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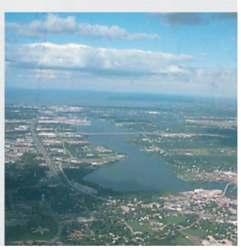
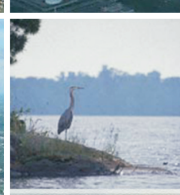
Madison, Wisconsin 53707

Northeast Regional Headquarters
1125 North Military Avenue
Green Bay, Wisconsin 54307

United States Environmental Protection Agency
Region 5
77 West Jackson Blvd.
Chicago, IL 60604

Proposed Remedial Action Plan
Lower Fox River and Green Bay



October 2001

Proposed Remedial Action Plan – Lower Fox River and Green Bay
Wisconsin DNR & U.S. EPA Region 5

MARK YOUR CALENDARS. Public meetings to be held during the public comment period are scheduled for:

Monday evening, October 29, 2001 Holiday Inn Select 150 Nicolet Road (US 41 & College Ave.) Appleton, WI	Tuesday evening, October 30, 2001 Oneida Radisson Convention Center 2040 Airport Road (across from Austin Straubel Airport) Green Bay, WI

A presentation on the proposed plan will begin at 6:30 p.m. Following the presentation there will be an opportunity for the public to ask questions and to make comments. Prior to these meetings, at the same location and dates, there will be an open house for the public beginning at 4:30 p.m. so the public can meet with DNR and EPA staff involved with the project and discuss the plan. Supplemental material will be available.

1 Purpose of the Proposed Plan

This Proposed Plan (Plan) describes the remedial alternatives that were considered for cleanup of the Lower Fox River and Lake Michigan's Green Bay and identifies the proposed remedial alternative as well as the rationale for its selection. The primary contaminant of concern is a group of manufactured chlorinated chemicals known collectively as ***polychlorinated biphenyls (PCBs)***.

This Plan was developed by the ***Wisconsin Department of Natural Resources (DNR)*** in cooperation with the ***U.S. Environmental Protection Agency (EPA)***. DNR has issued the Plan pursuant to DNR's authority under Ch. 292, Wisconsin Statutes, with EPA's concurrence, in order to give the public an opportunity to comment on the proposed remedial alternative, consistent with public participation procedures required by the National Contingency Plan (40 CFR Part 300).

The alternatives that are summarized in this Plan are described in detail in the Lower Fox River and Green Bay ***Remedial Investigation and Feasibility Study (RI/FS)*** reports and in other documents contained in the Administrative Record file for the site (see "Administrative Record" in Section 2.2 for a list of those documents). Readers are referred to the Administrative Record file for a complete understanding of issues presented by the Lower Fox River and Green Bay site and of the studies DNR has completed regarding the site. The RI/FS and this Plan are consistent with the findings of the National Academy of Science's (NAS) National Research Council report entitled *A Risk Management Strategy for PCB-Contaminated Sediments*.

The remedy described in this Plan is the ***proposed alternative*** for the site. This Plan solicits public comments on DNR's and EPA's proposed alternative and the other remedial alternatives that were considered. Changes to the proposed alternative or to another remedy may be made if public comments suggest such a change will result in a more appropriate remedial action.

1.1 Terminology and Units of Measure

Technical terms and acronyms used in this Plan are defined in the Glossary that appears at the end of the Plan. Technical terms that can be found in the Glossary are ***italicized and bolded*** the first time they appear in this Plan.

The units of measure used in this Plan (such as kilograms, cubic yards, centimeters, and feet) are the measurement units typically applied to a given medium; sometimes they are metric units and sometimes they are standard English units. For instance, sediment volumes are typically discussed in terms of cubic yards, while a mass of PCBs is typically discussed in terms of kilograms. Units of measure that might not be familiar to readers are also defined in the Glossary.

1.2 Brief Description of the Proposed Alternative

The proposed alternative targets the removal of approximately 7.25 million cubic yards (cy) of contaminated sediment containing over 29,259 kilograms (kg) of PCBs from the Lower Fox River using environmental dredging techniques that minimize adverse environmental impacts, including the resuspension of sediment during dredging. The proposed alternative also incorporates Monitored Natural Recovery (MNR) of the residual PCB contamination remaining in dredged areas and undisturbed areas until the concentrations of PCBs in fish tissue are lowered to an acceptable level. Fish consumption advisories and fishing restrictions will remain in place until acceptable levels are achieved. The proposed alternative calls for dewatering and stabilizing the dredged sediment and disposing of it off site at licensed solid waste disposal facilities, including existing licensed facilities and possibly new facilities yet to be constructed and licensed in the Fox River Valley. The Proposed Plan seeks to define a set of remedial alternatives that, if implemented, will result in the cleanup of sediments that lead directly to the protection of human health and the environment. WDNR and EPA's goal is for the cleanup action to result in the removal of all fish consumption advisories, and the protection of the fish and wildlife that use the Fox River and Green Bay. DNR and EPA (Figure 6) are also considering thermal treatment of contaminated sediment.

2 Community Role in the Selection Process

Since the summer of 1997, DNR and EPA have participated in an ongoing process for community involvement that has included numerous public meetings. These meetings have focused on a variety of topics, including cleanup and restoration activities, the status of pilot projects, fish consumption advisories, the draft RI/FS released by DNR in February 1999, and small group discussions. Over the same period, DNR and EPA staff members have also spoken to various community groups. In addition, DNR and EPA publish a bimonthly newsletter, the *Fox River Current*, which is mailed to over 10,000 addresses. This effort is consistent with the recommendation of the NAS that risk management of PCB-contaminated sediment sites include early, continuous, and frequent involvement of affected parties.

2.1 Public Comment Period

DNR and EPA will rely on public input to ensure that the concerns of the community are considered in selecting an effective remedy for each ***operable unit (OU)*** within the Lower Fox River and Green Bay Remediation site. To this end, various previous reports and this Plan are available to the public for a public comment period, which begins on October 5, 2001, and concludes on December 7, 2001.

Written comments will be responded to in a Responsiveness Summary, which is appended to the Record of Decision. The Record of Decision is the document that will formalize remedy selection. Written comments on the RI/FS and this Plan should be addressed to:

Edward K. Lynch, PE – RR/3
Wisconsin DNR
Fox River Proposed Plan Comments
101 South Webster St., PO Box 7921
Madison, WI 53707-7921

Comments postmarked by midnight December 7, 2001, will be accepted. Comments can also be e-mailed to DNR at FOXRIFS@dnr.state.wi.us.

Where can you get more information? This Plan, the RI/FS, and other supporting documents containing information upon which the proposed alternative is based are available on the web at http://www.dnr.state.wi.us/org/water/wm/lowerfox/index.html and at the following public information repositories:

Appleton Public Library, Contact: Margaret Ernst
225 N. Oneida St.
Appleton, WI
920-832-6173

Brown County Library, Contact: Peggy Quinn
515 Pine St.
Green Bay, WI
920-448-4381, ext. 394

Door County Library, Contact: Nancy Emery
107 S. Fourth Ave.
Sturgeon Bay, WI
920-743-6578

Oneida Community Library, Contact: Lou Williams
201 Elm St.
Oneida, WI
920-869-2210

Oshkosh Public Library, Contact: Susan Velsky
106 Washington Ave.
Oshkosh, WI
920-236-5200

This information is also available at the government offices listed on the next page.

2.2 Administrative Record

The Administrative Record contains all of the documents and information that DNR and EPA used to support their selection of the proposed alternative. These documents include the Lower Fox River and Green Bay RI/FS, the ***Risk Assessment (RA)*** and supporting documents, some of which are mentioned in this Plan, such as various assessments and compilations of data, *the Data Management Report*, the *Sediment Technology Study*, the draft *Long-Term Monitoring memo*, a report titled *Review of Natural PCB Degradation Processes in Sediment*, a report titled *Time Trends Analysis of Sediment and Fish Tissue*, the *Model Documentation Report*, and other supporting information. Much of this documentation is available at the information repositories noted above and on the DNR's Lower Fox River Web page. The complete record is available at the following location:

Wisconsin DNR
Remediation and Redevelopment – 3rd Floor
101 S. Webster Street
Madison, WI 53707
Contact: Ed Lynch
608/266-3084

Wisconsin DNR
Lower Fox River Basin Team,
801 East Walnut Street
Green Bay, WI 54301
Contact: Kelley O'Connor
920/448-5133

Office Hours are Monday-Friday, 8:00 a.m. – 4:30 p.m. Please call for an appointment. These materials are also available at the EPA Region 5 office at the following location.

United States Environmental Protection Agency
Office of Public Affairs
77 West Jackson Boulevard
Chicago, IL 60604
Contact: Bri Bill, P-19J
Community Involvement Coordinator
312/353-6646

This Plan also refers to studies performed by others, such as the University of Wisconsin and the Institute of Paper Chemistry. Full citations for these references are not provided in this Plan, but the list of references can be located in the Administrative Record.

3 Site Description

The study area comprises two distinctly different water bodies, the Lower Fox River and Lake Michigan's Green Bay (Figure 1). The Lower Fox River flows northeast approximately 39 miles (mi) from Lake Winnebago to the river mouth at the southern end of Green Bay. Green Bay's watershed drains approximately 15,625 square miles (mi^2). Two-thirds of the Green Bay basin is in Wisconsin; the remaining one-third is in Michigan's Upper Peninsula.

Green Bay is a narrow, elongated bay, approximately 119 mi long and an average of 23 mi wide. The southern end of the bay is a warm-water estuary with shallow water depths, while the northern end is deeper and has cold water more typical of Lake Michigan. The mean depth of the bay is approximately 65 feet (ft). Few areas of the bay have depths exceeding 131 ft. Green Bay covers an area of approximately 1,600 mi^2 and has a water volume of about 20 cubic miles (mi^3). Currents tend to flow counterclockwise in Green Bay. Water from the Lower Fox River flows northeasterly up the east shore of Green Bay, while Lake Michigan and northern Green Bay waters move southward along the west shore.

Figure 1 – Overall Study area location and Bay

The Lower Fox River is the primary tributary to Green Bay, draining approximately 6,330 mi^2. The river's elevation drops approximately 168 ft between Lake Winnebago and Green Bay. Twelve dams and 17 locks accommodate this elevation change and allow navigation between Lake Winnebago and Green Bay. Large cargo vessels can currently navigate only from Green Bay upriver approximately 3.8 mi to the Georgia Pacific (formerly Fort James) turning basin. However, while the entire Lower Fox River still has a federally authorized navigation channel and is navigable by recreational boats, the Rapide Croche lock is permanently closed to restrict upstream migration of the sea lamprey. The two dams in the cities of Neenah and Menasha that control the pool elevation of Lake Winnebago also regulate river discharge.

The Lower Fox River is generally less than 1,000 ft wide over much of its length and is up to approximately 20 ft deep in some areas. Where the river widens significantly, the depth generally decreases to less than 10 ft, and, in the case of Little Lake Butte des Morts (LLBdM), water depths range between 2 and 5 ft except in the main channel. The main channel of the river ranges from approximately 6 to 20 ft in depth.

Since 1918, flow in the Lower Fox River has been monitored at the Rapide Croche Dam, midway between Lake Winnebago and the river mouth. Mean annual discharge is approximately 4,237 cubic feet per second (cfs). The recorded maximum daily discharge of 24,000 cfs occurred on April 18, 1952; the minimum daily discharge of 138 cfs occurred on August 2, 1936. The overall river velocity averages just under 0.5 foot per second (f/s), with two notable exceptions. Flow in the river between Appleton and the Little Rapids Dam averages 0.78 f/s, while a significant portion of the river from its mouth to the De Pere Dam experiences frequent flow reversals (i.e., the river flows upstream) as a result of conditions present in Green Bay commonly known as ***seiche events.*** These events are oscillations in water level in the range of 1-2 feet, driven by wind and barometric pressure.

EPA's proposed inclusion of the Lower Fox River and Green Bay site on the National Priorities List (NPL) defines the site as the Lower Fox River from the outlet of Lake Winnebago to a point in Green Bay 27 mi from the river mouth. The site is officially called the Fox River NRDA PCB Releases Site in the proposed NPL listing. The federal trustees conducting a *Natural Resource Damage Assessment (NRDA)* have defined the site somewhat differently to also include all of Green Bay and nearby areas of Lake Michigan. For the purposes of the RI/FS and this Plan, the site is defined as the 39 river miles of the Lower Fox River and Green Bay to a line that extends between Washington Island, Wisconsin, and the Garden Peninsula of Michigan.

3.1 Operable Units

For purposes of the RI/FS and the RA, the river was divided into four sections or river reaches and Green Bay was divided into three major zones on the basis of physical features and information generated in previous investigations (Figure 2). Each of the river reaches has been deemed a separate operable unit (OU 1 through OU 4), while all of Green Bay has been designated a single operable unit (OU 5). An operable unit is a geographical area designated for the purpose of analyzing remedial actions, usually on the basis of uniform properties and characteristics throughout the OU. The river reaches, Green Bay zones, and corresponding operable units are:

- OU 1 – Little Lake Butte des Morts river reach
- OU 2 – Appleton to Little Rapids river reach
- OU 3 – Little Rapids to De Pere river reach
- OU 4 – De Pere to Green Bay river reach (also referred to as Green Bay Zone 1, but not for of this Plan)

- OU 5 – Green Bay; Zones within Green Bay include:
  - Zone 2
  - Zone 3
  - Zone 4

3.2 Chemicals of Concern and Impairments to Use

The site includes the contaminated sediment found within the Lower Fox River and Green Bay. Identified Chemicals of Concern (COCs) include PCBs, dioxins/furans, the pesticide DDT and its metabolites (DDD and DDE), the pesticide dieldrin, and arsenic, lead, and mercury. The U.S. and Canadian International Joint Commission, which oversees implementation of the Great Lakes Water Quality Agreement, has designated the Lower Fox River and lower Green Bay as a Great Lakes Area of Concern (AOC). In cooperation with citizen advisory committees that included public, private sector, and technical expert representatives, a Remedial Action Plan (RAP) was developed for the Lower Fox River/Green Bay AOC. The RAP documented 11 impairments to use of the AOC, identified two suspected impairments and determined that one impairment is absent (see Table 1). The RAP linked many of the use impairments to the presence of PCBs in river and bay sediment and identified goals, objectives and a framework for conducting remedial actions in the Lower Fox River and Green Bay.

Figure 2 - Lower Fox River Reaches

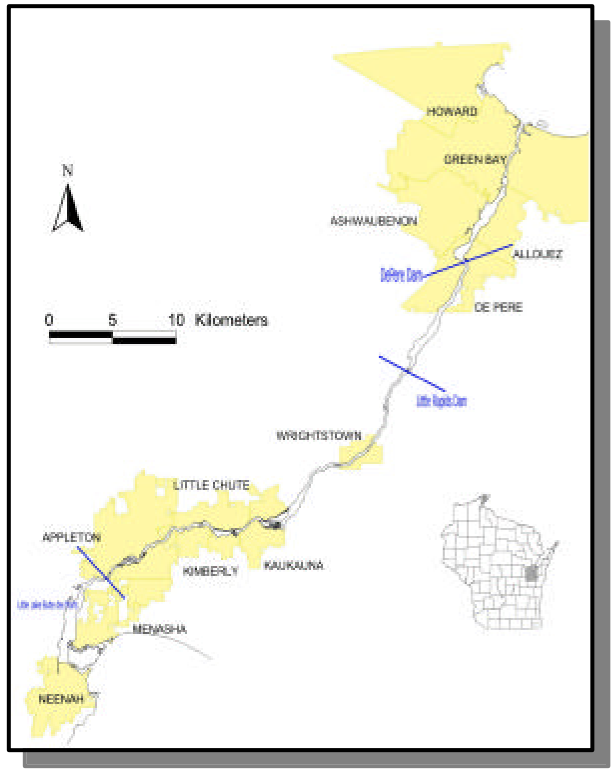


Table 1. Summary of Lower Fox River/Green Bay Impairments

Beneficial Use	Impairment
Fish or wildlife consumption advisories	Present
Tainting of fish or wildlife flavor	Suspected
Degraded fish or wildlife populations	Present
Fish tumors or other deformities	Suspected
Bird or animal deformities or reproductive problems	Present
Degradation of benthos	Present
Restrictions on dredging activities	Present
Eutrophication or undesirable algae	Present
Restrictions on drinking water consumption or taste and odor problems	Present
Beach closings	Present
Degradation of aesthetics	Present
Added costs to agriculture or industry	Absent
Degradation of phytoplankton and zooplankton populations	Present
Loss of fish and wildlife habitat	Present

Although the AOC includes the Lower Fox River below the De Pere Dam and only the southernmost portion of Green Bay, the RI/FS includes the Lower Fox River below Lake Winnebago and all of Green Bay due to the extent of PCB contamination. That is why this Plan occasionally makes distinctions between the lower bay, usually in a historical context, and the entirety of Green Bay.

4 Site History

The Fox River Valley is one of the largest urbanized regions in the state of Wisconsin, with a population of approximately 375,000. The Fox River Valley has a significant concentration of pulp and paper industries, with 20 mills located within approximately 39 mi. Other important regional industries include metal working, printing, food and beverages, textiles, leather goods, wood products, and chemicals. In addition to heavy industrial land uses, the region also supports a mixture of agricultural, residential, light industrial, and conservancy uses, as well as wetlands.

Problems related to water quality have been noted and measured in the Lower Fox River and lower Green Bay almost since the area was settled. Water quality studies were initiated in the early 1900s and have been conducted almost annually since. Between the early 1930s and mid-1970s, the population of desirable fish and other aquatic organisms in the system was poor. Recorded fish kills and the increasing predominance of organisms able to tolerate highly polluted conditions were found throughout the Lower Fox River and lower Green Bay. A 1927 report prepared by the Wisconsin Conservation Commission and the Wisconsin State Board of Health noted that in the area downstream from the confluence with the East River, *"The river was dark colored, very turbid and evil smelling at this point, during most of the period covered by the survey*."

Figure 3 - Plume in the Fox River, April 1957

Few people used the river or lower Green Bay for recreation because of the poor water quality and the lack of a sport fishery. During this same time period, dissolved oxygen levels were often very low (2 milligrams per liter [mg/L] or less). The poor water quality was attributed to many sources such as the effluent discharged from pulp and paper mills and municipal sewage treatment plants (Figure 3).

In large part because of the federal Clean Water Act (1972), improved waste treatment systems began operations. As part of this effort, DNR developed and implemented a Waste Load Allocation system to regulate the discharge of oxygen-demanding pollutants from wastewater treatment plants. Fish and aquatic life in the Lower Fox River and Green Bay have responded dramatically to the improved water quality conditions. Fishery surveys conducted from 1973 to the present indicate a sharp increase in the sport fish population. Species sensitive to water quality, such as lake trout, which were absent since the late 1800s or early 1900s, have been found in the river since 1977. These improvements result from a substantial reduction in organic wastes discharged into the river.

With the return of the sport fishery, human use of the river and Green Bay has also returned. Recognizing the increase in recreational fishing, DNR began routinely monitoring contamination in fish. The first fish consumption advisories for the site were issued in 1976 and 1977 by DNR and the state of Michigan, respectively. Fish consumption advisories remain in effect today. DNR has continued to collect contaminant fish tissue concentration date since that time.

4.1 PCB Use in the Lower Fox River Valley

The former National Cash Register Company (NCR; presently AT&T Global Solutions Company) is credited with inventing carbonless copy paper. The method used microcapsules of a waxy material to enclose a colorless dye dissolved in PCBs (Figure 4). This material was manufactured as an emulsion and could be coated onto the back of a sheet of paper. A second reactive coating was then applied to the front of a second sheet of paper. When the two sheets were joined, an impact on the front sheet would rupture the capsules and allow the dye to react with the coating on the second sheet, leaving an identical image. Because the capsules were fragile, special paper coating methods and equipment were required to produce carbonless copy paper.

Figure 4 - PCB Emulsion

NCR first produced the capsule emulsion in Dayton, Ohio, and later in Portage, Wisconsin. The emulsion was sold to Appleton Coated Papers, who produced the coated paper in Appleton, Wisconsin. The finished product was distributed and sold by NCR.

Nearly all PCB discharges to the Lower Fox River are believed to have resulted from the production and recycling of NCR carbonless copy paper (NCR Paper) made with PCB-containing coating emulsions. PCBs were released to the river from:

1. **NCR PAPER PRODUCTION.** PCBs were released during the manufacturing process, primarily at the Appleton Papers - Appleton Coated Papers Mill.
2. **BROKE and CONVERTER TRIM.** NCR Paper "broke" derived from pre-consumer manufacturing and converting processes was sold to de-inking mills in the Fox River Valley and elsewhere. (Broke is defined as paper trimmings or damaged paper resulting from breaks on the paper machine, in finishing operations, or elsewhere in the process of paper manufacturing.)
3. **WASTE PAPER / SECONDARY FIBERS.** PCBs were released through the recycling of paper sources, including post-consumer paper sources, containing NCR Paper forms, as well as through the use of secondary fiber sources containing detectable PCB levels.

The production of carbonless copy paper increased nearly exponentially during the 1950s and 1960s. By 1971, approximately 7.5 percent of all office forms were printed on carbonless copy paper. As PCB use increased with the increased production of NCR Paper, PCBs began to appear in many types of paper products made using recycled NCR Paper, NCR Paper broke, and other paper products made with NCR Paper broke. As documented in an EPA report, nearly all paper products contained detectable levels of PCBs by the late 1960s. During this time period, other Fox River Valley paper mills also began recycling wastepaper laden with PCBs. Evidence of PCBs in paper products includes studies conducted by the Institute of Paper Chemistry to determine the rate at which PCBs migrated from paper container materials to the food products contained in them.

According to NCR, PCBs were not used in the carbonless copy paper emulsion after April 1971 because of increased concern about PCBs in the environment. When PCBs were being used, and shortly thereafter, significant quantities of PCBs were released into the Lower Fox River. Approximately 13.6 million kg (30 million lbs) of emulsion were reportedly used in the Fox River Valley between about 1954 and 1971. Approximately 313,600 kg (690,000 lbs) of PCBs were released to the environment during this time. Ninety-eight percent of the total PCBs released into the Lower Fox River had been released by the end of 1971. Five facilities, including the Appleton Papers - Appleton Coated Papers Mill, P.H. Glatfelter Company and associated Arrowhead Park Landfill, Fort James (currently Georgia Pacific), Wisconsin Tissue Mills (currently WTM I Company), and Appleton Papers-Locks Mill, contributed over ninety-nine percent of the total PCBs discharged to the river.

4.2 Past Studies of the Lower Fox River System

There have been several cooperative efforts to study the Lower Fox River and Green Bay. These efforts have had varying levels of success. In 1989/90, following recommendations made in the RAP, EPA and DNR began sediment and water sampling in the Lower Fox River and Green Bay for use in the *Green Bay Mass Balance Study* (GBMBS). The GBMBS was a pilot project to test the feasibility of using a mass balance approach for assessing the sources and fates of toxic pollutants spreading throughout the food chain. The objectives of the GBMBS were to:

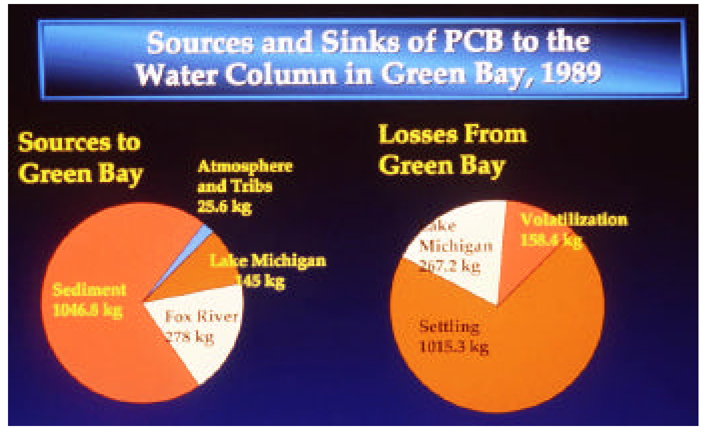
- Inventory and map PCB mass and contaminated sediment volume;
- Calculate PCB fluxes into and out of the Lower Fox River and Green Bay by evaluating Lake Winnebago, point sources, landfills, groundwater, atmospheric contributions, and sediment resuspension;
- Increase understanding of the physical, chemical, and biological processes that affect PCB fluxes;
- Develop, calibrate, and validate computer models for the river and bay systems; and
- Conduct predictive simulations using computer models to assist in assessing specific management scenarios and selecting specific remedial actions.

What is a mass balance?

A mass balance is an accounting mechanism based on the classical concept of the conservation of mass: that the total mass of a system remains unchanged. A mass balance reflects the fact that the amount of pollutant entering a system should equal the amount of pollutant leaving, trapped in, or chemically changed in a system. Thus, if PCB mass is lost from one physical, chemical, or biological component, it must be gained in another.

The GBMBS provided valuable insight into the chemical, physical, and biological processes that control movement of PCBs within the Lower Fox River and Green Bay systems. The most significant finding was that the primary source (more than 95 percent) of the PCBs moving within the Lower Fox River is the river sediment itself. The contribution of PCBs from wastewater discharges, landfills, groundwater, and the atmosphere is insignificant in comparison to the PCBs originating from the sediment. Inventory and mapping activities showed that PCBs are distributed throughout the entire Lower Fox River. Thirty-five discrete sediment deposits were identified between Lake Winnebago and the De Pere Dam. One relatively large, continuous sediment deposit exists downstream of the De Pere Dam. Water column sampling indicated that the water entering the Lower Fox River from Lake Winnebago contains relatively low PCB concentrations. However, upon exposure to the contaminated river sediment in Little Lake Butte des Morts, water in the river very quickly exceeds state water quality standards. During the GBMBS, the lowest water column concentration (5 nanograms per liter [ng/L]) of PCBs measured in any river sample still exceeded the state water quality standard by a factor of more than 1,500. As expected, water column concentrations also increased as river flow increased and PCBs attached to river sediment were resuspended into the water column. These higher flows resulted in PCB concentrations that exceeded standards by a factor of almost 40,000. The GBMBS also documented that more than 60 percent of PCB transport occurs during the relatively short time when river flows are above normal. Movement of PCBs in the water column extends throughout Green Bay, with some PCBs from the Lower Fox River ultimately entering Lake Michigan proper. The GBMBS also documented that a considerable amount of PCB is lost to the atmosphere from the surface of the water in the river and bay (Figure 5).

Figure 5 – PCB Sources and Sinks



EPA's Great Lakes National Program Office (GLNPO) initiated a similar mass balance study for all of Lake Michigan, the *Lake Michigan Mass Balance Study* (LMMBS). To accomplish the objectives of this study, which were similar to those of the GBMBS but on a larger scale, pollutant loading (including PCBs) from 11 major tributaries flowing into Lake Michigan was measured. The Lake Michigan Tributary Monitoring Program confirmed the magnitude and significance of the Lower Fox River contribution to pollutant loading in Lake Michigan. It is estimated that each day, up to 70 percent of the PCBs entering Lake Michigan via its tributaries come from the Lower Fox River.

In 1993, a group of paper mills approached DNR to establish a cooperative process for resolving the contaminated sediment issue. The outcome was formation of the Fox River Coalition, a private-public partnership of area businesses, state and local officials, environmentalists, and others committed to improving the quality of the Lower Fox River. The Coalition focused on the technical, financial, and administrative issues that would need to be resolved to achieve a whole river cleanup.

Figure 6 - Sediment Core Sample collected on EPA Research Vessel Mud Puppy

The Coalition's first project was an RI/FS of several sediment deposits upstream of the De Pere Dam. The sediment deposits targeted for the Coalition's RI/FS were selected after all the deposits had been prioritized based on their threat and contribution to the contaminant problems. Previous studies on the river had focused only on the nature and extent of contamination. The Coalition's RI/FS first confirmed the nature and extent of the contamination within each deposit, then evaluated remedial technologies for cleaning up two of the deposits.

The Coalition also undertook a project to more thoroughly inventory and map sediment contamination in the river downstream of the De Pere Dam, collecting sediment cores from 113 locations. The sampling was completed in 1995 with technical and funding assistance from both DNR and EPA. The resulting data led to a revised estimate of PCB mass and the volume of contaminated sediment in this river reach. The expanded database also made it possible to prioritize areas of sediment contamination, much as had previously been done for areas upstream of the De Pere Dam.

Following completion of the Coalition's RI/FS for the upstream sites, the Coalition selected Deposit N as an appropriate site for a pilot project to evaluate remedial design issues. The primary objectives were to determine requirements for implementing a cleanup project and to generate site-specific information about cleanup costs. Although the Coalition initiated the effort, DNR, with funding from EPA, was responsible for implementing the Deposit N pilot project (results are discussed in Section 4.3.1).

In 1994, the U.S. Department of the Interior acting through the ***U.S. Fish and Wildlife Service*** (F&WS), the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce, the Menominee Indian Tribe of Wisconsin, and the Oneida Tribe of Indians of Wisconsin initiated an NRDA action at the site. F&WS identified seven paper companies, now known as the ***Fox River Group*** (FRG), as potentially responsible parties for the contamination. The FRG includes Appleton Paper Company, NCR, P.H. Glatfelter Company, Georgia Pacific (formerly Fort James), WTM1 (formerly Wisconsin Tissue), Riverside Paper Co., and U.S. Paper Co. Of these, P.H. Glatfelter, Georgia Pacific, WTM1, Riverside Paper Co., and U.S. Paper Co. all had conducted paper recycling activities.

In January 1997, the DNR and the FRG signed an agreement dedicating $10 million to fund demonstration projects on the river and other work to evaluate various methods of restoration. This collaborative effort, however, was not completely successful and did not resolve issues as was initially hoped. At about this same time, F&WS issued a formal Notice of Intent to sue the paper companies. In June 1997, the EPA announced its intent to list the Lower Fox River and portions of Green Bay on the National Priorities List (NPL), a list of the nation's hazardous waste sites eligible for investigation and cleanup under the federal Superfund program. The state indicated its opposition to listing the river as a Superfund site. Federal, state, and tribal officials subsequently signed an agreement on July 11, 1997, to share their resources in developing a comprehensive cleanup and restoration plan for the Lower Fox River and Green Bay. EPA formally proposed listing of the site to the NPL in a *Federal Register* publication on July 28, 1998.

In October 1997, the FRG submitted an offer to conduct an RI/FS on the Lower Fox River. An RI/FS is the first step in the federal process initiated by EPA to assess current health risks and evaluate potential remediation methods. Following unsuccessful attempts to negotiate this work activity with the FRG, EPA delegated the lead role for the site to DNR and helped craft a scope of work and cooperative agreement with DNR for completing the RI/FS. Section 5.0 summarizes results of the state-led RI/FS.

4.3 Lower Fox River Pilot Dredging Projects

This section summarizes the two demonstration dredging projects conducted as part of the past investigations into site conditions and possible remedial options. More information on these projects is available on the DNR's Lower Fox River web page. Information learned from these projects has been used in the RI/FS.

4.3.1 Deposit N

In 1998 and 1999, the DNR and EPA-GLNPO sponsored a project to remove PCB-contaminated sediment from Deposit N in the Lower Fox River. This project was successful at meeting its primary objective by demonstrating that dredging of PCB-contaminated sediment can be performed in an environmentally safe and cost-effective manner. Other benefits of the project included the opportunity for public outreach and education on the subject of environmental dredging, as well as the actual removal of PCBs from the river system (Figure 7). Deposit N, located near Little Chute and Kimberly, Wisconsin, covered approximately 3 acres and contained about 11,000 cy of sediment. PCB concentrations were as high as 186 milligrams per kilogram (mg/kg). Of the 11,000 cy in Deposit N, about 65 percent of the volume was targeted for removal.

Figure 7 - Dredge at Deposit N

Approximately 8,200 cy of sediment were removed, generating 6,500 tons of dewatered sediment that contained 112 total pounds of PCBs. The total included about 1,000 cy of sediment from Deposit O, another contaminated sediment deposit adjacent to Deposit N. Monitoring data showed that the river was protected during the dredging and that wastewater discharged back to the river complied with all permit conditions. The project met the design specifications for the removal, such as the volume of sediment removed, sediment tonnage, and allowed thickness of residual sediment. It should be noted that the project's goals were to test and meet the design specifications and focus on PCB mass removal, not to achieve a concentration-based cleanup, i.e., removal of all PCB-contaminated sediment above a certain cleanup level. A cost analysis of this project indicated that a significant portion of the funds was expended in pioneering efforts associated with the first PCB cleanup project on the Lower Fox River, for the winter construction necessary to meet an accelerated schedule, and for late season work in 1998.

4.3.2 Fox River Group Demonstration Project

As part of the January 1997 agreement between the FRG and the State of Wisconsin, the FRG agreed to make available a total of $10 million for a number of projects. One of these was a sediment remediation project for which the objective was to design, implement, and monitor a project downstream of the De Pere Dam. The project was intended to yield important information about large-scale sediment restoration projects in the Lower Fox River. The project, as described in the agreement, had a pre-defined financial limit of $8 million. The FRG and DNR agreed on Sediment Management Units 56 and 57 (SMU 56/57) as the project site. Contractors and consultants, under contract to the FRG, designed and implemented the project. The FRG contractor began dredging at SMU 56/57 on August 30, 1999. Dewatered sediment was trucked to a landfill owned and operated by Fort James Corporation (now Georgia Pacific). Because of cold weather and ice, dredging ceased on December 15, 1999, after approximately 31,350 cy of contaminated sediment containing more than 1,400 pounds of PCBs were removed from the river.

At the time this project was halted for the first year, certain areas of SMU 56/57 had not met the project's dredging objective of removal of 80,000 cy of material. This resulted in unacceptably high concentrations of PCBs in surface sediment in portions of the dredged area. Despite this, the project provided instructive experience concerning hydraulic dredging. Building on the successes of this project, Fort James (now Georgia Pacific) worked cooperatively with DNR and EPA in the spring of 2000 to complete the SMU 56/57 project.

Figure 8 – Truck Cleaned at Fort James Disposal Site

An Administrative Order By Consent (Docket No. V-W-00-C-596) was entered into by Fort James, EPA, and the State of Wisconsin. Under its terms, Fort James funded and managed the project in 2000 with oversight from both DNR and EPA. Figure 8 depicts equipment decontamination during the project.

The sediment volume targeted for removal in 2000 was 50,000 cy. The additional volume of sediment removed from SMU 56/57 in 2000 was 50,316 cy, which was transported to the same Fort James landfill following dewatering. Approximately 670 pounds of PCBs were removed from SMU 56/57 during the 2000 project phase. Overall, the 1999 and 2000 efforts at SMU 56/57 resulted in the removal of approximately 2,070 pounds of PCBs from the river. The 2000 project phase met all goals set forth in the Administrative Order By Consent, and also met or exceeded the project's operational goals for removal rates, dredge slurry solids, filter cake solids, and production rates that were set forth for the original 1999 FRG project.

4.4 Release of Draft RIFS and Peer Reviews

In February 1999, DNR released a draft RI/FS for public review and comment. The draft RI/FS was released to solicit public comment early in the planning process, to better evaluate public acceptance, and to assist DNR and EPA in selecting a cleanup alternative having the greatest public acceptance. Comments were received from other governmental agencies, the public, environmental groups, and private sector corporations. These comments were used to revise and refine the scope of work that led to the current draft final RI/FS, which is being published concurrent with this Plan.

Four peer reviews were conducted on the February 1999 draft Lower Fox River RI/FS; two were sponsored by the EPA and two by the FRG. In all four cases, the reviews were conducted by panels of independent experts. The EPA peer reviews focused on data sufficiency and natural recovery. EPA contractor Roy F. Weston, Inc., moderated the EPA panels. The FRG peer reviews focused on issues associated with the human health and ecological RAs and computer modeling.

The EPA-sponsored data sufficiency peer review panel found that the available data was adequate to support the need for a cleanup, to determine the distribution of contaminants if all data sources were considered, and to support identification and selection of a remedy using technologies that have been used on a large scale at other similar sites. The review determined that the data is insufficient for developing in-situ (in-place) biotechnologies that could be applicable to the site.

The EPA-sponsored natural recovery peer review panel found that the process of natural recovery was not sufficiently characterized or evaluated in the draft FS and that there was not an adequate review of literature regarding the environmental transformation of PCBs. To address these concerns, the current draft final FS incorporates a more detailed discussion of natural recovery. In addition, DNR commissioned a report entitled *Review of Natural PCB Degradation Processes in Sediment,* which is an appendix to the FS.

The FRG-sponsored peer review of the human health and ecological RAs was conducted by the Association for the Environmental Health of Soils (AEHS). This peer review panel assessed the RA performed as part of the February 1999 draft RI/FS, as well as an RA conducted by Exponent, an FRG consultant. The panel found that both RAs had strengths and weaknesses. In response to concerns about the DNR's RA, DNR conducted a probabilistic risk assessment on human heath issues (see Appendix B of the Baseline Risk Assessment entitled "Additional Evaluation of Exposure to PCBs in Fish from the Lower Fox River and Green Bay"). This assessment addresses concerns related to prenatal and developmental effects and to more clearly state the basis for risk assumptions. Concerns raised by the AEHS review were considered in developing the current draft final RI/FS.

The FRG-sponsored peer review of computer modeling was conducted by the American Geological Institute. The panel reviewed two models for the last seven miles of the Lower Fox River, from the dam at De Pere to the river mouth at Green Bay: (1) the Lower Fox River Model (LFRM) used by DNR for the February 1999 draft RI/FS and

(2) a model generated by LimnoTech, Inc., of Ann Arbor, Michigan, an FRG consultant. The panel did not find either model adequate for decision making. DNR considered the panel's comments in development of the model ultimately used in the current draft final FS. These issues are discussed in the Model Documentation Report, which is a support document to the current RI/FS.

5 Summary of the Remedial Investigation

DNR's RI/FS evaluated data from numerous prior investigations conducted between 1971 and 2000. This data has been incorporated into a single Fox River Database, available at DNR's Lower Fox River Web page. The database currently contains more than 500,000 analytical results for over 200 chemical parameters analyzed in sediment, water, air, and biota (e.g., fish and wildlife tissues).

5.1 PCB Distribution and Sediment Volumes

Much of volume of PCBs discharged into the Lower Fox River in the past has already been transported throughout the system and is now concentrated in sediment within specific areas. In general, the upper three river reaches can be characterized as having discrete soft sediment deposits within interdeposit areas that have little or no soft sediment. In contrast, the last river reach from De Pere to Green Bay is essentially one large, continuous soft sediment deposit. Because there were several points of PCB discharge along the entire length of the Lower Fox River, PCB concentrations and m ass distributions are highly variable.

Approximately 70 percent of the total PCB quantity discharged into the river system has migrated into Green Bay. PCBs are widely distributed throughout Green Bay; nearly one-half of the total quantity of PCBs in Green Bay is concentrated near the mouth of the Lower Fox River in Zone 2. The remaining PCBs in Green Bay are dispersed over an extremely large area and volume of sediment. Table 2 summarizes the distribution of PCBs within the river and bay sediments.

Table 2. PCB Distribution in the Lower Fox River and Green Bay

	Sediment Volume (cy)	PCB Mass (kg)	PCB Mass in Top 100 cm (%)[1]
River Reaches			
OU 1 - Little Lake Butte des Morts	2,200,400	1,849	98%
OU 2 - Appleton to Little Rapids	339,200	109	100%
OU 3 - Little Rapids to De Pere	3,030,100	1,250	98%
OU 4 - De Pere to Green Bay	8,491,400	26,647	61%[2]
River Totals	**14,061,100**	**29,855**	**64 %**
OU 5 - Green Bay			
Zone 2	51, 850,000	31,390	
Zone 3	571,380,000	35,980	
Zone 4	191,980,000	1,960	
Green Bay Totals	**815,210,000**	**69,330**	

Notes:
[1]The top 100 centimeters (cm) of sediment is approximately the top 39 inches.
[2] In OU 4, 91% of the PCB mass is in the top 200 cm.

5.2 Contaminant Fate and Transport

Contaminant fate and transport in the Lower Fox River and Green Bay are largely a function of deposition, suspension, and redeposition of the Chemicals of Concern (COC) that are bound to sediment particles. The organic COCs (PCBs, pesticides) exhibit strong affinities for organic material in the sediment. The ultimate fate and transport of these organic compounds depends significantly on the rate of flow and water velocities through the river and bay. More sediment becomes suspended and transported downstream during high-flow events like storms and spring snowmelt. High-flow events occur approximately 15 to 20 percent of the time, but can transport more than 50 to 60 percent of the PCB mass that annually moves over the De Pere Dam and into Green Bay. Other modes of contaminant transport, such as volatilization, atmospheric deposition, and point source discharges, are negligible when compared to the river transport.

5.3 Changes in Sediment Bed Elevation

The Lower Fox River is an ***alluvial*** river that exhibits significant changes in bed elevations over time in response to changing volumes of flow during annual, seasonal, and storm events, changes in sediment load, and changes in its base level, which is determined by Lake Michigan. Sediment in the riverbed is dynamic and does not function as discrete layers. River sediment movement is in marked contrast to the sediment dynamics found in a large quiescent body of water, such as a deep lake or the deeper portions of Green Bay. ***Scouring*** of the sediment bed plays a significant role in the quantity of sediment and contaminants transported through the river system. In response to comments received from the FRG on the 1999 draft RI/FS to the effect that less than one inch of sediment would be resuspended from the riverbed as a result of a 100-year storm event, DNR investigated changes in sediment bed elevation. This work (see Technical Memo 2g of the Model Documentation Report) was completed by a group called the FRG/DNR Model Evaluation Workgroup. This workgroup was assembled as part of the 1997 agreement between the FRG and DNR.

Results of the workgroup's analysis indicate that sediment bed elevation changes occur in the Lower Fox River over both short and long-term time frames. Changes in sediment bed elevation were observed both across the channel and downstream profiles. These changes show little continuity. Since river flows have not significantly changed in recent years, the complexity of these sediment bed elevation changes reflects the prevailing hydrologic and sediment conditions that occurred over a 22-year period from 1977 through 1998. The wide range of discharges and sediment loads continuously reshapes the Lower Fox River sediment bed. Short-term (annual and sub-annual) changes in average net sediment bed elevations range from a decrease or scour of over 11 inches to an increase or deposition of over 14 inches. Long-term (over several years) changes in average net elevations range from a decrease of more than 39 inches to an increase of nearly 17 inches. The changes documented are well supported by U.S. Army Corps of Engineers (USACE) sediment volume calculations from pre- and post-dredge sediment bed elevation surveys, as well as by results of a U.S. Geological Survey (USGS) analysis of bed surveys performed at intermediate time scales (8 months to 45 months).

5.4 The Potential for Natural Biodegradation of PCBs

Responding to comments received from the EPA's peer review panel concerning natural recovery, the viability of natural degradation as a potential remedial action for the sediment-bound PCBs in the Lower Fox River and Green Bay was evaluated. Two basic processes, both anaerobic (without oxygen) and aerobic (in the presence of oxygen) degradation, must occur to completely decompose PCBs. Based on evidence in the literature, anaerobic PCB degradation was demonstrated to have occurred under field conditions at almost all the sites studied. However, a reduction in PCB concentrations through anaerobic processes is site-dependent. In the Lower Fox River, University of Wisconsin researchers found only a 10 percent reduction that could be attributed to anaerobic degradation processes in deposits with average PCB concentrations greater than 30 mg/kg. More important, no PCB reductions resulting from anaerobic processes could be accounted for in deposits with average concentrations less than 30 mg/kg.

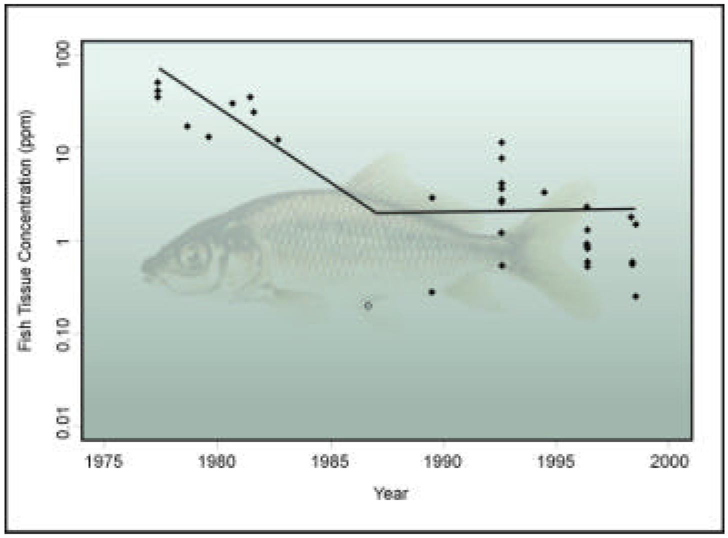
Other active treatment options might possibly promote dechlorination of the sediment, making the PCBs more amenable to biological destruction. However, a pilot-scale experiment conducted at the Sheboygan River, another site with PCB-contaminated sediment, yielded inconclusive results regarding the viability of enhanced biodegradation. In that study, PCB-contaminated sediment was removed from the river and placed into a specially engineered treatment facility. The sediment was seeded with microorganisms and nutrients and the sediment was manipulated between aerobic and anaerobic conditions to optimize biological degradation. Even under these conditions, the data were insufficient to conclude that PCB decomposition was enhanced.

5.5 Effects of Time

The Fox River Database includes sediment and water test results derived over a 10-year period and test results for tissue samples collected between 1971 and 1999. During the 1970s, after PCB discharges into the river had ceased, PCB concentrations in fish tissue showed significantly declining concentrations. Since the mid-1980s, however, changes in PCB levels in fish have slowed, remained constant, or, in some cases, increased (See Figure 9).

Trends in PCB concentrations in the surface layer (top four inches) of river sediment are not consistent, but concentrations generally appear to be decreasing over time as more PCB mass is transported downstream. However, the time trends showed that concentrations in the subsurface sediments do not appear to be declining. This indicates that a considerable amount of PCB mass remains within the sediments of the Lower Fox Rivers. Any changes to the current lock and dam configuration on the River could result in increased scour and resuspension of those underlying sediments, which could in turn result in increases in fish tissue concentrations. In addition, soil eroded from the watershed mixes with and may further dilute PCB concentrations in the sediment.

Figure 9 - PCB Concentration (ppm) in Little Lake Butte des Morts Carp, Whole Body, versus Time



5.6 Modeling Effort for the Lower Fox River and Green Bay

For the RI/FS and RA, four interrelated models were used to simulate the fate and transport of PCBs in the Lower Fox River and Green Bay. They are mathematical representations of the transport and transfer of PCBs between the sediment, the water, and uptake into the river and bay food webs. The models are intended to not only provide information on the fate and transport of PCBs in an unremediated river system, but are also used to compare the potential remedial alternatives in the in the FS. The models tend to be conservative in their predictions: i.e., the predicted concentrations are lower than the observed concentrations.

The modeling effort included:

- Bed mapping of the Lower Fox River and Green Bay to define sediment thickness, sediment physical properties (such as total organic carbon and bulk density), and total PCB concentrations;
- Use of the whole Lower Fox River Model (wLFRM) to simulate the movement of PCBs in the water column and sediment of the Lower Fox River from Little Lake Butte des Morts to the mouth of the river at Green Bay;
- Use of the Fox River Food Chain Model (FRFOOD) to simulate the uptake and accumulation of PCBs in the aquatic food chain in the Lower Fox River using model results from wLFRM;
- Use of the Enhanced Green Bay PCB Transport Model (GBTOXe) to simulate the movement of PCBs in the water column and sediment of Green Bay from the mouth of the Fox River to Lake Michigan, including loading rates to Green Bay based on model results from wLFRM; and
- Use of the Green Bay Food Chain Model (GBFOOD) to simulate the uptake and accumulation of PCBs in the aquatic food chain in the lowest reach of the Fox River and in Green Bay.

Bed mapping provided the foundation for the modeling inputs. Total PCB concentrations in surface sediment for the baseline and action levels serve as inputs to both hydrodynamic models: the wLFRM and the GBTOXe. These two models project total PCB concentrations in water and sediment. The output from those two models is in turn used in the ***bioaccumulation*** models, FRFOOD and GBFOOD, to project whole fish tissue concentrations of PCBs. The output from all of the models is then compared to the remedial action levels specified in the FS. This information is used in the FS to estimate the length of time it would take for a receptor to achieve the acceptable fish tissue concentration in response to a given action level.

Taken together, these models provide a method for evaluating the long-term effects of different remedial alternatives and different ***action levels*** on PCB concentrations in water, sediment, and aquatic biota in the Lower Fox River and Green Bay. The models are then used to predict PCB concentrations in the aquatic environment over a 100-year period under different remedial alternatives and action levels. The modeling results are discussed in the FS, and a more detailed discussion on modeling can be found in the Model Documentation Report. A complete copy of that report is available on the DNR's Lower Fox River Web page.

6 Summary of Site Risks

The project area covered by the RI/FS is large and complex. Sample results are available for a long list of chemicals in the sediment and water column of the river and Green Bay. People use these waters in a wide variety of ways, and the river and bay support a complex ecosystem. In order to focus the RI/FS process, a screening level risk assessment (SLRA) was conducted to evaluate which chemicals in the Lower Fox River system pose the greatest degree of risk to people and animals (human and ecological receptors). The baseline risk assessment (BLRA) then focused on the most significant human exposure routes and most sensitive ecological receptors.

How are risks evaluated?

Evaluating health risks related to contamination begins with identifying the chemical contaminants that cause toxic effects. Toxicity information for these chemicals is then used to determine levels of chemical exposure that will cause adverse effects. Next, information is collected about how people or animals come in contact with the contaminants. This is used to predict the amount and length of chemical exposure. All of this information is combined to determine if the level of chemical exposure is sufficient to cause harm and to provide a quantifiable measure of the level of the risks identified.

6.1 Screening Level Risk Assessment

The SLRA for the Lower Fox River and Green Bay evaluated the potential for human health and ecological risks associated with a comprehensive list of contaminants in sediment, surface water, and biota. On the basis of the SLRA, COCs to be carried forward into the RI/FS and for further risk analysis were identified. In the SLRA, the threat posed by PCBs was at least an order of magnitude greater than the risks for any other COCs.

COCs identified in the SLRA were:

- PCBs (both total PCBs and selected ***congeners***)
- Dioxins/furans (specifically, 2,3,7,8-TCDD and 2,3,7,8-TCDF)
- DDT (dichlorodiphenyltrichloroethane) and its metabolites (DDD and DDE)
- Dieldrin
- Arsenic
- Lead
- Mercury

The contaminants identified in sediment have similar fate and transport properties and are generally found with PCBs. For this reason, a remedy that effectively addresses PCB exposure also effectively addresses the other COCs in the sediment.

6.2 Baseline Risk Assessment

A baseline human health and ecological risk assessment for the Lower Fox River and Green Bay was prepared as a companion document to the RI/FS. For both the human health and ecological assessments, risk was characterized for the four reaches of the Lower Fox River and the entirety of Green Bay. In this way, risks could be compared between each of the operable units.

General conclusions of both the human health and ecological RAs are that:

- Fish consumption is the exposure pathway representing the greatest level of risk for receptors, other than the direct risks posed to benthic (bottom-dwelling) invertebrates.
- The primary contaminant is PCBs; other COCs carried forward for remedial evaluation and long-term monitoring are mercury and DDE.
- Human health and ecological receptors are at risk in each operable unit.
- In general, areas with the greatest risk are De Pere to Green Bay (OU 4) and Green Bay's Zone 2; however, estimated risk to human health did not differ greatly between the river reaches and bay zones.

6.2.1 Human Health Risk Assessment

The human health risk assessment for the Lower Fox River and Green Bay calculated cancer risks and non-cancer hazard indices (HIs) for the following groups of receptors:

- Recreational anglers
- High-intake fish consumers
- Hunters
- Drinking water users
- Local residents
- Recreational water users (swimmers and waders)
- Marine construction workers

How are cancer and non-cancer health effects evaluated?

Cancer Risk: A person's risk for developing cancer increases with the level of exposure and with the frequency of exposure over time. Cancer risks are expressed as the probability (e.g., 1 in 10,000 cancer risk) that a chemical exposure will result in cancer for an individual.
Hazard Index (HI): For non-cancer health effects, there is an exposure level below which no health effects are expected. The hazard index is a comparison of the expected level of exposure with the level believed to be safe. A hazard index of less than 1 indicates that non-cancer health effects are not expected, while a hazard index greater than 1 indicates that health effects are possible. The higher the hazard index, the greater the concern.

In the BLRA, the highest cancer risks and non-cancer HIs were calculated for recreational anglers and high-intake fish consumers expected to consume fish containing PCBs. No significant risks were identified for local residents, recreational water users, or marine construction workers. The risk associated with drinking water uses was elevated. However, it is important that there are no drinking water supplies to communities of the Lower Fox River are drawn from the river itself.

In a follow-up focused assessment (an assessment limited to specific topics requiring further exploration), potential risks to recreational anglers and high-intake fish consumers were examined in more detail. Using fish concentration data from 1990 and 1989 walleye data from Green Bay, the cancer risks were as high as 9.8×10^{-4} for recreational anglers and 1.4×10^{-3} for high-intake fish consumers. These risks are 1,000 times greater than the 10^{-6} cancer risk, the level at which risk management decisions may be made under Superfund, and 100 times greater than the 10^{-5} cancer risk used by Wisconsin in evaluating sites under Chapter NR 700 of the Wisconsin Administrative Code (WAC). This portion of NR 700 WAC covers the investigation and remediation of upland sites with multiple contaminants. The highest cancer risks for recreational anglers and high-intake fish consumers are more than 20 times greater than background risks calculated for eating fish from Lake Winnebago (which is a background location relative to the Lower Fox River and Green Bay).

The hazard indices were as high as 36.9 for the recreational angler and 52.0 for the high-intake fish consumer; far exceeding the value of 1.0 established to protect people from long-term adverse non-cancer health effects. The non-cancer health effects associated with exposure to PCBs include reproductive effects, developmental effects, and immune system suppression. The highest non-cancer HIs for recreational anglers and high-intake fish consumers are more than 20 times greater than background HIs calculated for eating fish from Lake Winnebago.

What is a hazard quotient?

A hazard quotient is a tool used for assessing ecological risk. An HQ is the ratio of measured contaminant concentration in a medium (e.g., wildlife) to a safe concentration of the same contaminant in the same medium. HQs greater than 1 imply that a risk may be present.

To provide perspective on the number of individuals who are potentially exposed, there are an estimated 136,000 anglers in counties adjacent to the Lower Fox River and Green Bay. Up to 10 percent of the anglers are estimated to be potentially exposed to PCBs via fish consumption at "high intake" rates. These estimates take into account significantly diminished use of the fishery after more than 20 years of fish consumption advisories by DNR and the Wisconsin Department of Health and Family Services.

A typical human health RA makes individual assumptions that are intended to be protective of the overall population. However, no two people are alike in the way they are exposed to contaminants or in how they respond to similar exposures. For this reason, it is often helpful to look at the range of characteristics in an exposed population that could more accurately reflect the range of risks to that population. This probabilistic risk assessment was performed to evaluate the adequacy of the exposure assumptions made in the baseline human health and ecological RAs. The findings of the probabilistic RA confirm that those exposure assumptions realistically serve their intended purpose of protecting public health, are not overly conservative, and are consistent with EPA guidance on conducting risk assessments.

In summary, the human health RA indicates that recreational anglers and high-intake fish consumers are at greatest risk for developing cancer or experiencing non-cancer health effects. The primary reason behind the elevated risks and HIs is the ingestion of fish containing PCBs.

6.2.2 Ecological Risk Assessment

Overall, PCBs and mercury were the COCs that most frequently exceeded criteria for all ecological receptors evaluated. This section presents all ***reasonable maximum exposure*** (RME) hazard quotients (HQs) developed from the BLRA for mercury and PCBs; calculated HQs are one part of the weight of evidence evaluated in the estimation of risk. HQs were as high as 15 for ***piscivorous*** (fish-eating) birds and exceeded 350 for piscivorous mammals.

In water, concentrations of total PCBs exceeded criteria in the LLBdM reach (OU 1), Appleton to Little Rapids reach (OU 2), and De Pere to Green Bay reach (OU 4), where HQs were greatest. In sediment, HQs for total PCBs exceeded 1.0 in all areas. Sediment PCB HQs were greatest in the LLBdM reach (OU 1) and lowest in Green Bay (OU 5) Zone 4. In intermediate areas, sediment PCB HQs decreased with downstream distance (i.e., decreased as the river flows downstream to the bay). However, total PCB HQs in both benthic (bottom-dwelling) and pelagic (non-bottom-dwelling) fish increased with downstream movement from the river to the bay. Total PCB HQs for benthic fish were highest in the De Pere to Green Bay reach (OU 4) and Green Bay (OU 5) Zone 2; for pelagic fish, they were highest in Green Bay Zone 3B.

Ecological risks to birds included those birds that eat fish (cormorants, terns) and to birds that may eat fish, birds or mammals (bald eagles). The risk assessment demonstrated that there is a potential for risk to both fish eating and omnivorous birds. The calculated HQs for piscivorous mammals suggest that reproductive risk is greatest in the De Pere to Green Bay reach (OU 4) and Green Bay (OU 5) Zone 2, followed by Green Bay Zone 3B.

7 Scope and Role of Action

The primary objective of remediation in the Lower Fox River and Green Bay is to reduce risks to human health and the environment by addressing contaminated sediment. Remediation of the contaminated sediment will reduce PCB concentrations in fish and wildlife tissue, thereby reducing potential future human and ecological risks. In addition, remediation will control the source of PCBs to the water column, which contributes to fish and wildlife tissue concentrations and to the transport of PCBs downstream.

The FS brought together the four major components used to evaluate risk, remedial goals, and alternative technologies in its analysis of remedial options. These components are briefly described below, then discussed in more detail on the following pages.

- **Remedial Action Objectives.** Remedial Action Objectives (RAOs) are site-specific goals for the protection of human and ecological health. Five RAOs were developed; all five apply to the river, while RAOs 1,2,3 and 5 apply to Green Bay.
- **Sediment Action Levels.** A range of action levels were considered for the river and bay; action levels were chosen based in part on ***Sediment Quality Thresholds*** (SQTs), which link risk in humans, birds, mammals, and fish with safe threshold concentrations of PCBs in sediment. The SQTs were developed in the human health and ecological risk assessments.
- **Operable Units.** The four river reaches (OU 1 through OU 4) and Green Bay (OU 5) were identified based on geographical similarities for the purpose of analyzing remedial actions.
- **Remedial Alternatives.** Following a screening process detailed in the FS, six remedial alternatives (A-F) were retained for the Lower Fox River and seven (A-G) were retained for Green Bay.

For each river reach, six possible remedial alternatives were applied to each of five possible action levels and evaluated against each of five remedial action objectives. For each Green Bay zone, seven possible remedial alternatives were applied to each of three possible action levels and evaluated against each of four remedial action objectives. The steps in this process are described in more detail below. Cost estimates were also prepared for each combination of river reach/bay zone, remedial alternative, and action level.

7.1 Remedial Action Objectives

No numeric cleanup standards have been promulgated by the federal government or the State of Wisconsin for PCB-contaminated sediment. Therefore, site-specific RAOs to protect human and ecological health were developed based on available information and standards, such as ***applicable or relevant and appropriate requirements***

(ARARs), ***to be considered*** (TBCs) non-promulgated requirements, and risk-based levels established using the human and ecological RAs. The following RAOs were established for the site:

- **RAO 1.** Achieve surface water quality criteria, to the extent practicable, as quickly as possible. The current water quality criteria for PCBs are 0.003 ng/L for the protection of human health and 0.012 ng/L for the protection of wild and domestic animals. Water quality criteria incorporate all routes of exposure assuming the maximum amount is ingested daily over a person's lifetime.
- **RAO 2.** Protect human health by being able to remove fish consumption advisories as quickly as possible. DNR and EPA defined the expectation for the protection of human health as the likelihood for recreational anglers and high-intake fish consumers to consume fish within 10 years and 30 years, respectively, at an acceptable level of risk or without restrictions following completion of a remedy. A remedy is to be completed within 10 years.
- **RAO 3.** Protect ecological receptors like healthy invertebrates, birds, fish, and mammals. DNR and EPA defined the ecological expectation as the likelihood of achieving safe ecological thresholds for fish-eating birds and mammals within 30 years following remedy completion. Although the FS did not identify a specific time frame for evaluating ecological protection, the 30-year figure was used as a measurement tool.
- **RAO 4.** Reduce the transport of PCBs from the river into Green Bay and Lake Michigan as quickly as possible. DNR and EPA defined the transport expectation as a reduction in loading to Green Bay to levels comparable to the loading from other tributaries. This RAO applies only to river reaches.
- **RAO 5.** Minimize the downstream movement of PCBs during implementation of the remedy.

7.2 Sediment Action Levels

PCB remedial action levels were developed based on the Sediment Quality Thresholds (SQTs) derived in the RA for the Lower Fox River and Green Bay. SQTs are estimated concentrations that link risk in humans, birds, mammals, and fish with safe threshold concentrations of PCBs in sediment. The PCB remedial action levels considered are:

- For the Lower Fox River**:** 0.125, 0.25, 0.5, 1.0, and 5.0 ppm
- For Green Bay**:** 0.5, 1.0, and 5.0 ppm

A range of action levels is considered in order to balance the feasibility as determined by implementability, effectiveness, duration, and cost of removing PCB-contaminated sediment down to each action level against the residual risk to human and ecological receptors after remediation. For each river reach or bay zone, all of the sediment with PCB concentrations greater than the selected action level is to be remediated. Section 9.6 describes how the specific action level to be used in the proposed alternative was selected from among the candidate action levels.

One of the outcomes of applying a specific action level to a suite of active remedial alternatives is the recognition that Monitored Natural Recovery (MNR) may also be a component of the remedy. This was considered because when sediment is removed to a specific action level, some sediment with PCB concentrations above the SQTs will likely be left in place. MNR can also be a stand-alone remedy if it is determined to achieve sufficient protection within a reasonable time frame. As a result, each action level and each remedial alternative has an MNR component.

7.3 Operable Units

A remedial alternative is to be proposed for each operable unit. There are five OUs in the Lower Fox River and Green Bay site; OU designations are identified in Section 3.1.

7.4 Remedial Alternatives

The FS outlines the process used to develop and screen appropriate technologies and alternatives for addressing PCB-contaminated sediment and provides detailed descriptions of the remedial alternatives. The suite of remedial alternatives is intended to represent the remedial alternatives that are available, not to be inclusive of all possible approaches. The proposed alternative for an operable unit may consist of any combination of the alternatives described below. Other implementable and effective alternatives could also be used for actual cleanup.

7.4.1 Alternative A : No Action

A No Action alternative is included for all river reaches and bay zones. This alternative involves taking no action and relying on natural processes, such as degradation, dispersion, and burial to reduce contaminant quantities and/or concentrations and to control contaminant migration processes. The No Action alternative is required by the National Contingency Plan, because it provides a basis for comparison with the active alternatives.

7.4.2 Alternative B : Monitored Natural Recovery

Similar to Alternative A, the MNR alternative relies on naturally occurring degradation, dispersion, and burial processes to reduce the toxicity, mobility, and volume of contaminants. However, the MNR option also includes a 40-year, long-term monitoring program for measuring PCB and mercury levels in water, sediment, invertebrates, fish, and birds to effectively determine achievement of and progress toward the RAOs. Until the RAOs are achieved, institutional controls are necessary to prevent exposure of human and biological receptors to contaminants. Deed and access restrictions may require local or state legislative action to prevent development in contaminated areas of the river.

What are institutional controls?

Institutional controls are measures that restrict access to or uses of a site. They typically consist of some combination of physical restrictions (such as fences to limit access), legal restrictions (such as deed conditions that limit development), and outreach activities (such as public education programs and health advisories).

7.4.3 Alternative C : Dredge and Off-site Disposal

Alternative C includes the removal of sediment having PCB concentrations greater than the remedial action level using a hydraulic or mechanical dredge, dewatering the sediment either passively or mechanically, treating the water before discharging it back to the river, and then disposing of the sediment off site, either transporting it by truck or via a pipeline. Different combinations of these techniques are suitable for different river reaches (OUs), so that Alternative C has been subdivided into Alternatives C1 and C2. The precise differences between C1 and C2 vary depending on river reach. Preliminary staging areas have been identified in each river reach. In all cases, sediment disposal would be at a local landfill in compliance with the requirements of the NR [Natural Resources] 500 Wisconsin Administrative Code (WAC) series regulating the disposal of waste and the DNR's TSCA approval issued by EPA. EPA issued this approval under the authority of the federal Toxics Substances Control Act (TSCA). This approval allows for the disposal of PCB contaminated sediment with concentrations greater than 50 mg/kg (ppm) in NR 500 WAC series landfill provided that certain requirements are met.

7.4.4 Alternative D : Dredge to a Confined Disposal Facility (CDF)

Alternative D includes the removal of sediment having PCB concentrations greater than the remedial action level to an on-site CDF for long-term disposal. A CDF is an engineered containment structure that provides both dewatering and a permanent disposal location for contaminated sediment. A CDF can be located in the water adjacent to the shore or at an upland location near the shore. Sediment with PCB concentrations exceeding 50 mg/kg would not be disposed of in a CDF; such sediments would be mechanically dredged for solidification and disposal at an waste landfill conforming to requirements defined by the state in NR 500 WAC series and the DNR's TSCA approval previously discussed. Conceptual nearshore CDF locations were identified in the LLBdM (OU 1) and De Pere to Green Bay (OU 4) reaches of the Lower Fox River, and a location for an in-water CDF was identified in Green Bay (OU 5). In that analysis, the size of the CDF in Green Bay was varied to conceptualize how the necessary capacity could be provided at each action level. Completed CDFs provide a surface that can be used for recreation or habitat. Alternative D was determined not feasible for OU 2.

7.4.5 Alternative E : Dredge and High-temperature Thermal Desorption (HTTD)

This alternative is identical to Alternative C except that all the dewatered sediment would be thermally treated. Alternative E assumes that the residual material would be available for possible beneficial reuse after treatment. HTTD was retained as the representative thermal treatment process option and was selected over other technologies, such as vitrification, because it is more widely available commercially and could be better evaluated. However, DNR recently completed a pilot-scale evaluation of vitrification or glass furnace technology. Depending on the final outcome of that study, vitrification could be substituted for HTTD as the process option in this remedial alternative or for portions of other alternatives. Alternative E was determined not feasible for OU 5.

7.4.6 Alternative F : In-situ (In-place) Capping

Alternative F includes primarily sand capping to the maximum extent possible. The maximum extent of the capping action was defined in each river reach on the basis of water depth, average river current, river current under flood conditions, wave energy, ice scour, and boat traffic. Using these criteria, it was determined that capping is not a viable option for every river reach. Where capping is viable, a 20-inch sand cap overlaid by 12 inches of graded armor stone was selected. Sediment that is not capped but still exceeds the action level would be hydraulically dredged to an on-site CDF, similar to Alternative D. Several sand cap designs were retained for possible application; design factors that influence the final selection of an in-situ cap include an evaluation of capping materials and cap thickness when applied in the field. In general, sandy sediment is a suitable capping material, with the additional option of armoring at locations with the potential for scouring and erosion. Laboratory tests developed in the past indicate that a minimum in-situ cap thickness of 12 inches (30 cm) is required to isolate contaminated sediment. Full-scale design would require consideration of currents during storm events, wave energy, and ice scour. A minimum river depth of nine feet is required for any location where a cap is proposed. Institutional controls and monitoring and maintenance are also components of this alternative. Institutional controls may be necessary to ensure the long-term integrity of the cap. Monitoring and maintenance would be required in perpetuity to ensure the integrity of the cap and the permanent isolation of the contaminants. Alternative F was determined not feasible for OU 2 and OU 5.

7.4.7 Alternative G : Dredge to a Confined Aquatic Disposal (CAD) Facility

Alternative G includes the removal of sediment to a CAD facility for long-term disposal; this alternative is technically feasible only in Green Bay (OU 5). A CAD facility is a variation on capping in which the contaminated sediment is placed in a natural or excavated depression or natural deposition area and covered with clean material. Ideal CAD sites are in “null-zones” where circulation patterns create areas with net deposition, instead of erosion and scour. Three possible locations were determined in the FS on the basis of water depth and currents. Each location was assumed to provide enough capacity for each action level. Construction of the CAD would involve placing contaminated sediment with a mechanical dredge and covering the sediment at completion with three ft of clean sand. Institutional controls and monitoring are also components of this alternative. Institutional controls would be necessary to ensure the long-term integrity of the CAD cap. Monitoring and maintenance of the CAD cap would be required in perpetuity to ensure the integrity of the cap and the permanent isolation of the contaminants.

8 Significant Factors in Selection of the Proposed Alternative

The FS presents the factors considered in selecting the proposed alternative in detail. This section summarizes major issues that influenced the selection of the proposed alternative.

- Trends in fish tissue PCB concentrations indicate that the rate at which concentrations have been dropping has slowed considerably. Throughout the river and bay, fish tissue concentrations decreased significantly in the late 1970s and early 1980s as the sources of PCBs into the system (point sources) were eliminated. However, PCB concentrations in many fish species have not changed significantly since the mid-1980s, when the main source of PCBs became the widespread reservoir in the sediment. Similarly, PCB concentrations in the water column at the mouth of the river have not changed significantly in the past decade. PCB concentrations are still up to 40,000 times greater than water quality criteria.
- The recently completed NAS report titled *A Risk Management Strategy for PCB-Contaminated Sediments* concluded that “…the presence of PCBs in sediment may pose long-term public health and ecosystem risks.”
- The Technical Advisory Committee for the Lower Fox River and Green Bay Remedial Action Plan has stated, “Ideally, if no constraints existed, because of the persistence and potential negative effects of PCBs in the environment, the removal of nearly all PCBs from the Fox River would be desirable, and ignoring the problem is not acceptable.”
- As outlined in this Plan’s summary of the RAs, risks to human and ecological health continue to exceed acceptable levels some 30 years after PCB inputs have ceased. In addition, fishery creel survey information and WDHFS survey results indicate that fish consumption advisories are not strictly followed.
- Site-specific research showed that the complete degradation of PCBs into harmless compounds does not occur in Lower Fox River sediment below a concentration of 30 mg/kg PCB. The majority of PCB concentrations in sediment in the river and bay are less than 30 mg/kg.
- Natural recovery may take more than 100 years, as measured by the acceptable PCB concentrations in certain fish species. During this long time frame, ongoing significant risks to public health and the environment would continue. In contrast, remedial actions greatly reduce the time for recovery.
- Surveys of the river bottom, conducted by several different groups, show significant changes in sediment bed elevation. On average, sediment bed elevation data from throughout the De Pere to Green Bay reach suggest that this river reach is a net depositional zone. However, when examined at a finer scale, the data show areas of sediment scour up to 14 ft. It should be noted that during the survey period, there were no large storm events of a 10-year or greater magnitude. It is unknown what the scour would be during larger events.

- Successful sediment removal projects at Deposit N and SMU 56/57 demonstrated that large-scale removal can be accomplished:

  - with minimal site and community disruption;
  - with public acceptance;
  - in compliance with state and federal permits;
  - at rates necessary to complete a full-scale project in a timely manner; and
  - with acceptable levels of releases (resuspension and atmospheric) during the operation.

- The SMU 56/57 project drew attention to the role and scale that commercial shipping traffic can play in resuspending and redistributing PCB-contaminated sediment within the navigation channel. Resuspension of PCB-contaminated sediment resulting from the movement of coal boats in and out of the Georgia Pacific boat slip exceeds the concentration of PCB contaminated sediment resulting from dredging.
- Community support for local disposal of PCB-contaminated sediment is illustrated by:

  - DNR's successful acquisition of an approval from EPA to regulate sediment containing greater than 50 mg/kg PCBs in state-approved landfills, which have been shown to provide protection equivalent to that afforded under the federal Toxic Substances Control Act (TSCA), which regulates the handling and disposal of PCBs;
  - Local disposal of TSCA (greater than 50 mg/kg PCBs) and non-TSCA (less than 50 mg/kg PCBs) sediment from both pilot dredging projects;
  - The issuance of all local, state, and federal permits for the pilot dredging projects;
  - The passage of resolutions by many local governments in the Fox River Valley calling for the EPA, DNR, and the mills to agree to a PCB cleanup alternative that adequately addresses environmental and health concerns in a cost-effective manner while protecting the local economy;
  - DNR's commitment to support state legislation that provides indemnification to municipally owned landfills and wastewater treatment plants treating leachate from municipal landfills that accept PCB-contaminated sediment from the Lower Fox River;
  - Acceptance of leachate from the landfill cell that contains the dredged sediment from SMU 56/57 at a local sewage treatment plant;
  - Language in at least one host community agreement allowing for the acceptance of PCB-contaminated sediment in a local landfill; and
  - The opinion expressed by the River Leagues - League of Women Voters that the development of local landfills for the disposal of PCB-contaminated sediments is a necessary component to successful remediation.

- The forecast of the benefits of remediation, when compared to the No Action Alternative, show that progress can be accelerated toward reducing site risks and achieving the RAOs by undertaking active remediation. The benefits of remediation are reflected in reductions in the time it will take to remove fish consumption advisories, reductions in the site risks to fish and wildlife, and reduced transport of PCBs to Green Bay and Lake Michigan. However, as illustrated in the FS, no combination of remedial alternatives and action levels achieves all RAOs over the 10-year and 30-year time frames. These forecasts also indicate that to make progress toward achieving the RAOs in Green Bay, active remediation of Green Bay is necessary.
- Implementation of the remedial alternative will reduce the long-term, continuing release of PCBs into Green Bay and Lake Michigan.
- Efforts are presently under way to restore the Fox Locks. The 12 dams and 17 locks within the river system pose a risk of reversing the historical downward trend in fish tissue PCB concentrations and have the potential for catastrophic movement of PCB-contaminated sediment in the event of failure. This system will have to be maintained to preserve the present flow conditions to prevent the PCB-contaminated sediment deposited behind each dam from resuspending and moving downstream. DNR's dam safety program has documented concerns about underflow and leakage at the De Pere Dam.
- The potential of a cap failure could reverse progress toward reducing site risks and achieving RAOs. Perpetual maintenance and monitoring of a cap is necessary to keep contaminants contained.

Maintenance and monitoring of an in-water cap is more difficult than maintenance and monitoring at an upland disposal site.

- The goal of a capping option would be to provide a surface layer that has levels of contamination that do not pose a risk. Assuming that no remedial action can effectively eliminate every molecule of PCB, the surface of any cap placed downstream of residual contamination may become recontaminated following placement, which can therefore reduce the risk reduction provided by the cap.
- Given the same level of risk reduction and achievement of RAOs, the lower cost alternative is more cost-effective.

9 Proposed Alternative

Taking into account the above factors and other information in the RI/FS, DNR and EPA recommend that the following cleanup actions be taken in the Lower Fox River and Green Bay.

- Operable Unit 1 (Little Lake Butte des Morts): Implement Alternative C, dredge with off-site disposal, at an action level of 1.0 parts per million (ppm) PCB.
- Operable Unit 2 (Appleton to Little Rapids): Implement Alternative B, Monitored Natural Recovery and institutional controls.
- Operable Unit 3 (Little Rapids to De Pere): Implement Alternative C, dredge with off-site disposal, at an action level of 1.0 ppm PCB.
- Operable Unit 4 (De Pere to Green Bay): Implement Alternative C, dredge with off-site disposal, at an action level of 1.0 ppm PCB.
- Operable Unit 5 (Green Bay Zones 2, 3, and 4): Implement Alternative B, Monitored Natural Recovery and institutional controls.

DNR and EPA believe the selected 1.0 ppm action level is important to achieving the timely reduction of risks to an acceptable level. (See Section 9.6 for a discussion of how the 1 ppm action level was selected.) Successful implementation of remediation to this action level is a significant component of this Plan. DNR and EPA envision that all sediment contaminated at concentrations above the action level will be removed from each OU until no sediment with a concentration greater than 1.0 ppm remains. However, based on technological limitations and experience gained from the pilot projects, the agencies realize that this may not be entirely feasible in all situations. Consequently, we expect to use information on sediment contamination to set a dredge elevation above which all contaminated sediment will be removed, to the limitation of the technology and the design. To better define this elevation, and refine the contaminated sediment volume and PCB mass estimates made on the basis of bed maps generated in the RI, it may be necessary to conduct further sediment sampling and analysis prior to dredging. When necessary, this sampling will take place during the project's design phase, prior to construction. In addition, further assessment of technologies may be necessary to determine their site-specific feasibility.

The Plan for reducing the risk to human and environmental health will specify dredging to depths as great as 12 ft to capture hydraulically active PCB-contaminated sediment in the riverbed. The Plan will address PCB contamination in both the current biologically active zone (0-10 cm) and PCB contamination that will, in the future, be exposed and moved into the biologically active zone. After careful consideration of alternatives to remove or isolate the contaminated materials, removal of the sediment has been determined to be the only option that will cost-effectively ensure protection of the water column and the food chain following implementation and into the future.

Bathymetry data and sediment bed property analyses provide clear evidence of the dynamic nature of the bed of this alluvial river. The sediment bed is not a consistent and predictable layered quiescent zone. Riverbed elevation data over time show significant cross-sectional and longitudinal profile changes. The occurrence of PCBs at depths as great as 11.5 ft is evidence of scour, mixing, and burial over time. Recent surveys (1995 to 2000) clearly demonstrate scouring in the De Pere to Green Bay reach, with water bottom losses commonly up to six ft and at a maximum of nearly 14-ft. Analysis by DNR (in Technical Memorandum 2g) also supports this interpretation of dynamic bed properties.

Over 97 percent of the mass of PCB is in the upper 3.3 ft (100 cm) of sediment in OUs 1 through 3. In OU 4, the upper 6.6 ft (200 cm) contains over 90 percent of the PCB mass. Because of the significant depth associated with scour activities and the dynamic bed properties of the Lower Fox River, it is necessary to dredge to the depth of the concentration level in OU 4, as well as in OU 1 and OU 3. This is proposed in preference to capping, partial dredging followed by capping, or leaving higher concentrations exposed. Leaving higher concentrations exposed even at depth would allow the potential for PCB movement. Implementing a combination of dredging and capping would require multiple staging activities and mobilization efforts, at considerably increased cost. Problems associated with capping alone or in combination with dredging include the difficulty of determining where and at what depth sediment bed elevation changes will occur, the significant costs associated with placing, monitoring, and maintaining a cap, and the impracticality of partial dredging followed by capping because of the technical difficulties and expense associated with both. In addition, if the navigational channel were capped, dredging for navigation could be permanently limited, potentially affecting commercial and recreational uses of the river and related economic development. For all these reasons, Alternative C, dredging with off-site disposal, is favored over Alternative F, in-situ capping, for those OUs where active remediation is proposed.

The following sections discuss specifics of how the proposed alternative would be implemented at each OU. Five-year reviews will be conducted of remedial activities at all the OUs to determine remedy effectiveness.

9.1 OU 1 - Little Lake Butte des Morts, Alternative C

Alternative C includes the removal of sediment with PCB concentrations greater than the 1.0 ppm action level using a hydraulic dredge, followed by off-site disposal of the sediment. The total volume of sediment to be dredged in this alternative is 784,200 cy.

- **Site Mobilization and Preparation.** The staging area for this OU will be determined during the design stage, but staging could be conducted at Arrowhead Park, south of the railroad bridge. Site preparation at the staging area will include collecting soil samples, securing the onshore property area for equipment staging, and constructing the mechanical sediment dewatering facility, water treatment facilities, and sediment storage and truck loading areas. A docking facility for the hydraulic dredge may need to be constructed. Assuming a staging area can be found south of the railroad bridge, a smaller separate staging area for the dredge when operating north of the railroad bridge may be needed. This facility would be used solely for the purpose of docking the hydraulic dredging equipment—the dredge slurry will be pumped to southern staging area.

- **Sediment Removal.** Sediment removal will be conducted using a hydraulic dredge (possible a cutterhead or horizontal auger). Given the volumes and operating assumptions described in the FS, completing the removal effort will take approximately six years. In water pipelines will carry the slurry from the dredging area to the staging area for dewatering. For longer pipeline runs, it may be necessary to utilize in-line booster pumps to pump the slurry to the dewatering facility. Silt curtains around the dredging area may be used to minimize sediment resuspension downstream of the dredging operation. Buoys and other waterway markers will be installed around the perimeter of the work area. Other activities associated with sediment removal will be water quality monitoring, post-removal sediment surveys, and site restoration.

- **Sediment Dewatering.** Mechanical dewatering will require land purchase, site clearing, and construction of temporary holding ponds. Dewatering techniques will be similar to the mechanical processes used for both Lower Fox River demonstration projects, including a series of shaker screens, hydrocyclones, and belt filter presses.

- **Water Treatment.** Water treatment will require the purchase of equipment and materials for flocculation, clarification, and sand filtration. Water treatment will be conducted 24 hours per day, 7 days per week during the dredging season. Discharge water is estimated at 570,000 gallons per day. Daily discharge water quality monitoring is included in the cost estimate. Treated water will be sampled and analyzed to verify compliance with the appropriate discharge requirements. Carbon filtration could be added if necessary.

- **Sediment Disposal.** Sediment disposal includes the loading and transportation of the sediment to a NR 500 landfill with TSCA approval (needed for sediment if concentrations over 50 mg/kg PCB) after mechanical dewatering. The sediment will be loaded using a front-end loader into tractor-trailer end dumps fitted with bed liners or sealed gates. Each load will be manifested and weighed. The haul trucks will pass through a wheel wash prior to leaving the staging area to prevent the tracking of soil onto nearby streets and highways.

- **Demobilization and Site Restoration.** Demobilization and site restoration will involve removing all equipment from the staging and work areas and restoring the site to its original condition.

- **Institutional Controls and Monitoring.** Baseline monitoring will include pre- and post-remedial sampling of water, sediment, and biological tissue. Monitoring during implementation will include air and surface water sampling. Verification monitoring to confirm that PCB contamination has been removed to the action level will include surface and possibly subsurface sediment sampling. Long-term monitoring will include surface water, surface sediment, and biological tissue sampling.

9.2 OU 2 – Appleton to Little Rapids, Alternative B

The MNR alternative will include a 40-year monitoring program for measuring PCB and mercury levels in water, sediment, invertebrates, fish, and birds. The monitoring program will be developed to effectively measure achievement of and progress toward the RAOs. See Appendix C of the FS for the complete draft Long-term Monitoring Plan. In summary, the monitoring program will likely include:

- Surface water quality sampling at several stations along the reach to determine the downstream transport of PCB mass into Green Bay;
- Fish and waterfowl tissue sampling of several species and size classes to determine the residual risk of PCB and mercury consumption to human receptors;
- Fish, bird, and zebra mussel tissue sampling to determine the residual risk of PCB uptake to environmental receptors;
- Population studies of bald eagles and double-crested cormorants to assess the residual effects of PCBs and mercury on reproductive viability; and
- Surface sediment sampling in MNR areas to assess potential recontamination from upstream sources and the status of natural recovery.

Until the RAOs have been achieved, institutional controls will be required to prevent exposure of human and biological receptors to contaminants. Institutional controls may include monitoring, access restrictions, deed restrictions, dredging moratoriums, fish consumption advisories, and domestic water supply restrictions. Deed and access restrictions may require local or state legislative action to prevent development in contaminated areas of the bay. The agencies will further evaluate the feasibility of remediating Deposit DD, an area in OU 2 of greater contamination, as part of the active remediation at adjacent OU 3.

9.3 OU 3 – Little Rapids to De Pere, Alternative C

Alternative C includes the removal of sediment with PCB concentrations greater than the 1.0 ppm action level using a hydraulic dredge, followed by off-site disposal of the sediment. The total volume of sediment to be dredged in this alternative is 586,800 cy. The implementation of OU 3 will require careful design and operational coordination with OU 4.

- **Site Mobilization and Preparation.** Staging for the dredging will occur at an undetermined location to be determined during the design phase. Site mobilization and preparation will include securing onshore property area for equipment staging and the collection of baseline soil samples at the site as well as coordinating design and operational features with the OU 4 pipeline, dewatering and disposal features. An offshore docking facility for the hydraulic dredges may need to be constructed.

- **Sediment Removal.** Sediment removal will be conducted using a hydraulic dredge (possibly a cutterhead or horizontal auger). Given the volumes and operating assumptions described in the FS, the removal effort will require approximately five years to complete. Pipelines will be used to convey the dredge slurry from the dredging area to the dewatering area. Given the possible location of the dewatering facility and the longer pipeline runs, it will likely be necessary to utilize in-line booster pumps to pump the slurry to the dewatering facility. Silt curtains around the dredging area may be used. Buoys and other waterway markers will be installed around the perimeter of the work area. Other activities associated with sediment removal will include water quality monitoring, post-removal sediment surveys, and site restoration.

- **Dewatering and Disposal.** The proposed disposal option for OU 3 (and OU 4) is to construct a new upland disposal facility (meeting NR 500 requirements with TSCA approval) to accept sediment from the Lower Fox River. The landfill will be designed with adequate capacity to meet the volume requirements for the 1.0 ppm action level from OU 3 (as well as OU 4) and have a passive dewatering facility nearby. Sediment will be pumped directly to the dewatering facility near the landfill for dewatering prior to disposal. Passive dewatering will be conducted adjacent to the disposal facility.

- **Water Treatment.** The water treatment component will include purchasing equipment and materials for flocculation, clarification, and sand filtration. Water treatment will be conducted 24 hours per day, 7 days per week during the dredging season. An estimated 560,000 gallons of treated wastewater will be discharged to the river daily. Daily discharge water quality monitoring is included in the cost estimate. Treated water will be sampled and analyzed to verify compliance with the appropriate discharge requirements before it is discharged back to the river. This water treatment facility will need to be designed as part of the OU 4 water treatment operation.

- **Demobilization and Site Restoration.** Demobilization and site restoration will involve removing all equipment from the staging and work areas and restoring the site to its original condition.

- **Institutional Controls and Monitoring.** Baseline monitoring will include pre- and post-remedial sampling of water, sediment, and biological tissue. Monitoring during implementation will include air and surface water sampling. Verification monitoring will include surface and possibly subsurface sediment sampling. Long-term monitoring will include surface water, surface sediment, and biological tissue sampling.

9.4 OU 4 – De Pere to Green Bay, Alternative C

Alternative C includes the removal of sediment with PCB concentrations greater than the 1.0 ppm action level using a hydraulic dredge, followed by off-site disposal of the sediment. The total volume of sediment to be dredged in this alternative is 5,879,500 cy. OU4 will cover the design and operation of the pipeline, the dewatering and the disposal facilities.

- **Site Mobilization and Preparation.** Staging for the dredging will occur at an undetermined location to be determined during the design phase, but include possible locations such as the Bayport or the former Shell facilities. Site mobilization and preparation will include securing onshore property area for equipment staging and the collection of baseline soil samples at the site as well as coordinating design and operational features with the OU 3 pipeline, dewatering and disposal features.

- **Sediment Removal.** Sediment removal will be conducted using two hydraulic dredges (possibly cutterheads or horizontal augers) pumping directly to a dewatering facility at or near the landfill for dewatering and treatment prior to disposal. Given the volumes and operating assumptions described in the FS, the removal effort will require approximately seven years to complete. Pipelines will be used to move the dredge slurry from the dredging area to the dewatering area. For longer pipeline runs, it may be necessary to utilize in-line booster pumps to pump the slurry to the dewatering facility. Silt curtains around the dredging area may be used. Buoys and other waterway markers will be installed around the perimeter of the work area. Other activities associated with sediment removal will include water quality monitoring, post-removal sediment surveys, and site restoration.

- **Dewatering and Disposal.** The proposed disposal option for OU 4 (and OU 3) is to construct a new upland disposal facility (meeting NR 500 requirements with TSCA approval) to accept sediment from the Lower Fox River. The landfill will be designed with adequate capacity to meet the volume requirements for the 1.0 ppm action level from OU 4 (as well as OU 3) and have a passive dewatering facility nearby. Sediment will be pumped directly to the dewatering facility near the landfill for dewatering prior to disposal. Passive dewatering will be conducted adjacent to the disposal facility.

- **Water Treatment.** The water treatment component will include purchasing equipment and materials for flocculation, clarification, and sand filtration. Water treatment will be conducted 24 hours per day, 7 days per week during the dredging season. An estimated 5,130,000 gallons of treated wastewater will be discharged to the river daily. Daily discharge water quality monitoring is included in the cost estimate. Treated water will be sampled and analyzed to verify compliance with the appropriate discharge requirements before it is discharged back to the river. This water treatment facility will need to be designed as part of the OU 3 water treatment operation.

- **Demobilization and Site Restoration.** Demobilization and site restoration will involve removing all equipment from the staging and work areas and restoring the site to its original condition.

- **Institutional Controls and Monitoring.** Baseline monitoring will include pre- and post-remedial sampling of water, sediment, and biological tissue. Monitoring during implementation will include air and surface water sampling. Verification monitoring will include surface and possibly subsurface sediment sampling. Long-term monitoring will include surface water, surface sediment, and biological tissue sampling.

9.5 OU 5 – Green Bay, Alternative B

The alternative for OU 5 is much like the alternative for OU 2. The MNR option will include a 40-year monitoring program to measure PCB and mercury levels in water, sediment, invertebrates, fish, and birds. The monitoring program will be developed to effectively measure achievement of and progress toward the RAOs. See Appendix C of the FS for the complete draft Long-term Monitoring Plan. In summary, the monitoring program will likely include:

- Surface water quality sampling at several stations to determine the transport of PCB mass within Green Bay and into Lake Michigan;
- Fish and waterfowl tissue sampling of several species and size classes to determine the residual risk of PCB and mercury consumption to humans;
- Fish (several species and size classes), bird, and zebra mussel tissue sampling to determine the residual risk of PCB uptake to environmental receptors;
- Population studies of bald eagles and double-crested cormorants to assess the residual effects of PCBs and mercury on reproductive viability; and
- Surface sediment sampling in MNR areas to assess potential recontamination from upstream sources and the status of natural recovery.

Until the RAOs have been achieved, institutional controls will be required to prevent exposure of human and biological receptors to contaminants. Institutional controls may include monitoring, access restrictions, deed restrictions, dredging moratoriums, fish consumption advisories, and domestic water supply restrictions. Deed and access restrictions may require local or state legislative action to prevent development in contaminated areas of the bay. The agencies will further evaluate reconstruction of the cap at Renard Island as part of the remediation of OU 4.

9.6 Justification for Action Level Selection for OU 1, OU3, and OU 4

In revising the draft Lower Fox River and Green Bay RI/FS released in February 1999, DNR and EPA evaluated multiple remedial alternatives based on multiple action levels. These action levels were 0.125 ppm, 0.25 ppm, 0.5 ppm, 1.0 ppm, 5.0 ppm, and no action for the river. The results of model forecasts were used to compare the projected outcomes of remedial alternatives performed using various action levels with the RAOs, primarily RAOs 2 and 3, which deal with protection of human health and the environment. On the basis of that analysis and to achieve the risk reduction objectives using a consistent action level, 1.0 ppm was agreed upon as the appropriate remedial action level. In making this determination, the agencies relied on projections of the time necessary to achieve the risk reduction, the post-remediation surface-weighted average concentration (SWAC), and cost.

As shown in Table 3, the time needed to reach the endpoints for risk reduction varies by river reach. The upstream reach achieves risk reduction faster than does the area around the mouth of the river.

Table 3. Estimated Years to Reach Human Health and Ecological Thresholds to Achieve Risk Reduction for the Lower Fox River at an Action Level of 1.0 ppm

OU	Whole Fish Threshold Con. (µg/kg)	Fish	Risk Level	Receptor	Estimated Years
# 1	288	Walleye	RME hazard index of 1.0	Recreational angler	<1
	181	Walleye	RME hazard index of 1.0	High-intake fish consumer	4
	106	Walleye	RME 10^{-5} cancer risk level	Recreational angler	9
	71	Walleye	RME 10^{-5} cancer risk level	High-intake fish consumer	14
	121	Carp	NOAEC	Carnivorous bird deformity	14
	50	Carp	NOAEC	Piscivorous mammal	29
# 3	288	Walleye	RME hazard index of 1.0	Recreational angler	9
	181	Walleye	RME hazard index of 1.0	High-intake fish consumer	17
	106	Walleye	RME 10^{-5} cancer risk level	Recreational angler	30
	71	Walleye	RME 10^{-5} cancer risk level	High-intake fish consumer	42
	121	Carp	NOAEC	Carnivorous bird deformity	22
	50	Carp	NOAEC	Piscivorous mammal	43
# 4	288	Walleye	RME hazard index of 1.0	Recreational angler	20
	181	Walleye	RME hazard index of 1.0	High-intake fish consumer	30
	106	Walleye	RME 10^{-5} cancer risk level	Recreational angler	45
	71	Walleye	RME 10^{-5} cancer risk level	High-intake fish consumer	59
	121	Carp	NOAEC	Carnivorous bird deformity	20
	50	Carp	NOAEC	Piscivorous mammal	45

Note:
RME indicates the reasonable maximum exposure; NOAEC is the no observed adverse effect concentration.

The SWAC is a measure of the surface (upper 10 cm) concentration against a given area. In terms of the Lower Fox River, this would be the average residual contaminant concentration in the upper 10 cm divided by the area of the operable unit. The SWAC calculation includes interdeposit areas. The SWAC values for OUs 1, 3, and 4 are shown in Table 4.

Table 4. SWAC Based on 1.00 ppm Action Level

OU	SWAC
# 1	185 µg/kg
# 3	264 µg/kg
# 4	156 µg/kg

The SWAC value provides a number that can be compared to the SQTs developed in the RA. SQTs are estimated concentrations that link risk in humans, birds, mammals, and fish with safe threshold concentrations of PCBs in sediment. Human health and ecological SQTs for carp and walleye are listed in Tables 5 and 6, respectively.

Table 5. Human Health Sediment Quality Threshold (SQT) Values

	Recreational Angler		High-Intake Fish Consumer	
	RME µg/kg	CTE µg/kg	RME µg/kg	CTE µg/kg
Cancer Risk at 10^{-5}				
Carp	16	180	11	57
Walleye	21	143	14	75
Non-Cancer Risk (HI =1)				
Carp	44	180	28	90
Walleye	58	238	37	119

Note:
RME indicates the reasonable maximum exposure; CTE isthe central tendency exposure.

Table 6. Ecological Sediment Quality Threshold (SQT) Values

	NOAEC (µg/kg)
Carp – fry growth and mortality	363
Walleye – fry growth and mortality	176
Common Tern – hatching success	3,073
Common Tern – deformity	523
Cormorant – hatching success	997
Cormorant – deformity	170
Bald Eagle – hatching success	339
Bald Eagle – deformity	58
Mink – reproduction and kit survival	24

A comparison of the SWAC table (Table 4) and SQT tables (Tables 5 and 6) shows that there is overlap of the various SQT values for recreational anglers, high intake fish consumers and wildlife, and the SWAC values for the OUs 1, 3, and 4.

The volume of sediment and PCB mass that would be removed, as well as the cost to implement the remedy at the 1.0 ppm action level, were also considered. Tables 7 and 8 list the sediment volume, PCB mass removed, and the cost to implement the Plan at OUs 1, 3, and 4.

Table 7. Sediment Volume and PCB Mass Removed at 1.0 ppm Action Level

OU	Sediment (cy)	PCBs (kg)
1	784,200	1,715
3	586,800	1,111
4	5,879,500	26,433
Total	7,250,500 cy	29,259 kg

Table 8. Summary of Cost at 1.0 ppm Action Level (millions of dollars)

OU	1.0 ppm
1	$57.6
3	$30.9
4	$169.6
Total	$258.1

The above summary shows that the 1.0 ppm action level results in the removal of a significant volume of contaminated sediment and PCB mass at an estimated cost of $258.1 million. Note that this figure does not include the additional cost of $49.5 million for MNR in OUs 2 and 5, which will increase the total cost of the proposed alternative to $307.6 million. These cost estimates do not include any contingency amount. In the FS, cost calculations are included that provide for a 20% contingency.

RAO 1 relates to achieving surface water quality standards and RAO 4 concerns annual PCB loading to Green Bay. A comparison of the reduction expected 30 years after completion of the proposed alternative at the 1.0 ppm action level to the No Action alternative is presented in Tables 9 and 10.

Table 9. RAO 1: Surface Water PCB Concentrations 30 Years After Completion of the Proposed Alternative

River Reach	No Action	1.0 ppm Action Level	% Difference
OU 1	2.99 ng/L	0.18 ng/L	94
OU 3	5.37 ng/L	0.37 ng/L	93
OU 4	21.08 ng/L	0.42 ng/L	98

Table 10. RAO 4: Annual Sediment Loading Rates 30 Years After Completion of the Proposed Alternative

River Reach	No Action	1.0 ppm Action Level	% Difference
OU 1	11.33 kg/yr	0.66 kg/yr	94
OU 3	21.25 kg/yr	1.46 kg/yr	93
OU 4	75.27 kg/yr	1.67 kg/yr	97

On the basis of the analysis presented in this section, DNR and EPA selected 1.0 ppm as an appropriate, justifiable action level.

9.7 Justification for Monitored Recovery Selection for OU 2 and OU 5

For the most part, DNR and EPA have proposed MNR for OU 2 (the reach of the river from Appleton to Little Rapids) and OU 5 (all of Green Bay). However, removal of sediment Deposit DD in OU 2 will be further evaluated as part of the remedy for OU 3. In addition, reconstruction of the cap on Renard Island is being further evaluated as part of the remedy for OU 5. The costs for these two potential actions are not yet included in the cost summary of the Plan, as a decision has not yet been made as to whether this work will be done. The estimated costs are approximately $400,000 for Deposit DD and $15.5 million for work at Renard Island. These costs can be added once a final decision is made on whether to conduct this work.

The basis for selecting MNR for OUs 2 and 5 is discussed below.

9.7.1 OU 2 – Appleton to Little Rapids

The mass of PCBs and volume of contaminated sediment in this reach are approximately 109 kg and 339,200 cy, respectively, for all deposit and interdeposit sediment. This is a small portion of the PCB mass and sediment volume in the entire 39 mi of the Lower Fox River, which are 29,855 kg and 14,061,100 cy, respectively. This 20-mi river reach is a relatively long stretch of the river and is made up of 22 deposits with relatively small sediment volume and little PCB mass. Within OU 2, the deposits with the two largest masses are Deposit N (29.61 kg) and Deposit DD (33.58 kg). These two deposits account for 58 percent of the total PCB mass in this reach; a majority of the PCB mass at Deposit N was removed during the pilot project at that location, and the agencies will evaluate the feasibility of remediating Deposit DD as part of the OU 3 remediation. Because the removal of all the material from Deposit N is not reflected in the volume estimates in the RI/FS, risk for this reach may be overestimated. An evaluation of sediment volumes within individual deposits in OU 2 shows there are no deposits with a sediment volume greater than 10,000 m^3 having a PCB concentration above the 1.0 ppm action level. This demonstrates that the areas within this operable unit needing remediation are relatively few and that the risk of exposure from one of these areas with higher concentration is low. With no remediation, the SWAC would slightly exceed 126 µg/kg.

In addition to the small physical size and the small quantity of PCB mass within the deposits in this reach, there are numerous impediments, such as the presence of several dams, the physical characteristics of the river in this reach and the lack of good staging areas, that would cause difficulties in implementation and in mobilizing and operating dredging equipment. These same features also limit the ability to effectively cap the areas within this reach. These impediments would necessitate multiple staging areas. The cost estimate for dredging within this reach at the 1.0 ppm action level is $20.2 million to remove 46,200 cy of contaminated sediment. The cost to remediate this river sediment would be almost $440 /cy.

The RA identifies the risk within OU 2. At the time the RA was performed, final data and reports on Deposit N were not yet available; the RA therefore does not fully account for the remediation of Deposit N. Risk at OU 2 may be further reduced by remediating Deposit DD as part of the OU 3 remediation. Consequently, the level of risk in this reach is likely not as great as discussed in the RA. For all these reasons, DNR and EPA determined that the MNR alternative is appropriate and justifiable for OU 2. The estimated cost to implement the draft Long-term Monitoring Plan for OU 2 is $9.9 million.

9.7.2 OU 5 – Green Bay

Green Bay has an water surface area of approximately 1,600 mi^2 and a water volume of 20 mi^3. The mean depth of the bay is approximately 65 ft; the maximum depth is 176 ft. The bay contains an estimated 815,210,000 cy of sediment having approximately 69,330 kg of PCBs. While the PCB mass in the bay is greater than in the river, PCB concentrations in the sediment are typically low because the volume of sediment is vast. Of the total sediment volume in the bay, only about two percent, is greater than 1.0 ppm and less than 0.2 percent is above 5.0 ppm, representing 2.6 percent and 0.2 percent of the sediment mass, respectively.

Costs for active remediation in Green Bay were developed for each bay zone. The approximate sediment volumes and estimated costs for the least expensive active remediation alternative for these zones at 0.5 ppm, 1.0 ppm, and 5.0 ppm action levels are shown in Table 11.

Table 11. Cost Comparison of Active Remediation of OU 5 at the 0.5, 1.0, and 5.0 ppm Action Levels and MNR, by Zone

	Action level						
	0.5 ppm		1.0 ppm		5.0 ppm		MNR
Zone	Sediment Volume(cy)	Cost (million $)	Sediment Volume(cy)	Cost (million $)	Sediment Volume(cy)	Cost (million $)	Cost (million $)
2	29,748,000	707.4	29,322,250	697.8	4,070,200	124.0	9.9
3A	16,330,000	389.1	14,410	11	--	--	9.9
3B	43,635,000	1,010	--	--	--	--	9,9
4	--	--	--	--	--	--	9.9
Totals	89,713,000	2,106.5	29,336,660	708.8	4,070,200	124.0	39.6

Notes:
Zone 3 is subdivided into Zones 3A and 3B on the basis of sediment movement patterns.
There is insufficient volume of PCBs in Zones 3A, 3B, and 4 to warrant cost estimates at the 5.0 ppm action level. There is insufficient volume of PCBs in Zones 3B and 4 to warrant cost estimates at the 1.0 ppm action level. There is insufficient volume of PCBs in Zone 4 to warrant cost estimates at the 0.5 ppm action level.

The costs in Table 11 assume mechanical dredging and disposal of the contaminated sediment in an in-water CDF, which would have to be sited in the bay. If the sediment were disposed of in an upland disposal facility, the cost would increase. No upland disposal site for this quantity of dredged material has been identified.

The RA identifies the risks associated with the three OU 5 zones. It appears there is not a significant difference in the human and ecological health endpoints between an aggressive remedial approach throughout the bay and the No Action and MNR alternatives, in which no active remediation is undertaken for the bay as a whole. The cost to implement the MNR alternative in the bay is $39.6 million.

10 Comparative Analysis of Proposed Plan

This analysis consists of an assessment of the individual alternatives against each of nine evaluation criteria and a comparative analysis that focuses on the relative performance of each alternative against those criteria.

As described in the EPA's RI/FS guidance, the detailed analysis for individual alternatives consists of the following three sets of analyses, which together involve nine evaluation criteria:

Threshold Criteria
1. Overall protection of human health and the environment
2. Compliance with applicable or relevant and appropriate requirements (ARARs)

Balancing Criteria
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, and volume through treatment
5. Short-term effectiveness
6. Implementability
7. Cost

Regulatory/Community Criteria
8. Agency acceptance
9. Community acceptance

The following discussion describes these criteria and evaluates the proposed alternative against them. Tables summarizing how various alternatives fulfill these criteria for each OU are provided at the conclusion of this section (Table 12-OU 1 through Table 12-OU 5). Throughout this discussion, rules are cited from the Wisconsin Administrative Code (WAC) by the designation NR (Natural Resources) and the rule number.

10.1 Threshold Criteria

1. Protection of Human Health and the Environment

The primary risk to human health associated with the contaminated sediment is consumption of fish. The primary risk to the environment is the bioaccumulation of PCBs from the consumption of fish or, for invertebrates, the direct ingestion / consumption of sediment. Protection of human health and the environment is achieved to varying degrees for each remedial alternative by selecting protective SQT risk levels, action levels, and response actions. Protection of human health and the environment is evaluated by residual risk in surface sediment using three lines of evidence:

- Residual PCB concentrations in surface sediment using surface-weighted averaging after completion of a remedy;
- The projected number of years required to reach safe consumption of fish; and
- The projected number of years required to reach a surface sediment concentration protective of fish or other biota.

> **What are fish consumption advisories?**
>
> Fish consumption advisories have been established to inform people how much fish from contaminated waters can be safely eaten. In determining advisories, health officials consider a range of possible health risks linked to contaminants such as PCBs. The number of recommended meals that a person may safely eat is based upon the average for a given fish size, species, and location. PCBs build up in a person's body gradually over time and it may take years of regularly eating fish to build up amounts that are a health concern. As with humans, larger, older fish will tend to accumulate more PCBs over a lifetime, while younger, smaller fish may have a lower contaminant body burden. This is why advisories tend to be more restrictive for the larger fish. Fish with PCB concentrations of more than 1.9 mg/kg in their skin-on fillet fall into the "Do Not Eat" category; fish with body burdens of between 0.2 and 1.0 mg/kg of PCBs can be eaten at a rate of "One Meal per Month"; and there is no consumption advisory for fish with a body burden of less than 0.05 mg/kg PCBs. The consumption advisories are reevaluated and revised when new data are available and changed when warranted. More information on fish consumption advisories is available in the publication "Important Health Information for People Eating Fish from Wisconsin Waters," a joint publication of the WDHSF and DNR. More information is available on the Web at http://www.dnr.state.wi.us/org/water/fhp/fish/advisories/

The alternative-specific RA in the FS estimated the number of years it would take to reach protective human health and environment thresholds after completion of a remedy. Several different receptors, risk levels, and media were presented, each with a different sediment threshold concentration. For further evaluation, four human health and two environmental thresholds were carried forward to the FS to facilitate risk comparison between alternatives and action levels. Those key remedial thresholds were presented in Table 3 (Section 9.6.1).

The residual concentrations and duration of residual risk are dependent upon the action level selected. The residual risk is discussed for each river reach in Section 10.2 (Balancing Criteria) under the subhead "Magnitude and Type of Residual Risk."

Generally, the selected alternative must meet this threshold criterion of protection of human health and the environment. The tables at the end of this section summarize the degree to which each alternative meets this threshold criterion. Additional detail is provided in Section 9.2 of the FS.

2. Compliance with Project Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

ARARs are promulgated substantive requirements that legally apply to the alternative or are considered relevant and appropriate for the alternative. TBC requirements are non-promulgated requirements, such as guidance and reference documents that apply to the alternatives. This section describes the most important ARARs and TBCs for each of the remedial alternatives and briefly describes how the alternatives do or do not meet them. Tables 12-OU 1 through 12-OU 5 at the end of this section indicate whether a specific alternative for each OU meets the ARARs and TBCs. Section 9.2.2 of the FS has a detailed discussion of whether each alternative meets the requirements.

Generally, the selected alternative must meet all the ARARs and TBCs, to the extent practicable, unless an ARAR is waived or noncompliance with a TBC is justified. A cleanup conducted under Superfund authority would not have to formally comply with Wisconsin procedural regulatory requirements, such as the requirement to obtain a permit or approval, for any on-site actions, which are defined as occurring within the limits of the project area. Any activities associated with the cleanup, such as dewatering, storage, handling, or disposal, that take place outside of the defined limits of the project area would have to comply with all state regulatory requirements. Should a cleanup be conducted under an authority other than Superfund, such as under only state authority, then all permits and approvals would have to be obtained, even for on-site actions. Procedural requirements, such as permits and approvals, are not ARARs or TBCs, but any substantive requirements specified under such permits or approvals are ARARs.

The specific remedial alternatives presented for each river reach and Green Bay are developed from the retained process options and technologies identified in the FS. ARARs and TBCs are applicable to at least one process option used in the remedial alternatives. The following discussion summarizes significant ARARs and TBCs that must be addressed prior to and during the remedial work for the proposed alternative. Refer to the FS for further discussion of ARARs for the other alternatives.

- **All Alternatives.** (1) The Water Quality Standards (WQS) for Wisconsin surface waters are a TBC for all alternatives proposed. Sediment quality criteria derived from the WQS are also a TBC for all alternatives proposed. To meet these TBCs to the extent practicable, achievement of the WQS-based PCB concentrations in surface water and sediment as quickly as possible is an RAO for the site. The proposed alternative includes monitoring of surface water in the Lower Fox River and Green Bay for changing concentrations of PCBs over time. With the proposed alternative, it is predicted that the WQS-based surface water standards will not be reached; however, there will be a 90 percent reduction in PCB concentrations in the surface water column that will result in a 10-fold decrease in cancer risk, which is a significant improvement over the current situation. The proposed alternative achieves reductions in PCB concentrations in the water column and sediment much sooner than the No Action or MNR alternatives and comes much closer to achieving the RAOs for PCB concentrations in surface water and sediment. As part of the assessment of the effectiveness of the remedy, DNR and EPA will continue to assess the remedy's ability to achieve WQS-based surface water column concentrations. (2) Another important TBC for all alternatives concerns the fish consumption advisories that limit the consumption of fish containing PCBs by sensitive populations. Removal of the consumption advisories as quickly as possible is another RAO for the site. The proposed alternative results in the reduction and ultimate elimination of these advisories much sooner than would the No Action or MNR alternatives.
- **Removal.** The removal technology utilized in the proposed alternative is hydraulic dredging. The ARARs/TBCs that directly relate to the removal of sediment from the Lower Fox River and Green Bay concern the protection of surface water (NR 322, 200, and 220 through 297). The surface water ARARs/TBCs limit the discharge of PCBs into the receiving water bodies so that water quality is not adversely affected. These ARARs will be achieved by the proposed alternative.
- **Ex-Situ (Off-site) Treatment.** Thermal treatment is a process option that may be used in the river OUs. ARARs specific to this technology relate to the air emission and permitting requirements of thermal treatment units (40 CFR 701 and NR 400 through 499). In addition, the thermal unit must meet performance requirements in NR 157 for the efficient treatment of PCB sediment. If thermal treatment is conducted, these ARARs will be met.
- **Dewatering and Water Treatment.** There are two types of dewatering technologies proposed for the dredging alternatives: mechanical and passive dewatering. Effluent water from the dewatering technologies must also be managed. Discharge requirements (NR 200 and 220 through 297) are set forth for the discharge of water to publicly owned treatment works (POTWs) and to navigable waters (e.g., the Lower Fox River). Discharges from prior remedial activities on the Lower Fox River provide an indication of the treatment requirements for discharging effluent water to the Lower Fox River or to a POTW. Another requirement covers stormwater discharge. A potentially important ARAR (NR 108) involves the construction of a wastewater treatment facility specifically to treat water from remedial activities. The passive dewatering ponds are also managed under the wastewater treatment ARAR (NR 213), which sets effluent limitations associated with wastewater treatment facilities. These ARARs will be met by the proposed alternative.
- **Disposal.** The primary disposal option for PCB sediment removed from the Lower Fox River is disposal in an existing upland landfill or in a landfill newly constructed for receiving TSCA-level (greater than 50 mg/kg PCB) and non-TSCA-level (less than 50 mg/kg PCB) sediment. ARARs/TBCs specific to this process option include the siting requirements for a landfill (Chapter 289, Wisconsin Statutes) and the technical requirements for construction, operation, and closure of a landfill in the NR 500 WAC series. General disposal requirements for PCB-containing dredged material are simplified by the EPA's approval for placing TSCA-level PCB-containing material in a state-licensed landfill. In all cases, for sediment to be disposed of at a local landfill, the landfill must be in compliance with the requirements of the NR 500 WAC series regulating the disposal of waste and DNR's TSCA approval issued by EPA. This EPA approval allows for the disposal of PCB contaminated sediment with concentrations greater than 50 mg/kg in NR 500 WAC series landfills provided that certain technical and administrative requirements are met. These ARARs will be met by the proposed alternative.

- **Transportation.** There are two primary methods for transporting PCB sediment to upland disposal locations: trucking to the disposal facility and pumping sediment to a dewatering and disposal facility. ARARs and TBCs important to this process option include the requirements to prevent spills and releases of PCB materials (NR 140 and 157). Two ARARs applicable only to the trucking method include Wisconsin Department of Transportation (WDOT) requirements for the shipping of PCB materials and NR 157 shipping requirements. ARARs and TBCs related to in-water transportation activities (i.e., piping) include the protection of surface water (NR 322, 200, and 220 through 297). These ARARs will be met by the proposed alternative.

10.2 Balancing Criteria

In this section, the balancing criteria are evaluated for OUs having similar remedial alternatives.

10.2.1 OU 1: Little Lake Butte des Morts; OU 3: Little Rapids to De Pere; and OU 4: De Pere to Green Bay – Analysis of Alternative C: Dredging to 1.0 ppm Action Level with Off-site Disposal

3. Long-term Effectiveness and Permanence

- **Magnitude and Type of Residual Risk.** Following completion of remediation, safe fish consumption levels for recreational anglers may be reached within one to nine years in OU 1; nine to 30 years in OU 3; and 20 to 45 years in OU 4. Safe ecological levels may be reached within 14 to 29 years in OU 1; 22 to 43 years in OU 3; and 20 to 45 years in OU 4.
- **Adequacy and Reliability of Controls.** The proposed alternative relies on engineering controls at the off-site disposal facility. Properly designed and managed NR 500 landfills provide reliable controls for long-term disposal. Long-term monitoring and maintenance are included in operation of the landfill.

4. Reduction of Toxicity, Mobility, and Volume

- **Irreversibility of the Treatment.** No treatment of sediment is included in the proposed alternative, other than dewatering. Once the sediment is landfilled, the PCB exposure pathway will be broken and the PCB-contaminated sediment will no longer be available to the food chain. If thermal treatment, such as vitrification, takes place, treatment is irreversible.
- **Type and Quantity of Treatment Residual.** Water treatment residuals consist of flocculation sludges and filter sands. Quantities are dependent on the sediment volume removed. If thermal treatment, such as vitrification, takes place, there is a significant reduction in volume and an inert, glass-like residue is generated.
- **Reduction of Toxicity, Mobility, or Volume.** Toxicity is reduced by breaking the pathway of exposure. Dewatering of the sediment will produce some reductions in volume. The mobility of COCs is significantly reduced by sediment solidification and landfill disposal. If thermal treatment, such as vitrification, takes place, the residual is non-toxic.

5. Short-term Effectiveness

- **Risk to Community and Workers and Controls.** A slight additional short-term risk to the community and site workers may be possible as a result of potential air emissions and excessive noise from construction equipment, dewatering operations, and hauling activities. As was successfully shown during the Lower Fox River demonstration dredging projects, these risks can be effectively managed. Risks will be minimized by (1) coordinating with and involving the community; (2) limiting work hours; and (3) establishing buffer zones around the work areas; as well as through (4) contractor experience and project design. Risk to workers will be minimized with a site-specific health and safety program.
- **Environmental Impacts of Remedy and Controls.** Environmental impacts consist of COC releases from removed sediment into the air and water. As successfully shown during the Lower Fox River demonstration dredging projects, environmental releases will be minimized during remediation by (1) treating water prior to discharge; (2) controlling stormwater run-on and runoff; and (3) utilizing removal techniques that minimize losses; as well as through (4) the possible use of silt curtains where necessary to reduce the potential downstream transport of COCs. Environmental impacts from sediment removal may include a temporary loss of habitat for aquatic organisms.
- **Duration of Short-term Risks.** It is estimated that five to seven years will be necessary to complete the sediment removal and disposal remedy in each OU, assuming six working months per year.

6. Implementability

- **Technical Feasibility.** The proposed alternative is technically feasible and can reliably meet the cleanup goals. Effectiveness is measured by sampling the limit of excavation, ambient air quality, wastewater effluent, and river water. No backup remedy is required for off-site land disposal; however, consideration will be given to thermal treatment of certain dredged materials.
- **Administrative Feasibility.** The proposed alternative is administratively feasible. Compliance with dredging and water quality requirements of the DNR and the USACE will necessary for sediment removal. Dis charge permits (i.e., through the Wisconsin Pollutant Discharge Elimination System) and landfill licenses may be required for the water treatment facility effluent and the landfill should they be located off site. Landfill construction/operation approvals will be required for any disposal facility. Some local permits such as building permits, etc. may also be required depending upon the location of the facility.
- **Availability Estimated.** Dredging, dewatering, and water treatment equipment and off-site disposal facilities are commercially available.

7. Cost

The estimated cost for this alternative in OU 1 is $57.6 million; in OU 3, $30.9 million; and in OU 4, $169.6 million. These costs do not include a 20% contingency that can be found in the FS.

10.2.2 OU 2: Appleton to Little Rapids; and OU 5: Green Bay – Analysis of Alternative B: Monitored Natural Recovery

3. Long-term Effectiveness and Permanence

- **Magnitude and Type of Residual Risk.** In OU 2, MNR may take 40 to 70 years to reach safe fish consumption levels for recreational anglers and may take greater than 70 years to reach safe ecological levels for carp. Surface water WQS will not be met in 100 years. However, these risks may be overestimated. In OU 5, MNR may not meet safe fish consumption levels for recreational anglers for 100 years. Modeling suggests that MNR will not meet safe ecological levels in 100 years regardless of the action taken in the Lower Fox River.
- **Adequacy and Reliability of Controls.** Enforcement of institutional controls may be difficult along the entire length of the river. Fish advisories, in particular, are not completely effective and are difficult to enforce. Restrictions on dredging, in-water construction activities, and recreational uses are more readily enforced. Long-term sediment and water quality monitoring and tissue sampling will be required to evaluate recovery over time and the achievement of RAOs.

4. Reduction of Toxicity, Mobility, and Volume

- **Irreversibility of the Treatment.** Institutional controls are reversible. The monitoring associated with MNR can be stopped (or enhanced) at any time.
- **Type and Quantity of Treatment Residual.** Residuals do not exist under this alternative.
- **Reduction of Toxicity, Mobility, or Volume.** Minimal reductions in toxicity and mobility of COCs will take place through naturally occurring processes such as dispersion and dilution. The volume of contaminated sediment will not be reduced.

5. Short-term Effectiveness

- **Risk to Community and Workers and Controls.** There are no additional short-term risks associated with this remedy. MNR will likely require many years; therefore, institutional controls will remain in place for 40 years and perhaps longer.
- **Environmental Impacts of Remedy and Controls.** Since an active remedy is not part of the MNR alternative, there are no immediate additional short-term environmental impacts associated with the remedy.
- **Duration of Short-term Risks.** There are no short-term risks associated with the MNR and institutional controls alternative, because it does not include an active remedy.

6. Implementability

- **Technical Feasibility.** Although MNR is technically feasible, it does not achieve RAO goals immediately.
- **Administrative Feasibility.** Institutional controls, such as fish consumption advisories, may be administratively feasible but are not fully effective.

- **Availability Estimated.** Technologies, goods, and services are available to monitor river water, sediment, and tissue.

7. Cost

The estimated cost for the proposed alternative in OU 2 is $9.9 million; in OU 5, it is $39.6 million. These costs do not include a 20% contingency that can be found in the FS.

10.3 Regulatory and Community Criteria

These criteria are assessed on a whole-system basis for all five operable units.

8. Agency Acceptance

The State of Wisconsin has been actively involved in managing the resources of the Lower Fox River since before there was a federal Superfund law. These efforts have led to significant state knowledge of the river and bay and of the contamination problems within those areas. As a result of this expertise, DNR has served as the lead agency responsible for assessing risks and conducting the RI/FS, which forms the basis for this Plan. As the lead agency, DNR has worked closely with EPA to cooperatively develop this Plan. Both DNR and EPA support this Plan.

9. Community Acceptance

The contamination of the Lower Fox River and Green Bay is well known in the Fox River Valley and Green Bay area. To keep the public informed, DNR, along with various intergovernmental partners, has held numerous public meetings in the Fox River Valley and participated in publishing a newsletter, the *Fox River Current*. DNR expects to continue building community acceptance through the public outreach efforts that will accompany implementation of the Proposed Plan. DNR and EPA will hold two public meetings regarding the Plan, and there will be a 60-day period for the public to comment on the Plan. At the end of the public comment period, DNR and EPA will evaluate the comments and prepare a Responsiveness Summary that will accompany the Record of Decision. The comment period ends on December 7, 2001.

Table 12-OU 1. Little Lake Butte des Morts

Yes = Fully meets criteria Partial = Partially meets criteria No = Does not meet criteria	Alternative A No Action	Alternative B Monitored Natural Recovery	Alternative C1 Dredge with off site disposal	*Proposed Alternative* Alternative C2 Dredging with off site disposal	Alternative D Dredge to a Confined Disposal Facility	Alternative E Dredge and High Temperature Desorption	Alternative F In Situ Capping
1. Overall protection of human health and the environment	No	No	Yes	Yes	Yes	Yes	Partial
2. Compliance with Applicable or Relevant & Appropriate Requirements	No	Partial	Partial	Partial	Partial	Partial	Partial
3. Long-term Effectiveness and Permanence	No	No	Yes	Yes	Yes	Yes	Partial
4. Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	No	No	Yes	Yes	Yes	Yes	Partial
5. Short-term Effectiveness	No	No	Yes	Yes	Partial	Partial	Partial
6. Implementability	Yes	Yes	Yes	Yes	Partial	Partial	Partial
7. Cost (millions of $)	$ 4.5	$ 9.9	$ 108.1	$ 57.6	$59.4	$ 161.0	$ 81.9
8. Agency Acceptance	The DNR has been the lead agency in developing the RI/FS and proposed plan. Both DNR and EPA support the proposed alternative for this OU at the 1.0 ppm action level.						
9. Community Acceptance	Community acceptance of the proposed alternative will be evaluated after the public comment period.						

Table 12-OU 2. Appleton to Little Rapids

Yes = Fully meets criteria Partial = Partially meets criteria No = Does not meet criteria	Alternative A No Action	*Proposed Alternative* Alternative B Monitored Natural Recovery	Alternative C Dredge with off site disposal	Alternative E Dredge and High Temperature Desorption
1. Overall protection of human health and the environment	No	Partial	Partial	Partial
2. Compliance with Applicable or Relevant & Appropriate Requirements	No	Partial	Yes	Partial
3. Long-term Effectiveness and Permanence	No	Partial	Yes	Yes
4. Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	No	No	Yes	Yes
5. Short-term Effectiveness	No	Partial	Partial	Partial
6. Implementability	Yes	Yes	Partial	Partial
7. Cost (millions of $)	$ 4.5	$ 9.9	$ 17.1 to 36.7	$ 18.7 to 49.1
8. Agency Acceptance	The DNR has been the lead agency in developing the RI/FS and proposed plan. Both DNR and EPA support the proposed alternative of Monitored Natural Recovery for this OU.			
9. Community Acceptance	Community acceptance of the proposed alternative will be evaluated after the public comment period.			

Table 12-OU 3. Little Rapids to De Pere

Yes = Fully meets criteria Partial = Partially meets criteria No = Does not meet criteria	Alternative A No Action	Alternative B Monitored Natural Recovery	Alternative C1 Dredge with off site disposal	*Proposed Alternative* Alternative C2 Dredging with off site disposal	Alternative D Dredge to a Confined Disposal Facility	Alternative E Dredge and High Temperature Desorption	Alternative F In Situ Capping
1. Overall protection of human health and the environment	No	No	Yes	Yes	Yes	Yes	Partial
2. Compliance with Applicable or Relevant & Appropriate Requirements	No	Partial	Partial	Partial	Partial	Partial	Partial
3. Long-term Effectiveness and Permanence	No	No	Yes	Yes	Yes	Yes	Partial
4. Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	No	No	Yes	Yes	Yes	Yes	Partial
5. Short-term Effectiveness	No	No	Yes	Yes	Partial	Partial	Partial
6. Implementability	Yes	Yes	Yes	Yes	Partial	Partial	Partial
7. Cost (millions of $)	$ 4.5	$ 9.9	$ 90.0	$ 30.9	$ 47.4	$ 134.6	$ 57.8
8. Agency Acceptance	The DNR has been the lead agency in developing the RIFS and proposed plan. Both DNR and EPA support the proposed alternative for this OU at the1.0 ppm action level.						
9. Community Acceptance	Community acceptance of the proposed alternative will be evaluated after the public comment period.						

Table 12-OU 4. De Pere to Green Bay

Yes = Fully meets criteria Partial = Partially meets criteria No = Does not meet criteria	Alternative A No Action	Alternative B Monitored Natural Recovery	Alternative C1 Dredge with off site disposal	*Proposed Alternative* Alternative C2 Dredging with off site disposal	Alternative D Dredge to a Confined Disposal Facility	Alternative E Dredge and High Temperature Desorption	Alternative F In Situ Capping
1. Overall protection of human health and the environment	No	No	Yes	Yes	Yes	Yes	Partial
2. Compliance with Applicable or Relevant & Appropriate Requirements	No	Partial	Partial	Partial	Partial	Partial	Partial
3. Long-term Effectiveness and Permanence	No	No	Yes	Yes	Yes	Yes	Partial
4. Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	No	No	Yes	Yes	Yes	Yes	Partial
5. Short-term Effectiveness	No	Partial	Yes	Yes	Partial	Partial	Partial
6. Implementability	Yes	Yes	Yes	Yes	Partial	Partial	Partial
7. Cost (millions of $)	$ 4.5	$ 9.9	$ 660.6	$169.6	$ 505.1	$ 750.9	$ 357.1
8. Agency Acceptance	The DNR has been the lead agency in developing the RIFS and proposed plan. Both DNR and EPA support the proposed alternative for this OU at the 1.0 ppm action level.						
9. Community Acceptance	Community acceptance of the proposed alternative will be evaluated after the public comment period.						

Table 12-OU 5. All of Green Bay

Yes = Fully meets criteria Partial = Partially meets criteria No = Does not meet criteria	Alternative A No Action	*Proposed Alternative* Alternative B Monitored Natural Recovery	Alternative C Dredging with off site disposal	Alternative D Dredge to a CDF	Alternative G Dredge and Dispose in Contained Aquatic Disposal Facility
1. Overall protection of human health and the environment	No	No	No	No	No
2. Compliance with Applicable or Relevant & Appropriate Requirements	No	No	No	No	No
3. Long-term Effectiveness and Permanence	No	Partial	Partial	Partial	Partial
4. Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	No	No	Yes	Partial	Partial
5. Short-term Effectiveness	No	Partial	Partial	Partial	Partial
6. Implementability	Yes	Yes	No	No	No
7. Cost (millions of $)	18	39.6	11 – 507.2	166.5 – 2,454.1	124 – 2,107.4
8. Agency Acceptance	The DNR has been the lead agency in developing the RIFS and proposed plan. Both DNR and EPA support the proposed alternative of Monitored Natural Recovery for this OU.				
9. Community Acceptance	Community acceptance of the proposed alternative will be evaluated after the public comment period.				

Glossary of Terms and Acronyms

Action levels – Multiple concentrations levels of PCBs in sediment in the river (0.125, 0.25, 0.5, 1.0, and 5.0 ppm) and bay (0.5, 1.0, and 5.0 ppm) used to balance the feasibility as determined by implementability, effectiveness, duration, and cost of removing PCB-contaminated sediment down to the action level against the residual risk to human and ecological receptors after remediation.

Alluvial – A river or stream characterized by a bottom of clay, silt, sand, gravel or similar detrital material deposited by running water.

Applicable or relevant and appropriate requirements (ARARs) - The Federal and State environmental laws that a selected remedy will meet. These requirements may vary among sites and alternatives.

Bioaccumulation – The accumulation of toxic substances in tissue in living organisms.

Central tendency exposure (CTE) - the average exposure expected to occur at a site.

Congener - One of the 209 different configurations of a PCB molecule resulting from multiple combinations of hydrogen and chlorine positions on the PCB molecule.

Fox River Group (FRG) - This is the group of potentially responsible parties who have been identified as having the responsibility for the remediation of the Lower Fox River. The FRG includes Appleton Paper Company, NCR, P.H. Glatfelter, Georgia Pacific (formerly Fort James), WTM1 (formerly Wisconsin Tissue), Riverside Paper Co., and U.S. Paper Co.

Monitored Natural Recovery (MNR) – The monitoring of natural processes such as degradation, dispersion and dilution to reduce contaminant concentrations to the point where they are no longer of concern.

No observed adverse effect concentration (NOAEC) - This is the highest concentration in a field or laboratory toxicity study at which no adverse effect is seen.

Operable unit (OU) - A geographical area designated for the purpose of analyzing remedial actions, usually on the basis of uniform properties and characteristics throughout the OU.

Piscivorous – A piscivorous fish, bird, or mammal consumes fish for its main diet.

Polychlorinated biphenyls (PCBs) – A chemical family of manufactured chlorinated aromatic compounds. There are 209 possible PCB congeners .

Reasonable maximum exposure (RME) - The highest exposure that is reasonably expected to occur at a site.

Remedial Investigation and Feasibility Study (RI/FS) – The RI summarizes the physical chemical and biological characteristics of a study area, in this case the Lower Fox River and Green Bay. Information from the RI is used to support the studies such as the RA and FS. The FS is an assessment of the no action alternative along with various remedial technologies ability to remediate the contamination and to estimate costs.

Risk assessment (RA) – A RA is an assessment of the study that assesses and quantifies the risks to human health and the ecosystem from the chemicals of concern.

Scouring – The movement of sediment material, typically downstream, by water.

Sediment Quality Threshold (SQT) - SQTs are estimated concentrations that link risk in humans, birds, mammals, and fish with safe threshold concentrations of PCBs in sediment.

Seiche events – Tide like oscillations in the surface level of large inland lakes and bays**.**

Superfund – The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), is commonly known as Superfund. It provides Federal authority to respond to releases of hazardous substances that may endanger public health or the environment.

To be considered (TBC) - A TBC requirement is a non-promulgated requirement.

Toxic Substances Control Act (TSCA) - This federal law regulates the handling and disposal of PCBs.

United States Environmental Protection Agency (EPA) - EPA has been working cooperatively with DNR on preparation of the RI/FS and Proposed Plan.

United States Fish and Wildlife Service (FW&S) - F&WS is part of the United States Department of the Interior and a Natural Resource trustee.

Wisconsin Department of Natural Resources (DNR) - DNR is the lead agency responsible for preparation of the RI/FS and Proposed Plan.

AOC	Area of Concern
ARAR	applicable or relevant and appropriate requirement
BLRA	baseline risk assessment
CAD	contained aquatic disposal
CDF	confined disposal facility
CFR	Code of Federal Regulations
COCs	Chemicals of Concern
DNR	Department of Natural Resources
EPA	Environmental Protection Agency
FRFOOD	Fox River Food Web Model
FRG	Fox River Group
F&WS	United States Fish & Wildlife Service
GBFOOD	Green Bay Food Chain Model
GBMBS	Green Bay Mass Balance Study
GBTOXe	Enhanced Green Bay Toxics Model
GLNPO	Great Lakes National Program Office (EPA)
HI	hazard index
HQ	hazard quotient
HTTD	high-temperature thermal desorption
LFRM	Lower Fox River Model
LLBdM	Little Lake Butte des Morts
MNR	Monitored Natural Recovery
NAS	National Academy of Sciences
NCR	National Cash Register Company
NOAA	National Oceanic and Atmospheric Administration
NOAEC	No observed adverse effect concentration
NPL	National Priorities List
NR	Natural Recovery
NRDA	Natural Resource Damage Assessment
OU	operable unit
PCB	polychlorinated biphenyl
POTW	publicly owned treatment works
RAO	Remedial Action Objective
RAP	Remedial Action Plan
RME	reasonable maximum exposure
SLRA	screening level risk assessment
SQT	Sediment Quality Threshold
SWAC	surface-weighted average concentration
TBC	to be considered
TSCA	Toxic Substances Control Act
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WQS	Water Quality Standards

ADDITIONAL INFORMATION. Anyone interested in learning more about the Plan and the Lower Fox River and Green Bay Remedial Investigation/Feasibility Study, Risk Assessment, and ancillary documents is encouraged to review the documents in the information repositories for the site. Their locations are listed in Section 2.0. The Administrative Record, which contains detailed information upon which the proposed alternative is based, is also located at the DNR headquarters office in Madison, at the DNR's Northeast Regional headquarters in Green Bay, and at the EPA Region 5 office in Chicago. For further information about this Plan or the Lower Fox River and Green Bay site, please contact:

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The DNR's Lower Fox River Web page is located at: http://www.dnr.state.wi.us/org/water/wm/lowerfox/.
Please remember that comments postmarked by midnight December 7, 2001, will be accepted. Comments can be e-mailed to DNR at: FOXRIFS@dnr.state.wi.us.

UNITS OF MEASURE

Length

- One mile (mi) = 1.609 kilometers (km)
- One foot (ft) = 0.305 meter (m)
- One inch (in.) = 2.54 centimeters (cm)

Area

- One square foot (ft^2) = 0.929 square meters (m^2)
- One square mile (mi^2) = 2.59 square kilometers (km^2)

Volume

- One cubic yard (cy) = 0.765 cubic meters (m^3)
- One gallon (gal) = 3.785 liters

Weight / Mass

- One pound (lb) = 0.4536 kilograms (kg)
- One ounce (oz) = 28.35 grams (g)

Concentration

- micrograms per kilogram (µg/kg) for solids (like sediment) and micrograms per liter (µg/L) for liquids (like water) = Parts per billion (ppb) = 1×10^{-9} on a weight (solids) or volume (liquid) basis.
- milligrams per kilogram (mg/kg) for solids (like sediment) and milligrams per liter (mg/L) for liquids (like water) = Parts per million (ppm) = 1×10^{-6} on a weight / volume basis.

Flow

- One cubic feet per second (cfs) = 2477 cubic meters per day = 0.0283 cubic meters per second (m^3/s)