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LETTER REPORT AND ENVIRONMENTAL ASSESSMENT

POOL DRAWDOWN
POOL 5, UPPER MISSISSIPPI RIVER

BUFFALO COUNTY, WISCONSIN
WABASHA AND WINONA COUNTIES, MINNESOTA

MARCH 2005

EXECUTIVE SUMMARY

The St. Paul District, Corps of Engineers, in cooperation with the River Resources Forum (RRF) and associated sub-group, the Water Level Management Task Force (WLMTF), is proposing a pool-scale drawdown of Pool 5 in the summer of 2005. The selected plan is for a 1.5-foot drawdown at Lock and Dam 5 during the summer of 2005. This level of drawdown can be accomplished with currently programmed Fiscal Year 2005 Operation and Maintenance funding for main channel advance dredging.

The preferred plan, based on technical analysis, and agency and public input, was for a 2.0-foot drawdown. However, despite the best efforts of the Water Level Management Task Force and agency partners, additional funding could not be secured for the additional 0.5-foot of dredging required to implement a 2.0-foot drawdown. The 2.0-foot drawdown alternative is fully described in this document so this level of drawdown may receive fair consideration if funding becomes available for a 2.0-foot drawdown in 2006, or in a future year.

In 2001 and 2002, a pool-scale drawdown of Pool 8 was conducted. The Pool 8 demonstration drawdown was somewhat experimental, and preliminary results indicate the drawdown was largely successful in terms of emergent vegetation response on exposed substrate. More than 50 species of moist soil, perennial emergent, and aquatic plant species germinated on the 1,950 acres of substrates exposed during the 2001 drawdown. Increases in deep and shallow marsh, rooted floating aquatic, and submersed aquatic vegetation communities were observed in Pool 8 following the 2001 drawdown. These changes affected about 1,370 acres of lower Pool 8 through 2003. Much of the perennial emergent vegetation established with the drawdown persists (as of the 2004 growing season).

Early in the implementation studies for the Pool 8 drawdown, the WLMTF identified Pool 5 as the next highest priority pool for a drawdown. For Pool 5, a primary goal of the WLMTF was to exceed the 1.5-foot drawdown level in Pool 8 to better evaluate river resources responses with deeper drawdowns.

Large river ecosystems such as the Upper Mississippi River are characterized by seasonal cycles of flood and drought. A variety of natural ecological processes are linked to this cycle. Since construction of the locks and dams in the late 1930's for commercial navigation purposes, a series of shallow impoundments on the river provide relatively stable water levels during non-flood periods. The dams also cause sediment and nutrients to accumulate in the backwaters and the lower portion of the pools. These physical and water level changes have resulted in reduced habitat diversity and quality, loss of aquatic vegetation and invertebrates, reduced water clarity, and less species diversity in the ecosystem.

Emulation of naturally occurring drought conditions, through a drawdown of Pool 5, can contribute significantly to the reversal of the declining ecosystem health. The drawdown would provide an opportunity for reestablishment of emergent aquatic plants and consolidation of sediment. An increase in the abundance of emergent and submersed aquatic plants would improve habitat conditions and provide a valuable source of food for a variety of organisms,

including young-of-year and small fish, migratory birds, wading birds, furbearers, reptiles, and amphibians.

This Letter Report/Environmental Assessment evaluates the feasibility of conducting a drawdown of Mississippi River navigation Pool 5 within the St. Paul District. This report evaluates alternative drawdown levels of 1.5 feet, 2.0 feet, and 2.5 feet, and presents a selected plan. In addition, the information generated by the report is necessary to support a request to the Corps of Engineers' Mississippi Valley Division (MVD) to deviate from the approved reservoir regulation plan to implement a drawdown. The drawdown will be initiated only after approval of the deviation request by MVD.

The objectives of conducting a drawdown in Pool 5 are as follows:

1) increase fish and wildlife habitat by improving growing conditions to increase the production, extent, and diversity of aquatic vegetation, with special emphasis on perennial emergent species

2) continue to operate and maintain the 9-foot channel project

3) minimize any adverse effects of the drawdown on river resources and river uses, including recreational boating access

4) increase the level of knowledge concerning the effects of pool drawdown to support an adaptive management approach for future decisions concerning the use of this management measure

For each level of drawdown in Pool 5, there is a "window" of discharges within which the drawdown can be maintained. The potential for achieving at least a partially successful emergent aquatic vegetation response with varying levels of drawdown is as follows: 1.5-foot drawdown: 88 percent, 2.0-foot drawdown: 81 percent, and 2.5-foot drawdown: 69 percent.

Main channel advance dredging is required to maintain the 9-foot channel project during the drawdown. On the basis of current information, the estimated quantity and cost of the main channel dredging for each drawdown alternative level are shown below.

	Drawdown Level		
	1.5-foot	2.0-foot	2.5-foot
Quantity (cubic yards)	255,500	334,500	416,300
Cost	$1,772,000	$2,035,000	$2,423,000

It is important to note that all quantities and costs are estimates based on the best information currently available. Actual costs, cut locations, and quantities would be determined at the time of dredging (spring 2005). These costs do not cover future placement site unloading for supplemental dredging (dredging beyond what normally would have been completed).

Impacts to commercial navigation from a Mississippi River pool drawdown would be minimal.

No adverse impacts are anticipated to other social/economic infrastructure, such as water supply and power plants.

Minor adverse impacts on recreational boating and boating facilities are expected during the drawdown. A Citizens Advisory Committee has identified recreational access needs in anticipation of a Pool 5 drawdown, and has proposed a plan to achieve a "reasonable" level of public access. Using the best information currently available, the cost estimates for the recreational access dredging are approximately $30,000 for a 1.5-foot drawdown with a 35-foot-wide access channel. Actual costs, cut locations, and quantities would be determined at the time of dredging (spring 2005).

One measure of potential environmental benefit may be based on the area of substrate exposed during the drawdown. Conservative estimates of area exposed under the various alternatives are as follows: 1.5-foot drawdown – 940 acres; 2.0-foot drawdown – 1,459 acres; 2.5-foot drawdown – 1,950 acres. A cost-benefit analysis using Habitat Evaluation Procedures indicates that all three drawdown alternatives were well within the range of average annual costs per habitat unit for habitat projects considered justified for construction under the Environmental Management Program.

All three drawdown alternatives will promote the establishment of emergent vegetation in target areas identified (i.e., Spring Lake, Weaver Bottoms, Lost Island Lake, Krueger Slough, Belvidere Slough). However, the probability of establishment would likely be less in deeper-flooded areas. There would also be vegetation production (including seed and tuber production) during the year of drawdown, residual vegetation post-drawdown to serve as substrate and forage base for invertebrates, and potential consolidation and oxidation of exposed substrate. With greater drawdown, the area of submersed substrate that receives adequate photic activity for submersed aquatic plant establishment should increase.

The increased vegetation would provide valuable habitat for small fish and spawning habitat for fish the following spring. Further, an increase in the abundance of emergent and submersed aquatic plants would help to dissipate wind energy, resulting in less sediment resuspension in the near-shore zone and reduced bank erosion. Consolidation of sediments during a drawdown may help to limit sediment resuspension by wave action and bioturbation, and create beneficial conditions for establishment of submersed aquatic plants. In addition, the expanded vegetation would help to reduce sediment resuspension by wave action and promote the settling of suspended materials in the river, leading to improved water clarity. Benthic macroinvertebrates would rapidly recolonize in the dewatered areas following refilling.

No impacts to federally listed mussel species are expected from the drawdown. Conditions for mussels would be improved in the long term by improving water quality, cleaning substrate through scouring, improving overall productivity, improving conditions for host fish species, and other ecological benefits. As with the Pool 8 drawdown, a drawdown of 1.5 feet should not adversely affect mussels during drawdown if spring water levels are not excessive. Mussels typically occur in water depths exceeding 1.5 feet, but high water levels allow mussels to migrate or be carried to areas typically exposed or in very shallow water levels. A monitoring program assessing the impacts on mussels during the drawdown would be conducted to help

answer these questions.

During the drawdown, the greatest adverse impacts to fish would be from spawning disruption for some species, increased predation as young-of-year and smaller fish would be forced out of vegetated areas into open water, and strandings and entrapment in backwaters that become isolated from the drawdown. These short-term impacts are expected to be outweighed by the long-term benefits to fish habitat and fish populations.

Cultural resources laws require the Corps of Engineers to conduct cultural resource investigations, and to invite interested parties to provide their views on the project (i.e., Section 106 review). This will be accomplished through consultation with the State Historic Preservation Offices (SHPO) of Minnesota and Wisconsin, various Native American groups, and other agencies and may be fulfilled, in part, through the execution of a Programmatic Agreement (PA) among the concerned parties. Consultation has commenced for the Pool 5 drawdown. Drawdowns have the potential to have both beneficial and adverse effects on cultural resources. Water level management is being proposed under an adaptive management framework. Monitoring and evaluation of the drawdown will provide valuable information on application of this method of river regulation for habitat management.

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WABASHA AND WINONA COUNTIES, MINNESOTA

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LETTER REPORT AND ENVIRONMENTAL ASSESSMENT

POOL DRAWDOWN POOL 5, UPPER MISSISSIPPI RIVER

BUFFALO COUNTY, WISCONSIN WABASHA AND WINONA COUNTIES, MINNESOTA

1.0 INTRODUCTION

1.1 BACKGROUND

The Upper Mississippi River has been modified for navigation and other purposes for over 100 years. Construction of the 9-Foot Navigation Channel Project resulted in a series of locks and dams on the Upper Mississippi River; most of those in the St. Paul District were completed and operational by 1940. The purpose of the locks and dams is to furnish adequate water depths to provide for 9-foot channel navigation. Dredging is a necessary supplement to the locks and dams to provide the required channel depths.

The construction of the locks and dams resulted in a series of shallow impoundments (navigation pools) on the river. The operation of the locks and dams provides relatively stable water levels during non-flood periods. However, over the last 60 years, aquatic vegetation beds in Pool 5 have deteriorated due to loss of natural water flows and increased sedimentation that has reduced habitat quality in this pool. There has been growing interest in water level management on the Upper Mississippi River as a means of restoring and enhancing ecological conditions. The Water Level Management Task Force (WLMTF) was established by the River Resources Forum (RRF) in 1995.

The River Resources Forum was established to build consensus on resource issues concerning the Upper Mississippi River System within the Corps of Engineers' St. Paul District jurisdiction. Participating agencies include the U.S. Army Corps of Engineers; the U.S. Coast Guard; the U.S. Environmental Protection Agency; the U.S. Fish and Wildlife Service; the Minnesota Pollution Control Agency; the National Park Service, the Natural Resources Conservation Service; and the Departments of Natural Resources and Transportation from Minnesota, Wisconsin and Iowa. The Water Level Management Task Force, a sub-group of the RRF, includes many of the same agencies, as well as environmental and commercial navigation interests. The WLMTF is focused on water level management, particularly pool-scale drawdowns, within the St. Paul District.

Funds became available within the St. Paul District in Fiscal Year 1996 to undertake limited investigations of water level management on the Upper Mississippi River. St. Paul District resources were combined with those of other Federal and State agencies to prepare a "Problem Appraisal Report" to identify opportunities to improve ecological conditions through water level management and to do limited analysis of water level management alternatives. The Problem Appraisal Report was conducted under the auspices of the WLMTF in a spirit of interagency participation and cooperation.

Using Pool 8 as the study pool, the Problem Appraisal Report was completed in November 1996 (WLMTF 1996). The report evaluated 10 water level management options, as follows:

1) alternatives that would have site-specific effects
    a) isolate and manage small waterbodies
    b) isolate and manage large waterbodies
    c) modify the distribution of flow across the dam gates

2) alternatives that would have minor pool-wide effects
    a) discontinue 0.25-foot winter drawdown
    b) regulate on the "high" or "low" side of the regulation band
    c) increase the frequency of gate adjustments

3) alternatives that could have significant pool-wide effects
    a) winter drawdowns
    b) spring pool raises
    c) change pool control point
    d) summer growing season drawdowns

The Problem Appraisal Report concluded that, while many of these options had the potential to provide localized or minor pool-wide benefits, summer growing season drawdowns offered the greatest potential for providing significant habitat benefits over a large area.

On the basis of the 1996 Problem Appraisal Report results, the decision was made to proceed toward implementation of a pilot drawdown of a navigation pool within the St. Paul District. A study completed in 1999 (WLMTF 1999) recommended implementation of a 1.5-foot drawdown (beyond the current secondary control elevation of 630.0) at Lock and Dam 8. To minimize potential effects on recreational and commercial river uses in the La Crosse, Wisconsin, area, a constraint was included that the drawdown at the La Crosse gage (pool primary control point) would be limited to elevation 630.5, 0.5 foot below the current primary control elevation. A follow-up drawdown was recommended to provide additional opportunity for emergent aquatic plant growth resulting from the drawdown to become established.

The initial drawdown was scheduled for the summer of 2000, but was postponed because of predictions for unfavorable river discharge conditions. The drawdown was implemented during the summer of 2001, from the end of June until late September. The full 1.5-foot drawdown at Lock and Dam 8 could be maintained only until mid-August. At that time, river discharges declined to the point where the drawdown limitation at the La Crosse gage required raising water

levels at the dam. From mid-August until termination of the drawdown on September 23, 2002, the over pool drawdown was about 0.5 foot.

A follow-up drawdown was implemented in 2002. The drawdown began in mid-June and extended until late September. River discharges during the summer of 2002 generally remained above 40,000 cubic feet per second (cfs) at Lock and Dam 8. Because of this, the full 1.5-foot drawdown was maintained at the dam for the entire drawdown period. However, because of the relatively high river discharge levels, no drawdown occurred in that portion of Pool 8 upstream of Brownsville, Minnesota.

The drawdown in Pool 8 was monitored extensively. The preliminary results of the monitoring have been documented, and are discussed in Section 6.0 Environmental Assessment.

During the pool selection process for the initial pilot drawdown, Pool 5 was identified as the next highest priority pool after Pool 8. Following completion of the Pool 8 drawdowns, the WLMTF reconfirmed that Pool 5 remained the highest priority pool for implementation of a large-scale (>1.0 foot) drawdown. Pools 6 and 9 were identified as pools for trial implementation of minor ($\leq$ 1.0 foot) drawdowns.

Detailed planning was initiated in late 2002 for a Pool 5 drawdown in the summer of 2005. The results of this planning effort are discussed in this Letter Report/Environmental Assessment.

1.2 AUTHORITY

The 9-foot Navigation Channel Project on the Upper Mississippi River was authorized by the River and Harbor Act of 1930, which approved construction of a series of locks and dams, supplemented with channel maintenance dredging. Regulation of the navigation pools is governed by a "Master Regulation Manual for Mississippi River Nine Foot Channel Navigation Projects, St. Paul District," supplemented by appendices describing the regulation of each individual pool.

1.3 PURPOSE

The drawdown will provide an opportunity for reestablishment of emergent aquatic plants and consolidation of sediment. An increase in the abundance of emergent and submersed aquatic plants would improve habitat conditions and provide a valuable source of food and cover for a variety of organisms including young-of-year and small fish, migratory birds, wading birds, furbearers, reptiles, and amphibians.

The increased vegetation would provide valuable habitat for small fish and spawning habitat for fish the following spring. Further, an increase in the abundance of emergent and submersed aquatic plants would help to dissipate wind energy, resulting in less sediment resuspension in the near-shore zone and reduced bank erosion. Consolidation of sediments during a drawdown may help to limit sediment resuspension by wave action and bioturbation, and create beneficial conditions for establishment of submersed aquatic plants. In addition, the expanded vegetation would help to reduce sediment resuspension by wave action and promote the settling of

suspended materials in the river, leading to improved water clarity. Benthic macroinvertebrates would rapidly recolonize in the dewatered areas following refilling.

The purpose of this Letter Report/Environmental Assessment is to evaluate the feasibility of conducting a drawdown of Mississippi River navigation Pool 5 within the St. Paul District. In addition, the information generated by the report is necessary to support a request to the Corps of Engineers' Mississippi Valley Division (MVD) to deviate from the approved reservoir regulation plan to implement a drawdown. The drawdown will be initiated only after approval of the deviation request by MVD.

The RRF and associated sub-group, the Fish and Wildlife Work Group (FWWG), developed Environmental Pool Plans. The goals from the Environmental Pool Plans that apply to this project include the following:

- Maintain/enhance/restore/emulate a sustainable ecosystem (natural water levels, sediment transport and deposition regime, and distribution of water flows within the Mississippi River floodplain).
- Maintain/enhance/create quality habitat for all native and desirable plant, animal, and fish species.

The objectives of conducting a drawdown in Pool 5, as established by the WLMTF, are as follows:

1) Improve conditions for the growth of aquatic vegetation with special emphasis on perennial emergent species.

2) Continue to operate and maintain the 9-foot channel project.

3) Minimize any adverse effects of the drawdown on river resources and river uses, including recreational boating access, to a level acceptable to the public.

4) Increase the level of knowledge regarding the effects of pool drawdown to support an adaptive management approach to future decisions concerning the use of this management measure.

2.0 AFFECTED ENVIRONMENT

2.1 POOL DESCRIPTION

Pool 5 is part of the Upper Mississippi River system (see Figures 2-1 and 2-2). It was created in 1936 by the completion of Lock and Dam 5 and the filling of the pool. The entire pool is about 14.6 miles long, extending from river mile 738.2 to river mile 752.8. The target pool elevation is 660.0 feet above mean sea level.

Several tributaries empty into the Mississippi River within the pool. Many of these tributaries are small perennial to intermittent streams. Two large tributaries, the Whitewater and Zumbro Rivers, enter Pool 5 from Minnesota and strongly influence water quality.

The river meanders across a broad floodplain. The navigation channel in Pool 5 is generally located on the Minnesota side of the floodplain from Lock and Dam 5 to about river mile 742.5. From that point, the navigation channel shifts toward the center of the floodplain and generally remains there until river mile 751, where it begins to shift to the Wisconsin shoreline for the approach to Lock and Dam 4. A major feature of Pool 5 is Weaver Bottoms, a 4,000-acre backwater area located on the Minnesota side of the main channel between river miles 742.5 and 746.5.

2.2 WATER RESOURCES

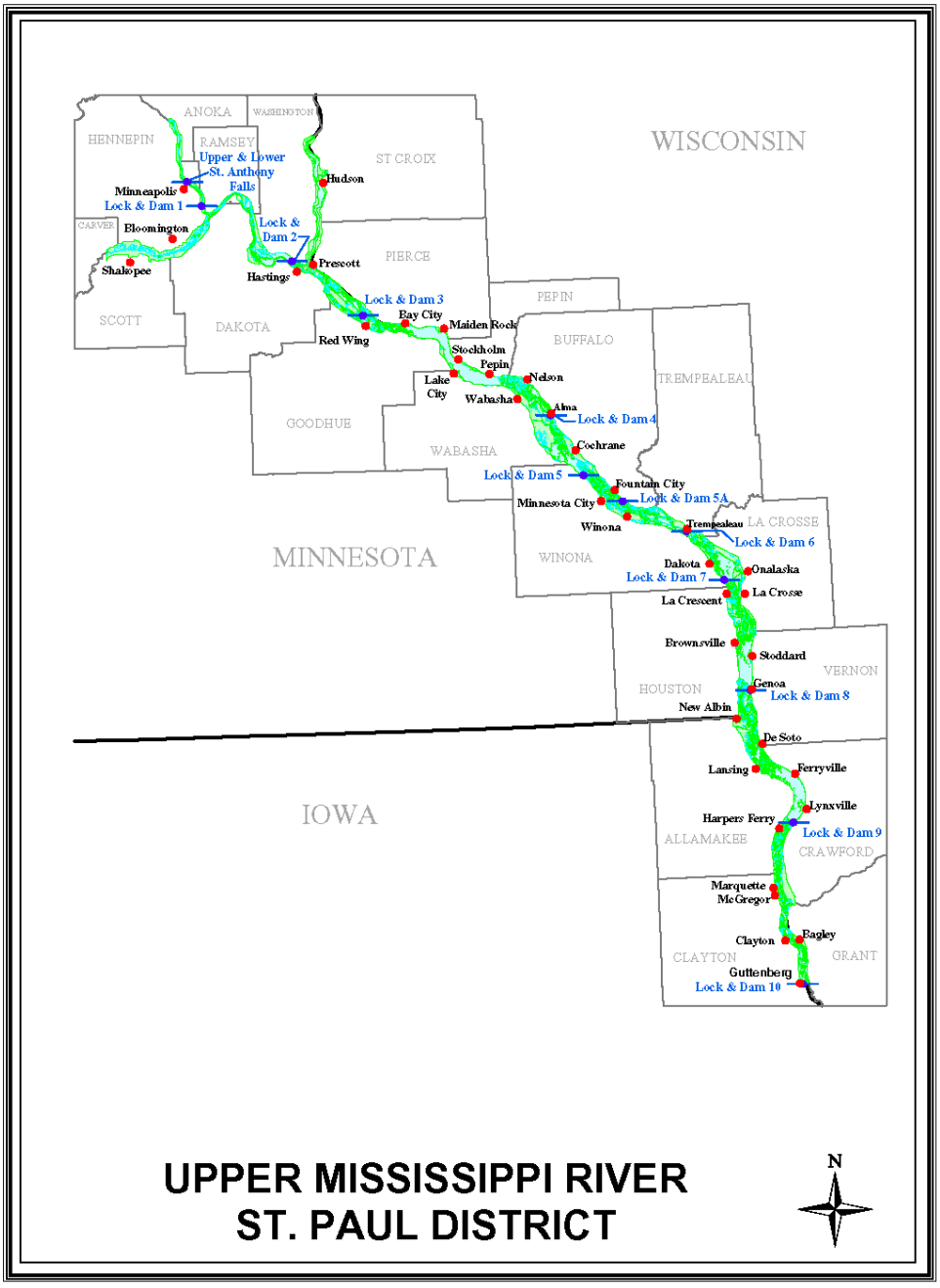
2.2.1 UPPER MISSISSIPPI RIVER

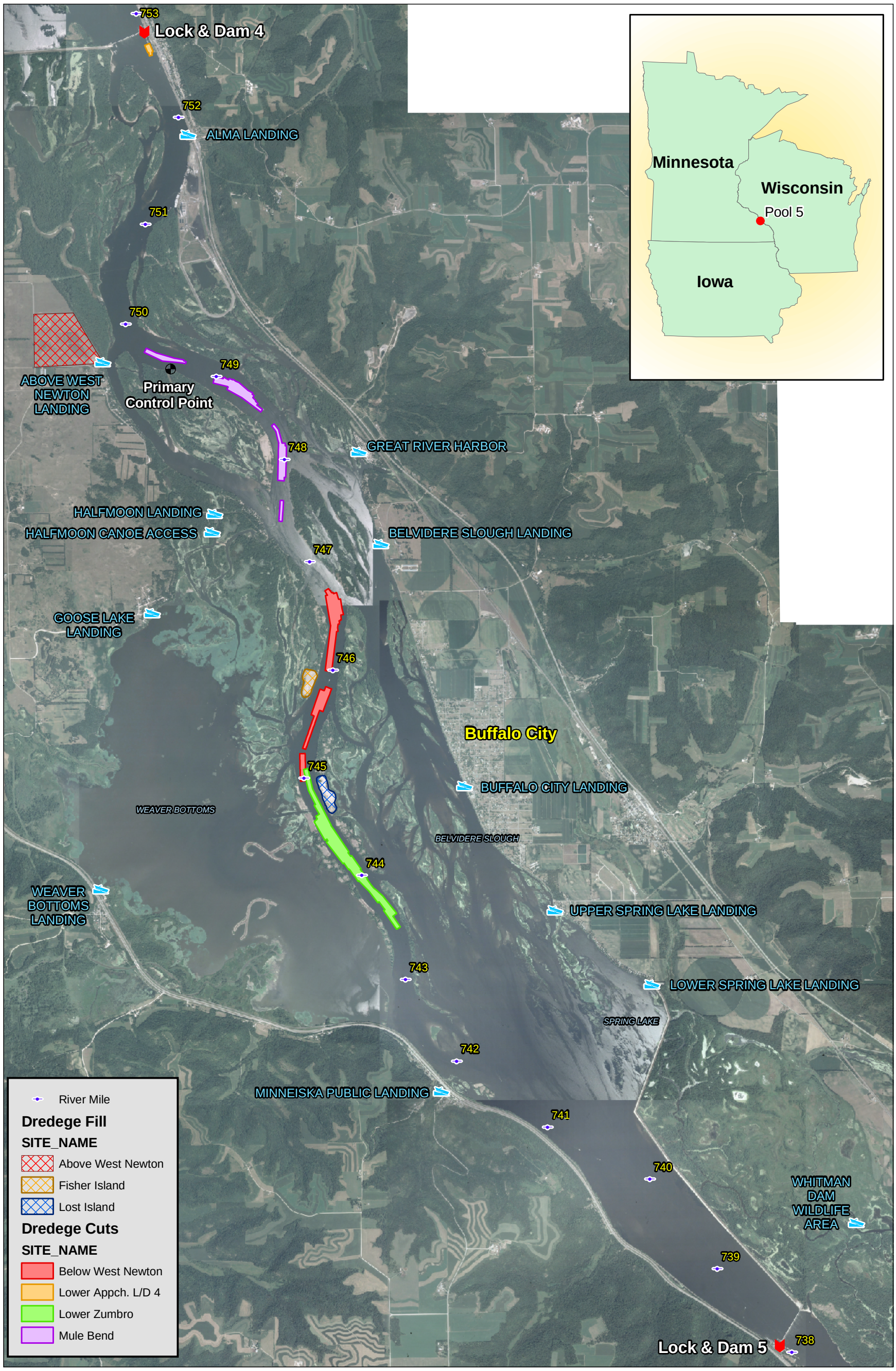
Early summer (June) discharges at Lock and Dam 5 generally range from 30,000 to 55,000 cfs. By late summer, discharges usually decrease to a range of 15,000 to 40,000 cfs. Winter low flows are usually in the range of 15,000 to 25,000 cfs. Table 2-1 shows the discharges and stages associated with the various high runoff events for the Mississippi River at Lock and Dam 5.

Table 2-1 – Mississippi River Discharge Frequencies – Lock and Dam 5

Event	Last Occurrence	Flow	Lock and Dam 5 Pool Elevation	Lock and Dam 4 Tailwater
5-year (20% chance)	May 2002	120,000 cfs	660.1	668.2
10-year (10% chance)	May 2001	150,000 cfs	662.2	669.9
50-year (2% chance)	May 2001	213,000 cfs	666.0	673.5
100-year (1% chance)	April 1965	245,000 cfs	667.6	675.0

Figure 2-1 – General Location Map of Pool 5





Mississippi River Pool 5 - Drawdown Analysis

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4,500 0 4,500 9,000 Feet

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Figure 2-2

Pool 5 is regulated in a manner typical for navigation pools in the St. Paul District. When river discharges are greater than 116,000 cfs, the gates are removed from the water at Lock and Dam 5 and the pool is unregulated. When discharges are between 28,000 and 116,000 cfs, the pool is in "secondary control"; i.e., a pool elevation of 659.5 is maintained at the dam. The pool upstream of the dam rises and falls with river discharge. Due to the slope on the pool, the range of fluctuation under secondary control is greater the farther upstream from the dam one progresses.

At a discharge of 28,000 cfs, regulation of the pool shifts to "primary control" whereby a water surface elevation of 660.0 is maintained at the primary control point at river mile 749.4. As discharges decline below 28,000 cfs, the water surface elevation at Lock and Dam 5 rises from 659.5 toward 660.0. If river discharges were to decline to zero, the pool water surface would (in theory) be flat at elevation 660.0.

The current allowable drawdown at Lock and Dam 5 between project pool elevation 660.0 and the secondary control elevation of 659.5 is 0.5 foot. When the dam first went into operation, the allowable drawdown was 2.5 feet to elevation 657.5. The allowable drawdown was reduced to 1.5 feet in 1960. In 1971, the allowable drawdown was reduced to the current 0.5 foot.

2.2.2 ZUMBRO RIVER

The Zumbro River has a watershed of approximately 1,375 square miles, draining a watershed in southeastern Minnesota with a large portion in agricultural use. The Zumbro River at times can contribute a substantial amount of suspended sediment to the Mississippi River. The Zumbro River contributes about 133,000 metric tons per year of sand to Pool 5 (Colorado State University 1979). This is about 27 percent of the sand inflow to the pool.

2.2.3 WHITEWATER RIVER

The Whitewater River has a watershed of approximately 300 square miles. The Whitewater River enters the lower reaches of Weaver Bottoms. The Whitewater River at times can contribute a substantial amount of suspended sediment to the Mississippi River. The Whitewater River contributes a modest amount of bed load sediment to the Mississippi River. Bed material sediment from the Whitewater River does not affect dredging requirements in Pool 5. Coarse sediments from the Whitewater River are trapped in Weaver Bottoms.

2.2.4 WEST NEWTON CHUTE

West Newton Chute is a major secondary channel located in the upper reaches of Pool 5. It branches off the navigation channel to the right at about river mile 749.8 and rejoins the navigation channel at about river mile 747.6. West Newton Chute conveys about 22 percent of the total river flow.

2.2.5 BELVIDERE SLOUGH

Belvidere Slough is a major secondary channel branching off the navigation channel to the left at about river mile 748.0. The slough conveys about 26 percent of the total river flow. The slough initially flows toward the Wisconsin shoreline and then follows that shoreline down past Buffalo City, Wisconsin. Below Buffalo City, Belvidere Slough swings back toward the main channel. In this area, bordering islands have been lost to erosion; however, the slough generally retains a defined channel through this open water area. On some maps, Belvidere Slough is shown as Pomme De Terre Slough. This report will use Belvidere Slough, the most commonly used name.

2.3 GEOLOGY

Most of Pool 5 is in an area not covered by the last glaciation. Pool 5 is underlain by relatively flat-lying Cambrian and Ordovician sandstone, limestone, and dolomite. These rocks were formed from sediment deposited by successive marine inundations occurring between 400 million and 600 million years ago. The sediments were later compacted and cemented, forming sedimentary rock. The sandstones have a combined thickness of more than 400 feet. They typically are poorly cemented and are easily eroded. They have a high porosity and permeability and are thus important aquifers in the basin. The sandstones are usually overlain by massive limestone or dolomite rocks as much as 100 feet thick. The limestone and dolomite are more resistant to erosion and are found capping bluffs and cliffs. The Minnesota bluffs are primarily north or east facing; thus, snow does not melt off during the winter. Because of the increased moisture, they are generally heavily timbered. By contrast, the Wisconsin bluffs are primarily south or west facing, causing drier conditions, which support less timber and result in grassier slopes, known as “goat prairies.”

The most significant geological event explaining the nature of the Mississippi River within Pool 5 occurred at the end of the Pleistocene glaciation approximately 10,000 years ago. Tremendous volumes of glacial meltwater, primarily from the Red River Valley's glacial Lake Agassiz, eroded the preglacial Minnesota and Mississippi River valleys. As meltwaters diminished, the deeply eroded river valleys aggraded substantially to about the present levels.

Since post-glacial times, an anastomosing stream environment has dominated this reach of the Mississippi River, due to the river's low gradient and oversupply of sediment from its tributaries. Prior to the impoundment of Pool 5 in the 1930's, the broad floodplain of the river was characterized by a stream system that consisted of multiple channels, swampy depressions, sloughs, natural levees, islands, and shallow lakes.

2.4 WATER QUALITY

Pool 5 of the Mississippi River has variable water quality. On the east side of the valley, water quality is good with low levels of suspended solids, reflecting the influences of Lake Pepin and the Chippewa River. However, the Zumbro and Whitewater River tributaries entering on the west side of Pool 5 drain predominantly agricultural areas and add extensive loads of suspended solids and agricultural chemicals.

Except for isolated sloughs and backwater lakes, the dissolved oxygen content of the water remains high year round and above levels required to sustain a quality fishery. In an isolated area immediately below Lock and Dam 4, Finger Lakes, aeration culverts were recently added to the lock and dam dike to correct problems with dissolved oxygen. Because of its turbulent nature, the river is well aerated and it can assimilate a considerable biochemical oxygen demand (BOD) loading. Fertility levels (nitrogen, phosphorus, potassium, calcium, etc.) are ample to support luxuriant growth of rooted aquatics and algae. Mead (1995), in investigations of contaminants in the Mississippi River from 1987 to 1992, found water quality to be generally better in this reach of the river than above Lake Pepin and in the reach downstream where tributaries that drain the Corn Belt begin to enter the Mississippi River.

Sediment quality is generally good in Pool 5. Main channel sediments are primarily medium to coarse sands with only trace amounts (generally less than 3 percent by weight) of silts and clays. Backwater sediments consist of fine material and sand. Levels of pesticides and other chlorinated hydrocarbons were generally below detection limits in all main channel and backwater samples that have been tested. PCB's have been detected in backwaters, but were generally less than 10 parts per billion. Selected heavy metals and nutrients were found in relatively low concentrations in the sediment samples that have been analyzed in Pool 5.

The Environmental Protection Agency and the States of Minnesota and Wisconsin have not designated sites within the Pool 5 floodplain for a response action under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). In compliance with Engineer Regulation (ER) 1165-2-132 for civil works projects concerning hazardous, toxic, and radioactive waste (HTRW), the dredged material has been evaluated in accordance with Section 404 of the Clean Water Act and other applicable guidance and regulations.

2.5 VEGETATION

Vegetation in Pool 5 shows an overlapping of eastern and western species. Several high "sand prairie" areas are scattered along the river valley forests, offering habitat conditions normally found much farther west. The climate moderation also allows more southern plant species to extend their ranges up the river valley.

The region's forested areas are of two types: upland xeric southern forest, and lowland forest of the floodplain. The small amount of upland forest is found at the edge of the Richard Dorer Memorial Forest. Forested areas are primarily wetland forest areas on river islands and riparian shorelines. Pool 5 has about 2,400 hectares of wetland forest habitats. These forests are typically seasonally flooded. The soil is without standing water during most of the growing season, but is waterlogged within at least 10 centimeters of the surface. Dominant tree species in the floodplain forest are river birch (*Bitula lutea*), cottonwood (*Populus deltoides*), silver maple (*Acer saccharinum*), and black willow (*Salix nigra*). American elm (*Ulmus Americana*) was once a dominant species in the floodplain forest; however, the occurrence of this species has been greatly reduced due to Dutch elm disease. Species that dominate in the better-drained areas are American elm, silver maple, green ash (*Fraxinus pennsylvanica*), basswood (*Tilia americana*), and black ash (*Fraxinus nigra*).

Inland fresh meadows are similar to wetland forests in that their soils are waterlogged. Vegetation found on fresh meadows includes sedges (*Carex* spp.), rushes (*Scirpus* spp.), redtop (*Agrotis gigantea*), reed grasses (*Phragmites* spp., *Phalaris* spp.), cattails (*Typha* spp.), manna grasses (*Glyceria* spp.), prairie cordgrass (*Spartina pectinata*) and mints (*Mentha* spp.).

Three classes of fresh marsh wetlands, shallow, deep, and open water, can be found in the floodplain of Pool 5. They occur mostly along major tributaries, on islands, or on peninsulas located throughout the river segment and within the channel of the Mississippi River. In the mid-1970's, Pool 5 contained about 3,850 acres of marsh wetland. Fresh marsh soils are usually waterlogged during the growing season. Water depths vary from 0.5 foot to 10 feet. Since inundation, however, the amount of vegetation has fluctuated and gradually declined, reducing many backwater marshes to open, windswept, riverine lakes. Emergent vegetation in these wetlands includes grasses, bulrushes, cattails, arrowheads (*Sagittaria* spp.), smartweeds (*Polygonum* spp.), coontail (*Ceratophylum demersum*), water lilies, and spatterdocks. *Phragmites* spp. also is present and provides important cover for wildlife. Submergent vegetation includes American wild celery (*Vallisneria Americana*), coontail, milfoil (*Myriophyllum verticillatum*), water stargrass, and sago pondweed (*Potamogeton pectinatus*).

2.6 FISH AND WILDLIFE

Various aquatic areas in Pool 5 support good, diverse habitat for both fish and wildlife. Aquatic areas present in Pool 5 include most of the classifications of Wilcox (1993). The most prevalent aquatic areas in Pool 5 include main channel, channel border, slough, river lakes, and tailwater. The important characteristics of these areas, relative to fish and wildlife uses, are described below.

Main Channel - The main channel usually conveys the majority of the river discharge and in most reaches includes the navigation channel. It has a minimum depth of 9 feet and a minimum width of 400 feet. A current always exists, varying in velocity with water stages. The bottom type is mostly a function of current. The upper section usually has a sand bottom, changing to silt over sand in the lower section. Patches of gravel are present in a few areas. No rooted vegetation is present. Pool 5 contains about 580 acres of main channel habitat.

Main Channel Border - Main channel borders are the areas between the navigation channel and the riverbank. Channel borders contain the channel training structures (wing dams, closing dams, revetted banks) and thus a diversity of depths, substrates, and velocities can be found in this habitat type. The bottom is sand in the upper section of the pool and silt in the lower section. Definable plant beds are frequently absent, but single species submersed plant clusters are sparsely scattered in areas of reduced current. Pool 5 contains about 1,620 acres of main channel border habitat.

Secondary Channel - Secondary channels are large channels that carry less flow than the main channel. Undercut or eroded banks are common along the channels' departure from the main channel. The bottom type usually varies from sand in the upper reaches to silt in the lower reaches. In the swifter current there is no root vegetation, but vegetation is common in the shallower areas having silty bottoms and moderate to slight current. Pool 5 contains about

1,110 acres of secondary channel habitat.

Sloughs - Sloughs are characterized by having no current at normal water stage, mud bottoms, and an abundance of submerged and emergent aquatic vegetation. Pool 5 has about 3,460 acres of slough, including the backwaters of the Weaver Bottoms and Belvidere Slough. These areas provide excellent spawning, nesting, and rearing areas, although sedimentation and loss of vegetation are causing a decline in the fish and wildlife habitat values of these areas.

River Lakes and Ponds - River lakes and ponds are distinct lakes formed by fluvial processes or are artificial (excavated or impounded). They may or may not have a slight current, depending on their location. Most of the bottoms are mud or silt, often consisting of a layer 2 feet thick or more. Aquatic vegetation in these bodies of water can be highly variable. Emergent vegetation is generally restricted to the perimeter of these water bodies. Pool 5 contains about 2,855 acres of river lakes and pond habitat.

Tailwaters - Tailwaters are the areas downstream of the navigation dams with deep scour holes, high velocity, and turbulent flow. The bottom is mostly sand. No rooted vegetation is present. Pool 5 contains about 75 acres of tailwater habitat.

2.6.1 Wildlife

The numerous backwater areas such as Weaver Bottoms, Belvidere Slough, and Mosiman's Slough interspersed with forested islands provide good habitat for a variety of wildlife species. Relatively abundant species include white-tailed deer (*Odocoileus virginianus*), gray fox (*Urocyon cinereoargenteus*), raccoon (*Procyon lotor*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethica*), mink (*Mustela vison*), and cottontail rabbit (*Sylvilagus floridanus*). Less abundant species would include otter (*Lutra canadensis*), opossum (*Didelphis marsupialis*), and gray and fox squirrels (*Sciurus* spp.). The Upper Mississippi River National Wildlife and Fish Refuge provides high quality wildlife habitat in this reach.

Backwater areas and lake type habitats provide important habitats for bald eagles and significant numbers of waterfowl each year. Waterfowl use in general has declined, likely due to changing habitat conditions on the Upper Mississippi River. The backwater areas of Weaver Bottoms and Belvidere Slough can provide important habitats for migrating canvasback ducks (*Aythya valisineria*) and nesting black terns (*Chlidonias niger*). Use of Weaver Bottoms by diving ducks, dabbler ducks, and tundra swans (*Cygnus columbianus*) has declined for over 15 years primarily due to a decline in wild celery and arrowhead production. However, use by Canada geese (*Branta Canadensis*) has remained fairly constant. Great egrets (*Casmerodius albus*) and great blue herons (*Ardea herodiasare*) are the most common wading birds to use the area. Spotted sandpiper (*Actitis macularia*) and killdeer (*Charadrius vociferous*) nest within Weaver Bottoms. Other birds that use the area include sandpipers, ring-billed gulls (*Larus delawarensis*), pelicans (*Pelecanus* spp.), and double-crested cormorants (*Phalacrocorax auritus*).

The sand prairie and marsh areas north of Weaver Bottoms (particularly the McCarthy Lake Wetland Management Area) provide habitat for Blanding's turtle (*Emydoidea blandingii*), a State endangered species, and many species of waterfowl. In addition, a small population of

sandhill cranes (*Grus Canadensis*) nests in the McCarthy Lake Wetland Management Area. A heron rookery once occurred in the Zumbro River bottoms, but was abandoned in the early 1990's.

The floodplain of Pool 5 provides habitat for a wide variety of amphibians and reptiles. Species found in the floodplain and adjacent sand prairies include the snapping turtle (*Chelydra serpentina*), map turtle (*Graptemys geographica*), false map turtle (*G. pseudogeographica*), Blanding's turtle, painted turtle (*Chrysemys picta*), Ouachita map turtle (*Graptemys ouachitensis*), smooth softshell (*Apalone mutica*), spiny softshell (*A. spinifera*), northern water snake (*Nirodia sipedon*), eastern garter snake (*Thamnophis sirtalis*), bullsnake (*Pituophis* spp.), fox snake (*Elaphe vulpine*), eastern tiger salamander (*Ambystoma tigrinum*), American toad (*Bufo americanus*), gray treefrog (*Hyla versicolor*), western chorus frog (*Pseudacris triseriata*), green frog (*Rana clamatans*), and leopard frog (*Rana pipiens*).

2.6.2 Fish

The continuum of aquatic habitats ranging from fast flowing main channel to lentic backwaters is present which provides for a great diversity and abundance of fish. Pitlo et al. (1983) lists 83 species of fish that have been recorded from Pool 5. Common sport fish include walleye (*Sander vitreus*), sauger (*Sander canadensis*), yellow perch (*Perca fiavescens*), white bass (*Morone chrysops*), bluegill (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*M. salmoides*), and northern pike (*Esox lucius*). The most common rough fish include common carp (*Cyprinus carpio*), shorthead redhorse (*Moxostoma macrolepidotum*), spotted sucker (*Minytrema melanops*), and freshwater drum (*Aplodinatus grunniens*). The most common forage fish include gizzard shad (*Dorosoma cepedianum*) and spottail shiner (*Notropis hudsonius*).

2.6.3 Aquatic Invertebrates

The pool has a large assemblage of invertebrate species. The varied invertebrate fauna is due to the variety of habitats in the area. Lake forms of invertebrates find suitable habitat in the lentic portions of the pools. Organisms that require running water find a wide range of water velocities in tailwaters, in the main channel, along wing dams, and in side channels. The rocks associated with wing dams and shoreline protection provide a suitable habitat for specialized invertebrates.

Historically, as many as 34 mussel species were present in Pool 5 (Wilcox et al. 2004). Presently, only 23 live species occur in the pool including five species listed as either threatened or endangered in Minnesota or Wisconsin (see Table 2-2). No federally endangered mussel species occur in Pool 5. Threeridge (*Amblema plicata*), Wabash pigtoe (*Fusconaia flava*), threehorn wartyback (*Obliquaria reflexa*), and fawnsfoot (*Trincilla donaciformis*) are common in Pool 5. The zebra mussel is present in Pool 5, and its numbers, although slightly fluctuating, have steadily been increasing since its first reported occurrence in 1991. The impacts of zebra mussels are still unclear, but it is generally thought to be deleterious in high numbers.

Table 2-2 – Protected Species of Pool 5 of the Upper Mississippi River*

	Federal	Wisconsin	Minnesota

Species	Status	Status	Status
Bald eagle (*H. leucocephalus*)	threatened	threatened	threatened
Loggerhead shrike (*L. ludovicianus*)	---	endangered	threatened
Great egret (*Casmerodius albus*)	---	threatened	---
Osprey (*Pandion haliaetus*)	---	threatened	---
King rail (*Rallus elegans*)	---	---	endangered
Wilson's phalarope (*Phalaropus tricolor*)	---	---	threatened
Forster's tern (*Sterna forsteri*)	---	endangered	---
Common tern (*Sterna hirunda*)	---	endangered	threatened
Eastern massasauga rattlesnake (*Sistrurus c. catenatus*)	---	endangered	endangered
Blanding's turtle (*E. blandingii*)	---	threatened	threatened
Wood turtle (*Clemmys insculpta*)	---	threatened	threatened
Blanchard's cricket frog (*Acris crepitans*)	---	endangered	endangered
Black buffalo (*Ictobus niger*)	---	threatened	special concern
Blue sucker (*Cycleptus elongates*)	---	threatened	special concern
Crystal darter (*Ammocrypta asprella*)	---	endangered	special concern
Goldeye (*Hiodon alosoides*)	---	endangered	---
Greater redhorse (*Moxostoma valenciennesi*)	---	threatened	---
River redhorse (*M. carinatum*)	---	threatened	---
Pallid shiner (*Notropis niger*)	---	endangered	special concern
Speckled chub (*Macrhybopsis aestivalis*)	---	threatened	---
Paddlefish (*Polyodon spathula*)	---	threatened	threatened
Butterfly (*Ellipsaria lineolata*)	---	threatened	endangered
Rock pocketbook (*Arcidens confragosus*)	---	threatened	endangered
Monkeyface (*Quadrula metanevra*)	---	threatened	threatened
Washboard (*Megalonaias nervosa*)	---	---	threatened
Round pigtoe (*Pleurobema sintoxia*)	---	special concern	threatened
Ottoe skipper butterfly (*Hesperia dacotae*)	---	---	threatened
Clustered broomrape (*Orobanche fasciculate*)	---	threatened	---
Prairie thistle (*Cirsium hillii*)	---	threatened	---
Tubercled orchid (*Platanthera flav*)	---	threatened	---
White lady's slipper (*Cypripedium candidum*)	---	threatened	---
Rough-seeded flameflower (*Talinum rugospermum*)	---	special concern	endangered

*Protected species are those listed as either threatened or endangered in either Minnesota, Wisconsin or federally. Species listed as only Special Concern in either State are not included.

Burrowing mayflies are abundant along much of the Mississippi River. Nymphal forms of the three major species (*Hexagenia bilineata, H. limbata,* and *Pentagenia vittigera*) are efficient detritivores and an important food organism for many species of fish and other wildlife.

2.7 THREATENED AND ENDANGERED SPECIES

The bald eagle (*Haliaetus leucocephalus*) is a federally listed wildlife species that occurs in Pool 5. Pool 5 contains at least 10 active bald eagle nesting sites that have produced fledglings over a number of years. Bald eagles have an established winter night roost (November - April) in the backwater of the Zumbro River. They feed along the main channel during the day and roost in the river bottoms just downstream of the Finger Lakes at night.

The Higgins eye mussel (*Lampsilis higginsii*) is a federally endangered mussel species that occurs in the Upper Mississippi River. However, it has not been recorded in Pool 5 in recent times. It has not occurred naturally in recent years in adjacent pools as well. However, the species has been propagated in Lake Pepin (Pool 4) since 2000, and juveniles have been placed in upper Pool 4 in 2003. It is unlikely at this time that the Higgins eye mussel has become established in Pool 5, but it is possible the species may become reestablished in Pool 5 in the near future. Five State-listed (threatened or endangered) mussel species occur in this reach (see Table 2-2).

No federally endangered fish species occur in Pool 5. However, nine fish species with State protected status (threatened or endangered) occur in this reach of the Upper Mississippi River (see Table 2-2).

Five species of plants listed for protection in either Minnesota or Wisconsin occur in this reach. The rough-seeded flameflower (*Talinum rugospermum*) found in Wabasha, Minnesota, is a State endangered plant. None of the plants are federally listed. The sand prairie and marshland north of Weaver Bottoms provide habitat for the loggerhead shrike.

The Blanding's turtle has been reported within Pool 5 near the McCarthy Lake Wetland Management Area. The largest known population of Blanding's turtles is in and along Pool 5.

2.8 CULTURAL RESOURCES

The Pool 5 locality contains numerous cultural resources indicating continual human occupation over approximately the last 12,000 years. Cultural resources include precontact and historic archaeological sites, shipwrecks, and standing structures situated across a variety of landforms. Several cultural resource sites within Pool 5 have been listed on or are eligible to be listed on the National Register of Historic Places (NRHP). The proposed drawdown has the potential to affect cultural resources.

Archaeological investigations have been ongoing in the Pool 5 locality for over a century (e.g., Lapham 1855; Pleger 1997; Thomas 1894, Winchell 1911). Early research in the area centered on the contents of burial mounds and who built them, although little information exists from burial mound delving from the Pool 5 locality (e.g., Arzigian and Stevenson 2003). By the early

twentieth century, most practitioners rejected the popular notion that a race of non-American Indians constructed the mounds, and non-scientific investigations gave way to systematic mapping and excavation.

Despite an awareness of cultural resources in the pool, no comprehensive preimpoundment survey was completed prior to construction and subsequent operation of Lock and Dam 5 in 1935 (e.g., Dunn 1996). More or less contemporary archaeological research within the pool began during the 1970s, with a Corps sponsored survey of dredged material placement sites (Johnson and Hudak 1975), followed by an expansive terrestrial investigation along the Great River Road in Wisconsin in 1979 (Penman 1984). Since the last quarter of the twentieth century, numerous cultural resource investigations have been completed within the Pool 5 locality.

Most of these investigations focused on several prominent terraces, such as the areas around West Newton Chute in Minnesota and Buffalo/Cochrane in Wisconsin (e.g., Florin 2003; O'Mack and Withrow 1989; Penman 1981; Rusch and Penman 1982; Styles-Hanson 1987). Additional investigations within the pool include surveys of dredged material disposal sites; environmental rehabilitation projects; several literature based overviews such as site inventories, geomorphic mapping, and shipwreck locations; navigation features; and site predictive models (Hudak et al. 2002; Jalbert et al. 1996; Jensen 1992; Madigan and Shermer 2001; Overstreet et al. 1983; Pearson 2003; Withrow 1990; Withrow and O'Mack 1989).

A survey of Pool 5, mainly consisting of a visual inspection of the shoreline, was completed in 1996 (Pleger 1997). In anticipation of the proposed Pool 5 drawdown, the Corps commissioned another survey of Pool 5 in fall 2004. This effort focused on exposed shoreline areas and assessed the potential effects of a drawdown on previously recorded cultural resource sites along, or proximal to, the shoreline (Boszhardt 2004, personal communication).

Despite greater awareness of cultural resources situated within floodplain settings (e.g., deeply buried sites), few areas within the pool have been subjected to deep site testing. Also, some cultural resources are experiencing profound effects from inundation, erosion, and other forces associated with modern river navigation (e.g., creation of the pool, recreation activities, etc.). Cultural resource practitioners are beginning to understand these complex mechanisms and their influence on cultural resources and are formulating strategies to manage this situation (e.g., site protection and preservation schemes).

In addition, few cultural resources within the pool have undergone evaluative testing to determine their eligibility for listing on the NRHP. Nevertheless, investigations from several archaeological sites within and proximal to the Pool 5 locality have contributed to our knowledge base concerning the cultural history of this region of the Upper Mississippi River (e.g., Benn 1979; Birmingham et al. 1997; Theler and Boszhardt 2004).

Depending on which alternative is selected (i.e., 1.5-, 2.0- or 2.5-foot drawdown), a drawdown has the potential to affect up to 37 recorded cultural resource sites. These include 31 precontact sites and six historic sites as well as several river navigation structures (wing dams). Precontact cultural resources include lithic and artifact scatters, village sites, rockshelters, and burial mounds. Historic cultural resources include early town sites, farmsteads, cemeteries, historic

standing structures, shipwrecks and river navigation structures (e.g., wing dams).

Several cultural resource sites within the Pool 5 locality have been listed on (e.g., Lock and Dam 5), or are eligible for listing on (e.g., wing dams), the NRHP. Cultural resource sites exist on a variety of landforms, including uplands, valley slopes, terraces, islands, tributary delta/fans, the river floodplain (e.g., natural levees, relict point bars, meander scrolls, etc.) and within the river channel. Potential effects to cultural resources from the proposed drawdown will be dictated by the alternative selected (1.5-, 2.0- or 2.5-foot drawdown) and are discussed in Section 6.7 Effects on Cultural Resources.

2.9 SOCIOECONOMIC SETTING

Alma and Buffalo City, Wisconsin, are the largest communities on the pool. The village of Minneiska is the largest Minnesota community bordering the pool. Adjacent larger Minnesota communities are Wabasha, located 10 miles upstream, and Winona, located 25 miles downstream. The pool is also adjacent to Buffalo County on the Wisconsin side of the river.

Despite the scarcity of river communities, Pool 5 is not isolated. Primary highways either closely parallel the shorelines for considerable distance along both sides of the pool or follow the nearby high-terraced areas within the valley in the same general north-to-south direction. Networks of secondary, county, and township roads connect with the primary roads to service the areas adjacent to the pool and to provide access from outlying areas. Railroads closely parallel the primary highways on both sides of the pool. No highway or railroad crossings from Minnesota to Wisconsin are located on Pool 5. Neither airline service nor small airports are available in the immediate area. There are two commercial navigation facilities in Pool 5, one just downstream from Alma, Wisconsin, at river mile 751.5 left bank (LB) and the second near Indian Point at river mile 748.0 LB.

Agriculture encompasses the largest single land use in this reach. Large tracts of agricultural land are found in Buffalo County, Wisconsin, and between the river and the Richard Dorer Memorial Forest in Minnesota. Pool 5's only commercial dock handles coal for an electric utility company, the Dairyland Power Cooperative. More significantly, Pool 5 serves as a thoroughfare for the river traffic between the region south of Pool 5 and the Twin Cities of Minneapolis and St. Paul, Minnesota.

2.10 RECREATION

Recreation activities in Pool 5 include fishing, recreational boating, hunting, trapping, camping, birdwatching, canoeing, island beach use, and sightseeing, primarily at lock and dam observation decks. Pool 5 provides 11 boat accesses with a total of 13 launching lanes (7 in Wisconsin and 6 in Minnesota), 227 parking spaces, 12 marina slips, 16 rental boats, 141 camping units, and 43 picnic units. The dredged material disposal islands along the main channel throughout the pool are popular with recreational boaters. Weaver Bottoms historically has been one of the most heavily used waterfowl hunting areas on the Upper Mississippi River. Compared to other areas, Pool 5 provides fair to good hunting and trapping opportunities.

Pool 5 contains Federal and State management areas, parks, refuges, and recreation areas. Two major parks near the pool are John Latsch State Park in Minnesota and Buena Vista Park in Wisconsin. John Latsch State Park, developed and operated by the State of Minnesota, overlooks Pool 5 from the bluff area just upstream from Lock and Dam 5.

The Upper Mississippi River National Wildlife and Fish Refuge provides high quality wildlife habitat in this reach. The backwater areas of Weaver Bottoms and Belvidere Slough provide good waterfowl hunting and trapping. Mosiman's Slough is one of the most heavily fished areas in Pool 5, particularly during the winter ice fishing season. The 900-acre Kellogg-Weaver Dunes Minnesota State Natural Area located in Wabasha County is a significant sand prairie grassland ecosystem. Also within the area is the McCarthy Lake Wildlife Management Area. Many of the surrounding bluffs and valleys in Minnesota are part of the Richard J. Dorer Memorial State Forest, which covers 43,000 acres in Wabasha County.

3.0 ALTERNATIVE FORMULATION AND EVALUATION

3.1 ALTERNATIVE FORMULATION

3.1.1 PRELIMINARY SCREENING

A 1.5-foot demonstration project drawdown of Pool 8 was conducted during 2001, with a follow-up lower level drawdown during 2002 to build upon the emergent aquatic plant recovery resulting from the 2001 drawdown. The demonstration drawdown was somewhat experimental, and preliminary results indicate the drawdown was largely successful in terms of emergent vegetation response on exposed substrate (Kenow et al. 2004).

No major adverse impacts to river resources were observed except for some mussel strandings during 2001 and some disturbance to cultural resource sites. The mussel strandings were probably a result of abnormally high water levels prior to the drawdown that allowed mussels to migrate or be carried there by currents to normally very shallow or exposed areas (M. Davis MNDNR, pers. comm.). Nearly one-half of the known cultural resource sites had a probable impact level of high from the Pool 8 drawdown (Kolb and Jalbert 2004). However, the Upper Mississippi River flood of 2001 may have skewed the results of the cultural resources study. Importantly, substantial variation in the quantity and character of cultural resources between the Pool 8 and Pool 5 localities renders comparison of potential impacts from a drawdown difficult to assess. Early in the implementation studies for the Pool 8 drawdown, the WLMTF identified Pool 5 as the next highest priority pool for a drawdown. For Pool 5, a primary goal of the WLMTF was to exceed the 1.5-foot drawdown level in Pool 8 to better evaluate river resources responses with deeper drawdowns.

Initially, drawdown alternatives evaluated were no action (continue routine regulation of Pool 5), and drawdowns of 1, 2, 3, and 4 feet at Lock and Dam 5. The 1-foot drawdown and the no action alternatives were eliminated because they would not provide the desired ecological benefits given the high priority need of a drawdown for Pool 5. Three- and 4-foot drawdowns were eliminated primarily because of the high dredging cost required to maintain the 9-foot navigation channel (Pool 5 has the highest dredging frequency and volume of any pool in the St. Paul District) coupled with the reduced chance of hydrologic conditions allowing for a successful drawdown. Subsequently, the WLMTF decided to reevaluate the no action and three drawdown alternatives at 0.5-foot increments (1.5, 2.0, and 2.5 feet). The alternatives are presented below, with brief summaries outlining the criteria for implementation, and are evaluated further in this section. Detailed analyses regarding ecological effects and the selection of a preferred alternative are presented in Section 6.0 Environmental Assessment and Section 4.0 Plan Selection.

1) **No Action Alternative** – The no action alternative would not provide the desired ecological benefits, given the high priority need for a drawdown in Pool 5. The deterioration of aquatic vegetation beds in Pool 5 over the last 60 years due to loss of natural water flows and increased sedimentation has reduced habitat quality in the pool. Habitat conditions would continue to decline as a result of continued routine

regulation of Pool 5. In Weaver Bottoms, for example, the Fish and Wildlife Work Group (FWWG) (1998), a sub-group of the River Resources Forum, reported that dramatic declines in marsh vegetation, and the inability of the marsh to reestablish itself, were attributable in part to changes in flow and sedimentation patterns and reductions in water clarity caused by wind-induced wave resuspension of sediments. The FWWG indicated that the problem would continue to worsen in the future if left unchecked. Water level management was identified as one of several important techniques required to restore aquatic vegetation in lower Pool 5 (FWWG 1998).

2) **1.5-Foot Drawdown** – A 1.5-foot drawdown at Lock and Dam 5 with a second year drawdown dependent on funding for main channel dredging requirements is the **selected alternative**. The WLMTF regards this as the minimum drawdown required to emulate periodic natural drought conditions and the associated positive ecological responses. This drawdown alternative has the greatest chance for success on the basis of historic hydrologic conditions, more so than deeper drawdown alternatives. It would probably provide a less desirable vegetation and habitat response but have fewer potential adverse impacts to cultural and other natural resources than deeper drawdowns. A drawdown to a 1.5-foot level at Lock and Dam 5 is justified as an operation and maintenance supported initiative. Funds have been specifically designated under Operations and Maintenance (O&M) for the St. Paul District Fiscal Year 2005 master program for advance maintenance dredging to implement the Pool 5 drawdown. Dredging required to sustain a 1.5-foot drawdown is considered to be advance maintenance and is expected to reduce future maintenance dredging by a comparable quantity.

3) **2.0-Foot Drawdown** – A 2.0-foot drawdown at Lock and Dam 5 with a second year drawdown dependent on funding available for main channel dredging requirements is the **preferred alternative, but cannot be implemented in 2005 with the available funding for main channel dredging**. The preferred alternative has an excellent chance (>80 percent) for success on the basis of historic hydrologic conditions. A 0.5-foot increase in drawdown depth from the 1.5-foot drawdown in Pool 8 is a logical next step in an adaptive management process of drawdown. The River Resources Forum (RRF) has endorsed the preferred alternative and has released the following statement:

   "The RRF endorses a drawdown in Pool 5 during 2005, or the earliest year possible to implement the drawdown, with a preferred level of 2 feet. Funding for supplemental dredging will be pursued to implement a 2-foot drawdown, but a minimum drawdown level will be 1.5 feet. The RRF also endorses the concept of a drawdown in the year following the initial drawdown. RRF agencies will assign staff to participate in a Task Force to address permanent placement of material at the Lost Island and Fisher Island placement sites."

4) **2.5-Foot Drawdown** – A 2.5-foot drawdown at Lock and Dam 5 with a second year drawdown dependent on funding for main channel dredging requirements. A 2.5-foot drawdown was identified as the maximum probable drawdown that could be

implemented in Pool 5 taking into account environmental benefits and impacts, projected dredging requirements necessary to maintain the navigation channel under drawdown conditions, and other factors. However, for this 2-year proposed drawdown event, this drawdown level is **not a preferred alternative** for Pool 5 at this proposed action. Main channel dredging requirements pose the greatest obstacle at this time, for the following reasons: 1) the incremental increase in cost for main channel dredging increases substantially while the chance for success decreases, which may not be worth the risk, 2) because of the high volume of dredged material to be removed, logistically it may not be possible in the relatively short period between the end of typically high water and the start of drawdown, and 3) dredging quantities will start to exceed the placement site capacities and force the premature transfer and added expense of material off site. In addition, until more is understood through the adaptive management process of the adverse and beneficial effects to river resources of drawdowns primarily through monitoring, a 2.5-foot drawdown at this time is excessive. If main channel dredging funds are acquired in the future, the logistics of dredging are resolved, and the biological and cultural resource responses from drawdowns are better understood, deeper drawdowns for Pool 5 should not be ruled out in the future.

3.1.2 DRAWDOWN DEPTH AT LOCK AND DAM 5

The drawdowns are defined from the secondary control elevation of 659.5 at Lock and Dam 5. Thus, a 1.5-foot drawdown would maintain a water surface elevation of 658.0 at the dam, a 2-foot drawdown would maintain a water surface elevation of 657.5 at the dam, and a 2.5-foot drawdown would maintain a water surface elevation of 657.0 at the dam.

3.1.3 DRAWDOWN DURATION

Previous studies (WLMTF 1996) concluded that a full growing season (approximately June 15 through September 30) should be the minimum drawdown duration considered for promoting the growth of emergent aquatic vegetation. These studies also determined that there would be habitat benefits associated with a follow-up drawdown during the subsequent growing season, although the depth of drawdown in the second growing season would not need to be as great as that during the initial growing season. Therefore, two drawdown durations were selected for evaluation, a single growing season and a multiple growing season drawdown, defined as follows:

Single Growing Season – Drawdown commencing with the recession of spring high water and continuing through approximately mid-September. The pool would be returned to normal operating levels by approximately October 1.

Multiple Growing Seasons – Drawdown during the first growing season as described above. Drawdown during the second growing season would follow the same sequence, with the depth of drawdown determined after reviewing the results of the first year drawdown.

The drawdown of the preferred alternative is scheduled for the 2005 growing season, beginning on June 15 and extending to about September 15. If hydrologic conditions prevent the implementation of the drawdown, the drawdown may be implemented in the earliest growing season thereafter as conditions permit. The date of mid-June to initiate the drawdown was chosen to minimize the impacts to earlier fish spawning while maximizing the duration of the drawdown for habitat benefits. Alternative earlier or later start dates would not satisfy these criteria. At the start of the drawdown, water levels would be lowered slowly (0.2 foot per day), allowing the escape of mussels from the dewatered zone and fish from dewatered areas and backwaters that may become isolated. The slow drawdown rate also produces greater emergent vegetation density and diversity by allowing substrates to dry slowly (Kenow et al. 2001, Fredrickson and Taylor 1982). For Pool 8, a follow-up lower level drawdown was conducted during the growing season following the initial year-one drawdown. For the Pool 5 drawdown, the WLMTF has proposed seeking a drawdown level equaling the year-one drawdown and exceeding it to 2.0 feet if the year-one drawdown is 1.5 feet. The level of the follow-up drawdown level will be dependent on funding available for main channel dredging requirements.

3.1.4 MITIGATION FOR RECREATIONAL BOATING

To mitigate for the decreased recreational boating access, three areas have been identified outside the main navigation channel to be dredged, and the Minnesota Department of Natural Resources would construct an additional boat ramp prior to the start of the drawdown that would be functional during the drawdown. Areas to be dredged were identified by a Citizens Advisory Committee, which has proposed a plan to provide a "reasonable" level of public access. Recreational access dredging would be conducted at five cuts within the three sites, and the impact would be a footprint of approximately 2.2 acres for a drawdown of 1.5 or 2.0 feet. The footprint for a 2.5-foot drawdown would increase slightly. The cuts would be 35 feet wide and differing in length. Approximately 1,600 cubic yards of sand typical of main channel dredged material would be removed and placed at a designated main channel dredged material placement site in Pool 5. See Section 3.2.6.5 Recreational Access Dredging.

3.2 ALTERNATIVES EVALUATION

3.2.1 HYDROLOGY

The drainage area above Lock and Dam 5 is 58,845 square miles. The drainage basin above Lock and Dam 5 includes portions of Minnesota, Wisconsin, and South Dakota. Approximately two-thirds of the watershed is in agricultural use; the rest is primarily forested land and urban areas. The annual precipitation at Lock and Dam 5 (Minnesota City) is around 30.5 inches.

3.2.1.1 Flow

Mean discharge at the U.S. Geological Survey gage located at Winona, Minnesota, has been 28,660 cfs over a 37-year period of record ending in September 1995. Maximum discharge recorded at the Winona gage was 268,000 cfs on April 19, 1965. Minimum flow recorded was 2,250 cfs on December 29, 1936.

Annual flow duration (percent of time at or above a certain discharge level over the course of a year) at Lock and Dam 5 is depicted on Figure 3-1. Monthly flow durations are shown in Table 3-1.

The annual hydrograph at Lock and Dam 5 is characterized by spring peak discharges following ice breakup, snowmelt, and spring rains. Spring runoff usually begins near the end of March and extends through April into May. The spring peak flow most typically occurs around mid-April. Summer flows generally range from 15,000 to 50,000 cfs. Average annual flow at Lock and Dam 5 is 43,000 cfs in June, 35,300 cfs in July, 24,700 cfs in August, and 25,000 cfs in September. River discharges typically increase from fall rains in September and October. Winter discharge is steady and low, at about 20,000 cfs.

Figure 3-2 is a discharge hydrograph for Lock and Dam 5 for the years 1988 through 1995. The discharge values are for releases from the lock and dam, estimated on the basis of gate discharge ratings. The 1992 and 1994 hydrographs provide examples of the "typical" bimodal pattern of high flows from spring runoff and fall rains, with lower flows during summer and winter (the hydrologic record for the Upper Mississippi River extends back to the turn of the century). The 1988 hydrograph illustrates a near-record low-flow year. The 1991 hydrograph illustrates a relatively high-flow year, with the 1993 hydrograph depicting a year of summer flooding, with river discharge greater than 50,000 cfs throughout most of the growing season.

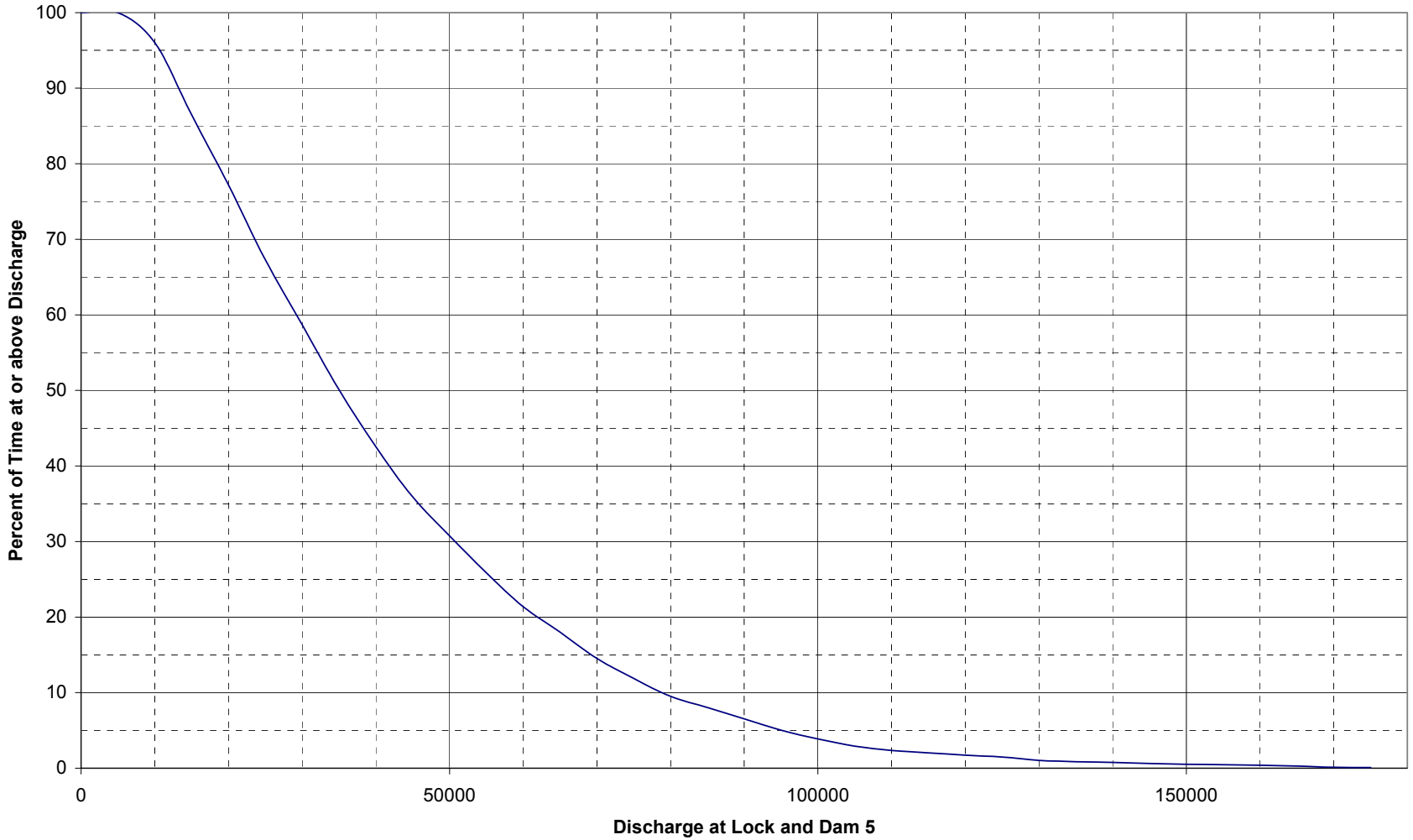


Figure 3-1 – Annual Flow Durations at Lock and Dam 5 (1972-2000)

Table 3-1 – Monthly Flow Durations at Lock and Dam 5

Percent of time at or above indicated discharge
For period 1972 to 2000

Flow	Apr	May	Jun	Jul	Aug	Sep	Oct
185000	0.46						
180000	0.69						
175000	0.80						
170000	0.92						
165000	1.26	0.33	0.46				
160000	1.61	0.44	0.69				
155000	1.95	0.44	0.69	0.22			
150000	2.18	0.56	0.69	0.33			
145000	2.53	0.67	0.80	0.44			
140000	2.99	0.89	0.80	0.67			
135000	3.33	0.89	0.80	0.78		0.34	
130000	4.02	1.00	0.80	0.89		0.46	0.22
125000	5.40	1.45	0.92	1.78		0.57	0.33
120000	6.32	2.11	0.92	1.89		0.57	0.44
115000	7.13	2.89	1.03	2.11		0.69	0.44
110000	8.28	3.89	1.03	2.11		0.69	0.56
105000	10.92	5.01	1.03	2.11		0.80	0.67
100000	15.29	6.79	1.72	2.11		0.80	0.67
95000	19.43	8.57	2.76	2.78	0.11	0.80	1.11
90000	24.37	11.68	3.68	3.23	0.22	0.92	1.89
85000	29.31	15.57	4.37	3.89	0.33	0.92	2.22
80000	33.91	19.47	4.94	4.34	0.44	0.92	2.89
75000	40.11	26.59	6.55	5.01	0.56	1.15	3.56
70000	45.63	32.37	9.66	7.34	1.67	1.38	4.00
65000	52.87	40.49	12.07	10.46	3.78	1.72	5.12
60000	59.66	45.72	16.55	14.02	5.12	2.53	6.56
55000	65.63	50.61	23.33	20.47	6.34	5.29	9.90
50000	71.49	54.62	32.18	27.70	8.34	8.05	13.46
45000	76.21	60.51	40.34	33.93	12.46	12.87	15.80
40000	80.00	66.74	51.38	43.27	17.58	18.97	20.58
35000	82.76	72.75	64.25	50.61	26.47	27.47	27.14
30000	87.82	78.09	74.14	61.51	36.48	36.78	36.82
25000	93.45	83.76	79.20	69.97	49.50	47.82	48.05
20000	98.16	90.99	84.25	76.75	65.52	61.84	63.29
15000	99.54	95.11	91.95	84.54	80.53	78.16	76.08
10000	100.00	100.00	97.59	93.66	91.21	95.06	94.77
5000	100.00	100.00	100.00	100.00	100.00	100.00	100.00

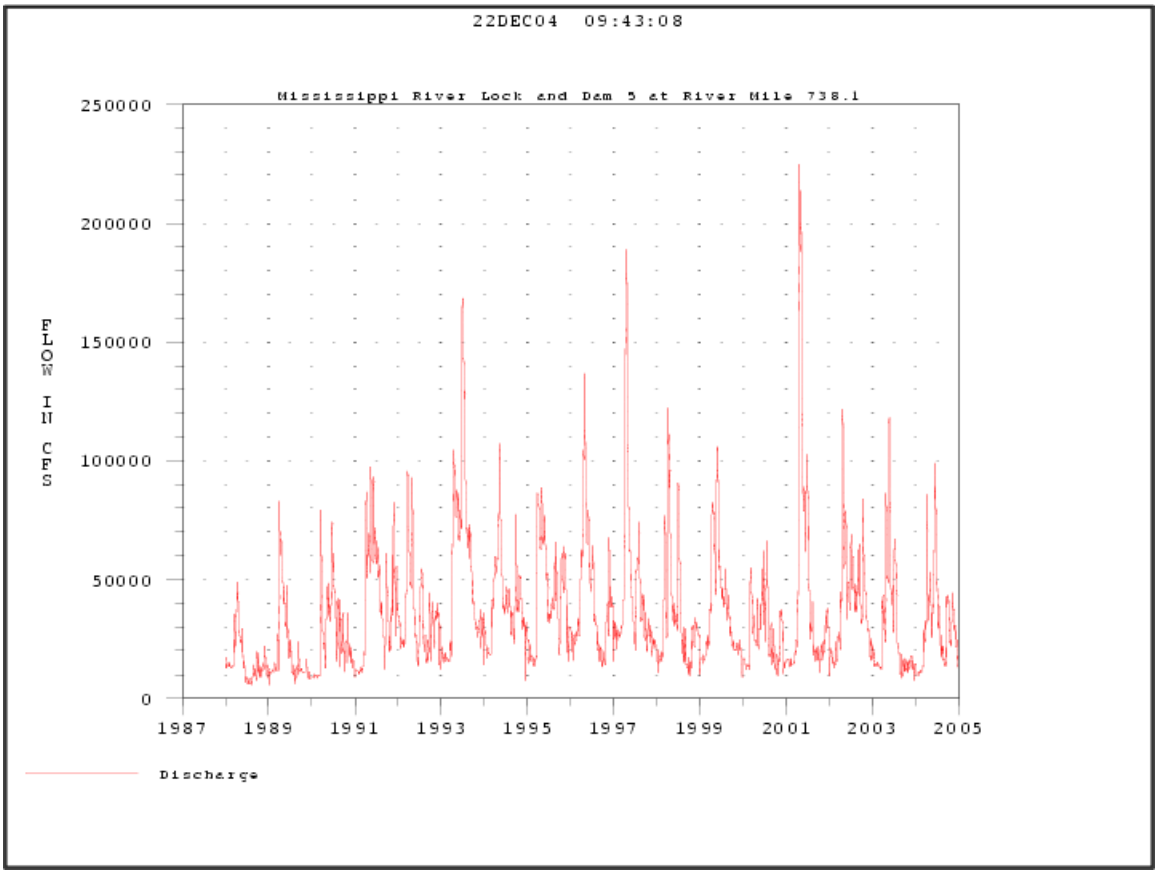


Figure 3-2 – Discharge Hydrograph for Lock and Dam 5

3.2.1.2 Pool 5 Discharge: Water Level Relationships - Routine River Regulation

Pool 5 varies between 0.4 and 3.3 miles wide and covers approximately 12,580 acres at project pool elevation (flat pool at 660.0 feet). Water surface elevation in Pool 5 is measured daily immediately above the dam, at the primary control point at Alma, Wisconsin (Alma gage, river mile 749.3), and at the tailwater of Lock and Dam 4. The pool and tailwater elevations are recorded every 4 hours. Alma elevations are recorded hourly.

The water level in Pool 5 is regulated with operating curves (Figure 3-3) for water surface elevations immediately above the dam and at the primary control point at Alma. When river discharge is less than 28,000 cfs (low flow), Pool 5 is regulated by maintaining a water level of 660.0 ($\pm$ 0.2 foot) at the primary control point. Water levels at the dam can range from 659.5 to 660.0 under these conditions. As river discharge increases above 28,000 cfs, Pool 5 is regulated at elevation 659.5 ($\pm$ 0.2 foot) at Lock and Dam 5. When river discharge exceeds 105,000 cfs (high flow), the dam gates are raised from the water, and the river assumes a water surface profile affected only by the swellhead of the dam.

The water surface profiles shown on Figure 3-4 indicate pool elevation by river mile at various levels of river discharge (solid lines). The term "backwater" in this sense refers to the water surface profile upstream from the dam. The water surface profile of the pool is not a simple plane, but has steeper gradient in the upper part of the pool, upstream of the control point at Alma. This change in water surface gradient is due to the impounding effect of Lock and Dam 5, regulation, and geomorphic characteristics.

The curves shown on Figure 3-4 are water surface elevations for the main channel. Water surface elevations in off-channel areas can be different from those in the adjacent main channel, especially at times of higher and changing flow, as the backwater areas of the pool fill and drain.

The elevation differences that occur between off-channel areas and the adjacent main channel in Pool 5 have not been measured. Head differential across the floodplain is greatest in the upper portion of Pool 5, where the river gradient is steeper, and the backwater areas are more hydraulically separated from the main channel. Riverbed geometry of each backwater area, geometry of inlets and outlets, along with level and rate of change of river discharge, determine the head differential between backwater areas and the main channel.

Wind set-up occurs in the large open-water area at the downstream end of Pool 5. Northwesterly and southeasterly winds produce the greatest effect on lower Pool 5 because of the generally northwest-southeast orientation of the valley. Southern winds produce a “setdown” at the dam. Wind set-up corresponds approximately to 0.1 foot of elevation at the dam per 10 miles per hour of sustained wind velocity from the north.

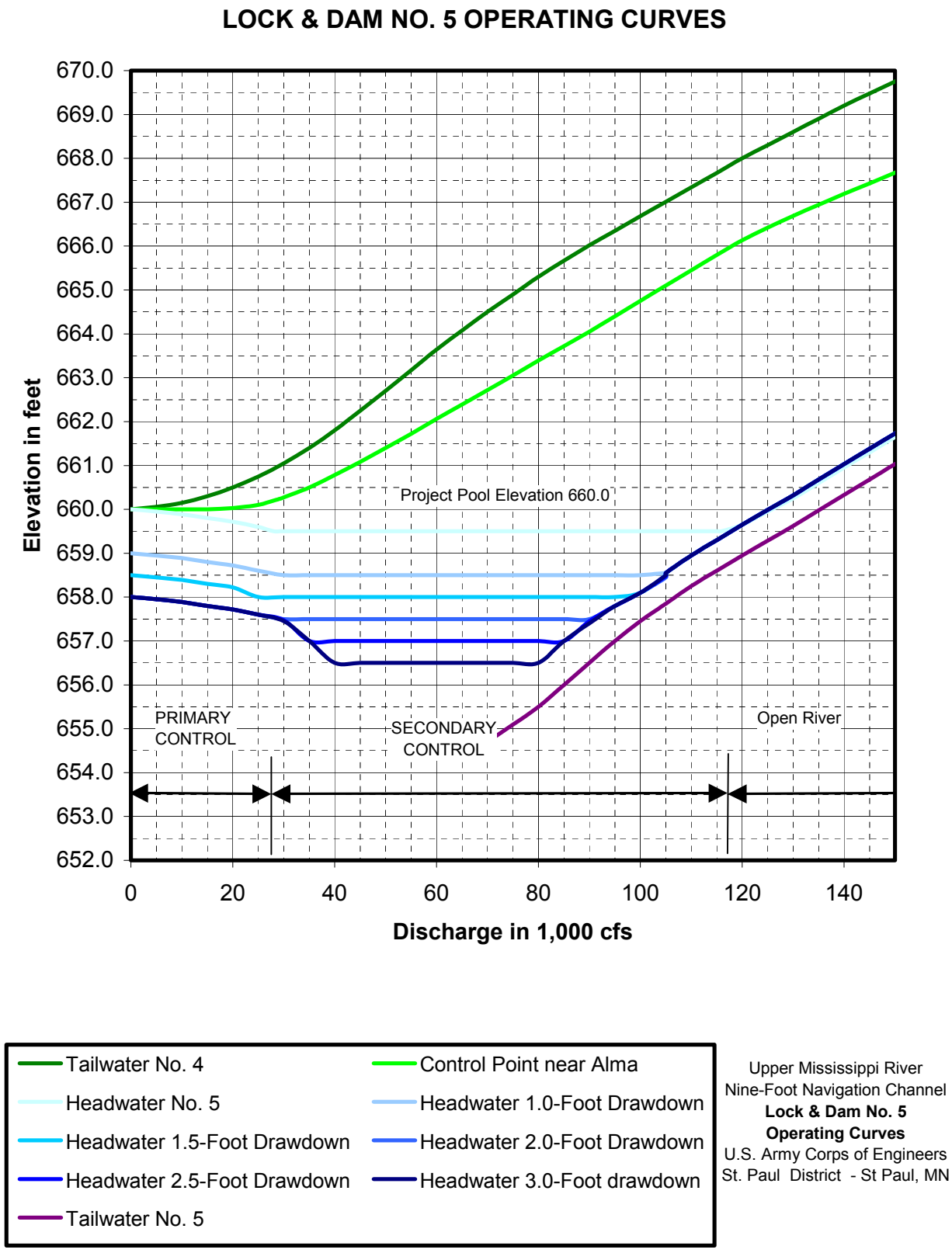


Figure 3-3 – Lock and Dam 5 Operating Curves

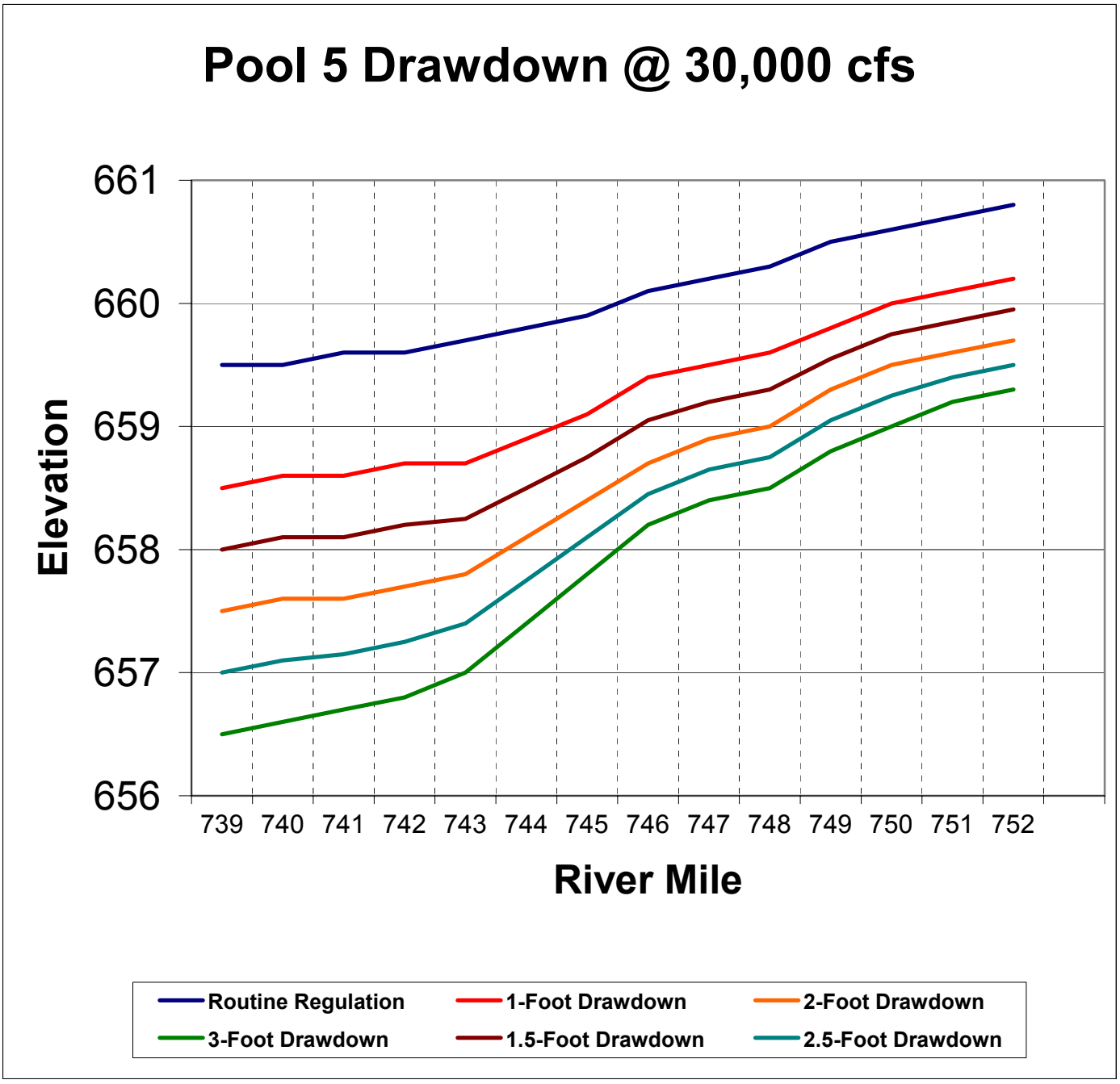


Figure 3-4 – Water Surface Profiles for Drawdowns at 30,000 cfs

3.2.1.3 Tributaries

Except for several small creeks, the only two major tributaries to the Mississippi River in Pool 5 are the Zumbro River and the Whitewater River. The Zumbro River has a drainage area of 1,380 square miles. The maximum flow measured on the Zumbro River was 35,900 cfs in 1951 at the U.S. Geological Survey gage near Zumbro Falls, Minnesota, where the drainage area is 1,150 square miles. The Zumbro River drainage is steep, driftless terrain. These characteristics result in rapid increases in flow during rainfall events.

The Whitewater River has a drainage area of approximately 300 square miles. The Whitewater River enters the lower reaches of Weaver Bottoms. At times, the Whitewater River can contribute a substantial amount of suspended sediment to the Mississippi River. The Whitewater River contributes a modest amount of bed load sediment to the Mississippi River. Bed material sediment from the Whitewater River does not affect dredging requirements in Pool 5. Coarse sediments from the Whitewater River are trapped in Weaver Bottoms.

3.2.1.4 Hydraulic Considerations

From a historic perspective, lower water levels or drawdowns are not without precedent. When the locks and dams were first constructed, the allowable drawdown was greater than it is today. Over time, the allowable drawdown was reduced in response to river resource management agency and public concerns with lower water levels, especially during the winter. The following shows the allowable drawdown at Lock and Dam 5 and how it has been reduced over time.

Year	Allowable Drawdown
1936	2.5 feet
1960	1.5 feet
1970	0.5 foot

The 2.0-foot drawdown alternative would simulate the way Pool 5 was regulated from 1936 through 1960, while the 1.0-foot drawdown alternative would simulate the way Pool 5 was regulated from 1960 through 1970.

The No Action alternative would not change the present system of river regulation, with the maximum drawdown of 0.5 foot at Lock and Dam 5.

Summer growing season drawdowns were modeled using HEC-2, a one-dimensional steady state gradually varied flow model. The model Manning's n values were adjusted by comparing the computed water surface profiles with water surface profiles used for operating Pool 5. The Manning's n values for the channel varied between 0.018 and 0.020. The Manning's n values for areas away from the main channel varied between 0.035 in the lower end of Pool 5 and 0.080 in the wooded areas of the upper end of Pool 5. There are variations in the actual water surface profiles due to seasonal variations of water temperature, bed forms, and vegetation.

For purposes of this study, it was decided to focus the evaluation on the range of discharges under which it would be practical to implement a growing season drawdown. This range extends

generally from zero to 105,000 cfs, depending on the level of drawdown. A maximum lowering of the Alma control point elevation to 659.0 feet is allowable. At that level, clearances over the lower lock sill at Lock and Dam 4 would be reduced to the minimum considered acceptable for safe navigation (12 feet). When discharges exceed 105,000 cfs, tailwater at Lock and Dam 5 is too high to allow a drawdown below the normal operating plan.

A discharge of 30,000 cfs was selected for use in the evaluation since this is the mean discharge for Pool 5 during the summer. Figure 3-4 shows the water surface elevation of Pool 5 under normal operation for a discharge of 30,000 cfs. Note how the slope on the pool becomes steeper as discharge increases. Table 3-2 displays the water surface elevations for 1.0-foot to 4.0-foot drawdowns for a discharge of 30,000 cfs. Figure 3-4 depicts this data graphically. It should be noted that the information displayed in Table 3-2 and on Figure 3-4 is for drawdowns controlled solely at Lock and Dam 5.

At 30,000 cfs, a drawdown of any depth in the 1.0- to 3.0-foot range is attenuated by approximately 20 percent at mid-pool and by approximately 50 percent at the head of the pool.

Table 3-2 – Water Surface Profiles for Drawdowns at 30,000 cfs

River Mile	Discharge = 30,000 cfs								
	Routine Regulation	Drawdown							
		0.5-foot	1-foot	1.5-foot	2-foot	2.5-foot	3.0-foot	3.5-foot	4-foot
739	659.5	659.00	658.5	658.00	657.5	657.00	656.5	656.00	655.5
740	659.5	659.05	658.6	658.10	657.6	657.10	656.6	656.10	655.6
741	659.6	659.10	658.6	658.10	657.6	657.15	656.7	656.20	655.7
742	659.6	659.15	658.7	658.20	657.7	657.25	656.8	656.40	656.0
743	659.7	659.20	658.7	658.25	657.8	657.40	657.0	656.65	656.3
744	659.8	659.35	658.9	658.50	658.1	657.75	657.4	657.10	656.8
745	659.9	659.50	659.1	658.75	658.4	658.10	657.8	657.55	657.3
746	660.1	659.75	659.4	659.05	658.7	658.45	658.2	658.00	657.8
747	660.2	659.85	659.5	659.20	658.9	658.65	658.4	658.20	658.0
748	660.3	659.95	659.6	659.30	659.0	658.75	658.5	658.35	658.2
749	660.5	660.15	659.8	659.55	659.3	659.05	658.8	658.65	658.5
750	660.6	660.30	660.0	659.75	659.5	659.25	659.0	658.90	658.8
751	660.7	660.40	660.1	659.85	659.6	659.40	659.2	659.05	658.9
752	660.8	660.50	660.2	659.95	659.7	659.50	659.3	659.15	659.0

3.2.1.5 Effects on Sediment Transport

The No Action alternative would not change the present system of river regulation or sediment transport regime in Pool 5.

Pool drawdown would result in an increase in the sediment transport capacity of the navigation channel. The increased transport capacity of the navigation channel would result from two changes in hydrodynamics. A lower water surface throughout the pool would decrease depths over closing

dams and wing dams, reduce flow into side channels, and correspondingly increase flow in the main channel. Lower water surface profiles would result in increased velocities in the main channel due to a decrease in channel area. The resulting increases in navigation channel velocities would increase sediment transport capacity of the main channel. The changes in water surface elevation would not result in immediate changes in the channel bottom profile, so additional dredging would likely be required (see Section 3.2.3 Channel Maintenance). Since the whole system would not have an increased sediment carrying capacity, overall dredging quantities may not decrease, but the locations of the dredge cuts may change. Generally, channel areas are expected to scour in areas with the smallest cross sections, such as in the vicinity of wing dams, and fill in deeper areas. Deposition is possible in secondary channel delta areas where they enter the impounded portion of Pool 5.

The lower water surface profile during the drawdown would increase the effectiveness of channel training structures in concentrating flow in the navigation channel. Current velocities would increase in the main channel and channel border areas. Estimated current velocities are presently about 1.5 to 2.0 ft/sec in the main channel at 22,000 cfs of river discharge, and would increase to 2.5 to 3.0 ft/sec during drawdown at the same level of river discharge with a 1.5-foot drawdown. Velocities would be nearly the same as existing conditions with lesser drawdown depths, and somewhat more with greater depth of drawdown at Lock and Dam 5. Drawdowns would increase the steepness of the water surface profile of the pool, inducing higher current velocities.

Lowering pool elevations would also have an effect on tributary sediment sources. The magnitude of the effect would vary with the change in pool elevations at the tributaries. For Pool 5, the major tributary is the Zumbro River. For a mean discharge of 30,000 cfs, a 1-foot drawdown would result in a change in stage at the Zumbro River of 0.6 foot. For a 3-foot drawdown, the change in stage would be 1.6 feet at the Zumbro River. The tailwater elevation of smaller tributaries in Pool 5 would also be reduced, and some head cutting would be possible in their delta areas. This effect is not expected to result in significant downcutting of the tributary riverbeds or mobilization of much sediment. This physical process would also be increased with the depth of drawdown.

During the initial phase of a drawdown, sediment would be mobilized by advective flow, as water drains from shallow areas. Wind-driven sediment resuspension would occur, as shear stresses from wind-driven waves mobilize sediment in water normally too deep for these processes to occur. Advective transport of resuspended sediment by river currents to downstream locations would occur. These processes would be increased with depth of drawdown (see alternative drawdown depths described above). Sediment mobilized by the drawdown would generally be focused into deeper areas within Pool 5.

Surficial substrate type may be affected in some areas by drawdown-induced sediment erosion and deposition. Areas newly exposed to wind-induced sediment resuspension would have finer materials resuspended and focused into deeper areas. The sustained higher current velocities in channel areas during the drawdown may result in an increased area of gravel substrate. Existing mussel beds, armored by the presence of mussels and shells, are not expected to be scoured.

Sediment water content in the drawdown zone would decrease, depending on the drawdown depth at Lock and Dam 5, initial water content of the sediment, position in the drawdown zone, length of the drawdown period, rainfall during the drawdown, air temperature, wind, humidity, groundwater seepage, and reflooding. Limited consolidation of sediment would occur, because most of the drawdown zone is silty sand with low organic content. Organic materials and reduced nitrogen compounds in the drawdown zone sediments would oxidize, reducing the substrate volume and increasing available plant nutrient concentrations. Some surface crusting and cracking of the dewatered sediment may occur, especially in the more isolated backwater sediments containing higher concentrations of clay and marl (calcium carbonate). Woody debris exposed in the drawdown zone would decay more rapidly than when under water. Much of the smaller woody debris would decay completely during the drawdown.

The combination of consolidated and oxidized sediment in the drawdown zone and more extensive areas of emergent and submersed aquatic plants should reduce sediment resuspension by wave action in the lower portion of Pool 5 following reflooding, increasing water clarity and available underwater light. These effects may persist for a number of years following the drawdowns.

A pool-wide drawdown of navigation Pool 8 was conducted during the summers of 2001 and 2002. Discharge measurements were collected during the drawdown and compared to discharge conditions without a drawdown. The Integrated Surface Difference Over Time (ISDOT) method was used to measure bed load transport. This method was developed by personnel from the Engineering Research and Development Center (Abraham and Pratt 2002) and was used for the first time in Pool 8. Hydrographic surveys were collected in Pool 8 during the drawdowns and were compared to pre-drawdown surveys collected during 1998 and 1999 to assess bathymetry changes. Cross sections were obtained on Coon Creek and the Root River before and after the drawdown in 2001 to assess changes due to the drawdown. Initially, the drawdown was planned during the summer of 2000, but unfavorable hydrologic conditions delayed the drawdown until the summer of 2001. This information will be used to predict the effects of similar water level management activities planned for other navigation pools of the Upper Mississippi River.

Water levels were lowered about 1.5 feet during July to September 2001 and during June to September 2002. Hydrodynamic monitoring indicated an increase in main channel discharge and velocity during the drawdown. This was due to the reduced water levels resulting in a smaller channel cross-section and a reduction in secondary channel discharge. Measurements of sand wave movement using the ISDOT method (Abraham et al. 2003) indicated an increase in sediment transport during the drawdown in 2001. Hydrographic surveys in the main channel dating back to 1999 were reviewed to determine changes that may have been induced by the drawdown. A comparison of bathymetric surveys between river miles 686 and 691 indicated relatively small amounts of deposition and erosion between 2001 and 2003. What is significant is that this reach normally aggrades to the point where main channel dredging is needed, so the fact that significant aggradation did not occur may be due to increased sediment transport caused by the drawdown. This is supported by the fact that navigation channel dredging in Pool 8 was not needed in 2002 and was only 37,960 cubic yards in 2003, well below the typical annual value of about 80,000 cubic yards. It could be that the high dredging volumes during 2001 combined with increased sediment transport caused a reduction in dredging in 2002 and 2003.

The average annual volume of sand dredged in Pool 8 for the 3-year period 2001-2003 is about 89,000 cubic yards, representing an 11-percent increase over typical annual volumes based on long-term trend analysis. District-wide dredging volumes were normal and matched long-term trends during 2002 and 2003.

A comparison of cross sections before and after the 2001 drawdown on Coon Creek indicates degradation of less than 0.5 foot. A comparison of cross sections before and after the 2001 drawdown on the Root River indicates aggradation in the lower portion of the Root River and degradation upstream. The Root River results are not consistent with those expected from a water level drawdown, and may be due to hydrologic conditions in the Root River watershed.

Sullivan (2003) found that, in general, total suspended solids and turbidity were not significantly greater during the summer of 2001 (when the pool was drawn down 1.5 feet) as compared to 1999, when accounting for changes in river flow between the monitoring periods. Wind-induced effects (sediment resuspension) explained less of the variation in total suspended solids, turbidity, or light penetration than river flow.

The results of this monitoring suggest that small drawdowns, such as the 1.5-foot drawdown in Pool 8, increase main channel water discharge and sediment transport. Degradation occurred on Coon Creek, but it was generally less than 0.5 foot in the lower portion of this tributary. The high main channel dredging volumes needed in advance of a drawdown result in reduced future dredging. The lack of change in the main channel bed elevations in the study reach may be due to the fact that while the sediment transport rate increased, inputs balanced outputs. This is a desirable condition, since normally the study reach would be aggrading until dredging was needed.

The Corps of Engineers is facilitating a 1.5-foot drawdown and not performing advance maintenance dredging of 1.5 feet. Under normal operating conditions, the channel is dredged to 12 feet below low control pool elevation to insure maintenance of the 9-foot channel project. This is a standard practice that allows for inaccuracies in the dredging process and provides advance maintenance to reduce the frequency and volume of dredging. Sometimes, dredging is performed to 11 or 13 feet below low control pool on the basis of various hydraulic and operational factors. Prior to 1974, the standard practice was to dredge to a depth of 13 feet. The 11- and 12-foot dredging depth was instituted in an effort to reduce dredging quantities. The reduced depth has helped the Corps of Engineers to successfully decrease dredging quantities, but other dredging reduction and avoidance measures have a much greater influence in decreasing overall quantities. During the drawdown, only a depth of 11 feet below the drawdown water surface at each dredging location will be maintained. The maximum drawdown is 1.5 feet at the dam; in the location of the dredge cuts, it ranges going upstream from 1.5 feet to 1.0 foot. Maintaining the 11-foot depth equates to a range of 12.5 to 12.0 feet below low control pool elevation, which is comparable to our normal advance maintenance practice in terms of dredging depth. The biggest reason for an increase in advance maintenance in 2005 is the fact that the Corps of Engineers is accelerating on a pool basis when the advance maintenance is performed. Dredging at the various cuts is being compressed into one year, where under normal maintenance practices it would normally be spread out over several years, although a review of the frequency and last time dredged indicates that statistically most of the cuts are due for

dredging anyway in 2005.

3.2.1.6 Potential for Reflooding During the Drawdown Period

Reflooding of the drawdown zone during the drawdown period can be expected to occur due to changes in river discharge. At low levels of river discharge, drawdown at the dam must be reduced to maintain at least elevation 658.0 feet at the Alma gage (2 feet below the primary control point elevation). At high levels of river discharge, the drawdown area would be reduced to the point where, at over 105,000 cfs, no drawdown at the dam can be maintained. The potential for an ecologically effective drawdown (good vegetation response) will be influenced by the depth, duration, seasonal timing, and recurrence of reflooding of the drawdown zone during the drawdown period. Although there are wide differences in flooding tolerance among plant species, developing seedlings generally cannot survive more than about 1 or 2 weeks of total inundation. The potential for maintaining a continuous drawdown in Pool 5 is primarily affected by the occurrence of low levels of river discharge. High levels of river discharge during the growing season are infrequent. The hydrologic record was examined to determine the degree to which growing season drawdowns can be maintained in Pool 5. Criteria for an ecologically effective drawdown (with respect to vegetation response) were established as follows:

Drawdown during growing season June 15 - September 30
Less than 1 week of reflooding per event
Less than two reflooding events during the growing season

A 1.0-foot drawdown of Pool 5 and elevation 659.0 at the Alma gage could be maintained with no river flow. For the period of record examined (1960 through 2001), an ecologically effective 1.0-foot drawdown could have been achieved during about 8 out of 10 years. An ecologically effective 2-foot drawdown could have been achieved in about 3 out of 5 years (Table 3-4), while an ecologically effective 3-foot drawdown could have been achieved in about 1 year out of 4.

The above criteria were developed for the purpose of alternatives comparison. In most of the years where the above criteria were not met, it is likely that a smaller drawdown (less depth) or duration could have been implemented. The only year that had sustained high summer flows, which would have made a drawdown ineffective or impossible to implement, was 1993. In 1984 and 2001, high discharges would have delayed the beginning of drawdowns to the first week of July.

Positive ecological effects of a drawdown are expected in addition to vegetation response. Consolidation of sediment during the drawdown, reduction in future sediment resuspension due to increased plant cover, and scouring of channel areas, especially main channel areas, can all be considered positive ecological effects of a drawdown that can occur even if the drawdown is interrupted by periods of higher river discharge. Delta development is generally a factor of higher river flows and levels that carry additional sediment, not lower river flows and levels.

3.2.1.7 Potential for Drawdowns Above the Alma Gage

As shown on Figure 3-4, at higher discharges the slope on the pool is such that with drawdown at Lock and Dam 5, there would be no reduction in water surface elevations in Pool 5 above the Alma gage below at discharges above 30,000 cfs. For a 1.0-foot drawdown, the duration of time that water surface elevation at the Alma gage is below 660.0 is shown below.

June	26 percent
July	38 percent
August	63 percent
September	63 percent

The actual occurrence of discharges above 30,000 cfs in any given year can vary substantially.

3.2.1.8 Acres of Substrate Exposed

Acres exposed for the three drawdown alternatives (1.5-foot, 2.0-foot, and 2.5-foot) are presented in Table 3-3 and on Figures 3-5, 3-6, and 3-7, respectively. Bathymetric data is not available for the entire pool so area exposed is underestimated, but relative comparison among the drawdown scenarios can be drawn. The largest incremental increase in acres exposed is for a 2.0-foot drawdown, followed by a 2.5-foot and a 1.5-foot drawdown, respectively, although the difference between a 2.0-foot and a 2.5-foot drawdown is negligible.

Table 3-3 – Acres Exposed by Drawdown Level in Pool 5

Drawdown	Acres Exposed*	% of Pool 5 Aquatic Area*	Incremental Acres Exposed*
1.0-foot	630	5.6	630
1.5-foot	**940**	**8.3**	**310**
2.0-foot	**1,459**	**12.9**	**519**
2.5-foot	**1,950**	**17.2**	**491**
3.0-foot	2,831	25.0	881
4.0-foot	3,939	34.8	1,108

*Merge 2 data used. Acres underestimated, as bathymetry data was not available for the entire pool.

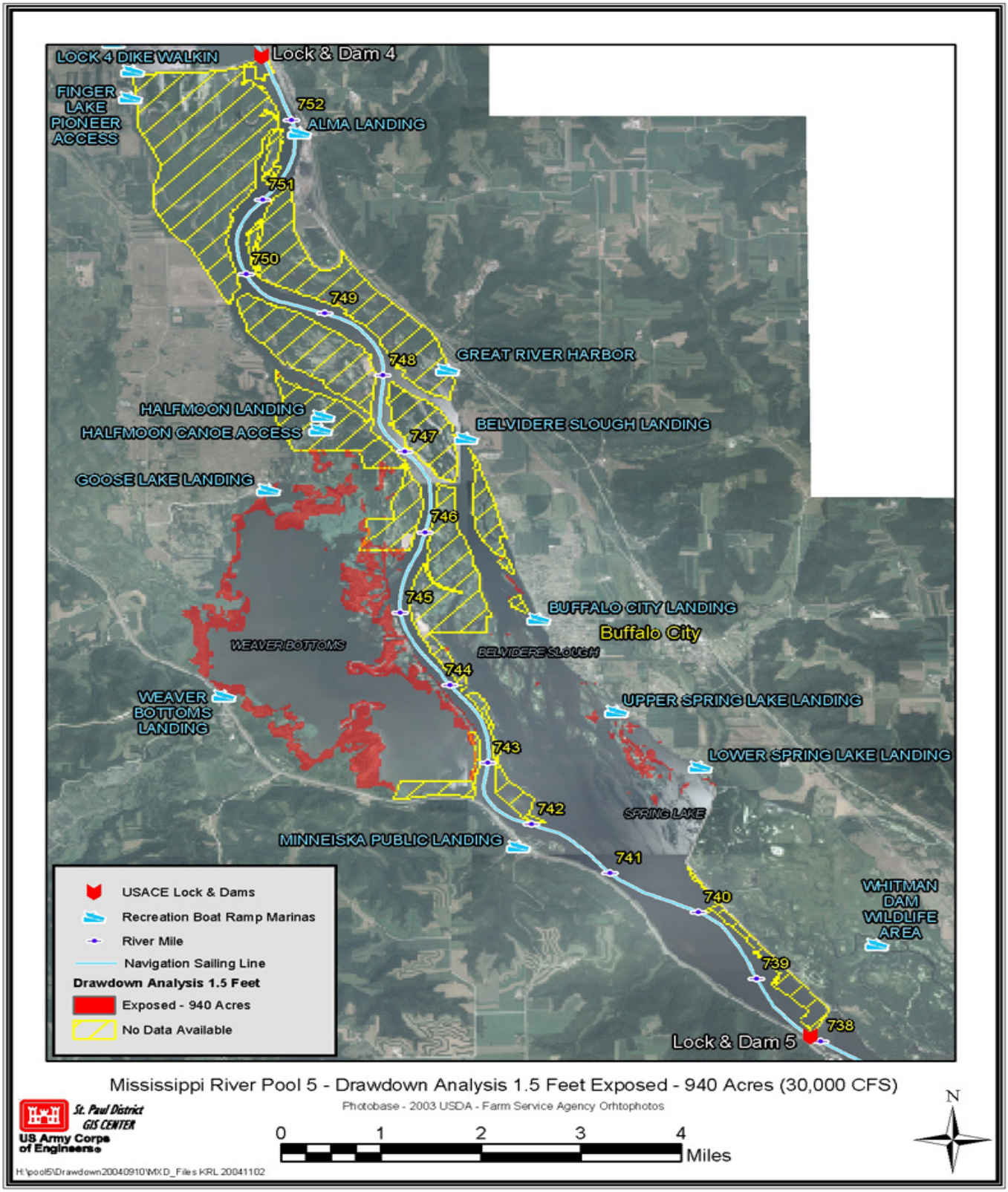


Figure 3-5 – Acres of Substrate Exposed - 1.5-foot Drawdown

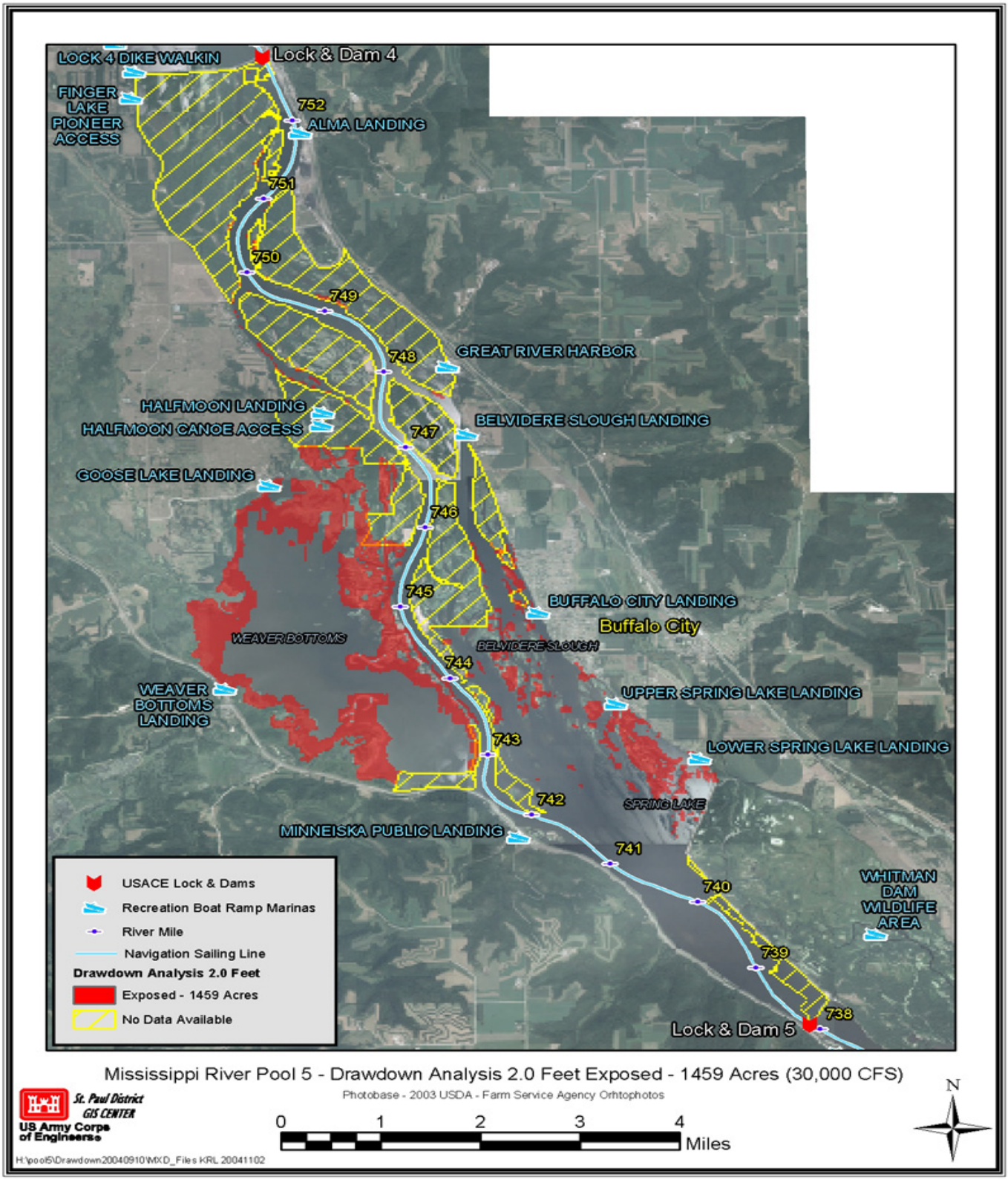


Figure 3-6 – Acres of Substrate Exposed – 2.0-foot Drawdown

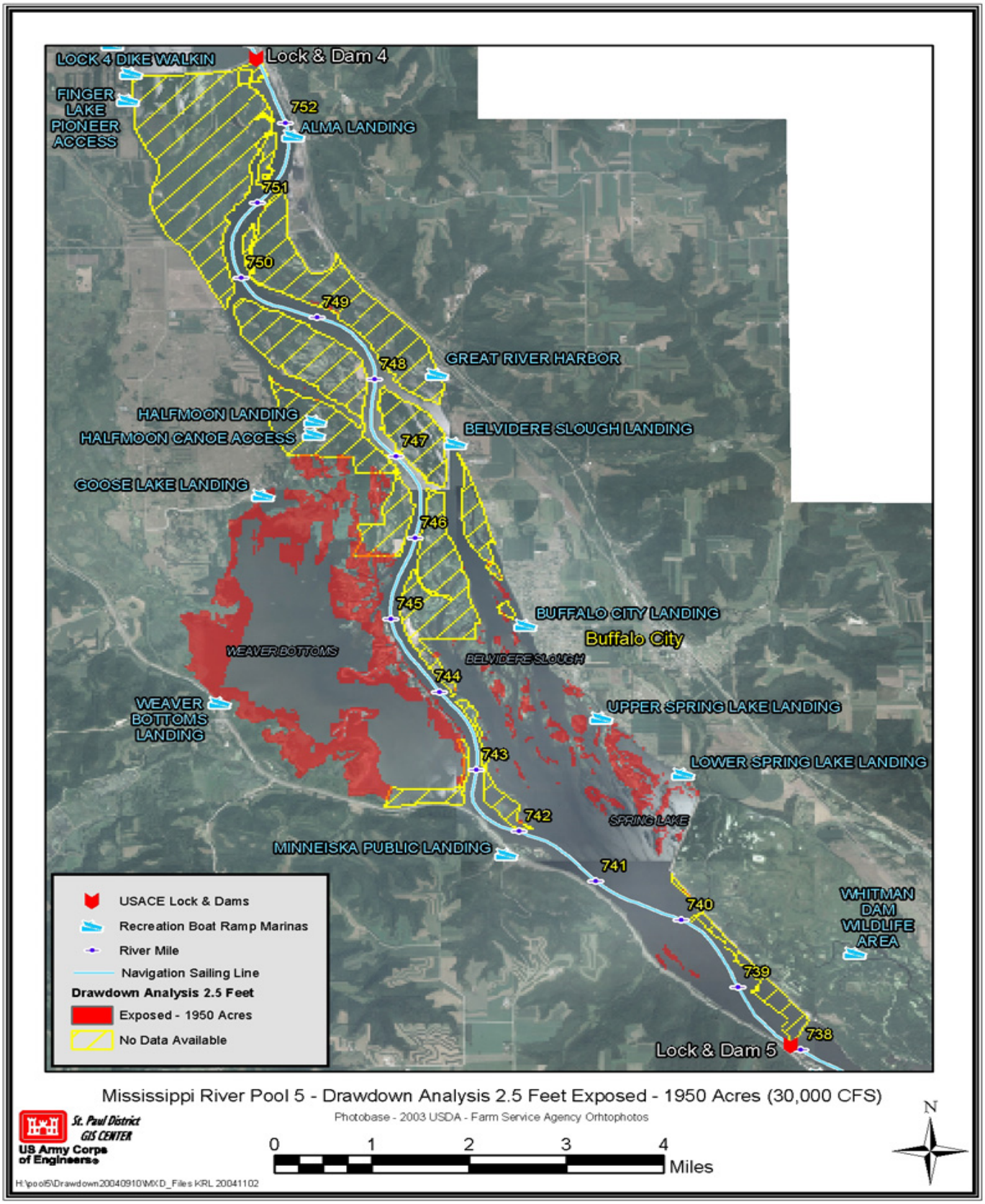


Figure 3-7 – Acres of Substrate Exposed – 2.5-foot Drawdown

3.2.1.9 Potential for a Successful Drawdown

The potential for achieving a successful emergent aquatic plant response is related to river discharges and the operating characteristics of the individual dams. An assessment has been made of the potential for achieving successful results in Pool 5 and others based on a review of river discharges for the period 1960-2001 (see Table 3-4).

Table 3-4 – Probability of Optimum Flows for a Drawdown

Period	1-Foot Drawdown	2-Foot Drawdown	3-Foot Drawdown
1960-1969	9 of 10 years (90%)	6 of 10 years (60%)	1 of 10 years (10%)
1970-1979	9 of 10 years (90%)	4 of 10 years (40%)	1 of 10 years (10%)
1980-1989	7 of 10 years (70%)	5 of 10 years (50%)	2 of 10 years (20%)
1990-1999	7 of 10 years (70%)	7 of 10 years (70%)	5 of 10 years (50%)
1960-2001	34 of 42 years (81%)	24 of 42 years (57%)	10 of 42 years (24%)

Drawdown can be effective in stimulating the germination and growth of emergent aquatic plants, provided that river discharge allows maintaining the drawdown. Periods of high water following initial drawdown can kill newly germinated plants, eliminating some of the positive ecological benefits of the drawdown.

The probability of having optimum drawdown conditions was defined as the probability for river discharge to allow a drawdown to the target depth during the June through September growing season, with no more than two reflooding events of less than 1 week duration (Table 3-5). It was recognized that this is an arbitrary definition, and that any drawdown will provide some measure of vegetation response. The primary function of this definition was to provide a relative comparison of the potential for success between drawdown levels. River discharge records for the 1960-2001 period of record were used to estimate the probabilities.

Table 3-5 – Probability of Having Optimum River Discharges for a Drawdown in Pool 5 with a Minimum of 11-foot Depth at Lock 4 Miter Gate End Sill

Drawdown	Probability
1.0-foot drawdown	81 percent
1.5-foot drawdown	69 percent*
2.0-foot drawdown	57 percent
2.5-foot drawdown	41 percent*
3.0-foot drawdown	24 percent

* based on interpolation

Four categories for ranking the potential for positive emergent aquatic plant growth response in any given year were developed as follows:

Successful – Drawdown would likely have provided a successful emergent aquatic plant response on exposed areas. It is assumed that, if aquatic substrate can be exposed for the entire growing season, there would have been a successful emergent aquatic plant response.

Partially Successful – Drawdown would likely have provided at least partially successful emergent aquatic vegetation response.

Marginally Successful – Drawdown would likely have provided some emergent aquatic plant response in portions of the pool, but growth would likely have been less than desirable due to frequent or prolonged flooding.

Unsuccessful – Drawdown would have been unsuccessful because of either prolonged high or low discharges. For example, 1993 would have been an unsuccessful year for a drawdown because of prolonged periods of excessively high flows.

Using these criteria, Table 3-6 summarizes the results for Pool 5.

Table 3-6 – Probability for a Successful Drawdown Based on Historic Discharge Records

Drawdown	Successful	Partially Successful	Marginally Successful	Unsuccessful	Successful + Partially Successful
1.5-foot	69	19	5	7	88%
2.0-foot	57	24	7	12	81%
2.5-foot	41	28	11	22	69%

As can be seen, the potential for having either a successful or partially successful drawdown is relatively high for the 1.5-foot and 2.0-foot drawdowns. There is substantial decline in this potential for the 2.5-foot drawdown, although the potential for having a successful or partially successful drawdown is still 69 percent for the 2.5-foot drawdown.

3.2.2 ECOLOGY

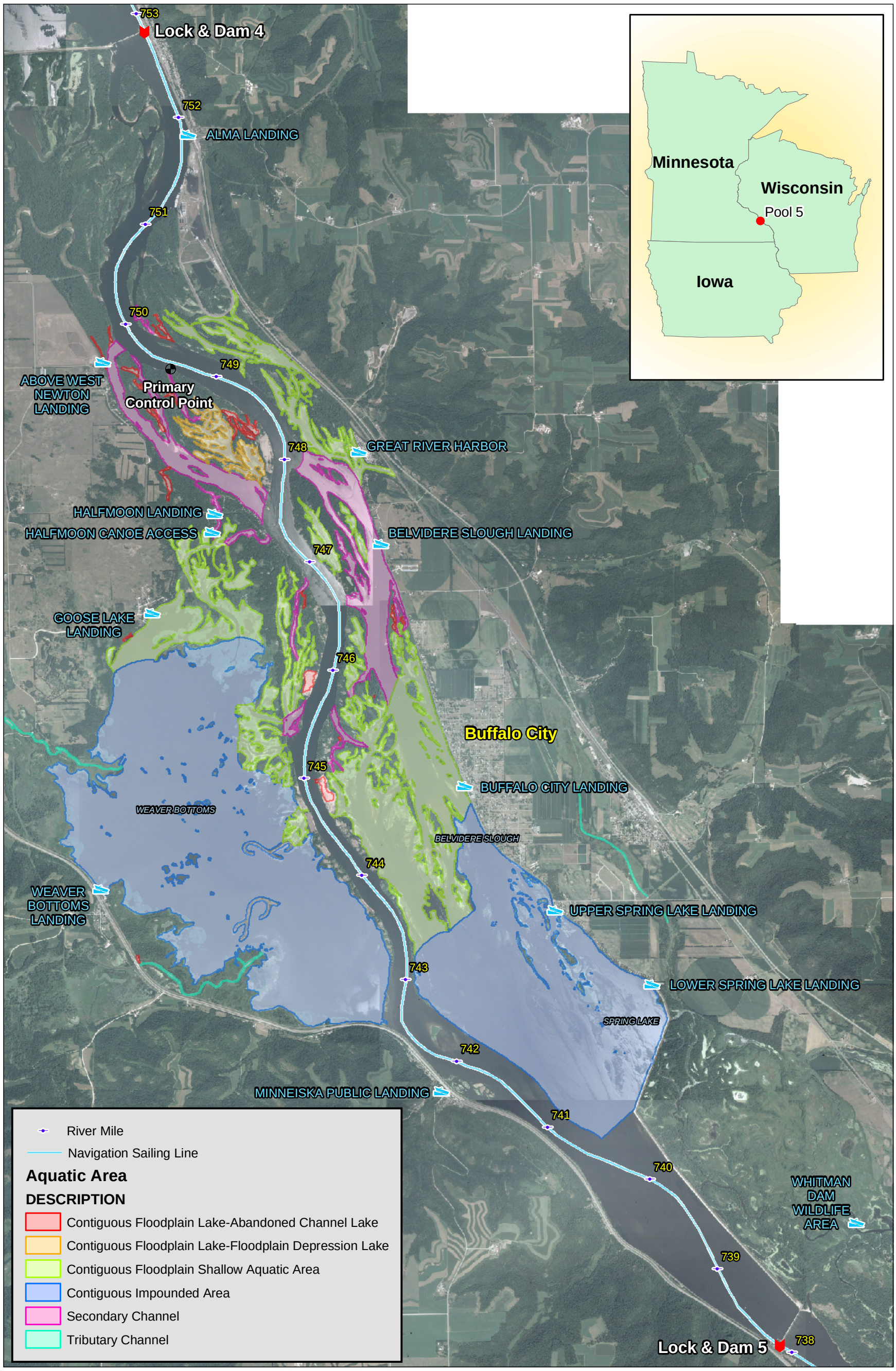
Section 6.0 Environmental Assessment presents a full evaluation of the potential ecological effects of the proposed drawdown that were considered in the alternative formulation, evaluation, and selection. Minor adverse effects on cultural resources, recreation, mussels, fish, and other aquatic organisms may occur during the drawdowns and are discussed in Section 6.0 Environmental Assessment. Quantification of habitat benefits for the various alternatives is presented below.

Habitat suitability modeling was used to quantify and incrementally compare the costs and benefits of the drawdown alternatives. For this evaluation, it was assumed that the vegetation established from a drawdown would be maintained at a similar quality for the first 5 years. Afterward, the vegetative community would begin a slow decline and would approximate the future without project conditions at around year 10. The vegetation that develops will depend on a variety of factors including the seed bank available in the sediments, the substrate characteristics of the individual sites, timing of the drawdown, and climatic conditions. Some perennial herbaceous emergent seedlings would be established. Some of these young perennial emergents would be lost upon reflooding. However, the oxidized and consolidated sediments should allow some of the surviving emergents to expand over time. With a second year of drawdown, the perennial herbaceous emergents should develop more vigorous rootstock, allowing a greater degree of survival upon reflooding. Additional areas would also be colonized by seedlings and through vegetative expansion by rhizomes. The response of herbaceous emergents should be relatively good after 1 year of drawdown and it would improve with 2 consecutive years of drawdowns. The habitat benefits for only 1 year of drawdown were analyzed with the assumption that benefits after a second year would be consistent.

Enhancement/restoration of marsh and shallow aquatic habitat through drawdowns would benefit a variety of fish and wildlife species. To represent the broad community and guilds that would benefit from the proposed drawdowns, habitat suitability modeling was completed for two fish species (bigmouth buffalo and northern pike); two bird species (American coot and red-winged blackbird); and one aquatic mammal species (muskrat). The benefits were then averaged to obtain a community response (Table 3-7). This reduces the benefits value over what could have been obtained by selecting the single species model that was most sensitive to the proposed drawdowns. However, it strengthens the benefits qualitatively by demonstrating the diverse fish and wildlife community that would benefit from the proposed drawdowns. All five organisms evaluated showed positive responses to the drawdowns but varied slightly.

Between 940 and 1,950 acres will be exposed for the drawdown alternatives (Table 3-7). Other aquatic areas will be benefited by having lower water levels (increased photic zone depth) and will also benefit from the revegetation that occurs on the exposed areas once they are reflooded. Pool 5 contains about 11,300 acres of aquatic habitat. However, some aquatic areas will be affected only slightly or not at all by the drawdown such as the far upper reaches of the pool, main channel, main channel border, and isolated aquatic areas. To better quantify the habitat benefits to the selected species, specific aquatic areas expected to be affected the most by the drawdown were used for the study area in the analysis (Figure 3-8). The resulting aquatic area encompasses 7,566 acres, extends from about river mile 740.5 to about river mile 750.0, and consists of contiguous floodplain lakes, contiguous floodplain shallow areas, contiguous impounded areas, secondary channels, and tributary channels (see Figure 3-8). Main channel, main channel border, and isolated backwaters were not used in the analysis.

During the drawdown, it was conservatively assumed that the dewatered area for each alternative would not be available for use by the species analyzed, essentially having a zero Habitat Suitability Index (HSI). This may be reasonable for the fish species, but it is likely overly conservative for the birds and mammals.



Mississippi River Pool 5 - Drawdown Analysis

Aquatic areas used for Habitat Evaluation Procedure and Incremental Cost Benefit Analysis

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St. Paul District GIS CENTER
US Army Corps of Engineers®

4,500 0 4,500 9,000 Feet

N

Drawdown20040910HREP11x17.mxd MRW 2/17/2005

Figure 3-8

The results of the habitat analysis are shown in Tables 3-7 and 3-8 and on Figure 3-9. With this community model, all drawdown alternatives are justified as the cost per average annual habitat unit ($/AAHU) gained for all alternatives is less than $900 and well within what is typically justified for ecosystem restoration projects. The $/AAHU for the ecological community would be $4, $335, and $883 for a 1.5-, 2.0-, and 2.5-foot drawdown, respectively (see Table 3-8 and Figure 3-9). By far, the greatest incremental increase in AAHU (1,090) and the lowest $/AAHU ($4) were for the 1.5-foot drawdown. This is probably because there are no added main channel dredging or off-loading costs, only recreational access dredging costs. Dredging required to sustain a 1.5-foot drawdown is considered to be advance maintenance and is expected to reduce future maintenance dredging by a comparable quantity. The $/AAHU increases incrementally with drawdown depth, $335/AAHU and $883/AAHU for a 2-foot and a 2.5-foot drawdown, respectively (see Table 3-8). Since future channel maintenance benefits associated with advance dredging for the 1.5-foot drawdown alternative are not guaranteed, the analysis was run assuming zero future dredging benefit. The 1.5-foot drawdown alternative still provided <$200/AAHU, the lowest among the alternatives.

Table 3-7 – Acres Exposed, Cost, and Average Annual Habitat Units Gained for Pool 5 Drawdown Alternatives

	Drawdown		
	1.5-foot	**2-foot**	**2.5-foot**
Acres exposed	940	1,459	1,950
Incremental increase (acres exposed)	940	519	491
Incremental increase in dredging cost*	$30,228	$659,064	$798,280
Average annual cost (6 5/8% interest)	$4,230	$92,216	$111,695
Community AAHU	4,525.1	4,800.0	4,926.6
Incremental increase in AAHU	1,090.1	275.0	126.6
Incremental $/AAHU	$4	$335	$883

*Incremental increase in dredging cost includes supplemental main channel dredging (beyond advance dredging), recreational access dredging, and future off-loading of material from placement sites. Dredging required to sustain a 1.5-foot drawdown is considered to be advance maintenance and is expected to reduce future maintenance dredging by a comparable quantity.

Table 3-8 – Summary of Average Annual Costs per Habitat Unit for Pool 5 Drawdown

		Model					
	Unit	BM Buffalo	N. Pike	A. Coot	Blackbird	Muskrat	Community
No action	AAHU	6733.7	5296.2	529.6	2572.4	2042.8	3435.0
1.5-foot	AAHU	7172.4	5792.9	2062.2	4402.6	3195.3	4525.1
Change	AAHU	438.6	496.7	1532.6	1830.1	1152.5	1090.1
AA$/AAHU	**$/AAHU**	**$10**	**$9**	**$3**	**$2**	**$4**	**$4**
2-foot	AAHU	7255.2	6304.4	2166.3	4662.3	3612.0	4800.0
Change	AAHU	82.8	511.5	104.1	259.8	416.7	275.0
AA$/AAHU	**$/AAHU**	**$1,113**	**$180**	**$886**	**$355**	**$221**	**$335**
2.5-foot	AAHU	7286.3	6287.2	2270.5	4865.8	3923.1	4926.6
Change	AAHU	31.1	-17.2	104.2	203.5	311.1	126.6
AA$/AAHU	**$/AAHU**	**$3,590**	**($6,500)**	**$1,072**	**$549**	**$359**	**$883**

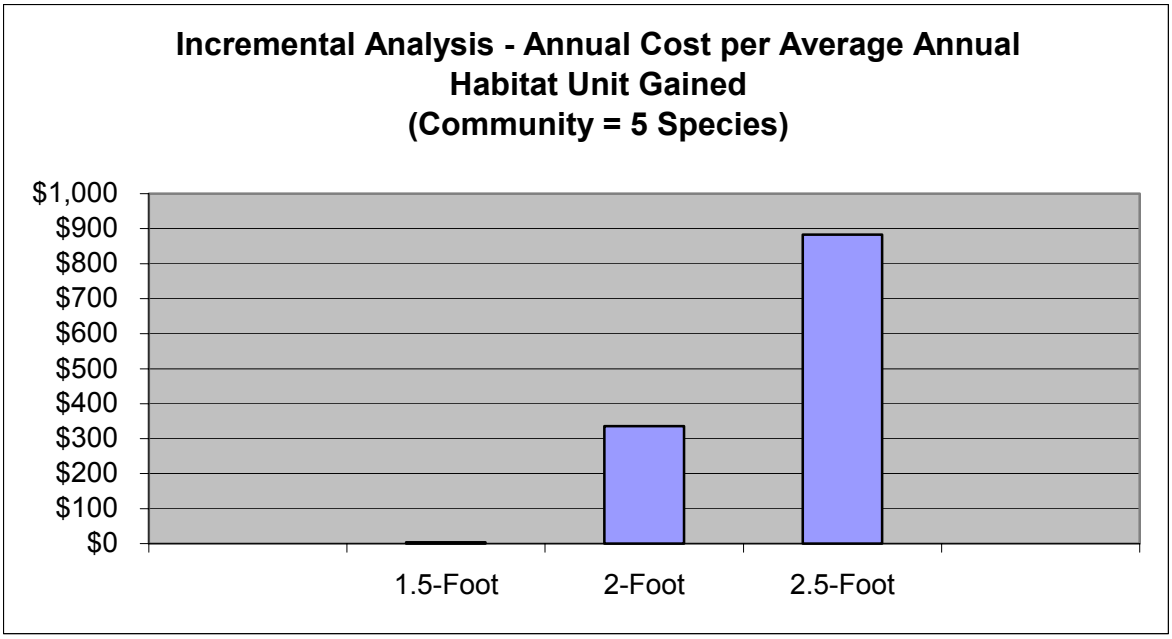

Figure 3-9 – Pool 5 Drawdown Incremental Analysis – Annual Cost Per Average Annual Habitat Unit Gained

3.2.3 CHANNEL MAINTENANCE

3.2.3.1 Dredging Requirements and Costs

An assessment has been made of the dredging requirements and costs that would be associated with a drawdown in Pool 5. The results are summarized in Table 3-9. Note that these are **estimated costs** of dredging associated with the drawdown. Also, there are a number of variables that influence channel maintenance quantities and costs for implementing a Pool 5 drawdown. The following assumptions and factors were considered in developing the cost estimates:

- Estimated dredging quantities are based on 2001 channel condition surveys. Actual dredging quantities and corresponding costs in 2005 will vary from these estimates.
- Hydraulic dredging costs are based on the current Dredge Thompson and ancillary plant cost of $33,000/day. The new Dredge Goetz will be in operation in 2005. Daily rental rates are not yet established for the new plant. The Dredge Goetz will have little or no operational experience at the time of the drawdown dredging. Delays and increased costs may be experienced due to equipment start-up issues.
- Hydraulic dredging costs are based on the estimated time required to perform the work, which is influenced by numerous factors. Area and dredging face are key factors. The time and cost for dredging the same area under different drawdown scenarios may be similar if the face does not change substantially.

- Mechanical dredging costs are estimated at $8.00/CY based on the 2002-2004 contract rate of $7.20/CY plus $0.80/CY for anticipated increases for a new contract to be awarded in 2005. Actual costs will vary from the estimates used.
- Channel maintenance benefits are anticipated through a 1.5-foot drawdown, thus justifying that level as an Operation and Maintenance expenditure. A greater drawdown results in dredging and costs that will require supplemental funding as estimated in Table 3-9.

Table 3-9 – Dredging Requirements and Costs for Various Drawdown Levels

Dredge Cut	Placement Site	Dredge Type	Qty (CY) ~ Area (SF) ~ Cost		
			1.5-foot	2.0-foot	2.5-foot
Mule Bend	748.0R Above West Newton	Hyd	27,000 612,500 $193,000	30,300 612,500 $193,000	40,300 815,000 $257,000
West Newton	748.0R Above West Newton	Hyd	31,100 840,000 $240,000	39,500 930,000 $266,000	49,900 1,035,000 $296,000
Below West Newton	745.8R Fisher Island	Hyd	21,600 515,000 $176,000	25,900 515,000 $176,000	30,300 515,000 $180,000
Fisher Island	745.8R Fisher Island	Hyd	78,300 1,588,750 $381,000	95,500 1,588,750 $394,000	110,800 1,588,750 $458,000
Lower Zumbro	744.7L Lost Island	Hyd	36,800 1,292,500 $297,000	54,600 1,292,500 $297,000	72,000 1,292,500 $328,000
Sommerfield	744.7L Lost Island	Mech	31,900 $255,000	50,300 $402,000	64,200 $514,000
Mt. Vernon	744.7L Lost Island	Mech	28,800 $230,000	38,400 $307,000	48,800 $390,000
TOTAL		QTY COST	255,500 $1,772,000	334,500 $2,035,000	416,300 $2,423,000
DIFFERENCE FROM 1.5-FOOT		QTY COST	0 0	79,000 $263,000	160,800 $651,000

Each incremental half-foot increase of drawdown requires an increasingly greater level of dredging investment up to a 2.5-foot drawdown. The increases in quantity and cost above a 1.5-foot drawdown are 79,000 CY / $263,000 (2-foot) and 160,800 CY / $651,000 (2.5-foot), respectively.

The dredging costs displayed in Table 3-9 do not include the additional costs of eventually having to unload this material from the dredged material placement sites. This information is summarized in Table 3-10.

Up-front additional navigation channel dredging and associated costs necessary to implement a

drawdown may be recouped by reduced channel dredging requirements in future years. St. Paul District hydraulic engineering staff believes there is a high probability for this to occur for a drawdown that does not exceed 1.5 feet.

3.2.3.2 Dredged Material Placement

A drawdown of Pool 5 would require additional dredging to insure adequate depths in the navigation channel. Two methods for placement of the additional dredged material were evaluated – placement in existing dredged material placement sites and island construction.

Supplemental dredging results in additional material that will require future removal from the containment areas, as shown in Table 3-10. The estimated total quantity placed at the site includes a 20 percent inflation factor related to non-pay yardage that is dredged to insure project depth and due to equipment operating characteristics. The cost for future removal of the supplemental quantity is uncertain because a final placement site is undetermined. Hydraulic removal with island construction is assumed. The estimated cost is based on $4.00/CY and excludes base contract costs because the site is already being excavated.

Table 3-10 – Estimated Quantities and Cost for Future Removal of Supplemental Material

Placement Site	Pre-Project Capacity (CY)	Estimated Total Placed at Site (CY) (Includes 20% factor) Post-Project Site Capacity (CY)		
		1.5-foot	2.0-foot	2.5-foot
748.0R Above West Newton	1,100,000	69,720 1,030,280	83,760 1,016,240	108,240 991,760
745.8R Fisher Island	167,000	119,880 47,200	145,680 21,320	169,320 -2,320
744.7L Lost Island	286,000	117,000 169,000	171,960 114,040	222,000 64,000
TOTAL QUANTITY PLACED		306,600	401,400	499,560
DIFFERENCE FROM 1.5-FOOT		0	94,800	192,960
ESTIMATED COST FOR FUTURE REMOVAL OF SUPPLEMENTAL QUANTITY		0	$379,000	$772,000

Table 3-10 shows that the Fisher Island placement site will nearly reach (under the 2.0-foot drawdown scenario) and exceed (under the 2.5-foot scenario) site capacity this dredging season (2005) if a drawdown is implemented. The Lost Island placement site will have from 2 to 6 years of storage capacity remaining if the drawdown is implemented. Because of this increased amount of material placed during a single dredging season, our timeline to excavate these sites has been shortened.

3.2.3.3 Individual Dredge Cut Discussions

Lower Approach to Lock and Dam 4 Dredge Cut – Dredging at the Lower Approach to Lock and Dam 4 cut in order to conduct a drawdown of Pool 5 is not anticipated.

Mule Bend and West Newton Dredge Cuts – The Above West Newton placement site was unloaded in 2003-2004. It has an approximate capacity of 1,100,000 cubic yards and a life expectancy of about 30 years before it will need to be unloaded again. With a drawdown in Pool 5, an estimated 70,000 to 108,000 cubic yards of material would need to be dredged, depending on the depth of drawdown. Placing supplemental dredged material in the Above West Newton site would shorten its life expectancy 2 to 3 years.

The most practical approach would appear to be placement of material from these dredge cuts in the Above West Newton placement site. These dredge cuts are the farthest from potential island construction locations in Weaver Bottoms or lower Pool 5. Use of this material for island construction would be more costly than using material from the lower dredge cuts.

Below West Newton and Fisher Island Dredge Cuts – With a drawdown in Pool 5, an estimated 100,000 to 150,000 cubic yards of material would need to be dredged from these two dredge cuts, depending on the depth of drawdown. Placing this material in the Above Fisher Island placement site would fill the site to capacity.

If island construction in Weaver Bottoms is considered, then material from these two dredge cuts could be used for that purpose. If island construction were considered only in lower Pool 5, then the most practical approach would be to place material from these two dredge cuts into the Above Fisher Island site. Their distance from potential lower Pool 5 island construction sites is probably too great to make it cost effective to mobilize the equipment necessary to pump those distances.

Lower Zumbro, Sommerfield Island/Minneiska Dredge Cut – Material dredged from these cuts to accommodate a drawdown would range from 29,000 to 72,000 cubic yards, shortening the life expectancy of the Lost Island placement site by 1 to 2 years (supplemental dredged material only). Material from these dredge cuts could be used for island construction in Weaver Bottoms or the upper reaches of the open water portion of lower Pool 5.

Mount Vernon Light Dredge Cut – Material from this cut is scheduled for use to construct the first (Island E3) of a series of cluster islands in the upper reaches of the open water portion of lower Pool 5. Each island will be built on the basis of a single dredging event. Island construction is scheduled for spring 2005. If Island E3 is not constructed, the material will be placed in the Lost Island placement site, shortening the site's life expectancy 1 year (supplemental dredged material only).

3.2.3.4 Summary

Material dredged to accomplish a drawdown can be placed in existing containment sites or used to construct islands, or both. Placing the material in existing containment sites would be the

easiest option from an operational standpoint and probably less costly, both initially and over the long term.

Island construction would be a more costly option. However, the additional costs may be offset by the environmental benefits associated with island construction. Dredge cut location would be an important factor as to whether the dredged material could readily be used for island construction.

Another option currently under consideration in Pool 5 is the construction of a cluster of small islands vs. one larger island. The method of island construction is currently scheduled for a test in 2005. Whether this is a cost-effective method of island construction will be evaluated as part of this test.

3.2.3.5 Summarized Costs Including Future Placement Site Excavations

1.5-foot Drawdown – No additional costs; all funded by Corps of Engineers Operations.
2.0-foot Drawdown – Estimated $642,000 additional costs; no funding source identified.
2.5-foot Drawdown – Estimated $1,423,000 additional costs; no funding source identified.

3.2.4 COMMERCIAL NAVIGATION

3.2.4.1 Lockages at Lock and Dam 5

Over the last 14 years, Lock and Dam 5 has averaged about 4,500 lockages per season. This figure is similar to the average of the other locks in the St. Paul District (excluding Lock 1 and the locks at St. Anthony Falls, which have lower traffic). The navigation season in the St. Paul District typically opens by mid-March and continues through late November. Lockages at Lock and Dam 5 are fairly evenly split between commercial tows and recreational craft, although some variation between years is evident. The total number of lockages is also fairly stable. The number of commercial lockages is higher than the number of commercial tows because about 75 percent of commercial tows require two lockages to pass through the lock. The lockage data for Lock and Dam 5 is shown in Table 3-11.

Table 3-11 – Lockages at Lock and Dam 5 (1990-2003)

Year	Commercial	Recreational	Other	Total
1990	2,673	2,442	90	5,205
1991	2,285	2,500	115	4,900
1992	2,342	2,385	103	4,830
1993	1,446	1,769	88	3,303
1994	1,751	2,857	198	4,806
1995	1,946	2,643	115	4,704
1996	2,113	2,334	264	4,711
1997	1,946	2,362	207	4,515
1998	2,163	2,275	133	4,571
1999	2,207	2,169	103	4,479
2000	1,993	2,348	166	4,507
2001	1,449	2,015	146	3,610
2002	1,879	2,217	128	4,224
2003	1,660	2,317	93	4,070

Transporting bulk commodities by barge is generally less expensive than using other forms of transportation, such as train or truck. Commodities typically transported through Lock and Dam 5, reported as a percentage of total tonnage, are grain (60 percent), agricultural chemicals (14 percent), coal (8 percent), petroleum products (4 percent) and other commodities (14 percent).

As with any transportation system, disruptions to the normal flow of traffic add to the overall costs of shipping. Channel shoaling, accidents, maintenance of structures, or "loss of pool" can all cause temporary shutdowns of the navigation system. Congestion at the locks can also cause delays that add to cost. Planned shutdowns can result in fewer losses due to advance notification.

Disruption costs can be divided into two categories: delay costs and diversion costs. Delay costs accrue in circumstances when it is cheaper to wait for the waterway to reopen than it is to switch to another mode of transport. Delay costs typically amount to $7,800 per tow per day. Diversion costs accrue when it is cheaper to switch to other modes of transport, rather than to accept delays on the waterway. Costs for switching to other modes of transportation range from $50,000 to $190,000 per tow, depending on commodity.

A basic criterion to be met by any pool drawdown alternative is that the navigation channel will be maintained. Thus, in theory, the effects of a partial pool drawdown on commercial navigation should be minimal. However, there are a number of areas where effects on commercial navigation may occur.

3.2.4.2 Lock 4 Lower Sill

The lower lock sill at Lock 4 is at elevation 647.0. (Lock sills are the highest points in the bottom of a navigation lock chamber. They are elevated areas against which the lock gates rest when they are in a closed position, providing support for the gates and a seal against leakage.) For all but the most extreme low water conditions, there is 13.0+ feet of depth over this sill under the current regulation of Pool 5. For a fully loaded tow with 9 feet of draft, this provides a minimum of 4 feet of static clearance. TR HL-87-3 APR 1987, "Safe Navigation Speeds and Clearance at Lower Sill, Temporary Lock 52, Ohio River," by S.T. Maynord, concludes that, for static clearances of 2.5 feet between the sill and the tow, a dynamic clearance of at least 1 foot was maintained while the tow was under way for all propeller speeds. For a 1.5-foot drawdown, a minimum of 2.5 feet of static clearance over the miter gate end sill is always maintained. For a 2.0-foot drawdown, 2.0 feet of static clearance over the miter gate end sill is always maintained.

This will serve as a regulating criterion for a drawdown; i.e., if river discharges fall to the point where there is less than 11.0 feet of depth over the lower sill at Lock and Dam 4, the drawdown will be stopped and Pool 5 will be allowed to refill until 11.0 feet of depth is restored.

3.2.5 COMMERCIAL FACILITIES

The only commercial facility identified in Pool 5 is the Dairyland Power Cooperative facility in Alma, Wisconsin. This facility is located at river mile 752 on the left descending bank (Wisconsin side). The maximum potential impact on this facility from a drawdown in Pool 5 would be a lowering of the water surface elevation by up to 1 foot, depending on river flows.

In a conversation with Mr. Larry Kelley, the facility site manager, in November 2004, Mr. Kelley indicated that a 1-foot drawdown at the facility would not be expected to have any significant impact on facility operations. Mr. Kelley will be kept informed of the progress of the drawdown to ensure that no adverse impacts to the Dairyland Power Cooperative facility occur.

3.2.6 RECREATION

3.2.6.1 Recreational Facilities Survey

The Minnesota Department of Natural Resources (MDNR) surveyed recreational boat facilities in Pool 5, assessing the potential for adverse effects for 1-foot through 4-foot drawdowns, the original range of alternatives identified prior to preliminary screening. For the purpose of this analysis, to arrive at an evaluation for 1.5-foot and 2.5-foot drawdowns, sufficiently accurate results can be obtained by interpolating.

This information was presented in a document entitled "Pool 5 Recreational Boat Access Survey," dated January 3, 2002 (see Appendix A). Conversations with the Minnesota Department of Natural Resources in October 2004 indicated that the information in this survey is still sufficiently accurate for use in this report.

This discussion of potential recreation effects is based upon the Minnesota Department of

Natural Resources survey. See Appendix A for this report.

3.2.6.2 Public Boat Landings

There are 11 public boat access points in Pool 5. Table 3-12 summarizes the Minnesota Department of Natural Resources assessment of the current condition of the ramps and how various levels of drawdown may affect them.

Table 3-12 – Minnesota Department of Natural Resources Assessment of Boat Ramp Effects

	Current Condition	Drawdown Level			
		1 Foot	2 Feet	3 Feet	4 Feet
Minnesota					
Weaver Landing	M	U	U	U	U
Minneiska Landing	A	I	U	U	U
Halfmoon Landing	M	I	U	U	U
West Newton Colony Ramp	A	A	M	I	I
Prichard's Landing	I	U	U	U	U
Clear Lake	I	U	U	U	U
Wisconsin					
Alma Boat Landing	A	A	A	A	A
Belvidere Slough Landing	A	A	A	A	A
Buffalo City Landing	A	A	A	A	A
Upper Spring Lake Landing	A	A	A	I	U
Lower Spring Lake Landing	A	A	A	A	A

A = adequate (>2.0 feet of water)
M = marginal (1.5 to 2.0 feet of water)
I = inadequate (1.0 to 1.4 feet of water)
U = unusable (<1.0 foot of water)

The Minnesota Department of Natural Resources assessment indicates that drawdown would have a greater effect collectively at Minnesota ramps, probably because most of those ramps are considered currently to have less than adequate access conditions.

The actual effects on boat access in Wisconsin would probably be more severe than the MDNR assessment indicated. Except for the Alma landing, located on the main channel, the other ramps are located in the Belvidere Slough/Spring Lake area. Even if water depths at the ramps would be adequate during a drawdown, shallow water in Belvidere Slough would likely make access to the main channel difficult at best, especially for drawdowns in the 2- to 4-foot range.

3.2.6.3 Marinas

The only marina in Pool 5 is the Great River Harbor located on the Wisconsin side at river mile 747.9. The MDNR survey indicates that depths within the harbor and at the boat ramp appear to be relatively good. Water depths within the harbor could become a problem with a 4-foot drawdown.

The larger concern with this facility would be depths in its access channel and within Belvidere Slough, especially with 3-foot and 4-foot drawdowns. Dredging could be required to maintain adequate depths for the larger houseboats that use this facility.

3.2.6.4 Private Docks

The MDNR identified approximately 140 private docks on the Wisconsin side of the river and approximately 50 private docks on the Minnesota side of the river. The MDNR assessment indicates that very few of the docks on the Minnesota side would be adversely affected by drawdown, as most are located on relatively deep sloughs and side channels.

The MDNR assessment indicates that over 50 percent of the docks on the Wisconsin side could be affected by drawdown. This assessment only looked at the dock locations and areas immediately adjacent to the docks. All of the Wisconsin docks are located in the Belvidere Slough/Spring Lake area, and users are likely to be affected by shallow water in Belvidere Slough even if water depths at their docks remain adequate during a drawdown.

3.2.6.5 Recreational Access Dredging

A Citizens Advisory Committee has identified recreational access needs in anticipation of a Pool 5 drawdown. During public input meetings in fall 2003, citizens supported a Pool 5 drawdown as long as some "reasonable" level of public access could be provided. A Citizens Committee formed to address this issue provided the Water Level Management Task Force with a map showing areas commonly used by recreational boaters that would be affected by a drawdown and that might need additional dredging. All of the areas identified are channels typically used to get from public boat accesses to the main river channel.

The Water Level Management Task Force used the map to estimate dredging quantities and costs. Three sites were identified as needing dredging, and alternative solutions to dredging (moving temporary docks or developing a new access) were identified for two additional sites. Sites that need to be dredged are near Murphy's Cut by Halfmoon Landing on the Minnesota side and at two locations in Belvidere Slough on the Wisconsin side.

Table 3-13 shows estimated dredging quantities and costs for maintaining 3 feet of water at the Halfmoon/Murphy's Cut and 4 feet of water at the Belvidere north and south cuts. The dredge cuts were calculated for 25-foot and 35-foot widths for reasons discussed below. Estimates are based on Corps of Engineers August 2004 surveys.

Table 3-13 – Recreational Access Dredging Quantities and Costs

	Cubic Yards/Drawdown Level							
Drawdown Level	1.5 feet		2.0 feet		2.5 feet		3.0 feet	
Cut Width (feet)	25	35	25	35	25	35	25	35
Halfmoon/Murphy's Cut	6	8	13	18	25	34	34	46
Belvidere Slough North – Totals	146	197	327	441	634	856	851	1,149
1A (lower cut)	80	108	181	244	259	350	314	424
1B (upper cut)	0	0	22	30	166	224	251	339
1C (middle cut)	66	89	124	167	209	282	286	386
Belvidere Slough (Buffalo City)	412	556	856	1,156	1,177	1,589	1,552	2,095
Total yards to be dredged	564	761	1,196	1,615	1,836	2,479	2,437	3,290
Total Dredging Costs ($20/cubic yard)	$11,280	$15,228	$23,920	$32,292	$36,720	$49,572	$48,740	$65,799
Mob/Demob $15K ($5K/site)	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000
Total Cost	$26,280	$30,228	$38,920	$47,292	$51,720	$64,572	$63,740	$80,799

Comments: - The Pool 8 drawdown contract was used as a reference.
- The cost/cubic yard was reduced to $20 (from $25) and a base mob/demob was added.

After discussions with several dredging contractors, it was decided to increase the dredge cuts to a 35-foot width. This extra 10 feet of cut area will allow the contractors to use more typical equipment when performing this dredging versus specialized equipment that would cost more to use. The extra 10 feet of width will increase the quantity by about 35 percent; however, there will be a cost savings in the long run (i.e., no specialized equipment costs). The contract will be written to meet a certain excavation elevation and minimum width per job basis, not per cubic yard (as was done for Pool 8).

Both mechanical and hydraulic dredging equipment should be considered when evaluating and estimating this work. Small hydraulic equipment is available and capable of performing this work. Existing dredged material placement sites are within reach of the cuts using either mechanical or hydraulic equipment. Note: Because of the minimal dredging quantities, there are no apparent, measurable impacts to the placement site.

Limited access issues are expected at all dredge cuts; however, they should be manageable. It is recommended that all dredging occur during the spring runoff, if possible, to help alleviate the access issues.

Note: All quantities and costs are estimates based on the best information available. Actual costs, cut locations, and quantities will be determined at the time of dredging (spring 2005). It is assumed that all estimates are on the high side.

3.2.6.6 Recreational Beaches

Boat access to recreational beaches along the main channel could be affected by reduced water depths during a drawdown. These impacts have not been quantified.

The drawdown will create "new" beach area by exposing additional sand. It is not practical to attempt to quantify how much sand would be exposed by various drawdown alternatives. The effect would be greater in the lower portion of Pool 5, where the drawdown will be more pronounced. In the upper portions of Pool 5, there would likely be an insignificant effect, especially with alternative methods of operation designed to limit the amount of drawdown in the upper pool.

3.2.6.7 Recreational Boating

Recreational boating on the main channel of the Mississippi River should not be affected by the drawdown because of the more than adequate water depths available. However, boating in off-channel areas may be affected by reduced water depths.

3.2.7 WING DAMS

Many wing dams and closing dams were constructed in the area that is now Pool 5. Many of these structures were deeply submerged by formation of the pool or have been covered by accreted sediment. However, in a number of locations, wings still project out into the main channel of the river not too far below the present-day water surface. These structures are familiar hazards to boaters on the river. Pool drawdown will bring these structures closer to the surface, potentially increasing the hazard to recreational boat traffic. These structures are most dangerous when they rise out of relatively deep water to within 3 feet or less of the water surface.

An extensive public notification plan will be implemented to advise river users that a drawdown is being conducted and that extra care should be taken while boating. Section 5.5 Public Information Plan describes the public notification plan.

4.0 PLAN SELECTION

Plan selection focused on identification of a preferred pool drawdown alternative. It was recognized throughout the process that if a feasible pool drawdown alternative could not be identified, the selected plan would then be the No Action alternative - continued regulation of Pool 5 under existing reservoir regulation procedures.

The target drawdown level at Lock and Dam 5 was selected so as to maximize habitat benefits while minimizing adverse biological effects, as well as effects on commercial and recreational interests, and river resources, and to minimize additional channel maintenance requirements. The availability of funding for advance main channel dredging was also a key determinant of the selected drawdown level.

4.1 CRITERIA CONSIDERED IN SELECTING A PLAN

The following criteria were considered significant in selection of a target drawdown at Lock and Dam 5:

- Probability of optimum river discharges for the target drawdown
- Channel maintenance requirements
- Ecological benefits and potential adverse impacts
- Effects on river uses
- Fiscal considerations
- Stakeholder and public input

4.1.1. PROBABILITY OF A SUCCESSFUL DRAWDOWN

The probability of having a successful drawdown was discussed in detail in Section 3.2.1.9 Potential for a Successful Drawdown. The results of this analysis are shown in Table 4-1.

Table 4-1 – Potential for Successful Drawdowns Based on Historic Discharge Records

	Drawdowns					
	1-ft	1.5-ft	2-ft	2.5-ft	3-ft	4-ft
Successful	81%	69%	57%	41%	24%	17%
Partially successful	14%	19%	24%	27%	31%	21%
Subtotal	95%	88%	81%	68%	55%	38%
Marginally successful	2%	4%	7%	11%	14%	21%
Unsuccessful	2%	7%	12%	21%	31%	41%
Subtotal	4%	11%	19%	32%	45%	62%

4.1.2 CHANNEL MAINTENANCE REQUIREMENTS

Channel maintenance requirements to achieve the drawdown have been evaluated for drawdown depths of 1.5 feet, 2.0 feet, and 2.5 feet. This evaluation is presented in detail in Section 3.2.3 Channel Maintenance.

In order to use this evaluation in determining a selected plan, the following criteria were applied:

- Determination of which dredging would be advance maintenance and which would be supplemental. The evaluation determined that dredging up to 1.5 feet is advance maintenance dredging, while dredging in excess of 1.5 feet is supplemental dredging.
- Cost of the main channel dredging required for various drawdown levels.
- Funds programmed in the Fiscal Year 2005 Operation and Maintenance budget for advance dredging.
- Dredging equipment available in the relatively short period between high water and the start of the drawdown.
- Dedication of a large amount of dredging equipment to Pool 5 in the early spring decreases the Corps of Engineers' ability to respond quickly to dredging needs in other pools and increases the risk of a channel closure.
- Impact of dredging for the drawdown on existing placement site capacity.

4.1.3 ECOLOGICAL BENEFITS AND POTENTIAL IMPACTS

An environmental assessment (EA) prepared for the proposed Pool 5 drawdown is presented in Section 6.0 Environmental Assessment.

In using the information in Section 6.0 Environmental Assessment to select a plan, the following criteria were applied:

- Acres of substrate exposed
- Average annual costs per habitat unit gained
- Consolidation of sediments and improved water quality
- Expected aquatic vegetation response
- Expected overall habitat improvement expected
- Potential impacts and benefits for mussels, fisheries, and wildlife
- Potential impacts on cultural resources

4.1.4 EFFECTS ON RIVER USERS

4.1.4.1 Commercial Navigation

It is mandated by Congress that the Corps of Engineers maintain a 9-foot channel for commercial navigation. The advance maintenance dredging (and supplemental dredging if funds are secured) is planned to ensure adequate maintenance of the 9-foot channel project for any level of drawdown implemented.

4.1.4.2 Recreational Boating

A plan to provide "reasonable" recreational access during the drawdown has been developed by the Water Level Management Task Force, with support from the Citizens Committee. This is discussed in detail in Section 5.4.3 Recreational Facilities.

4.1.4.3 Commercial Facilities

The only commercial facility identified in Pool 5 is the Dairyland Power Cooperative facility in Alma, Wisconsin. The maximum potential impact of a drawdown in Pool 5 on this facility would be a lowering of the water surface elevation by up to 1 foot, depending on river flows.

In a conversation with Mr. Larry Kelley, the facility site manager, in November 2004, Mr. Kelley indicated that a 1-foot drawdown at the facility would not be expected to have any significant impact on facility operations.

4.1.5 FISCAL CONSIDERATIONS

4.1.5.1 Main Channel Dredging

Funding is programmed in the Corps of Engineers Fiscal Year 2005 Operation and Maintenance (O&M) budget for the "advance" dredging needed to accomplish a 1.5-foot drawdown in Pool 5. The Corps of Engineers O&M program is not funded to perform the additional "supplemental" dredging needed to conduct a 2.0-foot or a 2.5-foot drawdown. Advance maintenance is dredging to specific dimensions to avoid frequent redredging and ensure the least overall cost of maintaining the project. Supplemental dredging is not justified as routine or advance maintenance, and results in additional costs beyond what is needed to maintain the project.

The River Resources Forum is currently seeking additional funding to conduct this supplemental dredging.

4.1.5.2 Recreational Access Dredging

The WLMTF has both confirmed and made verbal commitments for the money needed for recreational access dredging during the drawdown for all of the alternative drawdown levels being considered (1.5-foot, 2.0-foot, and 2.5-foot). The cost of the proposed recreational access dredging for various drawdown levels is shown in Section 3.2.6.5 Recreational Access Dredging.

4.1.6 STAKEHOLDER AND PUBLIC INPUT

Stakeholder and public input received on the project is described in Section 7.0 Coordination.

4.2 SELECTED PLAN

On the basis of the technical analysis conducted, input received through the collaborative process, and in consideration of funding availability, the selected plan is a 1.5-foot drawdown at Lock and Dam 5 during the summer of 2005.

Identification of a selected plan was a collaborative effort of the Water Level Management Task Force, the River Resources Forum, and the Corps of Engineers. The three alternative drawdown levels were evaluated and judged against the criteria for plan selection listed in Section 4.1 Criteria Considered in Selecting a Plan.

At a meeting on November 9, 2004, the WLMTF developed the following position regarding the drawdown level:

> "The Water Level Management Task Force strongly recommends at least a 2-foot drawdown in Pool 5, preferably a 2.5-foot drawdown, for the summer of 2005. At this time, the Task Force understands that the Corps of Engineers has funding and can justify a 1.5-foot drawdown with Operation and Maintenance money. The Task Force requests the River Resources Forum to seek additional funds of approximately $600,000 to $1.3 million for environmental main channel dredging (2-foot and 2.5-foot drawdowns, respectively). The Task Force has both confirmed and made verbal commitments for the money needed for recreational access dredging during the drawdown."

This position was forwarded to the River Resources Forum. (Note that the cost estimates of $600,000 and $1.3 million in the WLMTF position have been revised downward. See Section 3.2.3 Channel Maintenance.)

At the River Resources Forum meeting on December 8, 2004, endorsement of a recommended drawdown level was sought. In the discussions, and in written agency positions, the following pros and cons of various levels of drawdown were identified.

1.5-Foot Drawdown

Pros

- A drawdown to a 1.5-foot level at Lock and Dam 5 is justified as an operation and maintenance supported initiative. Dredging required to sustain a 1.5-foot drawdown is considered to be advance maintenance and is expected to reduce future maintenance dredging by a comparable quantity. $1.0 million has been specifically designated in the St. Paul District, Corps of Engineers Operation and Maintenance Fiscal Year 2005 master program for advance maintenance dredging to implement the Pool 5 drawdown.
- The probability of success is greatest of the three drawdown alternatives evaluated.
- The Wisconsin Department of Natural Resources is satisfied in the pursuit of a 1.5-foot drawdown due to the current funding available for the summer of 2005.

Cons

- A 1.5-foot drawdown does not achieve the WLMTF goal of incrementally increasing the drawdown level for subsequent drawdowns. (The drawdown level for Pool 8 was 1.5 feet.)
- The Minnesota Department of Natural Resources indicated that a 1.5-foot drawdown would be a disappointment to some stakeholders and members of the public as not providing sufficient ecological benefits.

2.0-Foot Drawdown

Pros

- The Corps of Engineers supports a drawdown of 2.0 feet, if supplemental funding for main channel dredging were available for implementation. The Wisconsin Department of Natural Resources concurred with this in its written position.
- The probability of success exceeds 75 percent for a 90-day drawdown (actually 81 percent chance of occurring). (Wisconsin Department of Natural Resources)
- 2.0 feet is deeper than the 1.5-foot drawdown in Pool 8 and is a reasonable next step in the adaptive management process of implementing drawdowns. (Wisconsin Department of Natural Resources)

Cons

- Additional dredging required to implement a drawdown in excess of 1.5 feet is considered not justified in terms of navigation maintenance and is not supported as an operation and maintenance expenditure because the additional dredging is not expected to be effective at reducing future maintenance requirements.
- Funds for the supplemental dredging were not identified.

2.5-Foot Drawdown

Pros

- The U.S. Fish and Wildlife Service supports a 2.5-foot drawdown for Pool 5. A drawdown of 2.5 feet will provide the greatest resource benefits of the alternatives being seriously considered. This alternative best reverses a long-term trend of habitat loss in Pool 5. (U.S. Fish and Wildlife Service)
- Funding and plans for recreational access dredging are in place to handle a 2.5-foot drawdown. (U.S. Fish and Wildlife Service)
- Citizen support is currently strong and will remain strong to the extent that the public sees the greatest visual change in vegetation and fish and wildlife response. (U.S. Fish and Wildlife Service)

Cons

- Dredging requirements are considered excessive for the equipment that is available in the relatively short period between high water and the start of a drawdown. Additional equipment would have to be contracted. Navigation channel maintenance risk increases throughout the District because of dedicated resources to Pool 5. (Corps of Engineers)
- Dredging quantities start to exceed the remaining placement site capacity. This will accelerate the need for restoring capacity at the Pool 5 sites and will further burden an already strained Operation and Maintenance budget for maintenance of transfer sites throughout the District. At this time, the Corps of Engineers does not have an RRF-endorsed dredged material management plan for ultimate transfer of material from the Fisher Island and Lost Island containment areas. (Corps of Engineers)
- In Pool 8, advance dredging, combined with dredging in years 2 and 3, resulted in only a small increase in annual dredging volumes. This was a very positive outcome and led to a willingness to attempt a drawdown in Pool 5. To increase the chances for success and more positive outcomes, the Corps of Engineers feels it is important to adaptively approach the Pool 5 drawdown, assuming a greater level of risk but in a small increment. (Corps of Engineers)
- The potential for adverse impacts to mussels and isolation of backwaters for fish movement is considered significant. This is a concern to the Corps of Engineers, not only for the impacts but also for regulatory compliance. Until more is understood through the adaptive management process of the adverse and beneficial effects to river resources of drawdowns primarily through monitoring, a 2.5-foot drawdown at this time is excessive. (Corps of Engineers)
- The risk of exposing cultural resources increases, which also exposes the St. Paul District to a higher risk for unexpected mitigation costs. (Corps of Engineers)
- The costs, risks, direct adverse impacts, and logistical requirements all increase, while the probability of success and incremental benefits decrease. Costs are incurred up front with no guarantee that the advance dredging benefits will extend beyond the targeted drawdown year should a failure occur in 2005. (Corps of Engineers)
- A 2.5-foot drawdown has the potential to delay the Spring Lake Habitat Project and add expense to the Habitat Rehabilitation and Enhancement Project (HREP). (Wisconsin Department of Natural Resources)
- The incremental expense and decreased success rate of going from a 2.0-foot drawdown to a 2.5-foot drawdown are significant and may not be worth the risk. (Wisconsin Department of Natural Resources)
- It is unknown whether perennial emergent plants established from a deeper drawdown will be able to persist once reflooding occurs. (Corps of Engineers)

Overall Pros and Cons of Drawdowns

In addition to the input regarding specific drawdown levels, statements were made in support of the drawdown. The U.S. Fish and Wildlife Service put several of these forward in support of a 2.5-foot drawdown. Some of the benefits outlined by the Service would also be achieved at lower levels of drawdown, albeit to a potentially lesser degree. These benefits are as follows:

Pros

- Restoring aquatic vegetation in Pool 5 will benefit up to 22 species of wildlife on the Service's Region 3 Resource Conservation Priority list. Twenty-one of these species are birds, including American bittern, sedge wren, and nine species of waterfowl. The eastern massasauga would also benefit and is on the Minnesota and Wisconsin endangered wildlife lists. (U.S. Fish and Wildlife Service)
- Improving emergent and submergent vegetation also benefits a variety of fish species. (U.S. Fish and Wildlife Service)
- Improved fish and wildlife populations will dramatically improve hunting, fishing, and wildlife observation opportunities in this pool, opportunities that have markedly declined. (U.S. Fish and Wildlife Service)
- The Service recognizes the potential for adverse impacts to mussels, but stated the long-term benefit to mussels outweighs any short-term impacts. (U.S. Fish and Wildlife Service)

Cons

- None

Other Input

The following statements were also made regarding the proposed drawdown. These were not related to the discussion on the depth of drawdown.

- A second year of drawdown should be included in all proposals and planning. (U.S. Fish and Wildlife Service)
- The RRF should commit to developing a lower Pool 5 Dredged Material Management Plan that includes use of the dredged material for environmental enhancement within the lower Pool 5 floodway as the primary placement option. The plan should also address rehandling of the supplemental dredged material from the drawdown project including consideration of Environmental Management Program (EMP) funding for removal of that material. (Corps of Engineers)
- All of the supporting agencies should commit to their responsibilities for monitoring and evaluating the effects of the drawdown. (Corps of Engineers)

After a thorough discussion of the issues regarding various alternative levels of drawdown, the RRF unanimously endorsed a 2.0-foot drawdown of Pool 5. The specific endorsement language is as follows:

> "The RRF endorses a drawdown in Pool 5 during 2005, or the earliest year possible to implement the drawdown, with a preferred level of two feet. Funding for supplemental dredging will be pursued to implement a 2-foot drawdown, but a minimum drawdown level will be 1.5 feet. The RRF also endorses the concept of a drawdown in the year following the initial drawdown. RRF agencies will assign staff to participate in a Task

Force to address permanent placement of material at the Lost Island and Fisher Island placement sites."

On the basis of the technical analysis conducted, and the input received through the collaborative process, the ***preferred*** plan was for a 2.0-foot drawdown at Lock and Dam 5 during the summer of 2005. However, despite the best efforts of the Water Level Management Task Force and agency partners, additional funding could not be secured for the additional 0.5-foot of dredging required to implement a 2.0-foot drawdown. The 2.0-foot drawdown alternative is fully described in this document so this level of drawdown may receive fair consideration if funding becomes available for a 2.0-foot drawdown in 2006, or in a future year.

The ***selected*** plan is for a 1.5-foot drawdown at Lock and Dam 5 during the summer of 2005. This level of drawdown can be accomplished with currently programmed Fiscal Year 2005 Operation and Maintenance funding for main channel advance dredging. Although a 1.5-foot drawdown is not considered optimal, this level of drawdown would still provide significant ecological benefits, and would continue the momentum of the water level management program achieved with the Pool 8 drawdowns in 2001-2002.

5.0 DETAILED DESCRIPTION OF THE SELECTED PLAN

5.1 IMPLEMENTATION DECISION

5.1.1 DECISION TO PROCEED

The decision to proceed with the selected drawdown plan for Pool 5 in 2005 will be made by May 1, 2005, to provide time for public notice of the decision, to prepare for advance dredging, and to prepare for monitoring effects of the drawdown. The decision to proceed will be made by the St. Paul District, Corps of Engineers in consultation with the Water Level Management Task Force and the River Resources Forum. Some considerations in making the decision to proceed are as follows:

- Fiscal - Sufficient funds must be available to conduct the advance main channel dredging, and recreational access dredging, for the drawdown.

- Monitoring - The parties responsible for monitoring should be prepared to proceed with monitoring the effects of the drawdown.

- Unexpected Conditions - Unanticipated conditions may have a bearing on the decision to proceed; for example, extremes in river flows.

When a decision to proceed is made, notice will be provided to interested parties immediately and publicized in the media.

5.1.2 DECISION TO POSTPONE

If the decision is made not to proceed with a Pool 5 drawdown in 2005, this decision will be publicized in the media. The rationale for the decision will be provided, along with an indication of when the drawdown may be tried again, most likely in 2006.

5.2 WATER CONTROL PLAN FOR POOL 5 DRAWDOWN

5.2.1 INITIATING THE DRAWDOWN

Channel surveys and any needed advance dredging will be completed as soon as possible during or following the recession of spring high water. The goal will be to have any required dredging completed by June 15, or sooner if possible.

The drawdown will be initiated only after approval of a deviation request made to the Mississippi Valley Division Office. The drawdown will be initiated as soon as possible following recession of the spring flood, contingent upon river discharge and navigation channel conditions. The criteria for initiating the drawdown are flexible and will be decided in consultation with the Water Level Management Task Force.

The initial drawdown will be conducted by reducing pool level at Lock and Dam 5 by approximately 0.2 foot per day. A 2.0-foot drawdown will be completed in about 10 days when the water surface elevation at the dam reaches 657.5.

5.2.2 MAINTAINING THE DRAWDOWN

For a 2-foot drawdown, a pool elevation of 657.5 will be maintained at Lock and Dam 5 throughout the drawdown period as long as the water surface elevation at the Alma gage (river mile 749.3) is at or above 658.0. If river discharges decline and a minimum elevation of 658.0 cannot be maintained at the Alma gage, the water surface elevation at the dam will be allowed to rise as necessary to maintain a water surface elevation of 658.0 at the gage. Allowing the water surface elevation to rise at the dam will be required when river discharge declines below about 27,000 cfs. The normal summer operating band of + 0.2 foot will apply during the drawdown; however, river regulators will be requested to minimize fluctuation around the drawdown target elevation to the extent practicable. An operating curve has been developed for the selected drawdown plan (Figure 3-3).

The drawdown will be maintained contingent on safe navigation channel conditions. If pool levels during the drawdown prevent maintenance of a safe navigation channel, the water level will be raised to the point where a safe channel can be maintained.

The drawdown may be interrupted for environmental concerns if unanticipated and unacceptable effects occur such as excessive dissolved oxygen depletion or avian botulism. In the same vein, if unanticipated and unacceptable effects on public uses of Pool 5 occur, the drawdown will be interrupted. The Water Level Management Task Force will determine if unacceptable effects on public use are occurring.

If the drawdown is interrupted for any of the above or other unforeseen reasons, the drawdown will be restored to pool elevation 659.5 at Lock and Dam 5 as soon as possible at a rate of 0.2 foot per day, unless determined otherwise through consultation with the Water Level Management Task Force.

5.2.3 END OF DRAWDOWN

The drawdown will end on or about September 15. Pool level at Lock and Dam 5 will be allowed to rise at a rate of approximately 0.1 foot per day. The goal is to have regulation of Pool 5 return to normal by October 1.

5.2.4 SECOND YEAR OF DRAWDOWN

It would be desirable from the perspective of regenerating emergent aquatic plant growth to follow up a drawdown in 2005 with a drawdown in 2006. The River Resources Forum endorsed the concept of a drawdown in the year following the initial drawdown. A second-year drawdown would give regenerated emergent aquatic vegetation additional time to grow and become established before the pool is returned to current operating levels. The decision to proceed with a second-year drawdown will be made during the winter of 2005-2006. This

decision will be made in coordination with all of the parties involved with the project, and will be based on the results/effects of the first-year drawdown. Expected major factors in this decision will be answers to such questions as the following:

- Were channel maintenance requirements reasonable and as expected?
- Were there any commercial navigation difficulties with the drawdown?
- Did the drawdown produce the intended vegetative response?
- What were the effects of the drawdown on recreational use in Pool 5?
- Did the drawdown have any unanticipated effects, either positive or negative?
- What sources of funding are available to conduct the second-year drawdown?

5.3 NAVIGATION MAINTENANCE PLAN

5.3.1 PRE-DRAWDOWN PERIOD

As discussed previously, as soon at the decision is made to implement the drawdown, this decision will be publicized in the media.

As soon as practicable following ice-out, areas that have had a history of shoaling will be surveyed to determine channel conditions. If the surveys indicate there would be inadequate channel depths with the target drawdown, advance maintenance dredging will be implemented. If dredging is required in historic locations, as identified in the Channel Maintenance Management Plan, the dredged material will be placed in approved placement sites.

If dredging is required in non-traditional locations, a placement site will be identified through established On-Site Inspection Team procedures. The On-Site Inspection Team will be notified of the decision to proceed with implementation of the drawdown and will be advised in advance that expedited review may be necessary.

5.3.2 DRAWDOWN PERIOD

5.3.2.1 Channel Monitoring

Regular monitoring of the navigation channel will take place during the drawdown, both to identify potential problems and as part of the monitoring program for evaluation of the drawdown. In addition, commercial towboat operators will be queried at Lock and Dam 4 and Lock and Dam 5 concerning channel conditions and other observations they may have.

5.3.2.2 Channel Maintenance

The channel will be maintained during the drawdown until it becomes impractical to do so. This determination will be made on the basis of the situation at that time. At that point, as discussed in Section 5.2.2 Maintaining the Drawdown, the pool would be allowed to rise to alleviate the channel maintenance problems.

5.3.2.3 Other Measures

Commercial tow operators using Lock 4 will be informed when depths over the lower lock sill are less than 12 feet. They will be advised of any special precautions to follow when entering or leaving the lock chamber. As discussed previously, if clearances over the lower sill fall below 11 feet, the pool will be allowed to rise as necessary to achieve the needed clearance.

5.4 MITIGATION

5.4.1 NATURAL RESOURCES

The selected plan will have some unavoidable adverse effects on natural resources as discussed in Section 6.0 Environmental Assessment. The effects are considered minor and an acceptable trade-off for the potential habitat benefits to be achieved with the drawdown. One purpose of the proposed monitoring plan will be to gather information that can be used to evaluate the effects of the drawdown. This will provide valuable information when considering future applications of pool drawdown as a management option.

5.4.2 COMMERCIAL FACILITIES

The only commercial facility identified in Pool 5 is the Dairyland Power Cooperative facility in Alma, Wisconsin. This facility is located at river mile 752 on the left descending bank (Wisconsin side). The maximum potential impact of a drawdown in Pool 5 on this facility would be a lowering of the water surface elevation by up to 1 foot, depending on river flows.

In a conversation with Mr. Larry Kelley, the facility site manager, in November 2004, Mr. Kelley indicated that a 1-foot drawdown at the facility would not be expected to have any significant impact on facility operations. No mitigation is expected to be needed at the Dairyland Power Cooperative facility in Alma, Wisconsin.

5.4.3 RECREATIONAL FACILITIES

A Citizens Advisory Committee has identified recreational access needs in anticipation of a Pool 5 drawdown. During public input meetings in fall 2003, citizens supported a Pool 5 drawdown as long as some “reasonable” level of public access could be provided. A Citizens Committee formed to address this issue provided the Water Level Management Task Force with a map showing areas commonly used by recreational boaters that would be affected by a drawdown and that might need additional dredging. All of the areas identified are channels typically used to get from public boat accesses to the main river channel. Prior to the start of the

drawdown, the Minnesota Department of Natural Resources will construct an additional boat ramp that will be functional during the drawdown.

The Water Level Management Task Force used the map to estimate dredging quantities and costs. Three sites were identified as needing dredging, and alternative solutions to dredging (moving temporary docks or developing a new access) were identified for two additional sites. Sites that need to be dredged are near Murphy's Cut by Halfmoon Landing on the Minnesota side and at two locations in Belvidere Slough on the Wisconsin side.

The recreational access dredging planned should be sufficient to provide "reasonable" access during the drawdown. In addition, an extensive public outreach program is planned to inform the public about the drawdown, including recreational access impacts and proposed locations for adequate access. The Task Force has both confirmed and made verbal commitments for the money needed for recreational access dredging during the drawdown.

No additional mitigation is proposed.

5.5 PUBLIC INFORMATION PLAN

In addition to the general notice that the drawdown will be implemented, other actions will be taken during the drawdown to keep recreational boaters informed that a drawdown is under way. The primary purpose is to keep seasonal visitors or infrequent users of the river informed of conditions they may encounter. The following actions will be taken:

- Monthly press releases (or more frequent, if necessary) to the media containing an update of the status of the drawdown.

- Handouts made available to boaters locking into the pool at Lock and Dam 4 and Lock and Dam 5 informing them of the drawdown and any precautions they should take. This would include information concerning the locations of wing dams and other channel structures with advisories of the hazards these structures pose, especially under low water conditions. Signs will be posted within the lock chambers alerting boaters of the drawdown.

- Posted notices at boat ramps and marinas describing the drawdown and any precautions recreational boats should take.

- Periodic updates on the St. Paul District Web Page concerning the status of the drawdown.

- A toll-free telephone number (1-800-291-5719) will be available to provide updates on the status of the drawdown and to give the public an opportunity to leave a message with questions or comments on the project.

5.6 MONITORING

The pool drawdown will be extensively monitored. The knowledge gained can be applied to future applications of this management technique. The proposed monitoring plan is summarized in this section.

5.6.1 WATER AND SEDIMENT MONITORING

5.6.1.1 Hydrology

Mississippi River discharge will be monitored daily as part of normal data collection protocols for regulation of the system.

5.6.1.2 Hydrodynamics

During the drawdown, two sets of velocity and discharge measurements will be obtained at established transects in the reach from Lock and Dam 5 to river mile 750. One set of measurements should be done for a total river discharge below 20,000 cfs, and the other set of measurements should be done for a total river discharge above 35,000 cfs. The drawdown should exceed 1 foot when discharge measurements are done. Continuity checks will be used to verify data integrity. These measurements will be compared to existing conditions flow distributions data, and adjustments will be made to existing rating curves.

5.6.1.3 Hydrographic Surveys

A complete set of main channel surveys will be done both before and after the drawdown. Additional surveys will be required during the drawdown as part of channel monitoring. Pre- and post-dredging surveys will be conducted. Selected secondary channels and tributaries will also be surveyed.

5.6.1.4 Sediment Transport

Bottom shear stresses due to wave action will be determined and incorporated into equations that predict sediment erosion. These equations will be calibrated to reproduce measured suspended solids concentrations. If information on critical shear stress for erosion is obtained, this will be incorporated into this analysis.

Information on particle size and bathymetric change will be used to calibrate bed load transport equations for the main channel, tributaries, and secondary channels.

5.6.1.5 Water Quality

Dissolved oxygen, temperature, and light penetration will be continuously monitored at historic sites of Upper and Lower Weaver Bottoms in Pool 5. The deployment will occur for at least two 8- to 10-day periods. The Upper Weaver Bottoms is done in July and the Lower Weaver Bottoms is sampled in August. This work will replicate work that has been done since 1987. Wind speed

and a longer deployment period could be done if there is help to clean the underwater sensors.

5.6.2 RIVER USE MONITORING FOR COMMERCIAL NAVIGATION

The U.S. Coast Guard records incidences of groundings, collisions, "bumpings", and other navigation incidents. Records of incidences before, during, and after the drawdown will be evaluated to determine the effect the drawdown may have had on the frequency of such incidents.

An information paper and pilot questionnaire will be given to tows as they lock through to obtain feedback regarding the pilot's experiences navigating the pool during the drawdown.

5.6.3 CULTURAL RESOURCES MONITORING

The effect of the drawdown on the 33 archaeological and historic sites on the shoreline within the project's area of potential effect will be determined by monitoring the sites' conditions. An assessment of the condition of each of the 33 sites will be made before the drawdown and documented by photographs and videotape. Similar assessments will be conducted in the drawdown year and in the year following the drawdown.

During the drawdown, the newly exposed land surfaces will be surveyed. This information will allow an estimation of the cultural resources that have been affected by inundation, especially in the lower pool.

5.6.4 WEATHER

Weather-related information will be collected from existing sources and used in the overall analysis of drawdown effects.

5.6.5 WILDLIFE

5.6.5.1 Aquatic Invertebrates

5.6.5.1.1 Mussels

Mussels will be monitored during the drawdown to assess impacts of drawdown. Three replicate sample sites within areas containing mussels will be monitored in lower Pool 5, and three control replicates will be monitored in Pool 5A in similar habitat. At each site, three quadrats of equal site will be established at different depths: 1) shallow water that will be exposed during the drawdown, 2) shallow water that will remain at or near the shoreline during the drawdown, and 3) shallow water that will remain submerged during the drawdown. A fixed set of randomly collected mussels of various species will be marked with a unique identifier and placed within the quadrat immediately prior to the drawdown. Mussels with quadrats will be sampled while the water is drawn down and in mid-summer and again near the end of the drawdown in September, and estimates of movement and survival will be made.

In addition, during the drawdown, a more wide-scale qualitative assessment will be made along various exposed areas (i.e., mud flats) to determine the extent, if any, that mussels have been stranded by the drawdown.

5.6.5.1.2 Macroinvertebrates

The U.S. Fish and Wildlife Service (Upper Mississippi River National Wildlife and Fish Refuge) will monitor for aquatic invertebrates at random sampling sites (post-drawdown in 2005 and 2006).

5.6.5.2 Birds

The U.S. Fish and Wildlife Service (Upper Mississippi River National Wildlife and Fish Refuge) will monitor for the following:

- Weekly aerial waterfowl surveys during fall migration
- Bald eagle nesting activity
- Bittern and rail surveys along Weaver Bottoms

5.6.5.3 Amphibians

The U.S. Fish and Wildlife Service (Upper Mississippi River National Wildlife and Fish Refuge) will conduct frog and toad surveys along Weaver Bottoms.

5.6.6 VEGETATION

5.6.6.1 U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service will conduct vegetation sampling using stratified random samples at established monitoring stations.

5.6.6.2 U.S. Geological Survey - Upper Midwest Environmental Science Center (UMESC) and Minnesota Department of Natural Resources

The main objectives of the study are as follows: 1) Determine short-term vegetation response to a pool-wide drawdown of Navigation Pool 5, 2) Determine changes in distribution and abundance of submersed aquatic vegetation through repeated annual surveys using a random sampling design, 3) Determine vegetation response/growth on exposed substrates during drawdown using transect sampling at peak biomass, and 4) Determine changes in distribution of emergent vegetation through the use of interpretation of aerial photography from pre- and post-drawdown years.

5.6.7 RECREATION MONITORING

Two sampling strategies will be used to determine if recreational use patterns changed as a result of the Pool 5 drawdown.

On the ground, a random access survey will be conducted between Memorial Day weekend (May 28, 2005) and Labor Day (September 5, 2005). A vehicle/trailer count will be conducted at all the landings in lower Pool 4, Pool 5, and Pool 5A. These counts will be conducted on weekdays and weekends on the basis of a randomly designated schedule. This data collection will replicate the work done for the 2003 recreational use survey conducted in Pools 4 through 9. It will therefore provide comparison data for conditions before and during the drawdown for use at adjacent boat landings.

Also, an abbreviated Recreational Aerial Boating Study that would replicate studies done in 1989, 1991, 1993, 1995, 1997, 1999, 2001, and 2003 is proposed. These aerial flights and digital photography will cover lower Pool 4, Pool 5, and Pool 5A. This information should provide watercraft distribution and densities within these pools, evaluate levels and locations of beach use, and potentially document displacement from the drawdown pool. From a statistical standpoint, 12 aerial surveys would be preferred, and no less than five aerial surveys are recommended.

5.6.8 DISSEMINATION OF MONITORING RESULTS

The extensive monitoring program for the Pool 5 drawdown will produce a wealth of information regarding the effects of the drawdown. It will also provide a foundation for lessons learned and adaptive management of future pool drawdown projects.

As with the Pool 8 drawdowns in 2001-2002, the scientific community and the public are expected to show great interest in the monitoring results and interpretation. It is an important project purpose to seek a wide audience for this information. The following mechanisms will assist in making the monitoring results available:

- Peer-reviewed scientific, ecological, or engineering journal articles
- Presentation in non-technical journals, newspapers, or other publications for a non-scientific audience
- Presentations and media interviews on the Pool 5 drawdown and monitoring by various team members
- Documentation in any after-action reports describing the drawdown
- Placement on the St. Paul District, Corps of Engineers Water Level Management web site
- Articles in the Water Level Management Update newsletter

Experience with the Pool 8 monitoring program indicates that monitoring results and interpretation should begin to be available within 2 years of completion of the drawdown.

6.0 ENVIRONMENTAL ASSESSMENT

An environmental assessment has been prepared assessing the effects of the selected plan and alternatives. As specified by Section 122 of the 1970 Rivers and Harbors Act, the categories of impacts listed in the impact assessment matrix (Table 6-1) were reviewed and considered.

The environmental assessment discusses the effects of the proposed drawdown of Pool 5 scheduled for 2005 if conditions permit or the earliest year possible, with a second drawdown the following year. A separate Environmental Assessment and/or 404(b)(1) evaluation may be required if main channel dredging is required outside non-traditional maintenance dredging areas and/or if non-previously approved placement sites are used.

6.1 RELATED DOCUMENTS INCORPORATED BY REFERENCE

The Final Environmental Impact Statement for the 9-Foot Channel Navigation Project (Corps of Engineers 1974) describes effects of the St. Paul District's operations and maintenance activities. This water level management study for Pool 5 is part of the District's Mississippi River operations and maintenance program. The Final Environmental Impact Statement and Long-Term 404(b)(1) Evaluation for the 9-Foot Channel Maintenance Management Plan (Corps of Engineers 1997) addresses navigation channel maintenance activities, some of which relate to the proposed water level management actions. The Definite Project Report, Environmental Assessment, and 404(b)(1) Evaluation for the Pool 5 Channel Management Plan (1999) relates to some of the proposed water level management action.

6.2 INTEGRATED REPORT AND ENVIRONMENTAL ASSESSEMENT

To minimize redundancy, this document is an integrated Decision Document and Environmental Assessment. The location in this document of other sections required in a stand-alone Environmental Assessment in accordance with Corps of Engineers Guidance and Regulations for Procedures to Implement the National Environmental Policy Act is as follows.

- Authority and Need for Action – Sections 1.2 and 1.3
- Existing Conditions – Section 2.0
- Coordination – Section 7.0

Table 6-1 - Environmental Assessment Matrix for the Pool 5 Drawdown

PARAMETER	MAGNITUDE OF PROBABLE EFFECT*							
	Alternative A No Action		SELECTED PLAN Alternative B 1.5' Drawdown		Alternative C 2.0' Drawdown		Alternative D 2.5' Drawdown	
	ST**	LT**	ST**	LT**	ST**	LT**	ST**	LT**
A. SOCIAL EFFECTS								
1. Noise Levels	0		0	0	0	0	0	0
2. Aesthetic Values	0	-1	-1	1	-1	1	-1	1
3. Recreational Opportunities	0	-1	-1	1	-1	1	-1	1
4. Transportation	0	0	-1	0	-1	0	-1	0
5. Public Health and Safety	0	0	0	0	0	0	0	0
6. Community Cohesion (Sense of Unity)	0	0	0	0	0	0	0	0
7. Community Growth and Development	0	0	0	0	0	0	0	0
8. Business and Home Relocations	0	0	0	0	0	0	0	0
9. Existing/Potential Land Use	0	0	0	0	0	0	0	0
10. Controversy	0	0	-1	0	-1	0	-1	0
B. ECONOMIC EFFECTS								
1. Property Values	0	-1	0	0	0	0	0	0
2. Tax Revenue	0	0	0	0	0	0	0	0
3. Public Facilities and Services	0	0	0	0	0	0	0	0
4. Regional Growth	0	-1	0	0	0	0	0	0
5. Employment	0	0	0	0	0	0	0	0
6. Business Activity	0	-1	0	0	0	0	0	0
7. Farmland/Food Supply	0	0	0	0	0	0	0	0
8. Commercial Navigation	0	0	-1	0	-1	0	-1	0
9. Flooding Effects	0	0	0	0	0	0	0	0
10. Energy Needs and Resources	0	0	0	0	0	0	0	0
C. NATURAL RESOURCE EFFECTS								
1. Air Quality	0	0	0	0	0	0	0	0
2. Terrestrial Habitat	-1	-2	0	1	0	1	0	2
3. Wetlands	-1	-2	0	1	0	2	0	2
4. Aquatic Habitat	-1	-2	0	1	0	2	0	2
5. Habitat Diversity and Interspersion	-1	-2	0	1	0	2	0	2
6. Biological Productivity	-1	-2	0	1	0	2	0	2
7. Surface Water Quality	-1	-2	0	1	0	2	0	2
8. Water Supply	0	0	0	0	0	0	0	0
9. Groundwater	0	0	0	0	0	0	0	0
10. Soils	0	0	0	0	0	0	0	0
11. Threatened or Endangered Species	0	0	1	0	1	0	1	0
D. CULTURAL RESOURCE EFFECTS								
1. Historic Architectural Values	0	0	0	0	0	0	0	0
2. Prehistoric and Historic Archeological Values	0	-1	0	-1	0	-1	0	-2

*Scale for Summarizing Impacts by Parameter						
Adverse				Beneficial		
Significant	Substantial	Minor	No Effect	Minor	Substantial	Significant
-3	-2	-1	0	1	2	3

** LT = Long Term, ST = Short Term

6.3 RELATIONSHIP TO ENVIRONMENTAL REQUIREMENTS

The proposed action would comply with all applicable Federal environmental laws, executive orders, and policies, and State and local laws and policies, including the Clean Air Act, as amended; the Endangered Species Act of 1973, as amended; the Land and Water Conservation Fund Act of 1956, as amended; the National Environmental Policy Act of 1969, as amended; the Fish and Wildlife Coordination Act of 1958, as amended; Executive Order 11988 - Floodplain Management; and Executive Order 11990 - Protection of Wetlands. The proposed action would not result in the conversion of farmland to non-agricultural uses. Therefore, the Farmland Protection Policy Act of 1981 does not apply. Placement of dredged material in connection with water level management would occur at approved placement sites that have been previously covered in the 404(b)(1) evaluations (see Section 6.1 Related Documents Incorporated by Reference) in accordance with the Clean Water Act of 1977, as amended.

6.4 SOCIAL EFFECTS

6.4.1 EFFECTS ON TRANSPORTATION

Advance dredging will be conducted at historical dredge cuts in the navigation channel to allow continued commercial navigation during a drawdown. All dredged material would be placed in existing placement sites, as specified in the Channel Maintenance Management Plan (Corps of Engineers 1996). Some short-term minor adverse effects are expected, as towboat pilots in the lower pool may have to exercise caution, and operate at somewhat lower speeds. This may result in some added transportation costs, which will be borne by the towing industry.

6.4.2 WATER APPROPRIATIONS AND WASTE ASSIMILATION

The proposed drawdown and alternatives would have no effects on water withdrawals from Pool 5, as most municipalities and industry obtain water from groundwater wells. Dairyland Power Cooperative obtains water from the Mississippi River for cooling at the upper end of Pool 5 near Alma, Wisconsin, where water levels will drop very little. Dairyland Power Cooperative has been contacted and anticipates no problems associated with the drawdown. One industry obtains water from the Zumbro River (North Fork), and water supply will not be affected by the drawdown. The Wisconsin Pollutant Discharge Elimination System (WPDES) and National Pollutant Discharge Elimination System (NPDES) municipal waste discharge permits issued in Wisconsin and Minnesota, respectively, in Pool 5 are not conditional on river stage.

6.4.3 REAL ESTATE

The Government would not have to acquire any additional real estate rights to draw the pool down.

6.4.4 AESTHETICS

A Pool 5 drawdown will probably be met by a combination of curiosity and concern by the general public. Minor short-term adverse effects are expected as exposed river bottom and stranded fish and mussels will initially raise concern, and odor from the initially exposed sediments may be objectionable, but should be a short-term inconvenience. Both are expected to be minor problems. Growing vegetation in the drawdown zone may become attractive. Curious members of the public will visit the drawdown zone to examine the exposed river bottom. The no action alternative would probably result in long-term adverse effects on the general appearance of Pool 5 due to continued loss of vegetation and degradation of wildlife habitat.

Over the long term, if the proposed drawdown results in greater extent and abundance of aquatic vegetation, the general appearance of Pool 5 will be improved.

6.4.5 RECREATION

The proposed drawdown and drawdown alternatives will limit recreational boating activities in the lower end of the pool, but the short-term effects will be minor. With no action, the long-term recreational opportunities in the pool will probably decline due to the decline in the quantity and quality of fish and wildlife habitat and aesthetics. Boaters may be restricted from some backwater areas, and they will need to exercise caution near structures that typically would be sufficiently below the water surface (i.e., wing dams, stumps, sandbars). Some fishing areas may be difficult to access, thus reducing the amount of area anglers can use. Some access facilities will be affected by the drawdown and may be difficult to use for larger or deeper draft boats. Transient boaters typically use the main channel, and the drawdown is not expected to affect them. Local visitors typically use smaller shallow draft boats and typically use the side channels and backwaters and probably will be minimally affected. To mitigate for the decreased recreational boating access, several areas have been identified outside the main navigation channel to be dredged, and the Minnesota Department of Natural Resources will construct an additional boat ramp prior to the start of the drawdown that will be functional during the drawdown. Areas to be dredged were identified by a Citizens Advisory Committee which has proposed a plan to provide a "reasonable" level of public access. See Section 4.1.5.2 Recreational Access Dredging.

Wildlife observation, waterfowl hunting, and fishing opportunities should all increase in the long term because the improved habitat and water quality can support additional fish and wildlife. Wildlife observation opportunities may also increase in the short term when the shallow water areas are heavily used by various bird species.

6.4.6 CONTROVERSY

A public meeting and news releases have informed the public in the vicinity of Pool 5 about the proposed drawdown. Some minor short-term adverse effects involving controversy have been noted. However, many members of the general public support the efforts to restore Mississippi River habitats. Some people voiced concern about recreational boating access during a drawdown. Owners of businesses associated with recreational boating are most concerned about

the potential for a pool drawdown to limit boat access to their facilities.

6.4.7 ENVIRONMENTAL JUSTICE

Environmental Justice is a national goal and is defined as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The proposed project would affect public lands; no acquisition of private lands would occur. Public involvement, via distribution of information concerning the proposed project, has been and will continue to be an integral part of planning for this project to ensure that concerns of all people will be fully considered in the decision-making process.

6.5 ECONOMIC EFFECTS

Many of the local communities and residents along the Upper Mississippi River have embraced the concept of ecotourism, and local businesses have developed to support ecotourism. The health and growth of this industry are dependent on maintaining and enhancing the Upper Mississippi River ecosystem. The No Action alternative would maintain or result in further habitat degradation that could stifle the growing tourism industry. The No Action alternative could have a negative effect on property values, regional growth, and business activity. The proposed drawdown alternatives should have no measurable effects on property values, tax revenues, regional growth, employment, farmland and food supply, flooding, or energy use. However, the proposed drawdown, in combination with other future ecosystem restoration measures, could have a very positive long-term effect on property values, tax revenues, regional growth, and employment.

The proposed drawdown will permit continued commercial navigation (with maintenance dredging at historic dredge sites) and recreational boating on Pool 5. Deeper drawdown alternatives beyond the proposed drawdown and alternatives would further restrict these activities and their associated economies. However, with no action, the long-term recreational opportunities and associated economies in the pool may decline due to the decline in the quantity and quality of fish and wildlife habitat and aesthetics. The proposed drawdown will require towboat pilots to operate slower than usual, increasing transit time and operating costs. These additional costs will be borne by the towing industry. Recreational boating activity and expenditures in the Pool 5 area may increase in the long term. An increase in recreational boating activity may occur as people investigate Pool 5 in a drawdown condition, but they may be restricted from some areas. Commercial fishing activity may be slightly disrupted by the drawdown, due to the reduced area of aquatic habitat and increased current velocities during the drawdown.

The proposed Pool 5 drawdown and alternatives may have some limited adverse effect on businesses involved with recreational boating during the drawdown. Water depths should remain adequate for recreational boating access at all public landings, private landings, and commercial marinas with recreational access dredging. Alternative drawdowns to a greater depth would significantly disrupt recreational boating and associated business. The areas affected by the drawdown are listed and described in Section 3.2.1 Hydrology. It is anticipated

that the long-term effects on local businesses would be either neutral or positive.

6.6 EFFECTS ON NATURAL RESOURCES

The significant natural resources are described in Section 2.0 Affected Environment.

Overall, the no action alternative will result in the continued decline in Pool 5 of terrestrial and aquatic habitat; habitat diversity and interspersion; marsh wetlands; biological productivity; and surface water quality. The short-term effects are expected to be minor, and long-term effects may be substantial. The adverse and beneficial effects of the proposed drawdown and alternatives are discussed in the following sections.

6.6.1 PHYSICAL AND WATER QUALITY EFFECTS

The drawdown will impose a number of physical changes to the aquatic habitat in Pool 5. Bathymetric data are only partially available for Pool 5 to quantify the amount of aquatic substrate that would be exposed with a drawdown. See Figures 3-5, 3-6, and 3-7 for the acres exposed for drawdown levels of 1.5 feet, 2.0 feet, and 2.5 feet, respectively. Therefore, the amount of substrate potentially exposed is underestimated because of the limitations in available bathymetric data. However, the data provides a relative comparison among drawdown alternatives. Estimated acres (on the low end) of aquatic substrate exposed for the various alternatives are calculated as follows: 1.5-foot drawdown – 940 acres; 2.0-foot drawdown – 1,459 acres; and 2.5-foot drawdown – 1,950 acres. A few aquatic areas would become isolated by the proposed 2.0-foot drawdown. Alternative drawdowns would affect different areas, depending on the depth of drawdown.

During the initial phase of the drawdown, sediment will be mobilized by advective flow, as water drains from shallow areas. Wind-driven sediment resuspension will occur, as shear stresses are exerted on sediment at lower elevations as the drawdown progresses. Sediment mobilized by the drawdown will generally be focused into deeper areas within Pool 5. Some increase in sediment transport may occur at the mouth of tributaries, as the base elevation of the rivers is temporarily reduced by the drawdown.

The lower water surface profile during the drawdown will increase the effectiveness of channel training structures in concentrating flow in the navigation channel. Current velocities will increase slightly in the main channel and channel border areas. Additional sediment transport along the main channel will occur during drawdown, but response of the main channel is expected to be slow.

Water temperature in the shallow portions of the pool will be slightly higher and will have greater day to night changes due to the reduced water volume.

Underwater light will be reduced by the increase in wave-resuspended sediment described above, at least during the first part of the drawdown period. However, a 2.0-foot drawdown will ultimately increase the area of river bottom receiving light by as much as 1,500 acres, assuming that the ambient turbidity level does not change.

Sediment water content in the drawdown zone will decrease, depending on the initial water content of the sediment, position in the drawdown zone, length of the drawdown period, rainfall during the drawdown, air temperature, wind, humidity, and groundwater seepage. Limited consolidation of sediment will occur, given that most of the drawdown zone is silty sand. Organic materials in the drawdown zone sediments will oxidize, increasing available plant nutrient concentrations. Some surface crusting and cracking of the dewatered sediment may occur, especially in the more isolated backwater sediments containing higher concentrations of clay and marl (calcium carbonate).

Recreational access dredging will be conducted at five cuts within three separate sites and will affect a footprint of approximately 2.2 acres for the proposed drawdown or the 1.5-foot alternative. The footprint would be slightly greater for the 2.5-foot alternative. For the proposed drawdown, approximately 1,600 cubic yards will be removed and placed at a designated main channel dredged material placement site in Pool 5. The cuts will be 35 feet wide and differing in length. Dredging will be done either hydraulically or mechanically. Dredging will have adverse impacts on water quality through increased turbidity and suspended solids concentrations and resuspension of pollutants. The impacts should be relatively short term and fairly localized, given the small footprints of the cuts and the small amount of material being removed. The placement of the dredged material will be confined to established dredged material disposal sites and should not have any impacts on water quality.

The Environmental Protection Agency and the States of Minnesota and Wisconsin have not designated sites within the Pool 5 floodplain for a response action under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). In compliance with Engineer Regulation (ER) 1165-2-132 for civil works projects concerning hazardous, toxic, and radioactive waste (HTRW), the dredged material has been evaluated in accordance with Section 404 of the Clean Water Act and other applicable guidance and regulations.

6.6.2 ECOLOGICAL EFFECTS

The no action alternative will result in continued ecological degradation in Pool 5. The proposed drawdown will have initial effects of dewatering between 940 and 1,459 acres for 1.5- and 2.0-foot drawdowns, respectively. A 2.5-foot drawdown would expose approximately 1,950 acres. Non-mobile aquatic macroinvertebrates, the majority of submersed aquatic plants, and benthic algae in the drawdown zone will be killed. The 0.2 ft/day rate was chosen to provide a greater likelihood that most fish and mobile macroinvertebrates such as native mussels will escape the drawdown zone and avoid stranding. Most emergent aquatic plants in the drawdown zone will survive.

Plant seeds in the drawdown zone will germinate, provided that the drawdown zone remains sufficiently dewatered. In addition to the perennial emergent aquatic plants such as cattail (*Typha* spp.), softstem bulrush (*Scirpus validus*), and arrowhead (*Sagittaria latifolia*), annual plants such as smartweed (*Polygonium* spp.), lovegrass (*Eragrostis hypnoides*), rice cut-grass (*Leersia oryzoides*), pigweed (*Amaranthus* spp.), and seedling trees of willows (*Salix* spp.) and cottonwood (*Populus deltoides*) will germinate and grow in the drawdown.

If seedling plants are not killed by reflooding during the drawdown period, vegetation in the drawdown zone should become fairly dense. Following reflooding in late September, annual plants and seedling trees will die, leaving viable propagules (roots, tubers, and seeds) of emergent aquatic plants in the drawdown zone. The flooded vegetation in the drawdown zone should provide good cover for young-of-year and small fish, and good foraging habitat for migrating waterfowl zone and other wildlife. Flooded vegetation in fall and the following spring will provide abundant invertebrates important to fish and wildlife growth.

The Pool 8 demonstration drawdown was somewhat experimental, and preliminary results indicate the drawdown was largely successful in terms of emergent vegetation response on exposed substrate (Kenow et al. 2004). More than 50 species of moist soil, perennial emergent, and aquatic plant species germinated on the 1,950 acres of substrates exposed during the 2001 drawdown. Rice cut-grass (*Leersia oryzoides*), broadleaf arrowhead (*Sagittaria latifolia*), water stargrass (*Zosterella dubia*), nodding smartweed (*Polygonum lapathifolium*), chufa flatsedge (*Cyperus esculentus*), false pimpernel (*Lindernia dubia*), and teal love grass (*Eragrostis hypnoides*) were the dominant species. Increases in deep and shallow marsh, rooted floating aquatic, and submersed aquatic vegetation communities were observed in Pool 8 following the 2001 drawdown. These changes affected about 1,370 acres of lower Pool 8 through 2003. Much of the perennial emergent vegetation established with the drawdown persists (as of the 2004 growing season).

The proposed Pool 5 drawdown and alternatives should encourage the growth of submersed aquatic plants to >1 percent photic zone (approximately 2-foot water depth) in shallow areas just outside the initial drawdown zone where they do not presently occur and should increase the robustness of existing plant beds.

The combination of consolidated and oxidized sediment in the drawdown zone and more extensive areas of emergent and submersed aquatic plants should reduce sediment resuspension by wave action in the lower portion of Pool 5, increasing water clarity and available underwater light. The persistence of these effects may extend for a number of years following the drawdown.

Recreational access dredging will remove and kill non-mobile organisms such as mussels and macroinvertebrates within the footprint of the dredge cuts. Such organisms should recolonize the areas. Resuspension of sediment and the resulting downstream turbidity and potential pollution plume may have an impact on plant and non-mobile animals as well. Species such as mussels and macroinvertebrates can be affected by turbidity, intakes of pollutants, direct coverage of settling sediments, and reduced oxygen levels. The impacts should be relatively short term and fairly localized, given the small footprints of the cuts and the small amount of material being removed. The placement of the dredged material should not have any ecological

impacts, given the very small quantities of material and its placement at a designated channel maintenance dredged material disposal site.

6.6.2.1 Effects on Fish

There will be long-term beneficial impacts to the fish community due to improvements in water quality and increased vegetation. Fish will rapidly reoccupy the drawdown zone following reflooding. The standing vegetation should provide good cover and abundant invertebrate food for young-of-year and small fish (Raibley et al. 1997). Smaller macroinvertebrates and zooplankton will thrive in the flooded vegetation, an effect that may last into the first part of the growing season in the year following the initial drawdown. Increased extent and density of emergent and submersed aquatic plants that will likely result from the drawdown should have a positive effect on fish in future years, by providing more cover, shelter from current, and a more abundant macroinvertebrate forage base (Raibley et al. 1997).

The proposed drawdown and the 1.5-foot alternative could affect between 940 and 1,459 acres of the total aquatic habitat area of approximately 11,300 acres of Pool 5, reducing the available aquatic habitat by less than 13 percent by area. The 2.5-foot drawdown alternative would reduce the available habitat by about 17 percent. The drawdown may isolate a few backwater areas where fish could become trapped. Most fish should be able to escape the drawdown zone without stranding or entrapment. The proposed 0.2-foot-per-day drawdown rate should prevent most stranding and entrapment of fish. Any areas that become isolated during the drawdown will trap some fish, which will become subject to stress by high water temperature, low dissolved oxygen, and bioturbation of sediment, and subject to predation by birds and furbearers (Adams et al. 1999, Dieterman, pers. comm.). Most fish that become entrapped in shallow isolated backwaters by the drawdown will be killed.

The proposed June drawdown may disrupt spawning by bluegills, crappies, largemouth bass, and other fish that spawn during the drawdown period. The nest spawning species may not find suitable habitat for spawning during the drawdown period, and recruitment of these species may be lower during the drawdown year (Pitlo and Rasmussen 2004, Maceina 2003, Raibley et al. 1997).

The drawdown may force many young-of-year and smaller fish out of vegetated areas into open water, making them more vulnerable to predation. This predation effect may also contribute to reduced recruitment of fish during the drawdown year (Pitlo and Rasmussen 2004, Raibley et al. 1997).

The generally higher current velocities during the drawdown would reduce the amount of suitable habitat for lentic fish, such as bluegills, many minnow species, crappies, largemouth bass, and yellow perch. The higher current velocities may increase the amount of suitable habitat for lotic species, such as walleye, sauger, darters, suckers, paddlefish, and white bass.

Sport and commercial fishing patterns will be disrupted by the drawdown to some extent, possibly resulting in reduced exploitation rates.

Recreational access dredging should have very little impact on fish, as they have the ability to

move away from dredging activity.

6.6.2.2 Effects on Wildlife

6.6.2.2.1 Effects on Wildlife – General

For the proposed drawdown and alternatives, except the no action alternative, non-mobile macroinvertebrates in the drawdown zone will be killed by stranding and desiccation. Some mobile species will escape to deeper water. Macroinvertebrates residing within the footprint of recreational access dredge cuts will be removed and killed but should quickly recolonize the dredge cut areas (Koel and Stevenson 2002). The newly exposed substrate should be the same as the existing surficial substrate material, thereby allowing fairly rapid recolonization of the same community of benthic macroinvertebrates as exists there now. Macroinvertebrate abundance in Pool 5 is substantial, on the basis of work done in Pool 5A (Anderson et al. 1983) and Pool 4 (Sauer and Lubinski 1998). Organisms occurring immediately upstream of any disturbed area should recolonize by drifting into the area. Some types of macroinvertebrates will thrive in the flooded vegetation following the drawdown, and most species presently existing in the drawdown zone should recolonize in the first year following the drawdown (Weller 1981). Any increase in the extent of submersed and emergent aquatic vegetation should have a positive effect on future abundance of macroinvertebrates. As shown by Johnson et al. (2000) in the Pool 5 Finger Lakes study, benthic macroinvertebrate biomass is greater in vegetated, rather than nonvegetated, areas. Sediment consolidation in the drawdown zone should persist for some time following drawdown, also improving conditions for burrowing macroinvertebrates such as *Hexagenia* mayflies.

From recreational access dredging, resuspension of sediment and the resulting downstream turbidity and potential pollution plume may have an impact on non-mobile animals as well. Macroinvertebrates can be affected by turbidity, intakes of pollutants, direct coverage of settling sediments, and reduced oxygen levels. The impacts should be relatively short term and fairly localized, given the small footprints of the cuts and the small amount of material being removed. The placement of the dredged material should not have any impacts to wildlife, given the very small quantities of material and placement at a designated channel maintenance dredged material disposal site.

For the proposed drawdown and alternatives except the no action alternative, the drawdown zone will initially be attractive to killdeers, sandpipers, eagles, crows, herons, raccoons, skunks, muskrats, and other birds and mammals that will feed on stranded aquatic organisms. Egrets and possibly sandhill cranes will also be attracted to the shallow water areas in relatively large numbers during the drawdown. Canada geese will congregate in areas with newly sprouted vegetation. Nesting black tern reproduction may be affected because of the timing of the start of the drawdown of mid-June. Nest building is usually complete and incubation has commenced by mid-June, and a drop in water levels may leave the nests vulnerable to predation. However, the mid-June timeline was chosen after careful consideration; an earlier start date would adversely affect fish spawning, whereas a later date would cut into the vegetative growing season.

Frogs, turtles, and other animals adapted to marsh vegetation may be forced from the drawdown zone into areas where they may become more vulnerable to predation. The drawdown zone may

provide attractive grazing for white-tailed deer as the sediment dries out and vegetation develops. The mud flat areas of the drawdown zone could harbor bacteria, which can cause avian botulism. The drawdown is scheduled to be discontinued in late September, prior to the arrival of large numbers of migrating waterfowl. The reflooded vegetation following the drawdown will provide food and cover for migrating waterfowl. Much of the Pool 5 drawdown area lies within protected zones within the Upper Mississippi River Wildlife and Fish Refuge, which were established to provide feeding and resting areas for migrating birds. Any increase in emergent aquatic and submersed vegetation in Pool 5 due to the drawdown would benefit many wildlife species.

6.6.2.2.2 Effects on Wildlife - Mussels

The proposed drawdown and the 1.5-foot alternative, if done slowly and not initiated after periods of abnormally high water levels, would generally not result in adverse impacts to mussels. It is somewhat speculative as to the impacts to mussels for deeper drawdowns, but they could be substantially adverse. Mussels have evolved and adapted accordingly with fluctuating water levels; they have the ability to move and are likely to retreat to deeper water with slow retreating water levels (Isley 1913). Similarly, when placed in shallow water or on the shore, mussels have been observed seeking out deeper water (Isley 1913, D. Kelner USACE, pers. obs.). However, some mussel species are not as mobile as other species, and mussel movement to deeper water can be impeded by debris, rocks, etc. Generally, mussels are not present in water depths of less than 1.5 feet because of increased predation (McMahon 1991) and the extreme environmental conditions associated with these areas (freezing, ice damage, excessive heat, wave action, etc.) (Hornbach 1992, Strayer and Ralley 1993, Strayer 1983).

Although Pool 5 supports a fairly diverse and abundant mussel community including five species listed as either threatened or endangered in Minnesota or Wisconsin (see Table 2-2), most of these species occur in areas deeper than the proposed drawdown. No known federally listed mussel species occur in the pool. The chance of significant numbers of mussels inhabiting very shallow water during normal pool elevations is unlikely. However, during flooding or high water conditions, mussels often migrate or are carried to areas typically exposed (Tucker 1996, Coker et al. 1921). A prolonged flood occurred during the spring of 2001 on the Upper Mississippi River. In 2001, river discharges and water levels were high most of the spring and early summer, and mussel tracks and stranded mussels were observed in floodplain forest areas after the water receded in several Upper Mississippi River pools, including Pool 5 (M. Davis, Minnesota Department of Natural Resources, 2001, personal communication). In 2001, a 1.5-foot experimental drawdown was conducted in Pool 8. During approximately a 30-day period from April 13 to May 13, 2001, Pool 8 water elevation was more than 2 feet above the secondary control pool elevation, and exceeded 6 feet for a few days. This flooding scenario is rare. From 1970 to 2003, there were only 4 years (1975, 1986, 1997, and 2001) where water levels remained high (greater than 2 feet) in Pool 8 for an extended period of time (more than 20 days) during the period April 1 through June 15. However, these conditions probably contributed to the number of stranded mussels observed during the 2001 Pool 8 drawdown. To minimize adverse impacts to mussels from an unexpected prolonged flood, the Corps of Engineers and partner agencies will evaluate hydrologic conditions immediately before the proposed drawdown; if conditions are similar to 2001, agencies may decide to delay the start of the drawdown, or suspend it until

the following year. In addition, at the start of any drawdown, water levels will be lowered slowly (0.2 foot per day), allowing the escape of mussels from the dewatered zone.

For the proposed drawdown, some mussels occurring in the drawdown zone may escape to deeper water and some stranded mussels may bury themselves in the substrate and survive the drawdown. However, some mortality of mussels from thermal stress, predation, and desiccation is likely in dewatered and shallow areas (Fuller 1974, Strayer 1983, Miller et al. 1984). Mussels outside the drawdown zone will probably not be much affected by the drawdown. Although current velocities will generally be higher during the drawdown, the increased current velocities should not cause scouring and displacement of mussels from the substrate, or cause behavioral inhibition to feeding. Predation on mussels by raccoons and muskrats may increase during the drawdown, due to the shallower water depths and easier access by predators (McMahon 1991). The drawdown will kill some zebra mussels (*Dreissena polymorpha*) by desiccation, but this should not have a substantial effect on the abundance of zebra mussels or their infestation of native mussels. Overall, the proposed drawdown is not expected to significantly affect the mussel community.

Conditions for mussels would be improved in the long term by improving water quality, cleaning substrate through scouring, improving overall productivity, improving conditions for host fish species, and other ecological benefits. For drawdowns greater than 2.0 feet, long-term habitat conditions would also improve, but some short-term impacts are expected (i.e., strandings). Although difficult to quantify, a drawdown in excess of 2.0 feet would strand more mussels than lower drawdowns. As with lower drawdowns, many mussels would escape to deeper water, some would burrow in the exposed substrate and survive, and others would die via thermal stress or desiccation or be preyed upon. A monitoring program assessing the impacts on mussels during the drawdown will be conducted to help understand the impacts of drawdowns on mussels and used for planning future drawdowns.

Recreational access dredging in Pool 5 is estimated to remove and kill between 700 and 800 mussels (Corps 2004). This impact will be irrespective of a drawdown of 1.5 to 2.0 feet, as only quantities of material to be dredged increased with drawdown depth, not the footprint of the dredge cuts. An additional dredge cut will be required for a 2.5-foot drawdown resulting in slightly more mussels being removed. Extensive mussel survey work by the Corps (2004) at the proposed dredge cuts allowed for the realignment of the initially proposed cuts to minimize, to the extent possible, impacts to mussels. Resuspension of sediment and the resulting downstream turbidity and potential pollution plume may have an impact on mussels as well. Mussels can be affected by turbidity, intakes of pollutants, direct coverage of settling sediments, and reduced oxygen levels (Fuller 1974). The impacts should be relatively short term and fairly localized, given the small footprints of the cuts and the small amount of material being removed.

6.6.2.3 EFFECTS ON HABITAT DIVERSITY AND INTERSPERSION

For the proposed drawdown and alternatives except the no action alternative, pool-scale growing season drawdowns would emulate the natural low-water period of an unregulated Mississippi River. Many species of perennial emergent aquatic plants are especially adapted for seasonally fluctuating water levels, and regenerate from seed only in dewatered mud flat conditions. The stable water levels have limited the perennial emergent aquatic plants, and without the plants, accumulated fine sediment is available for resuspension from waves generated by wind events and/or boat wakes. A drawdown that allows reestablishment of perennial emergent aquatic plants would encourage the settling of sediment, improve water clarity, and encourage the expansion of submersed aquatic plants in Pool 5 where they presently do not occur. Preliminary results from the Pool 8 drawdown show that sediment did not remain consolidated after water levels returned to normal (USGS-UMESC unpubl. data). Sediment consolidation remains one of the elements that will continue to be monitored to determine the long-term impacts from repeated drawdown.

A diversity of plant species will appear across the gradient of exposed substrate, extending from the water's edge to the limits of the drawdown. This reflects the adaptation of various species to different water regimes and substrate types. Beyond the exposed substrates, newly created shallow water zones will yield other species of emergent and submergent plants. More than 50 species of plants developed on the exposed substrates of Pool 8 during the 2001-2002 drawdown (USGS-UMESC unpubl. data); similar results are expected in Pool 5.

Recreational access dredging is not expected to have an adverse effect on habitat diversity and interspersion.

6.6.2.4 EFFECTS ON BIOLOGICAL PRODUCTIVITY

The drawdown should result in an increase in vegetated area and an increase in secondary production in years following the drawdown, potentially increasing the abundance of fish and wildlife in lower Pool 5. The proposed drawdown and alternatives except the no action alternative will kill most non-mobile macroinvertebrates in the drawdown zone and recreational access dredge cuts, resulting in a loss of secondary production during the drawdown year. Macroinvertebrates should rapidly recolonize the drawdown zone and dredge cut areas in the year following drawdown. Fish reproduction, particularly nesting species like bluegill and largemouth bass, may be reduced during the drawdown. Recreational access dredging will have a localized short-term impact on biological production.

6.6.2.5 EFFECTS ON SOILS AND GROUNDWATER

A Pool 5 drawdown would reduce the groundwater level in islands and floodplain soils, allowing oxidation and aeration to a greater depth. This would generally benefit riparian vegetation adapted to floodplain conditions. Recreational access dredging should have no impact on soils and groundwater.

6.6.2.6 EFFECTS ON ENDANGERED SPECIES

6.6.2.6.1 Effects on Federally Listed Species

One federally listed species, the bald eagle (threatened), occurs in the Pool 5 area. Bald eagles are commonly seen in the area, roosting in trees along the main channel and feeding on fish. Higher numbers of eagles occur in Pool 5 during the spring and fall migrations. There are at least 10 active bald eagle nesting sites in Pool 5 that have produced fledglings over a number of years. The eagles feed along the main channel during the day, and at night they roost in the river bottoms just downstream of the Finger Lakes. The drawdown and associated conditions should have no adverse effects on bald eagles (see Appendix B). The drawdown should have minor short-term beneficial effects in that fish that become stranded in isolated backwater areas will allow bald eagles to more readily catch prey.

Bald eagles will be nesting during the time that recreational access dredging occurs (May/early June). Eagles typically incubate eggs in March, and the young have hatched by early April. Fledging occurs about early July. Activity within 1/8 mile of a bald eagle nest would be prohibited if the dredging commences after May 1. Prior to May 1, dredging within 1/4 mile of an eagle nest would be prohibited. Locations of present bald eagle sites are greater than 1/2 mile from recreational access dredge cuts (B. Pember, USFWS, pers. comm.).

6.6.2.6.2 Effects on State Listed Mussels

See Section 6.6.2.2.2 Effects on Wildlife – Mussels for a more in-depth analysis of impacts to mussels, including State listed species. All mussel species, rare and common, typically occupy similar water depths within the Upper Mississippi River for the most part, and impacts to mussels in general will include listed species. Therefore, some of the mussels that may be stranded and killed by desiccation, thermal stress, or predation may be State listed species. Conversely, long-term benefits of the drawdown to mussels will benefit State listed species as well.

Five species listed for protection (threatened and endangered) in either Minnesota or Wisconsin presently occur within Pool 5: butterfly (*Ellipsaria lineolata*), rock pocketbook (*Arcidens confragosus*), monkeyface (*Quadrula metanevra*), washboard (*Megalonaias nervosa*), and round pigtoe (*Pleurobema sintoxia*) (see Table 2-2). No federally listed mussel species have been collected in the pool recently, and none are expected to occur in Pool 5. As a result, no impacts to federally listed mussel species are anticipated.

Some listed species occurring in the drawdown zone may escape to deeper water. Some may bury themselves in the substrate and survive the drawdown, and some may become stranded and die. Mussels outside the drawdown zone will probably not be much affected by the drawdown. Overall, a 2.0-foot or 1.5-foot drawdown is not expected to have major adverse impacts to listed mussel species. As stated previously, deeper alternative drawdowns would potentially affect more mussels than lower drawdowns, but it remains speculative as to the extent.

Recreational access dredging in Pool 5 is estimated to remove and kill between 700 and 800

mussels (Corps 2004). Of these, less than 10 percent of the individuals are expected to be State protected species. A slightly larger footprint area would be dredged for the 2.5-foot drawdown alternative, resulting in potentially a few more listed species being killed. Resuspension of sediment and the resulting downstream turbidity and potential pollution plume may affect some State listed mussels as well. The impacts should be relatively short term and fairly localized, given the small footprints of the cuts and the small amount of material being removed. Conditions for listed mussel species would be improved in the long term by improving water quality, cleaning substrate through scouring, improving overall productivity, improving conditions for host fish species, and other ecological benefits.

6.6.2.6.3 Effects on State Listed Fish Species

Nine Minnesota and/or Wisconsin State listed endangered and threatened fish species occur in Pool 5 (Pitlo et al. 1995) (Table 2-2). The proposed drawdown would generally increase current velocity in lower Pool 5 during the drawdown period, but should not otherwise disrupt habitat conditions for these species.

No federally endangered fish species occur in Pool 5, and two species listed for protection (threatened or endangered) in Wisconsin (goldeye and pallid shiner) and typically associated with backwaters or slow moving current areas potentially could become isolated in backwaters and be subjected to mortality via predation and poor water quality conditions (i.e., low dissolved oxygen) (Adams et al. 1999, Dieterman MNDNR, pers. comm.). As with fish in general, there should be long-term beneficial impacts on these species.

6.6.2.6.4 Effects on Other State Listed Species

Both Minnesota and Wisconsin list the Blanding's turtle as a threatened species, and Minnesota lists the smooth softshell turtle (*Apalone mutica*) and the snapping turtle (*Chelydra serpentina*) as special concern species, all of which occur in Pool 5. No adverse effects on these turtle species are anticipated during the drawdown, and the long-term increase in vegetation would enhance feeding and nursery habitat for turtles.

The northern cricket frog (*Acris crepitans*) is listed as an endangered species by Minnesota and Wisconsin. Northern cricket frogs may occur in Pool 5, inhabiting marsh areas. The proposed drawdown would dewater existing stands of emergent aquatic plants, possibly forcing cricket frogs from their preferred habitats. Increased extent of emergent aquatic plants that may result from the drawdown could expand suitable habitat for cricket frogs in years following the drawdown.

The Caspian tern (*Sterna caspia*) is listed as an endangered species by Minnesota. Caspian terns migrate through the Pool 5 area in the spring and fall. The drawdown may provide some easy foraging for Caspian terns in shallower areas during the drawdown.

The great egret *(Casmerodius albus*) is listed as a threatened species by Minnesota. Great egrets occur and nest in Pool 5. Egrets may forage in the drawdown zone and in any shallow areas that become isolated by the drawdown.

The osprey (*Pandion haliaetus*) is listed as a threatened species in Minnesota. Ospreys occur and nest in the Pool 5 area. Ospreys may also feed in areas that become isolated by the drawdown.

6.7 EFFECTS ON CULTURAL RESOURCES

Pool operations have the potential for direct and indirect impacts to cultural resources. Few studies focusing on impacts of a drawdown on cultural resources have been conducted along the Upper Mississippi River. However, on the basis of research conducted at Corps-operated reservoirs in southern and eastern portions of the United States, it is clear that a variety of direct (e.g., erosion) and indirect (e.g., looting) factors of pool water level management adversely affect cultural resources. Conversely, other management practices have positive effects on cultural resources, such as establishing vegetation (Dunn 1996). For example, one measure of potential effects to cultural resources relates to the proposed level of a drawdown.

Frequently, normal pool operation results in fluctuating water levels within 1 foot of the project pool elevation. Thus, drawdowns of up to 1 foot may not have significant negative and positive impacts to cultural resources beyond what may be occurring during normal operation, although this assertion has yet to be substantiated (cf. proposed drawdown plans for Pools 6 and 9: WLMTF 2003a, 2003b). However, drawdowns greater than 1 foot appear to have increased potential to affect cultural resources. For instance, results from the only cultural resources study for a drawdown along the Upper Mississippi River, in Pool 8, determined that the probable impacts from the 1.5-foot drawdown were high at 16 of 33 (48 percent) cultural resource sites (Kolb and Jalbert 2004). However, the Upper Mississippi River flood of 2001, which may have skewed the results, hampered the Pool 8 study. Importantly, the quantity and character of the cultural resources in Pool 8 are substantially different from those in Pool 5.

Consequently, predicting the potential effects of a Pool 5 drawdown to cultural resources is complicated and includes a number of idiosyncratic variables. These include the specific details of each alternative, direct and indirect impacts, unique impact zones, definition of the Area of Potential Effect (APE), the specific nature of cultural resource sites and their settings, and other natural and artificial aspects unique to the Pool 5 locality.

The scale of the drawdown, dictated by alternative (i.e., a 1.5-, 2.0-, or 2.5-foot drawdown), will have various ramifications to cultural resources. With decreased water levels, increased areas of shoreline and other land types typically inundated (e.g., natural levees, etc.) will be exposed, and a variety of direct and indirect impacts may ensue to these bare areas as well as to any cultural deposits they harbor. However, fluvial behavior and concomitant effects will not be uniform across the pool. For example, because of the slope and other characteristics of the pool, the drawdown will reach its greatest depths within the lower portion of the pool, while the upper portion of the pool may not receive any impacts. See Section 3.2.1 Hydrology.

This phenomenon is also at work in relatively flow-isolated areas of the pool, such as Weaver Bottoms where a 1.5-foot drawdown will result in lower water levels ranging from 1.0 to 1.4 feet. Other elements of the drawdown include water discharge rate, duration, projected areas of erosion and sedimentation, dredge cuts, and placement areas. While the drawdown alternatives will have different parameters across the pool, overall, the more water levels are drawn down, the more impacts to cultural resources may potentially be realized. The details of the drawdown alternatives assist in predicting potential effects to cultural resources and define the APE.

Direct impacts that may potentially affect cultural resources during a drawdown include inundation, erosion by rainfall, stream flow, wave action from wind and commercial and recreational boat traffic, ice wedging, alternate saturation/drying, sedimentation, and tributary downcutting. Indirect impacts may consist of biochemical activity, development of the shoreline (e.g., boat ramps) and back-lying lands (e.g., housing), recreation (e.g., camping), vandalism and looting, changes to the view shed, and erosion along tailwater stream banks with increased discharge levels (i.e., upper reaches of Pool 5A) (e.g., Dunn 1996).

The various factors that may have potential impacts to cultural resources may be further qualified by segregating areas within and around the pool into four impact zones: the conservation pool, the fluctuation zone, the backshore zone, and the tailwater zone. The conservation pool includes the portion of the pool below the average annual drawdown. Here, the effects to cultural resources (e.g., shipwrecks and wing dams) are largely biochemical, although submerged resources may be affected by mechanical actions or exposed with lower water levels.

The fluctuation, or drawdown, zone includes the area exposed to periodic, usually annual, shoreline fluctuation. In this zone, sites situated along the shoreline may be subjected to erosion. Erosion can cause severe impacts to shoreline cultural resource sites, such as bank destabilization, undermining foundations, loss of artifact provenience, destruction of artifacts and features from wave action, and washing away a site. In addition, increased access to sites may occur during a drawdown. This may result in inadvertent disturbance, vandalism, and artifact looting with greater surface areas of a site exposed from a drawdown. On the other hand, a drawdown may temporarily remove the river's action from cultural deposits and allow vegetation growth that may stabilize deposits.

The backshore zone includes the area above the level of the maximum flood pool, extending upslope, and includes portions of the pool watershed. Typically, there are no direct mechanical or biochemical impacts to cultural resources within this zone. However, a lower water level may cause downcutting of tributaries that may increase erosion to sites situated along these streams. The tailwater zone includes waterbodies immediately downstream of dams (i.e., the upstream section of Pool 5A). Here, erosion and associated sedimentation along the shoreline may accelerate with increased discharges during a drawdown.

Definition of the APE for cultural resources of the proposed drawdown includes several variables:

1) Extent of the drawdown per alternative (i.e., water level elevation, acres exposed, discharge rate).
2) Known cultural resource site locations as related to drawdown alternatives and impact zones (the conservation pool, the fluctuation zone, the backshore zone, and the tailwater zone).
3) Environmental contexts of cultural resource sites (e.g., slope, vegetation).
4) Historic land use changes (e.g., construction of embankments and roads).

Of the 65 cultural resource sites identified within the Pool 5 locality, four sites have the potential to be affected by a 1.5-foot drawdown; 22 sites have the potential to be affected from a 2.0-foot drawdown; and 37 sites have the potential to be affected by a 2.5-foot drawdown. Table 6-2 presents the total number of recorded cultural resource sites by impact zone that may be potentially affected for each alternative.

Table 6-2 – Number of Recorded Cultural Resource Sites Within Each Impact Zone That May Potentially Be Affected By Alternative*

Alternative/ ~ Acres Exposed	Zone				Total
	Conservation	Fluctuation	Backshore	Tailwater	
1.5-ft (~940 ac)		3		1	4
2.0-ft. (~1,459 ac)	3	3	15	1	22
2.5-ft. (~1,950 ac)	3	3	30	1	37

* Excluding wing dams and other navigation structures.

General information for the cultural resource sites that may potentially be affected by each alternative is presented in Table 6-3.

Table 6-3 – Summary of Pool 5 Recorded Cultural Resource Sites and Potential Impacts by Alternative*

Site	Type	Affiliation	Alternative		
			1.5-foot	2.0-foot	2.5-foot
47BF65	Mounds	Precontact	Yes	Yes	Yes
47BF198	Artifact Scatter	Precontact	Yes	Yes	Yes
47BF206	Foundation	Historic	Yes	Yes	Yes
47BF207**	Lithic Scatter	Precontact	Yes	Yes	Yes
47BF71	Artifact Scatter	Precontact	No	Yes	Yes
47BF73	Artifact Scatter	Precontact	No	Yes	Yes
47BF74	Artifact Scatter	Precontact	No	Yes	Yes
47BF75	Artifact Scatter	Precontact	No	Yes	Yes
21WN23	Artifact Scatter	Precontact	No	Yes	Yes
21WN42	Artifact Scatter	Precontact	No	Yes	Yes
21WNaj	Early Settlement	Historic	No	Yes	Yes
21WB2	Mound	Precontact	No	Yes	Yes
21WB48	Artifact Scatter	Precontact	No	Yes	Yes
21WB3	Mounds	Precontact	No	Yes	Yes
21WB4/38	Mounds/ Artifact Scatter	Precontact	No	Yes	Yes
21WB40	Artifact Scatter	Precontact	No	Yes	Yes
21WB5	Mounds	Precontact	No	Yes	Yes
21WB97	Artifact Scatter	Precontact	No	Yes	Yes
21WBD	Mounds	Precontact	No	Yes	Yes
Capt. Kidd	Shipwreck	Historic	No	Yes	Yes
West Newton	Shipwreck	Historic	No	Yes	Yes
'Wreck 178'	Shipwreck	Historic	No	Yes	Yes
47BF2	Cemetery	Historic	No	No	Yes
47BF112	Artifact Scatter	Precontact	No	No	Yes
21WB46	Artifact Scatter	Precontact	No	No	Yes
21WB43	Artifact Scatter	Precontact	No	No	Yes
21WB47	Mounds	Precontact	No	No	Yes
21WBh	Mounds	Precontact	No	No	Yes
21WB45	Rockshelter	Precontact	No	No	Yes
21WB13	Mounds	Precontact	No	No	Yes
21WB14	Mounds	Precontact	No	No	Yes
21WB15	Mounds	Precontact	No	No	Yes
21WB16	Mounds	Precontact	No	No	Yes
21WB7	Mounds	Precontact	No	No	Yes
21WBm	Mounds	Precontact	No	No	Yes
21WB17	Mounds	Precontact	No	No	Yes
21WB37	Mounds	Precontact	No	No	Yes

* Excluding wing dams and other navigation structures.
** 47BF207 is in Pool 5A.

Of the assemblage of 37 total sites that may potentially be affected by a drawdown, only two are eligible (Lock and Dam 5) or potentially eligible (wing dams) for listing on the NRHP. However, it is not expected that these properties will be affected by a drawdown. Although mound groups are considered eligible for listing on the NRHP, none in the Pool 5 locality have been evaluated, and the nature of many of the recorded mound groups in the Pool 5 locality is unknown.

For example, many mounds, and indeed entire mound groups, have been destroyed by cultivation or other development, such as road and building construction (e.g., Arzigian and Stevenson 2003; Pleger 1997). Thus, scrutiny of specific mound groups, dictated by the selected APE, will be necessary to assess potential impacts from a drawdown. Also, as the drawdown will have a relatively short duration (approximately 4 months), it is not expected that temporary and partial exposure of wing dams will negatively affect these properties. Further, the relatively short duration of the drawdown may, in general, preclude, or limit, potential negative impacts to cultural resources.

While the above discussion posits possible parameters for framing the APE, the number of cultural resource sites potentially affected, and the scope of cultural resource investigations for a drawdown, the effects of a Pool 5 drawdown to cultural resources remain obscure. Other variables include additional dredging requirements, the current context of cultural resources sites, and the potential for heretofore unidentified cultural resources to be exposed. Dredge cuts (main channel and recreational) and associated dredged material placement areas are not expected to affect cultural resources. The placement areas are existing sites and none of the cuts harbor known resources (such as shipwrecks), and all are located in previously dredged areas or are in areas that are historically mapped as channels.

The current contexts for many of the cultural resource sites are unknown, and it is likely that some sites are no longer extant (e.g., destroyed by cultivation, roads, etc.) or have been artificially separated from the river floodplain (e.g., by roads, railroads, other development, etc.). As with some of the mound groups, examination of a number of cultural resources sites may be necessary to assess potential effects from a drawdown. Finally, as stated above, overall, the greater water levels are drawn down, the more potential impacts to cultural resources may be realized. While previous pool surveys investigated shorelines at normal pool operating water levels (Pleger 1997), increased areas of exposed shoreline and other landforms have the potential to harbor cultural resources, and these areas must be inspected.

Because the effects of a drawdown to existing cultural resources are relatively unknown and various areas of land will be exposed, the Corps will undertake a pool-wide cultural resource survey and monitoring program during the proposed drawdown. The cultural resources investigations will have several goals, as follows:

- Systematically assess effects of the drawdown to cultural resources (e.g., monitoring),
- Survey exposed areas,
- Appropriately treat adverse effects clearly associated with the drawdown (e.g., evaluation, data recovery, protection), and
- Make recommendations for site management and protection.

In addition, provisions for increased law enforcement patrols to deter artifact looting will be arranged with the U.S. Fish and Wildlife Service during the drawdown.

The scope of the cultural resources investigation will be appropriately tailored to capture the APE for the selected alternative of a 1.5-foot drawdown. Implementation of cultural resources investigations will be based on the corresponding APE for the selected alternative.

The consultation with the Minnesota and Wisconsin SHPOs has not been completed as of this writing. The Corps of Engineers has prepared Programmatic Agreements with the Minnesota and Wisconsin SHPOs, and they will be transmitted to the respective SHPOs and tribes. They have 30 days to review and comment. After receipt of comments, the comments will be addressed to the satisfaction of all parties before the project proceeds.

6.8 SUMMARY AND CUMULATIVE IMPACTS DISCUSSION

Overall, the proposed Pool 5 drawdown project should have minor to substantial positive long-term impacts on shallow aquatic and wetland habitat; terrestrial habitat; recreational opportunities; aesthetic values; biological productivity; and water quality. Minor adverse short-term impacts are expected for recreational boating and boating facilities. To mitigate for the decreased recreational boating access, three areas outside the main navigation channel have been identified for dredging, and an additional boat ramp will be constructed prior to the start of the drawdown that will be functional during the drawdown. Impacts for a Mississippi River pool drawdown to commercial navigation will be minimal. Short-term adverse effects on suspended sediment and macroinvertebrates (except native mussels) in the drawdown zone will be alleviated upon reflooding. Short-term adverse impacts to fish and mussels should be minor. Only one federally endangered species (bald eagle) occurs in the pool, and it should not be adversely affected and may be benefited during the drawdown in that fish that become stranded in isolated backwater areas will allow bald eagles to more readily catch prey.

A drawdown zone of up to about 940 acres for the selected 1.5-foot alternative will provide an opportunity for reestablishment of emergent aquatic plants and consolidation of sediment. Submersed aquatic plants may have additional light and become more abundant in an additional 1,459 acres. The consolidated sediment should have greater shear strength and resist resuspension by wave action upon reflooding. Increased vegetation and water clarity in lower Pool 5 would improve habitat conditions for a variety of fish and wildlife. If river discharge conditions allow the proposed drawdown to be maintained through most of the growing season with limited reflooding, these ecological benefits could persist for a number of years.

Monitoring and evaluation of the drawdown will provide valuable information on application of this method of river regulation for habitat management (see Section 5.6 Monitoring).

7.0 COORDINATION

This study was a multi-party effort involving Federal, State, and local agencies; public interest groups; representatives of river user groups; and the public. The study was conducted under the auspices of the Water Level Management Task Force of the River Resources Forum. The River Resources Forum participation includes the following:

Federal	State
Corps of Engineers	Iowa Department of Natural Resources
U.S. Fish and Wildlife Service	Iowa Department of Transportation
Environmental Protection Agency	Minnesota Department of Natural Resources
U.S. Coast Guard	Minnesota Department of Transportation
Natural Resources Conservation Service	Minnesota Pollution Control Agency
National Park Service	Wisconsin Department of Natural Resources
	Wisconsin Department of Transportation

The coordination of the study took place at the WLMTF level. The Task Force was initially composed almost entirely of Federal and State agency representatives. These representatives still composed most of the Task Force throughout the study. However, early on, efforts were made to expand the Task Force to include representatives of the commercial navigation industry, recreational interests, environmental groups, and the public. Section 10.0 Participants describes the roles of various task force members and their primary areas of contribution.

An initial set of public meetings was held at Wabasha High School on May 21, 2003, and at Cochrane/Fountain City High School on May 22, 2003. The primary purpose of the meetings was to provide an information exchange with the public and to obtain input that would assist in planning for the Pool 5 drawdown. Invitations to the meetings were sent to more than 1,000 individuals, and announcements were sent to approximately 50 newspapers and other media outlets. Approximately 60 people attended these meetings. Input received at the meetings was instrumental in the planning process.

A second set of public meetings was held at Wabasha High School on September 22, 2004, and at Cochrane/Fountain City High School on September 23, 2004, to provide an information exchange with the public and to receive input relative to specific concerns the public may have with implementation of a drawdown in Pool 5. Approximately 20 individuals attended the Wabasha meeting, while approximately 27 individuals attended the Cochrane/Fountain City meeting.

Water Level Management Update newsletters that discussed the Pool 5 drawdown were published in January 2003, April 2004, and December 2004. The Water Level Management Update newsletter will continue to be published throughout the implementation of the drawdown. In addition, information concerning the study is posted on the St. Paul District Water Level Management Web Page.

A Citizens Advisory Committee was formed in August 2003 to help address recreational access and other issues associated with a Pool 5 drawdown. The Advisory Committee includes

approximately 15 to 20 participants representing local governments, businesses, and private citizens from Wisconsin and Minnesota. One of the Committee's co-chairs is an active member of the Water Level Management Task Force.

The Citizens Committee met several times and developed a recreational access map that identified areas they felt needed to be dredged prior to a drawdown. Committee members discussed a variety of potential sites where access may be problematic. However, to save dredging costs, they focused on three areas critical for providing access from public boat ramps to the main channel. The Water Level Management Task Force used this information to develop a dredging plan and has secured sufficient funding to implement the Committee's recommendations.

The Citizens Committee is currently helping to inform the public about a Pool 5 drawdown during summer 2005. The Committee presented an update on its work during two recent public meetings, is posting recreational access maps in local businesses, and is seeking cost share assistance from local citizens and groups.

8.0 RECOMMENDATION

I have weighed the benefits to be obtained from implementing a pilot drawdown in navigation Pool 5 of the Upper Mississippi River against the costs, and I have considered the alternatives, impacts, and scope of the proposed pilot drawdown. I have also considered the views expressed by Congressional interests, Federal and State agencies, public interest groups, river user groups, and the public. In my judgment, the anticipated benefits of the proposed drawdown outweigh the costs and unavoidable environmental, social, and economic impacts.

I recommend that a deviation from the Reservoir Regulating Plan for Pool 5 of the Upper Mississippi River be approved to allow for implementation of a drawdown to a water surface elevation of 657.5 at Lock and Dam 5, with a minimum water surface elevation of 659.0 at the primary control point, and with the operating band tolerances allowed under the existing Reservoir Regulating Plan. I also recommend that the drawdown be permitted during one open water season, and continued for the following open water season, if feasible.

MICHAEL F. PFENNING
COL, EN
Commander

9.0 FINDING OF NO SIGNIFICANT IMPACT (FONSI)

Environmental and Economic Analysis Branch
Planning, Programs and Project Management Division

FINDING OF NO SIGNIFICANT IMPACT

In accordance with the National Environmental Policy Act of 1969, the St. Paul District, Corps of Engineers, has assessed the environmental impacts of the following project:

MISSISSIPPI RIVER POOL 5 DRAWDOWN

The St. Paul District, in conjunction with the interagency Water Level Management Task Force of the River Resources Forum, proposes a 1.5-foot drawdown at Lock and Dam 5 for the 2005 growing season, with a second year of drawdown the following year. The specific objective of proposed growing season drawdown is to expose substrates and enhance conditions for the reproduction, growth, and survival of perennial emergent species of aquatic vegetation.

This Finding of No Significant Impact is based on the following factors:

The proposed drawdown should have positive effects on aquatic plants, sediment, physical conditions, and water quality that may persist for years following the drawdown. The drawdown would reduce depths available in the navigation channel, requiring advance dredging at historic dredge sites. The navigation channel will be maintained during the drawdown, and the drawdown water levels may be increased if necessary to maintain navigation. Towboat operators will have to reduce speed to navigate through Pool 5 because of the shallower depths in the navigation channel. Most recreational access points should remain functional with the drawdown. To mitigate for the decreased recreational boating access, three areas outside the main navigation channel have been identified for dredging, and an additional boat ramp will be constructed prior to the start of the drawdown. Short-term and minor adverse effects on water quality, macroinvertebrates, and fish will occur. The drawdown should not adversely affect populations of Federal threatened and endangered species. Short-term and minor adverse effects on aesthetic appearance and odor may occur during the initial drawdown period. Recreational boating activities will continue on Pool 5 during the drawdown, but access to shallow areas may be restricted. Cultural resources sites will be monitored during the drawdown.

The environmental review process indicates that the proposed action does not constitute a major Federal action significantly affecting the quality of the environment. Therefore, an environmental impact statement will not be prepared.

_____
Date

MICHAEL F. PFENNING
COL, EN
Commander

10.0 PARTICIPANTS

The Pool 5 Drawdown Study had many participants involved in various aspects of the study. This section identifies those who participated in the study and what their roles may have been.

10.1 WATER LEVEL MANAGEMENT TASK FORCE

The Water Level Management Task Force has an open membership policy. Thus, participation at the Task Force level varied throughout the study. Table 10-1 identifies the individuals who attended Task Force meetings during the course of the study.

Table 10-1 – Water Level Management Task Force Participants

Task Force Participants	Agency or Organization
Mark Anderson	Wisconsin Department of Natural Resources
Sharonne Baylor	U.S. Fish and Wildlife Service
Gretchen Benjamin	Wisconsin Department of Natural Resources
Kurt Brownell	Corps of Engineers
Jeff DeZellar	Corps of Engineers
Terry Dukerschein	U.S. Geological Survey
Mike Griffin	Iowa Department of Natural Resources
Jon Hendrickson	Corps of Engineers
Barry Johnson	U.S. Geological Survey
Scot Johnson	Minnesota Department of Natural Resources
Scott Jutila	Corps of Engineers
Dan Kelner	Corps of Engineers
Mike Kennedy	Citizen
Kevin Kenow	U.S. Geological Survey
Dan Koich	Wisconsin Department of Natural Resources
Dick Lambert	Minnesota Department of Transportation
Catherine McCalvin	The Nature Conservancy
Paul Machajewski	Corps of Engineers
Eric Nelson	U.S. Fish and Wildlife Service
Lee J. Nelson	Upper River Services
Jim Nissen	U.S. Fish and Wildlife Service
Dick Otto	Corps of Engineers
Kent Pehler	Brennan Marine
Lisa Reid	U.S. Fish and Wildlife Service
Bill Richardson	U.S. Geological Survey
Tim Schlagenhaft	Minnesota Department of Natural Resources, Chair
Randy Urich	Corps of Engineers
Gary Wege	U.S. Fish and Wildlife Service
Tim Yager	U.S. Fish and Wildlife Service

The Task Force chairperson at the initiation of the Pool 5 drawdown project was Gretchen Benjamin of the Wisconsin Department of Natural Resources. In November 2004, Ms. Benjamin stepped down as chair, and was succeeded by Tim Schlagenhaft of the Minnesota Department of Natural Resources.

11.0 BIBLIOGRAPHY

Abraham, D.D., and J.S. Hendrickson. 2003. Effects of Drawdown and Structures on Bed Load Transport in Pool 8 Navigation Channel. Technical Note in Publication. U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi.

Abraham, D.D., and T. Pratt. 2002. Quantification of Bed-Load Transport on the Upper Mississippi River Using Multibeam Survey Data and Traditional Methods. Technical Note ERDC/CHL CHETN-VII-4. U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, Mississippi.

Adams, S.R., T.K. Keevin, K.J. Killgore, and J.J. Hoover. 1999. Stranding potential of young fishes subjected to simulated vessel-induced drawdown. Transactions of the American Fisheries Society. 128:1230-1234.

Anderson, D.D., D.B. Wilcox, and D.R. McConville. 1983. Physical and biological investigation of the main channel border habitat of Pool 5A, on the Upper Mississippi River in 1980. Volume I. U.S. Army Corps of Engineers, St. Paul, Minnesota.

Arzigian, C., and K. Stevenson. 2003. Minnesota's Indian Mounds and Burial Sites: A Synthesis of Prehistoric and Early Historic Archaeological Data. Publication No. 1. The Minnesota Office of the State Archaeologist, St. Paul.

Benn, David. 1979. Some Trends and Traditions in Woodland Cultures of the Quad-State Region in the Upper Mississippi River Basin. The Wisconsin Archaeologist. 3:215-283.

Birmingham, R., C. Mason, and J. Stoltman. 1997. Wisconsin Archaeology. The Wisconsin Archeologist, 78 (1/2).

Coker, R.E., A.F. Shira, H.W. Clark, and A.D. Howard. 1921. Natural history and propagation of freshwater mussels. *Bulletin of the Bureau of Fisheries* 37:77-181.

Colorado State University. 1979. Sediment Transport in the Upper Mississippi River Within the St. Paul District. Attachment B of the GREAT I Study of the Upper Mississippi River, Volume 4.

Corps of Engineers. 1974. Final Environmental Impact Statement. Upper Mississippi River 9-Foot Channel Navigation Project. St. Paul District, U.S. Army Corps of Engineers. St. Paul, Minnesota.

Corps of Engineers. 1996. Channel Maintenance Management Plan. Upper Mississippi River Navigation System, St. Paul District. St. Paul District, U.S. Army Corps of Engineers. St. Paul, Minnesota.

Corps of Engineers. 1997. Final Environmental Impact Statement. 9-Foot Navigation Channel Project. Channel Maintenance Management Plan. Upper Mississippi River, Head of Navigation to Guttenberg Iowa. St. Paul District, U.S. Army Corps of Engineers. St. Paul, Minnesota.

Corps of Engineers. 2004. Mussel Survey, Pool 5 Recreational Access Dredging – Water Level Management Task Force, Upper Mississippi River Pool 5 Drawdown Project. St. Paul District, U.S. Army Corps of Engineers. St. Paul, Minnesota.

Dunn, R. 1996. Impacts to Historic Properties in Drawdown Zones at Corps of Engineers Reservoirs. Technical Report EL-96-7, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg.

Fish and Wildlife Work Group. 1998. The Weaver Bottoms rehabilitation project: resource analysis program, 1985-1997, final report. Channel Maintenance Forum, U.S. Army Corps of Engineers, St. Paul District. 172 pp.

Florin, F. 2003. Phase I Cultural Resources Investigation and Phase II Testing at Five Prehistoric Sites for the West Newton Chute Dredge Disposal Placement Site, Wabasha County, Minnesota. Reports of Investigations No. 031. Florin Cultural Resource Services, Boyceville.

Fredrickson, L.H., and T.S. Taylor. 1982. Management of Seasonally Flooded Impoundments for Wildlife. U.S. Fish and Wildlife Service Resource Publication 148. 29 pp.

Fuller, S.L.H. 1974. Clams and mussels (Mollusca: Bivalvia). Pages 215-273 *In* C.W. Hart, Jr., and S.L.H. Fuller (eds.). Pollution ecology of freshwater invertebrates. Academic Press, New York.

Hornbach, D.J. 1992. Factors influencing the distribution of unionids in the St. Croix River, Minnesota, USA. Pp 25-28. In F. Giusti and G. Manganelli (eds.). Abstracts of the 11th International Malacological Congress, Siena, Italy. University of Siena, Siena, Italy.

Hudak, G., E. Hobbs, A. Brooks, C. Sersland, and C. Phillips. 2002. A Predictive Model of Precontact Archaeological Site Location for the State of Minnesota. Mn/Model Final Report. Minnesota Department of Transportation, St. Paul.

Isley, F.B. 1913. Experimental study of the growth and migration of freshwater mussels. pp. 5-24 in Appendix III, Rep. U.S. Commission of Fisheries, 1913.

Jalbert, Andrew, D. Overstreet, and J. Richards. 1996. Cultural Resources Inventory of the Upper Mississippi River, St. Anthony Falls to Pool 10, Wisconsin, Iowa, and Minnesota. Reports of Investigations No. 384, Great Lakes Archaeological Research Center, Inc., Milwaukee.

Jensen, J. 1992. Gently Down the Stream: An Inquiry into the History of Transportation on the Northern Mississippi River and the Potential for Submerged Cultural Resources. State Underwater Archeology Program, Division of Historic Preservation, State Historical Society of Wisconsin, Madison.

Johnson, B.L., D.M. Soballe, R.F. Gaugush, B.C. Knights, T.J. Newton, E.M. Monroe, S.J. Rogers, J.S. Sauer, S.E. Weick, W.F. James, and A. Stevens. 2000. Evaluation of Hydrologic Modification for Habitat Improvement: The Finger Lakes Habitat Rehabilitation and Enhancement Project Biological Response Study. Final Report to the Army Corps of Engineers. St. Paul, Minnesota. U.S. Geological Survey Environmental Science Center, La Crosse, Wisconsin.

Johnson, E., and G.J. Hudak. 1975. Archaeological Survey of 1975 Season Dredge Spoil Deposit Sites in Mississippi River Pools USAF, 1, 2, 3, 4, and 5. The Science Museum of Minnesota, St. Paul.

Kenow, K.P., R.K. Hines, and J.E. Lyon. 2001. Final Report: Vegetation Response to an Experimental Drawdown on Pool 9 of the Upper Mississippi River. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin.

Kenow, K.P., J.E. Lyon, R.K. Hines, and L.R. Robinson. 2004. Vegetation Response to a Demonstration Drawdown on Pool 8 of the Upper Mississippi River. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin. Poster Presentation.

Koel, T., and K.E. Stevenson. 2002. Effects of dredged material placement on benthic macroinvertebrates of the Illinois River. Hydrobiologia 474(1-3):229-238.

Kolb, Michael, and A. Jalbert. 2004. Baseline Study for Cultural Resources Monitoring of Pool 8 Shoreline Sites, Houston County, Minnesota, and La Crosse and Vernon Counties, Wisconsin. Reports of Investigations No. 43, Strata Morph Geoexploration, Sun Prairie.

Lapham, I.A. 1855. The Antiquities of Wisconsin, as Surveyed and Described. Smithsonian Contributions to Knowledge 7. Washington, D.C.

Libois, R.M., and C. Hallet-Libois. 1987. The unionid mussels (Mollusca: Bivalvia) of the Belgian Upper River Meuse: An assessment of the impact of hydraulic works on the river self purification. Biological Conservation 42:115-132.

Maceina, M.J. 2003. Verification of the influence of hydrologic factors on crappie recruitment in Alabama reservoirs. North American Journal of Fisheries Management. 23:470-480.

Madigan, Thomas, and R. Shermer. 2001. Geomorphological Mapping and Archaeological Sites of the Upper Mississippi River Valley, Navigation Pools 1-10, Minneapolis, Minnesota, to Guttenberg, Iowa. Reports of Investigations No. 522, Hemisphere Field Services, Inc., Minneapolis.

McMahon, R.F. 1991. Mollusca: Bivalvia. Pp. 315-400 *In* Thorp, J.H., and A.P. Covich (eds.) Ecology and Classification of North American Freshwater Invertebrates, Academic Press, San Diego, California, 911 pp.

Mead, R.H. 1995. Contaminants in the Mississippi River, 1987-92. U.S. Geological Survey Circular 1133.

Miller, A.C., B.S. Payne, and R. Tipit. 1984. Changes in the naiad fauna of the Cumberland River below Lake Cumberland in central Kentucky. Nautilus 98:107-110.

O'Mack, S., and R. Withrow. 1989. Phase II Archaeological Testing of the Petersen (21WB51) and Rose (21WB52) Sites, Wabasha County, Minnesota. Reports of Investigations Number CENCS-PD-ER-35, U.S. Army Corps of Engineers, St. Paul District, St. Paul.

Overstreet, David, R. Fay, C. Mason, and R. Boszhardt. 1983. Literature Search and Records Review of the Upper Mississippi Basin: St. Anthony Falls to Lock and Dam 10. Reports of Investigations No. 116, Great Lakes Archaeological Research Center, Inc., Milwaukee.

Pearson, Marjorie. 2003. National Register Evaluation of the Channel Structures of the Upper Mississippi River, Pools 1-10 (From Saint Paul, Minnesota, to Guttenberg, Iowa). Heise, Roise and Company, Minneapolis.

Penman, J.T. 1981. Archaeology of the Great River Road: Survey and Testing in Buffalo, Pepin, and Pierce Counties. Wisconsin Department of Transportation, Archaeological Report No. 5. Madison.

Penman, J.T. 1984. Archaeology of the Great River Road: Summary Report. Wisconsin Department of Transportation, Archaeology Report 10, Madison.

Pitlo, J. Jr., and J. Rasmussen. 2004. UMRCC Fisheries Compendium, 3rd Edition. Upper Mississippi River Conservation Committee. Rock Island, Illinois.

Pitlo, J. Jr., A. Van Vooren, and J. Rasmussen. 1995. Distribution and relative abundance of Upper Mississippi River fishes. Upper Mississippi River Conservation Committee Fish Technical Section. Rock Island, Illinois. 20 pp.

Pleger, T. 1997. A Phase I Archaeological Survey of the Floodplain of Pool Nos. 5, 5A, and 6 of the Upper Mississippi River Valley. Reports of Investigations No. 248. Mississippi Valley Archaeology Center at the University of Wisconsin, La Crosse.

Raibley, P.T., T.M. O'Hara, K.S. Irons, and K.D. Blodgett. 1997. Notes: Largemouth bass size distributions under varying annual hydrological regimes in the Illinois River. Transactions of the American Fisheries Society. 126:850-856.

Rusch, L.A., and J.T. Penman. 1982. Historic Sites Along the Great River Road. Wisconsin Department of Transportation, Archaeological Report No. 7. Madison.

Sauer, J., and K. Lubinski. 1998. Spatial patterns of macroinvertebrates in the Upper Mississippi River System. Project Status Report PSR 98-02. U.S. Geological Survey.

Styles-Hanson, C. 1987. Phase I Archaeological Investigations of Two Proposed Dredged Material Disposal Sites: Parcel 3.10, Pierce County, Wisconsin, and Parcel 5.24, Wabasha County, Minnesota. Reports of Investigations Number 48, Mississippi Valley Archaeology Center, La Crosse.

Strayer, D.L., and R. Ralley. 1993. Microhabitat use by an assemblage of stream-dwelling unionaceans (Bivalvia), including two rare species of Alasmidonta. Journal of North American Benthological Society 12: 247-258.

Strayer, D. 1983. The effects of surface geology and stream size on freshwater mussel (Bivalvia, Unionidae) distribution in southeastern Michigan, U.S.A. Freshwater Biology. 13: 253-264.

Sullivan, J.F. 2003. Water Quality and Meteorological Monitoring Used in the Assessment of Water Level Drawdown of Navigation Pool 8 of Upper Mississippi River in 2001. Wisconsin Department of Natural Resources. La Crosse, Wisconsin.

Theler, James, and Robert Boszhardt. 2003. Twelve Millennia: Archaeology of the Upper Mississippi River Valley. University of Iowa Press, Iowa City.

Thomas, C. 1894. Report on the Mound Explorations of the Bureau of American Ethnology. Twelfth Annual Report of the Bureau of American Ethnology, 1890-1891. Smithsonian Institution, Washington, D.C.

Tucker, J.K. 1996. Post-flood strandings of unionid mussels. *Journal of Freshwater Ecology* 11(4):433-438.

Water Level Management Task Force. 2003a. Letter Report/Environmental Assessment: Pool 6 Minor Drawdown, Upper Mississippi River, Minnesota and Wisconsin. St. Paul District, Corps of Engineers, St. Paul.

Water Level Management Task Force. 2003b. Letter Report/Environmental Assessment: Pool 9 Minor Drawdown, Upper Mississippi River, Iowa, Minnesota and Wisconsin. St. Paul District, Corps of Engineers, St. Paul.

Water Level Management Task Force. 1999. Definite Project Report/Environmental

Assessment, Pilot Pool Drawdown, Pool 8, Upper Mississippi River, Wisconsin and Minnesota. St. Paul District, Corps of Engineers, St. Paul.

Water Level Management Task Force. 1996. Problem Appraisal Report for Water Level Management, Upper Mississippi River. St. Paul District, Corps of Engineers, St. Paul.

Weller, M. 1981. Freshwater marshes: ecology and wildlife management. University of Minnesota Press.

Wilcox, Daniel B. 1993. An aquatic habitat classification system for the upper Mississippi River system. U.S. Fish and Wildlife Service, Environmental Management Technical Center, Onalaska, Wisconsin. EMTC 93-T003.

Wilcox, D.B., E.L. Stefanik, D.E. Kelner, M.A. Cornish, D.J. Johnson, I.J. Hodgins, and S.J. Zigler. 2004. Improving fish passage through navigation dams on the Upper Mississippi River System. Interim Report for the Upper Mississippi River – Illinois Waterway Navigation Study Technical Report (in press). Rock Island District, U.S. Army Corps of Engineers, Rock Island, Illinois.

Winchell, N.H. 1911. The Aborigines of Minnesota. The Minnesota Historical Society, St. Paul.

Withrow, R.M. 1990. A Phase I Cultural Resources Investigation: Field Reconnaissance and Testing of Islands in Spring Lake, Pool 5, near Buffalo City, Buffalo County, Wisconsin. Reports of Investigations Number CENCS-PD-ER-42, St. Paul District, Corps of Engineers. St. Paul.

Withrow, R.M., and S. O'Mack. 1989. A Phase I Records Search and Preliminary Reconnaissance Survey of the Whitewater River/Weaver Bottoms Area, Wabasha County, Minnesota. Reports of Investigations Number CENCS-PD-ER-36, St. Paul District, Corps of Engineers. St. Paul.

Zeto, M.A., W.A. Tolin, and J.E. Schmidt. 1987. The freshwater mussels (Unionidae) of the upper Ohio River, Greenup and Belleville Pools, West Virginia. Nautilus 101: 182-185.

Appendix A

POOL 5 RECREATIONAL BOAT ACCESS SURVEY
Minnesota Department of Natural Resources

January 3, 2002

POOL 5 RECREATIONAL BOAT ACCESS SURVEY
Minnesota Department of Natural Resources
January 3, 2002

Minnesota Department of Natural Resources (MDNR) staff surveyed recreational boat access in Pool 5 on September 13, 2001, and October 22, 2001. Water levels at Alma, Wisconsin, were 660.24 (19,300 cfs) on September 13, 2001, and 660.26 (21,200 cfs) on October 22, 2001. Ramp type, general condition, number of lanes, depth to end of ramp, and substrates were determined for each boat access site. In addition, the number, location, and depth of private boat docks were determined throughout the pool, as well as channel depths at various areas where boaters typically access the main channel. This information was gathered to assist in planning for a Pool 5 drawdown.

Boat Access Sites

Boat access sites are described as follows (see also Figures 3-5, 3-6, and 3-7):

1) Weaver Landing (RM 744.6R) – surveyed on 9/13 – U.S. Fish and Wildlife Service (USFWS) owned access with two lanes, each consisting of concrete planks. The west lane extends 24 feet from the water's edge. Depth midway along the ramp (12 feet from shore) is 1.85 feet, and depth at the end of the ramp is 3.6 feet. The east lane extends 19 feet from the water's edge. Depth at the end of the ramp is 3.0 feet. There is a broken section of concrete near the end of this lane.

   Depths beyond the ramp are as follows: 33 feet from the water's edge = 1.6 feet deep; 50 feet from the water's edge = 1.5 feet deep; 75 feet from the water's edge = 1.55 feet deep. Depths are shallow due to more than 6 feet of muck between the top of substrate and hard bottom.

   Summary: This access has filled with sediment. Both ramps are currently marginal and would be unusable during a drawdown.

2) Minneiska Landing (RM 741.8R) – surveyed on 9/13 - MDNR owned ramp with one lane consisting of concrete planks. The ramp extends 15 feet from the water's edge, with a depth of 1.1 feet at 9 feet out from the water's edge, and a depth of 2.5 feet at the end of the ramp. Depth 21 feet from the water's edge is 4.0 feet. Maximum depth in the scour hole beyond the end of the ramp is 5.1 feet. Most of the ramp is covered with gravel.

   To reach the main channel, boaters must travel through an approximately 150-foot-long culvert as well as an area of relatively shallow depth beyond the culvert. Depth in the culvert is 2.5 feet, with approximately 2 to 6 inches of silt substrate over the concrete culvert bottom. Depths from the end of the culvert to the main channel (distance of approximately 450 feet) range from 2.1 to 3.8 feet, with the majority being 2.8 feet.

Summary: This ramp receives significant use primarily from small craft drafting less than 2.5 feet. The area into which boats are launched is small, no more than 40 feet across, which will limit boat access during a drawdown. Also, the shallow depth to the bottom of the culvert (2.5 feet) will limit or eliminate boat access during a drawdown, depending upon the extent of drawdown.

3) Halfmoon Landing (RM 747.5R) – surveyed on 9/13 – A Fish and Wildlife Service-owned access with a two-lane ramp consisting of poured concrete. The ramp is 50 feet long, 30 feet of which is below the water, with a depth of 6 to 7 feet at the end of the ramp. This site was renovated in 2000.

Boat access from Halfmoon Landing to the main channel is through Old John's Ditch and Murphy's Cut. Old John's Ditch is 6 feet deep or greater in most places (or at least somewhere in any cross section). Murphy's Cut is an approximately 1,000-foot flowing channel from the main channel to Old John's Ditch. The downstream 150 feet of Murphy's Cut is sand substrate less than 2 feet deep in most places. This area has been filling, causing significant boat access problems the last several years. As one moves upstream, depth increases to approximately 3 to 4 feet until reaching the scour hole below a rock-lined channel, where depth is over 20 feet. The rock-lined channel is approximately 150 feet long, with a minimum depth of 4.5 feet, and has a solid rock bottom. From the end of the rock-lined channel to approximately 150 feet from the main river channel, a 10-foot-wide channel has formed along the south bank ranging from 4 to 5 feet in depth. From 150 feet from the main river channel to the main river channel, there is an approximately 75-foot-long sandbar where depth is less than 2 feet.

Summary: Halfmoon Landing itself is in excellent shape with good depth and could remain open during a drawdown. However, the downstream and upstream ends of Murphy's Cut would require substantial dredging to maintain sufficient depths. Access in these areas is already limited, and various solutions to the problem are being considered by State and Federal agencies.

4) West Newton Colony Boat Ramp (RM 747.4R) – surveyed on 9/13 – Private ramp owned and maintained by residents of West Newton Colony. The ramp is primarily sand, with a concrete sill that is in disrepair and mostly out of the water. Depths at various distances from the water's edge are as follows: 8 feet = 1.3 feet deep; 15 feet = 3.5 feet deep; 20 feet = 4.7 feet deep (scour hole); 30 feet = 3.1 feet deep; 50 feet = 5.1 feet deep.

Summary: A sand hump approximately 25 to 35 feet from the water's edge would likely require dredging prior to drawdown.

5) Pritchard's (Goose Lake) Landing (RM 746.8R) – surveyed on 9/13 – MDNR owned access with one lane consisting of concrete planks. Determining the distance to the end of the ramp from the water's edge was difficult due to loose muck substrates.

Depth 15 feet from shore (at the end of the boat dock) was 2.8 feet, with 1.6 feet being muck and 1.2 feet being water.

Summary: This access is inadequate at this time. Duck hunters and some small-boat anglers use the ramp seasonally, however, not without difficulty due to the extensive muck substrates. The ramp would be totally unusable during a drawdown but may benefit from sediment consolidation.

6) Clear Lake (Pioneer) Landing (RM 752.7R) – surveyed on 9/13 – MDNR owned access with one lane consisting of concrete planks. Sand substrates cover the entire ramp. Depths from the water's edge are as follows: 5 feet = 1 inch deep; 12 feet = 1.9 feet deep; 16 feet = 2.7 feet deep; 30 feet = 2.9 feet deep.

Summary: Clear Lake is very shallow (mostly less than 3 feet deep). Access to nearby Schmoker's Lake and eventually the main channel is blocked due to very shallow depths in the channel between Clear and Schmoker's Lakes. As such, there is little, if any, current use of this ramp. Dredging may provide access into Schmoker's Lake, but not ensure access to the main channel due to shallow depths between those areas.

7) Alma Boat Landing (RM 751.6L) – surveyed on 10/22 – Wisconsin Department of Natural Resources (WDNR) owned access with a two-lane, poured concrete ramp approximately 30 feet long. A dock separates the two lanes. Depth at the end of the ramp on the right side (looking at the ramp from the parking lot) is 4.5 feet, and on the left side is 8 feet.

Summary: This popular and well-used ramp is adjacent to the main channel. The right lane would be questionable during a drawdown. It is near the shoreline that parallels the ramp and is relatively shallow in depth. The left lane would remain usable and provides substantial depth as one moves out from shore.

8) Belvidere Slough Landing (RM 746.9L) – surveyed on 10/22 – WDNR owned access with a single-lane paved ramp. The ramp is 40 feet long and extends 19 feet into the water. Depth at the end of the ramp is 4 feet, and substrates are solid gravel/rock. Bottom depth drops quickly in this area, and it is over 10 feet deep approximately 30 feet from shore.

Summary: With good depth and solid substrates extending well beyond the ramp, this access would continue to be usable during a drawdown.

9) Great River Harbor (RM 747.9L) – surveyed on 10/22 – privately owned access with a single-lane poured concrete ramp. The ramp is 50 feet long and extends 20 feet into the water. Depth at the end of the ramp is 6 feet, dropping to 8 feet of water farther from shore. Substrates are gravel/sand and relatively firm.

Depths in the harbor near the boat ramp where most boat traffic occurs are

approximately 7 feet. Access from the harbor to Belvidere Slough, and subsequently to the main channel, is marked with buoys. Depths in the marked area range from 4 to 8 feet; however, depths on either side of the marked channel are 2 to 3 feet.

Summary: This access has good depth and relatively solid substrates extending beyond the end of the ramp and would likely continue to be usable during a drawdown. Some dredging may be needed from the harbor to the main channel, especially for commercial houseboats.

10) Buffalo City Landing (RM 744.3L) – surveyed on 10/22 – Buffalo City owned access with a two-lane concrete ramp extending 20 feet into the water. Depth at the end of the ramp is 4 feet, dropping to 6 feet of water farther from shore. Substrates are firm.

Summary: This access has good depth and relatively solid substrates extending beyond the end of the ramp and would likely continue to be usable during a drawdown.

11) Upper Spring Lake Landing (RM 742.4L) – surveyed on 10/22 – This is a Corps-owned, and Buffalo City-operated access with a single-lane gravel ramp extending 15 feet into the water. Substrates beyond the ramp are sand. Depth at the end of the ramp is 3 feet, and maximum depth in the area is 4 feet, but most areas are shallower.

Summary: This ramp would be marginally usable or not usable during a drawdown due to shallow depths near the ramp and in the surrounding area.

12) Lower Spring Lake Landing (RM 741.2L) – surveyed on 10/22 – WDNR and Buffalo City operated access with a single-lane concrete ramp. The ramp extends only 3 feet into the water and has a depth of 1 foot at the end of the ramp. Substrates beyond the end of the ramp are sand, with gradually sloping depths out to 7 feet.

Summary: The concrete portion of the ramp would be out of the water during a drawdown. However, depth increases gradually over a hard sand bottom and may be sufficient to allow use during a drawdown.

Private Boat Docks and Other Access Areas

Boat docks are described by area. The number of docks, general description of depths, and other pertinent information are provided as follows:

Area A: Belvidere Slough to Great River Harbor – surveyed on 10/22 – There are 13 private docks in this area, with water depths at the end of each dock ranging from 4 to 10 feet. This area would be minimally affected by a drawdown.

Area B: Great River Harbor – surveyed on 10/22 – There are approximately 22 docks in the harbor with slips for approximately 40 boats. A number of large houseboats (several rentals) are moored in the marina. Water depths are generally 5 to 6 feet at the ends of

the docks, with the exception of four docks/boathouses on the south end and three docks on the north end where depths are less than 3 feet. Depth near the marina and gas dock is 6 to 7 feet. See discussion under Great River Harbor boat access for information on access to the main channel.

Area C: Downstream of Belvidere Slough Landing – surveyed on 10/22 – Six docks are located downstream of the Belvidere Slough landing in a small backwater channel. Water depths at the end of the docks range from less than 2 feet to 4 feet. The farther one goes from Belvidere Slough Landing, the shallower it gets. Many of these docks are in disrepair. Use of these docks during a drawdown is questionable.

Area D: Buffalo City – surveyed on 10/22 – There are 80 docks along this reach. Two docks on the very north end are in less than 1 foot of water. Depth increases as one moves downstream, with the majority of the remaining docks in water from 3 to 6 feet deep. There are isolated pockets with 2 feet of water. Water depths in the access channel out from the docks range from 5 to 14 feet. Many docks are in disrepair. This area would be affected by a drawdown; however, many of the docks would still be usable. Some dredging of the access channel may be needed; however, much of the area is over 8 feet deep.

Area E: Downstream of Buffalo City to Upper Spring Lake Landing – surveyed on 10/22 – There are 13 docks scattered in this reach. Water depths at the end of each dock range from 2 to 5 feet, with the majority at 2 feet. Water depths in the access channel out from the dock do not exceed 4 feet, with the exception of immediately above the Upper Spring Lake Landing where depths reach 7 feet. This area would be significantly affected by a drawdown, with most of the docks unusable.

Area F: Spring Lake – surveyed on 10/22 – There are 30 docks in this area. Water depths at the end of the docks range from 1 to 7 feet, with most less than 3 feet. Water depth in the access area out from the docks is 3 to 4 feet in most areas, with the exception of the very lower end (near Lower Spring Lake ramp) where depths exceed 8 feet. Most of the docks in this area would not be usable in a drawdown, without significant additional dredging.

Area G: Krueger Slough – surveyed on 9/13 – One dock near the upstream end of Krueger Slough near the main channel. Water depth from the main channel to the end of the dock is at least 4 feet. This dock would likely remain usable in a drawdown.

Area H: West Newton Colony downstream of Murphy's Cut – surveyed on 9/13 – There are four docks in this area, with 8 feet or more of depth at the end of each dock. These docks would remain usable in a drawdown.

Area I: West Newton Colony upstream of Murphy's Cut – surveyed on 9/13 – There are 14 docks in this area, with water depth at the end of most docks ranging from 6 to 8 feet. There are four docks that have less than 2 feet of water. Most of the docks in this area would remain usable during a drawdown.

Area J: West Newton Chute – There are 29 docks in this area. One dock in the upper end was in less than 2 feet of water, four docks were in 4 feet of water, and most of the remaining docks were in water depths 6 feet or greater. This area would be minimally affected by a drawdown, with the exception of the one dock already in shallow water.

Area K: Minneiska – There is one dock, just south of the Minneiska boat access, in 4 feet of water at the end of the dock.

Appendix B

COORDINATION ATTACHMENTS

Letter from St. Paul District to U.S. Fish and Wildlife Service, February 25, 2005

Letter from U.S. Fish and Wildlife Service to St. Paul District, March 2, 2005