAMINANTS WITH FRESHWATER INVERTEBRATES	
C584	01-Dec-96	REGION I, EPA-NE DATA VALIDATION FUNCTIONAL GUIDELINES FOR EVALUATING ENVIRONMENTAL ANALYSES	
C585	01-Jan-00	METHODS FOR MEASURING THE TOXICITY AND BIOACCUMULATION OF SEDIMENT-ASSOCIATED CONTAMINANTS WITH FRESHWATER INVERTEBRATES	
C591	01-Aug-95	RISK UPDATES NO 3	
C592	01-Nov-96	RISK UPDATES NO 4	
C593	01-Dec-01	RISK ASSESSMENT GUIDANCE FOR SUPERFUND VOLUME I: HUMAN HEALTH EVALUATION MANUAL. PART D. STANDARDIZED PLANNING, REPORTING, AND REVIEW OF SUPERFUND RISK ASSESSMENTS. FINAL	
C594	01-Oct-02	PRELIMINARY REMEDIATION GOALS TABLE REGION 9 TECHNICAL SUPPORT TEAM	

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DOCNUMBER	DOCDATE	TITLE	OSWEREPAID
C596	01-Dec-02	CALCULATING UPPER CONFIDENCE LIMITS FOR EXPOSURE POINT CONCENTRATIONS AT HAZARDOUS WASTE SITES	
C597	27-Dec-02	NATIONAL RECOMMENDED WATER QUALITY CRITERIA	
C600	14-Apr-04	RISK-BASED CONCENTRATION TABLE REGION III TECHNICAL GUIDANCE MANUAL RISK ASSESSMENT	
C601	01-Apr-04	PRO-UCL VERSION 3.0 STATISTICAL SOFTWARE TO COMPUTE UPPER CONFIDENCE LIMITS ON THE UNKNOWN POPULATION MEAN	
C602	01-Jul-04	RISK ASSESSMENT GUIDANCE FOR SUPERFUND VOLUME I: HUMAN HEALTH EVALUATION MANUAL (PART E SUPPLEMENTAL GUIDANCE FOR DERMAL RISK ASSESSMENT) FINAL	
C608	01-May-92	SUPPLEMENTAL GUIDANCE TO RAGS CALCULATING THE CONCENTRATION TERM	
C614	01-Apr-98	GUIDELINES FOR ECOLOGICAL RISK ASSESSMENT	
C618	01-Jan-00	METHODS FOR MEASURING THE TOXICITY AND BIOACCUMULATION OF SEDIMENT-ASSOCIATED CONTAMINANTS WITH FRESHWATER INVERTEBRATES	
C620	01-Oct-04	EPA REGION 9 PRELIMINARY REMEDIATION GOALS TABLE	
C625	01-Dec-95	DETERMINATION OF BACKGROUND CONCENTRATIONS OF INORGANICS IN SOILS AND SEDIMENTS AT HAZARDOUS WASTE SITES	EPA/540/S-96/500
C627	01-Jun-01	ECO UPDATE: THE ROLE OF SCREENING-LEVEL RISK ASSESSMENTS AND REFINING CONTAMINANTS OF CONCERN IN BASELINE RISK ASSESSMENTS	EPA 540/F-01/014
C629	01-Dec-05	CONTAMINATED SEDIMENT REMEDIATION GUIDANCE FOR HAZARDOUS WASTE SITES	EPA-540-R-05-012
C630	01-Feb-05	GUIDANCE FOR DEVELOPING ECOLOGICAL SOIL SCREENING LEVELS	OSWER 9285.7.5-55
C631	01-Jan-05	ECOLOGICAL SOIL SCREENING LEVELS (ECO-SSL) (VARIOUS METALS) GUIDANCE AND DOCUMENTS FOUND AT http://www.epa.gov/ecotox/ecossl/index.html	
C644	01-Dec-91	RISK ASSESSMENT GUIDANCE FOR SUPERFUND. VOL 1. HUMAN HEALTH EVALUATION MANUAL (PART B, DEVELOPMENT OF RISK-BASED PRELIMINARY REMEDIATION GOALS) INTERIM	OSWER 9285.6-03
C645	01-Jun-01	GUIDANCE FOR CHARACTERIZING BACKGROUND CHEMICALS IN SOIL AT SUPERFUND SITES EXTERNAL REVIEW DRAFT	OSWER 9285.7-41
C646	07-Oct-99	ISSUANCE OF FINAL GUIDANCE: ECOLOGICAL RISK ASSESSMENT AND RISK MANAGEMENT PRINCIPLES FOR SUPERFUND SITES	OSWER 9285.7-28 P

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DOCNUMBER	DOCDATE	TITLE	OSWEREPAID
C658		NATIONAL OIL AND HAZARDOUS SUBSTANCES POLLUTION CONTINGENCY PLAN, CODE OF FEDERAL REGULATIONS (TITLE 40, PART 300), 1985	
C661	01-Sep-02	GUIDANCE FOR COMPARING BACKGROUND AND CHEMICAL CONCENTRATIONS IN SOIL FOR CERCLA SITES	EPA-540-R-01-003
C663	01-Sep-96	ROLE OF COST IN THE SUPERFUND REMEDY SELECTION PROCESS	EPA-540/F-96/018
C664	01-Jan-91	COMPLYING WITH LAND DISPOSAL RESTRICTIONS (LDR) FOR CERCLA REMEDIAL ACTIONS INVOLVING CONTAMINATED SOIL AND DEBRIS	EH-231002/0191A
C668	01-Oct-92	A SUPERFUND GUIDE TO RCRA HAZARDOUS WASTES	OSWER/P9345.3-04FS
C670	14-Oct-98	MANAGEMENT OF REMEDIATION WASTE UNDER RCRA	EPA530-F-98-026
C687	01-Feb-05	GUIDANCE FOR DEVELOPING ECOLOGICAL SOIL SCREENING LEVELS	OSWER 9285.7-55
C688	01-Jan-06	NATIONAL RECOMMENDED WATER QUALITY CRITERIA	
C691	01-Aug-97	CLARIFICATION OF THE ROLE OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS IN ESTABLISHING PRELIMINARY REMEDIATION GOALS UNDER CERCLA	OSWER 9200.4-23
C701	01-Nov-09	UNDERSTANDING THE USE OF MODELS IN PREDICTING THE EFFECTIVENESS OF PROPOSED REMEDIAL ACTIONS AT SUPERFUND SITES	
C702	09-Sep-09	CHANGES TO THE ROLES AND RESPONSIBILITIES OF THE CONTAMINATED SEDIMENTS TECHNICAL ADVISORY GROUP (CSTAG)	
C703	01-Jul-08	USING FISH TISSUE DATA TO MONITOR REMEDY EFFECTIVENESS - SEDIMENT ASSESSMENT AND MONITORING SHEET (SAMS) #1	
C704	03-Jul-08	RESPONSE TO REGIONAL REQUEST REGARDING SEDIMENT CLEANUP AT MAY 2008 SUPERFUND DIVISION DIRECTORS MEETING	
C705	01-Mar-04	GUIDELINES FOR THE OSRTI REVIEW OF CONSIDERATION MEMOS ON TIER 1 SEDIMENT SITES	
C706	05-Mar-04	OSRTI SEDIMENT TEAM AND NRRB COORDINATION AT LARGE SEDIMENT SITES	
C708	01-May-09	TECHNICAL GUIDE: MONITORED NATURAL RECOVERY AT CONTAMINATED SEDIMENT SITES, ESTCP PROJECT ER-0622, MAY 2009	
C709	01-Sep-08	TECHNICAL GUIDELINES FOR ENVIRONMENTAL DREDGING OF CONTAMINATED SEDIMENTS	

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C710	01-Jan-08	THE FOUR RS OF ENVIRONMENTAL DREDGING: RESUSPENSION, RELEASE, RESIDUAL, AND RISK	
C711	01-Jan-07	SEDIMENT DREDGING AT SUPERFUND MEGASITES - ASSESSING THE EFFECTIVENESS	
C713	01-Nov-00	GUIDANCE FOR ASSESSING CHEMICAL CONTAMINANT DATA FOR USE IN FISH ADVISORIES	
C715	01-Jan-02	GUIDANCE MANUALS TO SUPPORT THE ASSESSMENT OF CONTAMINATED SEDIMENTS IN FRESHWATER □IMPLEMENTATION GUIDE FOR ASSESSING AND MANAGING CONTAMINATED SEDIMENT AT NAVY FACILITIES (MARCH 2003) (PDF)	
C716	01-Jan-02	U.S. EPA OFFICE OF WATER: METHODS FOR COLLECTION, STORAGE AND MANIPULATION OF SEDIMENTS	
C717	01-Jan-00	U.S. EPA OFFICE OF WATER: METHODS FOR SAMPLING AND ANALYZING CONTAMINANTS IN FISH AND SHELLFISH TISSUE	
C718	01-Jan-97	ECOLOGICAL RISK ASSESSMENT GUIDANCE FOR SUPERFUND	
C719	24-Feb-10	ADDITIONAL TOOLS FOR ECOLOGICAL RISK ASSESSMENT	
C720	08-May-98	CONTAMINATED SEDIMENT MANAGEMENT STRATEGY	
C721	26-Apr-02	ROLE OF BACKGROUND IN THE CERCLA CLEANUP PROGRAM	9285.6-07P
C722	27-Oct-90	ISSUANCE OF FINAL GUIDANCE:ECOLOGICAL RISK ASSESMENT AND RISK MANAGEMENT	9285.7-28 P
C723	01-May-09	TECHNICAL GUIDE: MONITORED NATURAL RECOVERY AT CONTAMINATED SEDIMENT SITES	
C724	01-Jun-09	UNDERSTANDING THE USE OF MODELS IN PREDICTING RISK RECUTION OF PROPOSED REMEDIAL ACTIONS AT SUPERFUND SEDIMENT SITES (SEDIMENT ASSESSMENT & MONITORING SHEET #2)	9200.1-96FS
C725	01-Jan-09	GUIDANCE FOR IMPLEMENTING THE JANUARY 2001 METHYLMERCURY WATER QUALITY CRITERION	
C726	01-Dec-97	MERCURY STUDY REPORT TO CONGRESS, VOLUME III: FATE AND TRANSPORT OF MERCURY IN THE ENVIRONMENT	
C727	01-Dec-08	2008 WATERSHED PROTECTION PLAN UPDATE, VOLME IID: SUDBURY AND FOSS RESERVOIRS WATERSHED	

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C728	01-Aug-00	GUIDANCE FOR INDUSTRY: ACTION LEVELS FOR POISONOUS OR DELETERIOUS SUBSTANCES IN HUMAN FOOD AND ANIMAL FEED	
C729	01-Jan-09	MASSGIS OLIVER DATA VIEWER	