US Army Corps
Of Engineers
St. Paul District

UPPER MISSISSIPPI RIVER SYSTEM

ENVIRONMENTAL MANAGEMENT PROGRAM

DEFINITE PROJECT REPORT/ ENVIRONMENTAL ASSESSMENT (SP-23)

AMBROUGH SLOUGH HABITAT REHABILITATION AND ENHANCEMENT PROJECT

Pool 10
Upper Mississippi River
Crawford County, Wisconsin

December 2000

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The Ambrough Slough complex is a 1200-hectare area containing a number of backwater lakes, sloughs and other wetland habitats in pool 10 of the Upper Mississippi River near Prairie du Chien, Wisconsin. The habitat concerns within the Ambrough Slough complex are primarily related to providing adequate habitat for backwater fish, especially overwintering habitat. Backwater dredging is recommended for Spring Lake, Big Missouri Lake and Upper Doubles Lake to increase water depths and improve summer and winter fish habitat. The largest lake in the complex, Gremore Lake, suffers dissolved oxygen depletion in the winter, which would be alleviated by constructing a small channel to introduce flows from Ambrough Slough into Gremore Lake. Reducing flows at Black Slough, Upper Double Lake and Tilmont Lake would improve winter habitat conditions by reducing current velocities and maintaining water temperatures within tolerance ranges of backwater fish.

15. SUBJECT TERMS
Mississippi River Channels(Waterways) Habitat Fisheries Dredging

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AMBROUGH SLOUGH
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

EXECUTIVE SUMMARY

The Ambrough Slough Habitat Rehabilitation and Enhancement Project consists of a number of features located pool 10 of the Upper Mississippi River near Prairie du Chien, Wisconsin. The study investigated habitat conditions and concerns in the Ambrough Slough complex, a 1200-hectare area containing a number of backwater lakes, sloughs, and other wetland habitats.

The habitat concerns within the Ambrough Slough complex are primarily related to providing adequate habitat for the backwater fish community, especially overwintering habitat. Habitat conditions for wildlife within the complex are considered above average.

The plan formulation process considered a number of alternatives for the habitat problems and opportunities within the Ambrough Slough complex. Reducing flows entering the complex and individual lakes were evaluated for a number of locations. The recommended flow reduction features of the project include a partial rock closure structure at the entrance of Black Slough, rock closures of two small openings at Upper Doubles Lake and Tilmont Lake, respectively, and the restoration of a peninsula that used to separate Tilmont Lake from Ambrough and Mudhen Sloughs. The primary purpose of these features is to improve winter fish habitat conditions by reducing current velocities and maintaining water temperatures within tolerance ranges of backwater fish species.

Backwater dredging was evaluated for a number of area lakes and is recommended for Spring Lake, Big Missouri Lake, and Upper Doubles Lake. The primary purpose is to increase water depths and improve both summer and winter habitat conditions for the backwater fish community.

Gremore Lake is the largest lake in the complex. The primary habitat problem in Gremore Lake is dissolved oxygen depletion during the winter. Mechanical aeration, dredging, and flow introduction were evaluated as potential solutions. Flow introduction is the recommended plan. This would be accomplished by construction of a small channel that would allow introduction of Ambrough Slough flows into the head of Gremore Lake. A culvert with a stoplog control structure would be used to control the flows entering the lake. This project feature is located outside the Upper Mississippi River National Wildlife and Fish Refuge, and as such, implementation would be cost shared with the Wisconsin Department of Natural Resources on a 65 percent Federal - 35 percent non-Federal basis.

Total direct construction costs for the recommend plan are estimated to be $2,052,600. Costs for plans and specifications and construction management bring the total estimated implementation cost to $2,428,600. (These costs are "fully funded", i.e., indexed for inflation). For those features located entirely within the Upper Mississippi River National Wildlife and Fish

Refuge, the cost of the project would be 100 percent Federal, in accordance with Section 906(e) of the Water Resources Development Act of 1986. The operation and maintenance requirements for those features would be the responsibility of the U.S. Fish and Wildlife Service.

As noted, the Gremore Lake channel would be cost shared with the Wisconsin Department of Natural Resources in accordance with Section 509(e) of the Water Resources Development Act of 1999. The estimated total cost of the Gremore Lake channel (including sunk planning costs) is $332,400. The Wisconsin Department of Natural Resources cost share would be $116,340. The Department would also be responsible for operation and maintenance of this feature.

**DEFINITE PROJECT REPORT/
ENVIROMENTAL ASSESSMENT**

**AMBROUGH SLOUGH
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 10, UPPER MISSISSIPPI RIVER
CRAWFORD COUNTY, WISCONSIN**

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INTRODUCTION

1.1 AUTHORITY

The authority for this report is provided by Section 1103 of the Water Resources Development Act of 1986, as amended (Public Law 99-662). The proposed project would be funded and constructed under this authorization. Section 1103 is summarized as follows:

Section 1103. UPPER MISSISSIPPI RIVER PLAN

(a) (1) This section may be cited as the Upper Mississippi River Management Act of 1986.

(2) To ensure the coordinated development and enhancement of the Upper Mississippi River system, it is hereby declared to be the intent of the Congress to recognize that system as a nationally significant ecosystem and a nationally significant commercial navigation system....The system shall be administered and regulated in recognition of its several purposes.

(e) PROGRAM AUTHORITY

(1) AUTHORITY

(A) IN GENERAL. The Secretary, in consultation with the Secretary of the Interior and the states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, may undertake, as identified in the master plan -

(i) a program for the planning, construction, and evaluation of measures for fish and wildlife habitat rehabilitation and enhancement; and....

1.2 PARTICIPANTS AND COORDINATION

Participants in the planning for the Ambrough Slough project include the Upper Mississippi River National Wildlife and Fish Refuge and the Region 3 Offices of the U.S. Fish and Wildlife Service (USFWS), the Wisconsin and Iowa Departments of Natural Resources (Wisconsin DNR and Iowa DNR), and the St. Paul District, Corps of Engineers.

The USFWS and the Wisconsin DNR were most heavily involved in project planning because the study area is located with the Upper Mississippi River National Wildlife and Fish Refuge and is located within Wisconsin. The USFWS would be considered a cooperating agency under Federal regulations governing the implementation of the National Environmental Policy Act of 1969.

The following individuals played an active role in the planning and design of the Ambrough Slough project. For St. Paul District personnel, the discipline and contribution of the individual planning team members is listed. For resource agency personnel, the individual's position title is listed.

ST. PAUL DISTRICT, CORPS OF ENGINEERS

Name	Discipline	Contribution
Gary Palesh	Fishery Biologist	Project Manager
Tim Yager	Fishery Biologist	Environmental analysis, NEPA doc.
Sissel Johannessen	Archaeologist	Cultural resources analysis
Keith LeClaire	Cartographer	GIS analysis
Michelle Schneider	Hydraulic Engineer	Hydraulic analysis
Jon Hendrickson	Hydraulic Engineer	Hydraulic analysis
Joel Face	Civil Engineer	Geotechnical analysis
Terry Williams	Civil Engineer	Design and layout
Phil Sauser	Civil Engineer	Structural Design
Rick Femrite	Civil Engineer	Cost Estimating
Ken Beck	Real Estate Specialist	Real Estate

U.S. FISH AND WILDLIFE SERVICE

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John Sullivan	Mississippi River Water Quality Specialist

IOWA DEPARTMENT OF NATURAL RESOURCES

Mike Griffin	Habitat Projects Coordinator
Scott Gritters	Area Fisheries Manager
Karen Aulwes	Asst. Area Fisheries Manager

1.3 PROJECT PURPOSE

1.3.1 RESOURCE PROBLEMS/OPPORTUNITIES

The purpose of this Definite Project Report is to document existing and predict future habitat conditions and deficiencies, define habitat goals and objectives, identify and evaluate alternative measures that would address the goals and objectives, and recommend a selected plan for habitat restoration and enhancement.

1.3.2 PROJECT BOUNDARIES

The Ambrough Slough project area is located in pool 10 of the Mississippi River, approximately 8 kilometers above Prairie du Chien, Wisconsin (plate 1). The general project area is that portion of the Mississippi River floodplain lying between the main channel and the Wisconsin uplands between river miles 638 and 641 (plates 2a, 2b, and 2c).

The majority of the study area lies within the boundaries of the Upper Mississippi River National Wildlife and Fish Refuge (Refuge).

GENERAL PROJECT SELECTION PROCESS

2.1 ELIGIBILITY CRITERIA

A design memorandum (or implementation document) did not exist at the time of the enactment of Section 1103. Therefore, the North Central Division, U.S. Army Corps of Engineers, completed a "General Plan" for implementation of the Upper Mississippi River System - Environmental Management Program (UMRS-EMP) in January 1986. The U.S. Fish and Wildlife Service, Region 3, and the five affected States (Illinois, Iowa, Minnesota, Missouri, and Wisconsin) participated through the Upper Mississippi River Basin Association. Programmatic updates of the General Plan for budget planning and policy development are accomplished through Annual Addenda.

Coordination with the States and the USFWS during the preparation of the General Plan and Annual Addenda led to an examination of the Comprehensive Master Plan for the Management of the Upper Mississippi River System. The Master Plan, completed by the Upper Mississippi River Basin Commission in 1981, was the basis of the recommendations enacted into law in Section 1103. The Master Plan report and the General Plan identified examples of potential habitat rehabilitation and enhancement techniques. Consideration of the Federal interest and Federal policies has resulted in the conclusions below:

a. (First Annual Addendum). The Master Plan report... and the authorizing legislation do not pose explicit constraints on the kinds of projects to be implemented under the UMRS-EMP. For habitat projects, the main eligibility criterion should be that a direct relationship should exist between the project and the central problem as defined by the Master Plan; i.e., the sedimentation of backwaters and side channels of the UMRS. Other criteria include geographic proximity to the river (for erosion control), other agency missions, and whether the condition is the result of deferred maintenance....

b. (Second Annual Addendum).

(1) The types of projects that are definitely within the realm of Corps of Engineers implementation authorities include the following:

- backwater dredging
- dike and levee construction
- island construction
- bank stabilization
- side channel openings/closures
- wing and closing dam modifications
- aeration and water control systems
- waterfowl nesting cover (as a complement to one of the other project types)
- acquisition of wildlife lands

(2) A number of innovative structural and nonstructural solutions that address human-induced impacts, particularly those related to navigation traffic and operation and maintenance of the navigation system could result in significant long-term protection of UMRS habitat. Therefore, proposed projects that include such measures will not be categorically excluded from consideration, but the policy and technical feasibility of each of these measures will be investigated on a case-by-case basis and the measures will be recommended only after consideration of system-wide effects.

2.2 PROJECT SELECTION

Projects are nominated for inclusion in the District's habitat program by the respective State natural resource agency or the U.S. Fish and Wildlife Service, based on agency management objectives. To assist the District in the selection process, the States and USFWS have agreed to use the expertise of the Fish and Wildlife Work Group (FWWG) of the River Resources Forum (RRF) to consider critical habitat needs along the Mississippi River and prioritize nominated projects on a biological basis.

The FWWG consists of biologists responsible for managing the river for their respective agency. Meetings are held on a regular basis to evaluate and rank the nominated projects according to the biological benefits that they could provide in relation to the habitat needs of the river system. The ranking is forwarded to the RRF for consideration of the broader policy perspectives of the agencies involved. The RRF submits the coordinated ranking to the District, and each agency officially notifies the District of its views on the ranking. The District then formulates and submits a program that is consistent with the overall program guidance as described in the UMRS-EMP General Plan and Annual Addenda and supplemental guidance provided by the North Central Division.

Projects consequently have been screened by biologists closely acquainted with the river. Resource needs and deficiencies have been considered on a pool-by-pool basis to ensure that regional needs are being met and that the best expertise available is being used to optimize the habitat benefits created at the most suitable locations.

The Ambrough Slough project was proposed for consideration by the Wisconsin Department of Natural Resources. The project was evaluated in 1990 by the FWWG and ranked for inclusion in the District's FY 1993 program. In that evaluation, the project was ranked as the number 14 priority project (out of 38) for consideration in FY 1993.

In 1991, the FWWG ranked projects for inclusion in the FY 1994 St. Paul District program. In this ranking, the Ambrough Slough project rose in priority to number 10 out of 33 projects ranked. In the 1992 ranking for the FY 1995 program, the project rose to number 6 in priority out of 31 projects. Based on this ranking, the project was programmed by the St. Paul District for study. The study was initiated in January 1996.

ASSESSMENT OF EXISTING RESOURCES

3.1 PHYSICAL SETTING

Pool 10 is part of the Upper Mississippi River system and was created in 1937 by the completion of Lock and Dam 10. The entire pool is about 53 kilometers long, extending from river mile 615.1 to river mile 647.9. The river valley in this pool is 3 to 5 kilometers wide and is bordered on either side by weathered bluffs.

The study area is a complex of backwater lakes, sloughs, and ponds lying between the main channel and the Wisconsin uplands bordering the floodplain (plates 2a, 2b, and 2c). Ambrough Slough is the predominant feature of the area.

3.2 WATER RESOURCES

The following are the primary water resource features of the study area. Many of the backwater lakes in the Ambrough Slough backwater complex will vary in size depending upon water levels and the amount of emergent vegetation encroachment. Because of this variability, the size ranges given for these lakes are approximate.

3.2.1 MISSISSIPPI RIVER

The study area lies about 13 kilometers below Lock and Dam 9 and about 14.5 kilometers above the confluence of the Wisconsin River with the Mississippi River. The Mississippi River main channel in this reach is typically about 500 meters wide.

Early summer (June) discharges at Lock and Dam 9 generally range from 850 to 1,500 cubic meters per second (cms). By late summer, discharges usually decrease to a range of 550 to 850 cms. Winter low flows are usually in the range of 400 to 550 cms. Table 3-1 shows the discharges and stages associated with these flows and for various high runoff events for the study area.

Table 3-1
Mississippi River Discharge Frequencies in Study Area

Event	Flow (cms)	Flow (cfs)	Stage (m)	Stage (ft)
winter low flow	500	18,000	186.5	612.0
late summer	700	25,000	186.8	613.0
early summer	1,200	42,000	187.4	614.9
5-year (20% chance)	3,900	138,000	190.1	623.8
10-year (10% chance)	4,700	166,000	190.7	625.8
June 1993	5,380	190,000	191.4	628.0
April 1997	5,830	206,000	191.4	627.9
April 1969	6,272	221,500	191.4	628.0
50-year (2% chance)	6,428	227,000	191.8	629.4
100-year (1% chance)	7,249	256,000	192.3	630.9
April 1965	7,815	276,000	192.5	631.7

3.2.2 AMBROUGH SLOUGH

Ambrough Slough is the main water feature of the study area. The slough branches off the main channel at river mile 641.9. It flows in a meandering pattern in a southerly direction for about 5 kilometers. The slough then widens and straightens, continuing to flow in a southerly direction for about 3 kilometers until in enters the East Channel of the Mississippi River at Prairie du Chien.

Measured flows in Ambrough Slough are shown in tables 3-2 along with flows for other sloughs entering the Ambrough Slough complex. Many of the smaller sloughs are unnamed and are only identified by their river mile location. The discharge measurements are ordered in table 3-2 by Lock and Dam 9 (L/D 9) discharge to make it easier to show how the discharges into the sloughs are related to L/D 9 discharges. It appears that Black Slough is the largest contributor of flow to the complex followed by Ambrough Slough. Flows from Black Slough have been increasing over the past decade as the mouth of this slough has been enlarging. Most of the other sloughs appear to contribute only small flows when the river discharges are low to moderate.

Table 3-2
Discharge Measurements (cms) in Sloughs

Slough	Date	L/D 9 Discharge	Site Discharge	% of L/D 9 Discharge
642.10	5/29/96	2,288	18	0.8
	6/25/96	2,186	15	0.7
	5/17/95	2,138	11	0.5
	7/10/97	1,671	3	0.2
	7/18/95	1,444	0	0.0
	10/23/96	966	0	0.0
Ambrough (641.90)	5/29/96	2,288	49	2.1
	6/25/96	2,186	37	1.7
	5/17/95	2,138	39	1.8
	7/10/97	1,671	21	1.3
	7/18/95	1,444	8	0.7
	10/23/96	966	*	*
641.85	5/29/96	2,288	23	1.0
	6/25/96	2,186	19	0.9
	5/17/95	2,138	19	0.9
	7/10/97	1,673	10	0.6
	7/18/95	1,444	*	*
	10/23/96	966	*	*
641.80	5/29/96	2,288	9	0.4
	6/25/96	2,186	8	0.4
	5/17/95	2,138	9	0.4
	7/10/97	1,678	2	0.1
	7/18/95	1,444	*	*
	10/23/96	966	0	0
641.70	5/29/96	2,288	7	0.3
	6/25/96	2,186	7	0.3
	5/17/95	2,138	3	0.1
	7/10/97	1,678	1	0
	7/18/95	1,444	*	*
	10/23/96	966	0	0
640.00	5/30/96	2,256	7	0.3
	6/26/96	2,175	5	0.2
	7/10/97	1,682	*	*
Black (639.40)	5/30/96	2,256	68	3.0
	6/26/96	2,175	51	2.3
	5/17/95	2,138	64	3.0
	7/09/97	1,702	49	2.9
	7/18/95	1,444	18	1.6
	10/23/96	966	14	1.4
Lower Ambrough	1/14/97	926	17	1.8
	2/14/96	762	12	1.6
	1/20/89	405	1	0.2
	1/10/91	362	1	0.3

* no measurement taken though flow may have been present

source: St. Paul District COE; Wisconsin DNR

3.2.3 VOTH'S LAKE

Voth's Lake is a relatively isolated backwater lake with two distinct basins, located in the northwest portion of the study area. The lake is connected via a small drainage to Big Missouri Lake. No bathymetric data is available for Voth's Lake, but observations are that most of the lake is less than 1 meter deep.

3.2.4 BIG MISSOURI LAKE

Big Missouri Lake lies southeasterly of Voth's Lake. Big Missouri has a direct connection to Ambrough Slough and to Upper Doubles Lake to the south. On historic aerial photographs, Big Missouri Lake ranges in size from 8 to 14 hectares. Bathymetric data is available for a portion of Big Missouri Lake, indicating much of the lake is likely less than 1 meter deep.

3.2.5 SPRING LAKE

Spring Lake is located in the northeasterly portion of the study area. On early maps, Spring Lake is called "Sioux Bayou." Spring Lake is connected to Ambrough Slough by Spring Slough. There is a small slough feeding into Spring Lake from the north. It is likely that during high flow periods, water from the Mississippi River enters Spring Lake via this slough. Approximately one-half of Spring Lake lies outside the boundaries of the Refuge. On historic aerial photographs, Spring Lake ranges in size from 18 to 30 hectares. No bathymetric data is available for Spring Lake, but it is likely that much of the lake is less than 1 meter deep.

3.2.6 ROULETTE LAKE

Roulette Lake is located in the upper portion of study area, lying to the west of Ambrough Slough. A small slough enters Roulette Lake from the north from the main channel. The lake outlets to Ambrough Slough. On historic aerial photographs, Roulette Lake ranges in size from 8 to 22 hectares. No bathymetric data is available for Roulette Lake, but observations are that much of the lake is less than 1 meter deep.

3.2.7 UPPER DOUBLES LAKE

Upper Doubles Lake is located west of Ambrough Slough and south of Big Missouri Lake. The lake has a direct connection with Big Missouri Lake and with Lower Doubles Lake. On historic aerial photographs, Upper Doubles Lake ranges in size from 10 to 16 hectares. Bathymetric data is available for a portion of Upper Doubles Lake, indicating most of the lake is less than 1 meter deep.

3.2.8 LOWER DOUBLES LAKE

Lower Doubles Lake is located west of Ambrough Slough and south of Upper Doubles Lake. In addition to the connection to Upper Doubles laked noted above, the lake has a connection with Fish Lake to the south. On historic aerial photographs, Lower Doubles Lake ranges in size from 8 to 12 hectares. Bathymetric data is available for much of Lower Doubles Lake, indicating most of the lake is less than 1 meter deep.

3.2.9 FISH LAKE

Fish Lake is located west of Ambrough Slough near the center of the study area. In addition to Lower Doubles Lake, Fish Lake has a direct connection with Ambrough Slough and with Dark Slough. On historic aerial photographs, the lake ranges in size from 10 to 18 hectares. Bathymetric data is available for much of Fish Lake, indicating most of the lake is less than 1 meter deep.

3.2.10 FLUKE'S LAKE

Fluke's Lake is located in the west central portion of the study area. The lake is connected to the main channel of the Mississippi River via Black Slough, and is connected to Ambrough Slough by Dark Slough. The area that would be considered part of Fluke's Lake has changed considerably over time with changes in Black Slough.

3.2.11 TILMONT LAKE

Tilmont Lake is located west of Ambrough Slough in the lower portion of the study area. The lake is directly connected to Ambrough Slough and Mudhen Slough. On historic aerial photographs, the lake ranges in size from 34 to 42 hectares. Bathymetric data for Tilmont Lake indicates a shallow flat basin with most of the lake being between 1.0 and 1.5 meters deep.

3.2.12 BLACK SLOUGH

Black Slough is a relatively short slough connecting Fluke's Lake to the Mississippi River. Water can flow both ways in Black Slough depending upon stages in the river and Fluke's Lake. However, in most instances, water flows from the main channel into Fluke's Lake.

Flows into Ambrough Slough have increased significantly over the past 10 years based on Wisconsin DNR discharge measurements. The erosion of Black Slough is believed to be a primary cause for this increase.

3.2.13 DARK SLOUGH

Dark Slough is a slough connecting Fluke's Lake to Ambrough Slough, Mudhen Slough, and other backwaters to the east. Water can flow both ways in Dark Slough depending upon stages in the river and Ambrough Slough. However, in most instances, water flows from Fluke's

Lake towards Ambrough Slough.

3.2.14 MUDHEN SLOUGH

Mudhen Slough flows south from Dark Slough to Ambrough Slough. Flow from Mudhen Slough also enters Tilmont Lake.

3.2.14 GREMORE LAKE

Gremore Lake is a 135-hectare backwater lake located east of Ambrough Slough in the lower reaches of the study area. Gremore Lake is deeper than most backwater lakes in the area, with water depths greater than 3 meters in isolated locations. Most of the lake has depths of 1 to 2 meters. All of Gremore Lake, except for a small portion of the northern shoreline, is located outside of the boundaries of the Refuge.

3.3 GEOLOGY AND SOIL/SUBSTRATE

The most significant geological event explaining the nature of the Mississippi River within pool 10 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 10 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.

3.4 WATER QUALITY

A number of the floodplain lakes in the Ambrough Slough complex have been sporadically monitored for water quality by the Wisconsin DNR. The results of those efforts are summarized here.

3.4.1 AMBROUGH SLOUGH

In June 1990 the Wisconsin DNR completed a diurnal dissolved oxygen study in Ambrough Slough. During continuous monitoring of surface waters dissolved oxygen (DO) levels fell below 5 mg/l about 13 percent of the time over a 9-day period. The study was completed during a relatively low flow period and based on the results of the study (i.e. depressed DO concentrations), concern was expressed about more serious DO depletions during even lower flow periods.

Winter water quality information collected during 1988-1989 also indicated low DO levels during low flow periods in Ambrough Slough.

3.4.2 GREMORE LAKE

Of the lakes in the Ambrough Slough complex, Gremore Lake has received the most attention in terms of water quality monitoring. Winter DO, temperature, ice conditions, and snow cover have been collected since the 1960's. In general, winter water quality conditions are typical of many floodplain lakes on the UMR, in that depletion of DO levels begins to occur as snow cover and ice thicknesses increase. Typically, by mid to late January 0.3 to 0.45 meters of ice are present with snow cover ranging from 0.15 to 0.25 meters. With these conditions, DO concentrations throughout the water column drop well below 5 mg/l, usually below 2 mg/l. Low DO levels persist into February, but usually have increased to above 5 mg/l by March. Winter water temperatures generally range from 2 to 3 °C. Table 3-3 presents selected water quality information collected in Gremore Lake since 1985.

3.4.3 OTHER LAKES

Spot sampling of temperature and DO concentrations in several of the floodplain lakes in the Ambrough Slough complex has been completed since 1985. Table 3-4 presents this information. Generally, those areas near the flowing water conditions of Ambrough Slough have good DO levels while more isolated lakes, such as Voth's and Roulette have low DO levels.

In summary, water quality in the Ambrough Slough complex varies greatly throughout the year and from water body to water body. Using the data collected from Gremore Lake it can be concluded that winter DO sags in most of the floodplain lakes create unfavorable conditions for overwintering fishes. However, Ambrough Slough itself generally maintains oxygen concentrations in excess of 5 mg/l throughout the winter months. Summer water quality is generally good, with no concerns for contaminants, however, diurnal DO monitoring has revealed some short-term summer-time sags in DO concentrations during low flow periods.

Table 3-3
Dissolved Oxygen and Temperature Observations from Gremore Lake.

Monitoring Category	Sampling Date 12-19-85	1-14-86	2-5-86	3-4-86	1-25-91	12-14-92
Ice Cover (meters)	>0.30	>0.30	<0.30	<0.30	0.38	0.13
Snow Cover (meters)	0.08	0.20	0.15	<0.02	0.10	0.04
Upper Lake Locations						
DO at Top of Water Column (mg/l)	8.2	1.6	1.9	5.5	---	5.7
DO at Bottom of Water Column (mg/l)	8.1	1.1	1.3	4.3	0.6	0.7
Temp. at Top of Water Column (C)	---	---	---	---	---	2.0
Temp. at Bottom of Water Column (C)	---	---	---	---	1.2	4.5
Mid Lake Locations						
DO at Top of Water Column (mg/l)	8.3	1.4	2.1	5.5	1.6	13.9
DO at Bottom of Water Column (mg/l)	8.1	0.7	1.2	4.3	0.5	5.6
Temp. at Top of Water Column (C)	---	---	---	---	1.0	1.0
Temp. at Bottom of Water Column (C)	---	---	---	---	3.8	3.0
Lower Lake Locations						
DO at Top of Water Column (mg/l)	8.7	1.4	3.5	8.9	2.7	14.0
DO at Bottom of Water Column (mg/l)	8.4	1.1	2.2	6.3	1.5	4.4
Temp. at Top of Water Column (C)	---	---	---	---	1.5	1.0
Temp. at Bottom of Water Column (C)	---	---	---	---	---	3.0

Monitoring Category	Sampling Date 1-10-92	2-3-94	1-30-95	1-23-96	1-15-97
Ice Cover (meters)	0.20	0.32	0.23	0.41	0.29
Snow Cover (meters)	---	0.18	0.06	0.06	0.08
Upper Lake Locations					
DO at Top of Water Column (mg/l)	3.4	12.4	7.7	1.0	3.1
DO at Bottom of Water Column (mg/l)	3.3	11.6	4.8	0.8	3.1
Temp. at Top of Water Column (C)	2.0	1.0	2.5	1.5	1.0
Temp. at Bottom of Water Column (C)	3.0	2.3	3.5	3.0	1.2
Mid Lake Locations					
DO at Top of Water Column (mg/l)	3.3	7.8	7.1	3.2	2.6
DO at Bottom of Water Column (mg/l)	2.9	5.2	6.7	1.6	2.5
Temp. at Top of Water Column (C)	2.0	2.0	3.2	1.5	1.6
Temp. at Bottom of Water Column (C)	2.5	3.0	3.0	3.0	1.7
Lower Lake Locations					
DO at Top of Water Column (mg/l)	5.2	---	14.4	4.0	6.5
DO at Bottom of Water Column (mg/l)	4.5	---	11.8	2.4	5.5
Temp. at Top of Water Column (C)	2.0	---	2.0	2.0	0.7
Temp. at Bottom of Water Column (C)	2.5	---	3.0	2.0	1.0

Source: Wisconsin Department of Natural Resources

Table 3-4
Dissolved Oxygen and Temperature Observations from Selected Locations
In the Ambrough Slough Area

Monitoring Category	Sampling Date 1-10-91	1-27-93	1-15-97
Ambrough Slough above Roulette Lake			
Ice Cover (meters)	0.36	0.18	
Snow Cover (meters)	0.08	0.03	
Dissolved Oxygen (mg/l)	12.8	12.4	
Temperature (C)	0.0	0.3	
Roulette Lake			
Ice Cover (meters)	0.33	0.40	
Snow Cover (meters)	0.10	0.12	
Dissolved Oxygen (mg/l)	1.2	4.6	
Temperature (C)	0.0	1.8	
Voth's Lake			
Ice Cover (meters)	0.32	0.27	0.24
Snow Cover (meters)	0.10	0.12	0.06
Dissolved Oxygen (mg/l)	0.4	1.0	6.4
Temperature (C)	0.0	1.1	2.0
Upper Big Missouri Lake			
Ice Cover (meters)	0.30	0.37	0.37
Snow Cover (meters)	0.13	0.12	0.06
Dissolved Oxygen (mg/l)	4.5	10.8	9.8
Temperature (C)	2.0	1.1	1.0
Lower Big Missouri Lake			
Ice Cover (meters)	0.22	0.44	0.37
Snow Cover (meters)	0.18	0.12	0.06
Dissolved Oxygen (mg/l)	8.5	8.2	8.9
Temperature (C)	0.0	1.2	1.0
Spring Lake (North)			
Ice Cover (meters)			0.37
Snow Cover (meters)			0.06
Dissolved Oxygen (mg/l)			6.6
Temperature (C)			2.0
Upper Doubles			
Ice Cover (meters)			0.37
Snow Cover (meters)			0.06
Dissolved Oxygen (mg/l)			10.6
Temperature (C)			1.0
Lower Doubles			
Ice Cover (meters)			0.24
Snow Cover (meters)			0.06
Dissolved Oxygen (mg/l)			11.8
Temperature (C)			0.0
Fish Lake			
Ice Cover (meters)	0.32	0.40	0.37
Snow Cover (meters)	0.08	0.12	0.06
Dissolved Oxygen (mg/l)	11.5	10.4	12.0
Temperature (C)	0.5	1.0	0.0
Black Slough			
Ice Cover (meters)	0.31	0.21	
Snow Cover (meters)	0.13	0.12	
Dissolved Oxygen (mg/l)	12.8	12.5	
Temperature (C)	0.0	0.4	
Tilmont Lake			
Ice Cover (meters)			0.37
Snow Cover (meters)			0.06
Dissolved Oxygen (mg/l)			11.5
Temperature (C)			0.2
Ambrough Slough near DNR Landing			
Ice Cover (meters)	0.39	0.20	0.24
Snow Cover (meters)	0.08	0.00	0.08
Dissolved Oxygen (mg/l)	12.5	11.8	14.4
Temperature (C)	0.0	0.4	0.0

Source: Wisconsin Department of Natural Resources

3.5 VEGETATION

Terrestrial vegetation present on "non-aquatic" areas in the Ambrough Slough study area is typical of the southern wet-mesic forest type (Curtis 1959). A characteristic feature of floodplain forests is the alluvial soil constantly deposited in some areas but eroded in others. Alluvial soils are inundated during flood events, but are usually well drained for much of the growing season (Shaw and Fredine 1956). Dominant tree species include American elm (*Ulmus americana*), silver maple (*Acer saccharinum*), green ash (*Fraxinus pennsylvanica*), and basswood (*Tilia americana*). Other tree species include river birch (*Betula nigra*), eastern cottonwood (*Populus deltoides*), black ash (*Fraxinus nigra*), swamp white oak (*Quercus bicolor*), red oak (*Quercus rubra*), white oak (*Quercus alba*) and black willow (*Salix nigra*). The herbaceous groundlayer is commonly composed of jewelweed (*Impatiens* spp.), wood nettle (*Laportea canadensis*), poison ivy (*Rhus radicans*), wild grape (*Vitis riparia*), cutgrass (*Leersia* spp.), and woodbine (*Parthenocissus inserta*).

Unlike floodplain forests, wooded swamps have soils saturated during much of the growing season, often inundated by as much as one foot of standing water (Shaw and Fredine 1956). Dominant trees include black ash, red maple (*Acer rubrum*), yellow birch (*Betula alleghaniensis*), and silver maple. The ground layer often contains skunk cabbage (*Symplocarpus foetidus*), marsh marigold (*Caltha palustris*) and sedges.

Marsh/sedge meadows include low-lying flat, wet areas, covered either partially or entirely with water and subject to annual flooding. Marsh habitats represent the transition zone between aquatic and terrestrial habitats and therefore have an interspersion of aquatic, semi-aquatic and terrestrial species. Dominant plants are reed canary grass (*Phalaris arundinacea*), sedges (*Carex spp.*), bluejoint grass (*Calamagrostis canadensis*) and a variety of broad-leaved species including swamp milkweed (*Asclepias incarnata*), Joe-pye weed (*Eupatorium maculatum*) and boneset (*Eupatorium perfoliatum*). An overstory layer of tall shrub species, like red osier dogwood (*Cornus stolonifera*), button bush (*Cephalanthus occidentalis*) and Indigo bush (*Amorpha fruticosa*), are present.

Aquatic vegetation within the study reach is varied, widely distributed and abundant. Common emergent species present in the shallower areas include arrowhead (*Sagittaria latifolia*), water-lily (*Nuphar sp.* and *Nymphaea sp.*), river bulrush (*Scirpus fluviatilis*), giant bur-reed (*Sparganium eurycarpum*), lotus (*Nelumbo lutea*), smartweeds (*Polygonum sp.*) and wild rice (*Zizania aquatica*). Deeper areas are vegetated with submersed species such as pondweeds (*Potamogeton sp.*), coontail (*Ceratophyllum demersum*), elodea (*Elodea canadensis*) and wild celery (*Vallisneria americana*).

3.6 FISH AND WILDLIFE

3.6.1 FISH

The mix of shallow aquatic areas adjacent to running secondary channels provides habitat for a wide variety of fish. Species adapted to both lentic and lotic conditions are prevalent. Common species typically found in association with backwater areas include black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), northern pike (*Esox lucius*), shortnose gar (*Lepisosteus platostomus*) and bowfin (*Amia calva*). Species typically found in association with secondary channel/flowing water habitats include; sauger (*Stizostedion canadense*), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), freshwater drum (*Aplodinotus grunniens*), redhorse suckers (*Moxostoma sp.*), white bass (*Morone chrysops*) and carpsuckers (*Carpiodes sp.*). Other important species which can be found in both lentic and lotic environments include walleye (*S. vitreum*) and largemouth bass (*Micropterus salmoides*). The more riverine habitats such as those found in lower Ambrough Slough may also be suited to paddlefish (*Polyodon spathula*). Carp (*Cyprinus carpio*) and a variety of minnows are also commonly found in association with a wide variety of habitats.

Electroshock and net surveys were completed by the Wisconsin DNR at several locations in the Ambrough Slough complex in 1991/1992. Fish species lists by location derived from these surveys are provided in table 3-5.

3.6.2 WILDLIFE

The interspersion of aquatic, wetland and terrestrial areas in the Ambrough Slough complex provides valuable habitat for wildlife including waterfowl, wading birds, and aquatic mammals. The area is important for waterfowl which utilize the aquatic and wetland habitats for resting and the wetland and adjacent terrestrial habitats for feeding during migration.

Floodplain forest areas in the project area contain a rich assortment of mammalian species particularly those species associated with and dependent on water. Raccoon (*Procyon lotor*), muskrat (*Ondatra zibethica*), beaver (*Castor canadensis*), river otter (*Lutra canadensis*) and mink (*Mustela vison*) are common inhabitants frequenting woodlands, marsh/sedge meadow areas and aquatic habitats alike. White-tailed deer (*Odocoileus virginianus*), red fox (*Vulpes fulva*), gray fox (*Vulpes cinereoargenteus*), opossum (*Didelphis virginianus*), striped skunk (*Mephitis mephitis*), gray squirrel (*Sciurus carolinensis*), fox squirrel (*Sciurus niger*), cottontail rabbit (*Sylvilagus floridanus*) and various smaller rodent species are also found in bottomland habitats, most generally in woodland and/or marsh/sedge meadow areas.

Table 3-5
Fish Species Captured by Electroshock and Net within the Ambrough Slough Study Area (RM 638 - 643)

Species	Scientific Name	Location: Ambrough Slough	Big Missouri	Roulette Lake	Upper Voth's Lake	Lower Voth's Lake
Shortnose Gar	*Lepisosteus platostomus*	x	x	x	x	
Longnose Gar	*Lepisosteus osseus*			x		
Bowfin	*Amia calva*	x	x	x	x	x
Gizzard Shad	*Dorosoma cepedianum*	x	x	x	x	x
Northern Pike	*Esox lucius*		x		x	x
Carp	*Cyprinus carpio*	x	x	x		
Golden Shiner	*Notemigonus crysoleucas*		x	x	x	x
Smallmouth Buffalo	*Ictiobus bubalus*	x	x			
Golden Redhorse	*Moxostoma erythrurum*	x				
Shorthead Redhorse	*Moxostoma macrolepidotum*	x	x		x	
Spotted Sucker	*Minytrema melanops*	x	x	x	x	x
White Sucker	*Catostomus commersoni*		x			
Highfin Carpsucker	*Carpiodes velifer*	x		x	x	
River Carpsucker	*Carpiodes carpio*			x		
Flathead Catfish	*Pylodictis olivaris*	x				
Channel Catfish	*Ictalurus punctatus*	x	x			
Yellow Bullhead	*Ictalurus natalis*		x		x	x
Black Bullhead	*Ictalurus melas*		x		x	x
White Bass	*Morone chrysops*	x	x	x	x	x
Yellow Bass	*Morone mississippiensis*		x			x
Largemouth Bass	*Micropterus salmoides*	x	x	x	x	x
Bluegill	*Lepomis macrochirus*	x	x	x	x	x
Pumpkinseed	*Lepomis gibbosus*				x	x
Warmouth	*Lepomis gulosus*				x	x
Green Sunfish	*Lepomis cyanellus*					x
Black Crappie	*Pomoxis nigromaculatus*	x	x		x	x
White Crappie	*Pomoxis annularis*		x	x	x	
Rock Bass	*Ambloplites rupestris*	x				
Sauger	*Stizostedion canadense*	x	x			x
Walleye	*Stizostedion vitreum*	x	x	x		
Yellow Perch	*Perca flavescens*	x	x	x	x	x
Freshwater Drum	*Aplodinotus grunniens*	x	x	x		x

Source: Wisconsin Department of Natural Resources

The river bottomlands serve as breeding areas for many species of marsh dwelling birds. Extensive wood duck (*Aix sponsa*) nesting and brood-rearing habitat is available. Hooded mergansers (*Lophodytes cucullatus*), mallards (*Anas platyrhynchos*), blue-winged teal (*Anas discors*), Canada geese (*Branta canadensis*), and herons, shorebirds and marsh passerines (e.g., red-winged blackbird (*Agelaius phoeniceus*), yellow-throated blackbird (*Xanthocephalus xanthocephalus*) and marsh wrens) use forest and marsh areas for nesting and brood-rearing.

Dabbling ducks use shallow backwater areas, feeding on submerged pondweeds and the seeds of emergents. Diving ducks use more open water areas, feeding on submerged pondweeds, wild celery, mollusks and invertebrates. Many species of waterfowl use the Mississippi River strictly for roosting, feeding primarily in adjacent upland areas (i.e., cornfields, grain fields).

Backwaters in the project area provide feeding habitat for wading birds from rookeries both upstream and downstream. An active nesting colony of great blue heron, double-crested cormorant, and great egret exists at approximately UMR mile 639.6, on the Wisconsin side, in an area known locally as Voth's Lake. Marsh and shorebird species, passerines, aquatic furbearers, and reptiles also favor many of the same habitats. Turtle, muskrat, and beaver are commonly trapped in the biologically rich Ambrough Slough complex.

Information on reptilian and amphibian species that inhabit the area is limited. Turtles, water snakes, mud puppies, salamanders, frogs and toads are all commonly found in marsh/sedge meadow areas and aquatic habitats. Turtles make use of sandbar areas as nesting habitat, while all life stages of mud puppies, salamanders, frogs and toads use backwater sloughs and marshes.

3.6.3 AQUATIC INVERTEBRATES/MUSSELS

Limited information on freshwater mussels is currently available for the aquatic areas in Ambrough Slough, however, mussel surveys have been completed in Black Slough, Big Missouri Lake, Spring Lake, Tilmont Lake and Ambrough Slough. Additionally, surveys conducted in the Harper's Slough area located upstream and across the main channel from Ambrough Slough and in the East Channel of the UMR at Prairie du Chien may also provide insight into the mussel resources of Ambrough Slough. While much larger than Ambrough Slough, these secondary channels should still be indicative of the potential mussel resources which may exist in Ambrough Slough.

The East Channel of the UMR at Prairie du Chien, WI provides habitat for one of the richest populations of mussels in the UMR. Historically, 44 species of freshwater mussels have been identified from the Prairie du Chien area. Recent studies indicate about 31 species of freshwater mussels exist in the East Channel (table 3-6).

Common mussel species which would be expected to occur in Ambrough Slough would include; threeridge (*Amblema plicata*), deertoe (*Truncilla truncata*), pimpleback (*Quadrula pustulosa*), pigtoe (*Fusconaia flava*), threehorn (*Obliquaria reflexa*), mapleleaf (*Quadrula

Table 3-6
Mussel Species Observed from Areas in Pool 10 near Ambrough Slough

Common Name	Scientific Name	East Channel	Harper's Slough
Mapleleaf	*Quadrula quadrula*	yes	yes
Wartyback	*Quadrula nodulata*	yes	yes
Pimpleback	*Quadrula pustulosa*	yes	yes
Monkeyface	*Quadrula metanevra*	yes	no
Pigtoe	*Fusconaia flava*	yes	yes
Spike	*Elliptio dilatata*	yes	no
Black Sandshell	*Ligumia recta*	yes	yes
Fragile Papershell	*Leptodea fragilis*	yes	yes
Pink Papershell	*Proptera laevissima*	yes	yes
Pink Heelsplitter	*Proptera alata*	yes	yes
Pocketbook	*Lampsilis ovata ventricosa*	yes	yes
Fat Mucket	*Lampsilis radiata siliquoidea*	yes	no
Higgins' Eye	*Lampsilis higginsi*	yes	no
Yellow Sandshell	*Lampsilis teres*	yes	no
Hickory Nut	*Obovaria olivaria*	yes	yes
Mucket	*Actinonaias carinata*	yes	no
Ellipse	*Actinonaias ellipsiformis*	yes	no
White Heelsplitter	*Lasmigona complanata*	yes	no
Butterfly	*Ellipsaria lineolata*	yes	no
Deertoe	*Truncilla truncata*	yes	yes
Fawnfoot	*Truncilla donaciformis*	yes	yes
Threehorn	*Obliquaria reflexa*	yes	yes
Threeridge	*Amblema plicata*	yes	yes
Rockshell	*Arcidens confragosus*	yes	no
Washboard	*Megalonaias gigantea*	yes	yes
Lilliput	*Carunculina parva*	yes	no
Paper Floater	*Anodonta imbecillis*	yes	no
Giant Floater	*Anodonta grandis*	yes	no
Strange Floater	*Strophitus undulatus*	yes	no
Ohio River Pigtoe	*Pleurobema sintoxia*	yes	no
Buckhorn	*Tritogonia verrucosa*	yes	no

Source: Wisconsin DNR and St. Paul District surveys

quadrula), pocketbook (*Lampsilis ovata ventricosa*), hickory nut (*Obovaria olivaria*) and giant floater (*Anodonta grandis*). Based on observations from other areas of pool 10 and knowledge of the habitats where these species are found, there is a good likelihood the Higgins' eye pearly mussel (*Lampsilis Higgins'*), butterfly (*Ellipsaria lineolata*) and possibly the wartyback (*Quadrula nodulata*) may also be present. However, mussel surveys completed in Black Slough, Big Missouri Lake, Spring Lake, Tilmont Lake and Ambrough Slough did not reveal the presence of these species. Mussel surveys of project specific areas would be completed as necessary to ensure mussel resources are identified and project impacts on this resource minimized.

3.6.4 THREATENED AND ENDANGERED SPECIES

Two Federally listed threatened and endangered species, the bald eagle and the Higgins' eye pearly mussel, are known to occur in the project area.

The bald eagle may be sighted in the area during migration. Bald eagles occasionally use trees in wooded floodplain areas for roosting. Bald eagle nesting is known to occur in the project vicinity.

The Higgins' eye pearly mussel is known from the general area. The East Channel of the UMR at Prairie du Chien contains a large population of Higgins' eye pearly mussels and is considered a critical habitat by the Higgins' Recovery Team (Stern et al. 1982). Higgins' eye pearly mussels have also been collected at the head of Scrogum Island in Roseau Slough, just downstream from the study area.

The following State threatened and endangered mussel species are listed from Crawford County, Wisconsin; buckhorn (threatened), butterfly (endangered), ebonyshell (endangered), elephant ear (endangered), Higgins' eye pearly (endangered), monkeyface (threatened), purple wartyback (endangered), rockshell (threatened), salamander (threatened), spectaclecase (endangered) and wartyback (threatened)

The ebonyshell, elephant ear, salamander and purple wartyback are very uncommon and probably do not occur in Ambrough Slough.

3.7 HABITAT TYPES

Following the classification scheme of Wilcox (1993), the most prevalent aquatic habitats in the Ambrough Slough study area include contiguous floodplain lake, isolated floodplain lake, secondary channel and main channel border. The important characteristics of these habitat types, relative to fish and wildlife uses are described below.

<u>Contiguous floodplain lake</u> - Floodplain lakes of the UMR have a diversity of habitat conditions relative to fish and wildlife uses. Most are shallow depressions, with depths averaging less than

1 meter. Most usually have some deeper areas (greater than 2 meters) and most are vegetated with a variety of rooted, floating and submersed aquatic plants. Contiguous floodplain lake habitat is distinguished from isolated floodplain lake habitat by hydraulic connectivity with the remainder of the river. Because of their connection to flowing waters, contiguous floodplain lakes usually have a current through them which can vary in velocity depending on river stage. The backwater lakes described in Sections 3.2.3 through 3.2.14 are contiguous floodplain lakes. The contiguous floodplain lakes in the study area are generally abandoned channels. The "channel" portions of these lakes generally are deep and provide important overwintering habitat.

Isolated floodplain lake - The primary feature distinguishing contiguous floodplain lakes from isolated floodplain lakes is hydraulic connectivity. Isolated floodplain lakes are not connected to the remainder of the river under normal pool conditions, although these lakes may form connections under high discharge conditions. With the exception of current, which is normally not present or very minor in isolated floodplain lakes, habitat conditions are similar to contiguous floodplain lakes.

Secondary channel - Secondary channels are generally large channels which convey less flow than the main channel. Secondary channel habitat in the study area is characterized by deep water (typically 1.8 to 5.5 meters), a lack of rooted vegetation except along margins, and flow under normal pool conditions. Ambrough, Black and Dark Sloughs are representative of this habitat. Secondary channels are important for maintaining an interspersion and diversity of habitat types and contributing to the redistribution of organic matter and DO. Deeper holes in these channel areas provide important winter habitat for fish.

Main channel border - Main channel borders are the areas between the navigation channel and the river bank. 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. Normally, channel borders lack rooted aquatic vegetation although vegetation may be present in isolated reaches.

Navigation channel - Navigation channel habitat is a minimum of 2.7-meters deep and 91.4-meters wide. No aquatic vegetation is present. Current velocities are much higher in the navigation channel than in most other habitat types.

The mix of floodplain lake (both isolated and contiguous), flowing channel and terrestrial habitat present in the Ambrough Slough complex provides a diversity of habitat conditions.

3.8 CULTURAL RESOURCES

The project area is included within the Lowland Floodplain District as defined by Stoltman and Theler (University of Wisconsin-Madison) in their 1979-1980 archaeological survey of pool 10. It includes both land and water below an elevation of approximately 620.0. Within the Prairie du Chien region, this covers an area of about 15 square miles of the Mississippi River bottom in the less inundated portion of pool 10. At normal pool levels, approximately 40% of this area is water. The remaining 60% is comprised of low extensions of the Prairie du Chien terrace and irregularly shaped islands. The islands are dominated by levee formations bordering either present water bodies or past river channels. At normal pool level, the levees stand about 5-10 feet above the water and are typically long and narrow. Although considerable erosion has occurred since the installation of Lock and Dam 10 at Guttenberg 15 miles downstream, the 1890's Mississippi River Commission maps show that the present island configurations are very similar to those predating the lock and dam.

Before the lateral erosion of the islands by fluctuating water levels and wave action, the fluvial processes had apparently been depositing alluvium, building the levees and burying archaeological sites since the end of the Archaic Period. Archaeological deposits are exposed in the eroding levee banks, often buried from 0.5-2.0 meters below the modern surface.

The area is extremely rich archaeologically (Effigy Mounds National Monument is on the adjacent Iowa shore), and a number of archaeological shoreline surveys and other investigations have been made in the lowlands. James Stoltman of the University of Wisconsin-Madison and James Theler surveyed in the UMR Wildlife and Fish Refuge in 1979-1980, Robert Boszhardt of MVAC in 1982, David Overstreet of the Great Lakes Archaeological Research Center in 1984, and Richard Wahls (University of Wisconsin-Madison) in 1988. At least fourteen sites are known from the shorelines of the project area. Seven of these are listed on the National Register of Historic Places, and others are potentially eligible. Typically, the sites in this area are buried sites and shell middens, formerly occupying the higher ridges of the levees, and now deeply buried. These levees were evidently rather heavily occupied between about 500 B.C to A.D. 500., and sporadically both before and after this time span. The major periods represented are Early Woodland and Middle Woodland/Effigy Mounds. Thousands of years of occupation are represented -- one site (CR 0349) is reported as having a Late Paleolithic component (ca 7000 B.C.) Several sites also have Late Woodland and Historic components.

In 1995, the Tilmont site (CR 460) was test-excavated by the University of Wisconsin-Madison. This site is located n an island on Tilmont Lake in the Ambrough Slough project area. The excavation revealed deeply buried strata with well-preserved cultural remains dating primarily to the Middle Woodland and Early Woodland period. Significantly, the site had been used for burials in both Late and Middle (and possible Early Woodland) times. A large and well-preserved mortuary feature containing the remains of at least 29 people and about 2000 years old was discovered at a depth of about 1.5 meters. This is underlain by earlier occupations.

The rich archaeological complex in the project location, including the river islands, necessitated careful testing of the areas of the project that could affect archaeological sites. The

COE conducted an archaeological survey of the Dillman field proposed for dredged material disposal, and the peninsulas to be restored. Since many archaeological deposits have been found buried in the floodplain in this vicinity, the edges of lakes proposed for dredging were also investigated by taking cores in the lake shallows (Frank Florin and Thomas Madigan, 2000. *Phase I Cultural Resources Investigation of Ambrough Slough Environmental Management Program Project, Mississippi River Pool 10, Crawford County, Wisconsin.* Hemisphere Field Services Report of Investigation Number 608. Minneapolis.) In addition, the Toberman and Hunzeker fields were surveyed for cultural resources. This investigation included deep coring to determine the structure of the alluvial fan complex underlying these two fields.

The cores taken at nine locations in the lake shallows showed no evidence of former intact surfaces to a depth of 2.5 meters below water surface. The pre-Holocene surface was encountered in one core, but well below the depths to which the lakes will be dredged. The survey of the peninsulas found no archaeological deposits.

The Dillman field survey identified three prehistoric archaeological sites (47 CR 616, 47 CR 617, and 47 CR 618). These sites are small lithic scatters that cannot be assigned a cultural context because of the lack of diagnostic artifacts. These sites, though unevaluated, are potentially eligible for listing on the National Register of Historic Places. Sites 47 CR 616 and 47 CR 617 are located on an alluvial fan in the northeastern edge of the Dillman field. Site 47 CR 618 is in the southeastern part of the field, and is situated some 100-110 cm below the ground surface.

The survey of the Toberman and Dillman fields revealed no evidence of archaeological sites on the surface. Deep coring was undertaken to determine the possibility of ancient surfaces within the alluvial fan that may have supported human occupation. The Toberman field is on the highest fan surface. Five deep cores revealed a moderate to low potential for buried archaeological deposits. The Hunzeker fan surface is historic in age. A buried soil is present beneath 150 cm to 180 cm of historic alluvium. The cores buried A horizon yielded lithic artifacts (thinning flakes) indicating the presence of an archaeological site underlying the historic alluvium.

The Pedretti field area contains two large known sites: 47 CR 127 (Pedretti III) and 47 CR 22 (Pedretti II) Pedretti III is a National Register eligible mound site containing Middle to Late Woodland effigy mounds. Pedretti II is also a Woodland mound site.

3.9 SOCIOECONOMIC/RECREATION

The Ambrough Slough study area lies approximately 8 kilometers north of Prairie du Chien, Wisconsin, which has a population of about 7,000. The communities of Marquette and McGregor, Iowa, are located across the river from Prairie du Chien. There is residential development around portions of Gremore Lake in the lower reaches of the study area. There are scattered homes along Wisconsin State Highway 35 which parallels the eastern boundary of the study area. There is also cottage development along the Iowa shoreline at the mouth of Harper's Slough, across the main channel from the upper portion of the study area.

The predominant recreational use of the Ambrough Slough area is for fishing and hunting. Gremore Lake, Tilmont Lake, Big Missouri, Fish Lake, Upper and Lower Doubles Lakes, and Spring Lake are all popular fishing areas. There are three boat access points on Gremore Lake, two access points on Ambrough Slough, and two access points on the Wisconsin side of main channel within 3 kilometers upstream of the study area. There is a boat access on Harper's Slough, as well as a number of access points in the Prairie du Chien area.

The Ambrough Slough area is popular for waterfowl hunting, deer hunting, and small game hunting. Though most of the study area lies within the Upper Mississippi River National Wildlife and Fish Refuge, no portion of the area is designated as a closed area for waterfowl hunting.

PROBLEM IDENTIFICATION

4.1 EXISTING HABITAT CONDITIONS

The general habitat types present in the Ambrough Slough complex have been described in Section 3.7. The distribution of aquatic habitats is presented in table 4-1.

Table 4-1
Distribution of Aquatic Habitats in the Ambrough Slough
Study Area (RM 638-643)

HABITAT TYPE	AREA (ha)
Contiguous Floodplain Lake	
Abandoned Channel Lake	388
Isolated Floodplain Lake	
Abandoned Channel Lake	44
Main Channel	
Channel Border	115
Navigation Channel	50
Secondary Channel	132
Tertiary Channel	3
Total Aquatic	732
Non-Aquatic	969
TOTAL	1,701

Source: EMTC and St. Paul District GIS

The mix of floodplain lake (both isolated and contiguous), flowing channel and terrestrial habitat present in the Ambrough Slough complex provides a diversity of habitat conditions. On a macro-habitat scale, the distribution of habitat types is suitable for supporting an abundance of fish and wildlife species, and indeed the Ambrough Slough complex is considered by local resource managers as highly productive. However, on a micro-habitat scale, conditions such as winter DO levels, current velocities and temperatures, the presence/absence of cover, or adequate water depths within the various habitat types appear to be seasonally sub-optimal, creating habitat "bottlenecks" which may be limiting the abundance of fish and wildlife species. A review of the potential habitat "bottlenecks" follows.

Habitat conditions for backwater fish species in the Ambrough Slough complex are seasonally suboptimal. Monitoring of DO concentrations reveals many areas experience oxygen depletion during the winter. Diurnal dissolved oxygen swings have also been observed in Ambrough Slough during the summer, though recent increases in flows due to Black Slough contributions may have ameliorated these conditions to a large degree. Wintertime dissolved oxygen depletion and summertime diurnal swings can be attributed to one or more of the following factors: lack of adequate water depth, respiration demands of aquatic vegetation, and/or lack of flow through many of the backwater lakes.

While the backwater lakes in the complex share a common hydraulic connection (Ambrough Slough), each has its own unique set of environmental conditions that can impact the quality of habitat available. A qualitative assessment of wintertime conditions important to backwater fish species is presented in table 4-2. As table 4-2 indicates, most of the lakes in the Ambrough Slough complex have some type of wintertime habitat deficiency.

Backwater complexes such as Ambrough Slough are often referred to as "centrarchid habitat" due to relatively low velocity, lacustrine or lake-like conditions present. However, many other species of fish use protected off-channel lacustrine habitat, either exclusively or for part of their life cycle. Riverine fish species would include, for example, redhorse, freshwater drum, catfish, shovelnose sturgeon, paddlefish, walleye, and sauger. Deeper sloughs and channels with moderate current velocities (like Ambrough and Black Sloughs) provide habitat suitable for riverine fish species. Some riverine species also use aquatic vegetation communities located in the main channel border, river lake, or backwater wetlands to meet part of their life requirements. A key component of "riverine" type habitat is cover, which provides velocity shelters and ambush sites for riverine species. In that Ambrough Slough is representative of the habitat conditions present prior to impoundment, it is intuitive that some suitable habitat is present for riverine species. However, it is unknown whether all habitat features needed by riverine species are present in the Ambrough Slough complex or are of optimum quality and quantity.

The extent of freshwater mussel habitat in the study area is currently unknown. However, as with habitat for riverine fish species, Ambrough Slough is representative of conditions existing on the UMR prior to impoundment, and thus likely provides some habitat for freshwater mussel species.

Habitat diversity and quality in the Ambrough Slough complex are considered good to excellent for most migratory water birds, neotropical migrants, marsh and shore birds, bald eagles, and turtles.

Table 4-2
Qualitative Assessment of Wintertime Habitat Conditions* in Floodplain Lakes of the Ambrough Slough Study Area

Lake	Dissolved Oxygen	Current Velocity	Water Temperature	Depth
Voth's	suboptimal	adequate	adequate	suboptimal
Big Missouri	suboptimal	adequate	adequate	suboptimal
Spring	suboptimal	adequate	adequate	suboptimal
Roulette	suboptimal	adequate	adequate	suboptimal
Upper Doubles	suboptimal	adequate	adequate	suboptimal
Lower Doubles	suboptimal	suboptimal	adequate	suboptimal
Fish	optimal	suboptimal	suboptimal	suboptimal
Fluke's	suboptimal	suboptimal	suboptimal	suboptimal
Tilmont	adequate	adequate	adequate	adequate
Gremore	suboptimal	optimal	adequate	optimal

* Assumes normal winter flows and water levels.

4.2 HISTORICALLY DOCUMENTED CHANGES IN HABITAT

4.2.1 PRE-LOCK AND DAM CONDITIONS

The primary sources of information concerning pre-lock and dam conditions in the study area are a Mississippi River Commission map based on survey data from 1893-94, 1927 aerial photographs, and the Brown Surveys (1929-30).

The Mississippi River Commission map shows the basic pattern of sloughs and ponds in the study area that exist today. Because water levels were lower under this pre-impoundment condition, Voth's Lake, Big Missouri Lake, Upper and Lower Doubles Lakes, Fish Lake, and Roulette Lake appear as isolated or semi-isolated ponds. Black Slough does not appear on this map. The map shows the floodplain vegetation as a mosaic of marsh and forest. There may have been some isolated farming going on in the area at this time.

The aerial photos from 1927 show agricultural activity in the study area. Agricultural activity is evident along the left bank of the river from above Sioux Bayou nearly down to the current Black Slough opening. A farmstead or other buildings appear on the river bank northwest of Voth's Lake.

Ambrough Slough is readily evident in these photographs. Most of the areas labeled as lakes on current maps appear as isolated ponds surrounded by marsh. Gremore Lake appears as a deep marsh/shallow lake with a lot of aquatic vegetation.

The only thing noteworthy about the Brown Survey map (1929-30) is that it confirms the presence of buildings northwest of Voth's Lake.

4.2.2 POST LOCK AND DAM CONDITIONS

Lock and Dam 10 was completed in October 1936 and placed in operation in November 1937. Most information concerning habitat changes after lock and dam construction comes from a series of aerial photographs. Table 4-3 summarizes the dates of photographs used to evaluate post-lock and dam changes.

Table 4-3
Post-Lock and Dam 10 Aerial Photography

Date	Water Surface Elevation (m)	Water Surface Elevation (ft)
October 20, 1938	186.7	612.5
September 26, 1940	186.4	611.7
August 7, 1947	186.6	612.1
October 30, 1964	186.5	611.8
September 12, 1973	186.8	612.9
September 17, 1984 (IR)	186.9	613.2
September 10, 1989 (IR)	186.8	613.0
September 6, 1994 (IR)	186.8	613.0

(IR) - color infrared photographs

The October 1938 and September 1940 photographs show conditions as they existed for the first few years following the creation of pool 10. In these early post-lock and dam photographs the increase in the amount of water area associated with the creation of pool 10 is readily evident, as is the increased connectivity between backwater areas and running sloughs such as Ambrough Slough. Areas that were previously farmed are still very evident on these photographs.

By the time of the August 1947 photograph, pool 10 had been in existence for ten years. Most of the areas that were farmed during the pre-lock and dam era still appear as relatively open areas. No significant invasion by woody species is evident. By October 1964, most of the pre-lock and dam farmed areas have become wooded. The 1973 and later aerial photographs do not show any significant changes in the general land cover in the study areas. Undoubtedly there has been some additional succession to forest habitat since 1973, but not on the scale that occurred during the 1938-64 period.

Detecting aquatic vegetation on aerial photographs is highly dependent on the time of year, type of photograph, type of vegetation, etc., and the aerial photographs for the Ambrough Slough/Gremore Lake area are no exception. However, some general observations can be made. Only limited aquatic vegetation is evident on the 1938 and 1940 photographs, the only exceptions being Upper and Lower Doubles Lakes which show considerable coverage by emergents or floating-leaved plants.

The 1947 photo shows some aquatic vegetation around the perimeters of most of the water bodies in the study area. The 1964 photograph shows much the same, with Upper and Lower Doubles Lakes, Spring Lake, and Gremore Lake showing the most vegetation. The 1973 photo shows less aquatic vegetation, though this may be a function of slightly higher water levels at the time of this photograph. Again, Upper and Lower Doubles Lakes show the most vegetation.

Aquatic vegetation is evident in most of the lakes in the study area in the 1984 photograph, more so than in many of the earlier photos. This may be a function of the use of color IR photography. Upper and Lower Doubles Lakes show the most vegetation, with Voth's Lake, Roulette Lake, and Spring Lake also showing substantial amounts of aquatic vegetation.

Aquatic vegetation is highly evident in most lakes in the 1989 photograph and there appears to be a considerable amount of emergent vegetation around the perimeters of most lakes. The years 1987 through 1989 were dry years, and the more abundant emergent vegetation in the 1989 photographs may be a function of the drier conditions during this time period. Aquatic vegetation is again highly evident in most lakes in the 1994 photographs, the exceptions being Roulette Lake, Tilmont Lake and Gremore Lake.

The photographic record seems to indicate more prevalent aquatic vegetation over the last 10-15 years, though this may be a function of the use of color IR photography. It is more likely that presence and abundance of aquatic vegetation in these lakes has fluctuated through the years with annual changes in river conditions. The only noticeable long term trend is that Upper and Lower Doubles Lake consistently show the presence of aquatic vegetation in nearly every photograph, while conversely, Tilmont Lake and Gremore Lake tend to show less aquatic vegetation in most of the photographs. The later may be a function of Tilmont and Gremore Lakes being slightly deeper. They would be less likely to support the emergent or floating-leaved aquatic vegetation that readily shows up on aerial photographs.

Plate 9 compares 1940 land/water area with 1994 land water area. It is evident that there has been localized erosion and accretion, but no significant change in the land water distribution.

In summary, the historic aerial photographs lead to the following general conclusions concerning post-lock and dam changes to the study area.

a. The creation of pool 10 increased the surface area of the water bodies in the study area, and increased the connectivity between backwater lakes and ponds and running sloughs. (It would be logical to assume that water depths increased also).

b. Areas that were farmed during the pre-lock and dam era have become forested, with most of the conversion from farm land to forest taking place during the first 25 years post-lock and dam completion.

c. While sedimentation has probably taken place in backwater habitats, it has not occurred to the degree that there has been any appreciable conversion of aquatic habitat to marsh habitat.

d. The only marked change to flowing habitats has been the cutting of a new channel by Black Slough.

4.3 FACTORS INFLUENCING HABITAT CHANGE

The following are the primary factors that have and/or are affecting habitat change in the Ambrough Slough area.

- water level regulation
- Federal land ownership
- sedimentation
- vegetative succession
- natural hydraulic processes
- changes in river discharge

4.3.1 WATER LEVEL REGULATION

With the initiation of Lock and Dam 10 operation in November 1937, water levels became regulated for the purpose of providing adequate depths for commercial navigation. Plate 10 is a rating curve for the study area showing pre- and post-Lock and Dam 10 river elevations. The 283 cms to 1,416 cms (10,000 to 50,000 cfs) range would be the range of discharges common to most growing seasons. As can be seen, water levels at low discharges were increased by about 1 meter. Above flows of about 1,019 cms (36,000 cfs) and above, post-lock and dam water surface elevations are lower. At the higher discharge levels not shown on the plate, the two lines would become roughly parallel about .3 meter apart.

The general effects of the change is water surface elevation are as follows:

a. An increase in the low water surface elevation by about 1 meter which accounts for the increased water surface area in the study area, and a general increase in wetland area. This also increased the permanent connectivity between backwater lakes and flowing sloughs and channels.

b. A general reduction in the elevation of flood events by about .3 meters, which may have an effect on the vegetation characteristics of the study area.

c. A flattening of the river slope which reduces the energy available for the river to change its geomorphology through scour. This flattening of the river slope also contributes to increased rates of sedimentation.

4.3.2 FEDERAL LAND OWNERSHIP

The purchase of much of the study area by the Federal government for the Upper Mississippi River National Wildlife and Fish Refuge halted all development on the purchased land. As noted earlier, portions of the study area were being farmed in the 1920's. It is likely that had the Federal government not acquired this area, agriculture and timber harvesting would probably have continued. This is discussed further under "Vegetative Succession" below.

4.3.3 SEDIMENTATION

As noted earlier, creation of pool 10 resulted in a flattening of the river slope, reducing the river's energy. This in turn has increased the sedimentation rate in the floodplain. The rate of sedimentation in the Ambrough Slough backwaters has not been assessed. Studies conducted under the GREAT I study indicated general backwater sedimentation rates in pool 10 of 3.5 centimeters/year for the period 1955-1963 and 4.2 centimeters/year for the period 1963-1975 (McHenry, Ritchie, and Verdon, 1976, in GREAT I Vol 4., 1980). However, the GREAT I study also compared aquatic habitat changes between 1939 and 1973, and that evaluation showed little loss of aquatic habitat in the Ambrough Slough/Gremore Lake area during that period. In fact, there was a general increase in aquatic habitat due to erosion. Thus, it is probable that the sedimentation rate in the Ambrough Slough backwaters has been somewhat lower than the rates shown by McHenry, Ritchie, and Verdon (1976) for pool 10 in general.

4.3.4 VEGETATIVE SUCCESSION

The change in the vegetation character of the study area is readily evident from historic aerial photographs. Most of this can be accounted for by vegetative succession. The purchase of the area by the Federal government resulted in the end of agricultural land use. The old farm fields have revegetated with forest vegetation.

While the initial inundation of portions of the study area would have resulted in a sudden change in the character of the water bodies, subsequent sedimentation is expected to result in slow successional changes as shallow aquatic areas fill in and become marsh. These areas eventually may become forested.

4.3.5 HYDRAULIC PROCESSES

Even though the construction of navigation control structures and the creation of pool 10 has had an affect upon natural riverine processes, it has not eliminated them. Processes such as channel cutting, channel abandonment, and bank erosion are still occurring. The most evident of these changes over the last decade or so has been the cutting of a new channel by Black Slough accompanied by the abandonment of a portion of its former channel.

4.3.6 CHANGES IN RIVER DISCHARGES

In 1999, local citizens expressed concern that regulation of pool 10 was resulting in the loss of trees along the water's edge, which led the St. Paul District to investigate this situation. Prior to 1971, the allowable drawdown at Lock and Dam 10 was 0.61 meters (2 feet). In 1971, the allowable drawdown was reduced to 0.30 meters (1 foot) and it was surmised that this change may have resulted in higher pool levels, resulting in the tree loss. A review of average water surface elevations based on annual data and growing season data produced the results shown in table 4-4.

Table 4-4
Average Water Surface Elevations - L/D 10 and McGregor Gage

Data Set	Time Period	L/D 10 Elev.	McGregor Gage Elev.
Average Annual Data	1944-1970	186.17	186.95
	1972-1998	186.24 (+.07)	187.24 (+.29)
Average for Growing Season*	1944-1970	186.20	186.88
	1972-1998	186.23 (+.03)	187.07 (+.19)

* June 15 through September 15

As would be expected from the change in operation, the average elevations at L/D 10 increased by 0.03 to 0.07 meter, depending on the data set used. The increase at the McGregor gage was 0.19 to 0.29 meter. If the increase was solely the result of the change in operation, then the increase at L/D 10 should have been greater than the increase at the McGregor gage, as the effects of pool regulation are moderated proceeding upstream from the dam. This led to further investigation into other factors that could be at play such as increased flow rates, geomorphic changes such as sediment deposition, or increases in floodplain roughness due to changes in plant communities.

Changes in discharge were analyzed because of the data available in the St. Paul District Water Control data base. Available data in computerized form only extended back to 1959 so that was as far back as the analysis was performed. The records were broken into three time periods to determine if there were any trends in discharge. The results are shown in table 4-5.

Table 4-5
L/D 10 Discharge (cms) during the Period 1959-1995

Data Set	1959-70	1972-83	1984-95
Average Annual Data	1,176	1,393	1,523
Average for Growing Season	911	1,246	1,471

As can been seen, the average discharge in pool 10 has increased over the past few decades, increasing by about 30 percent when annual data are used and by about 60 percent when growing season data are used. The conclusion of the analysis was that most of the increase in average water surface elevations observed at Lock and Dam 10 was the result of the operational change, but that the increase in average water surface elevations at the McGregor gage was more the result of an increase in river discharges.

What this analysis indicates is that river discharges change over time and these changes probably effect fish and wildlife habitats in a subtle manner. Habitat changes resulting from river discharge trends probably occur at such a slow rate that they are not discernable unless they are targeted by specific investigations looking for these changes.

4.4 ESTIMATED FUTURE HABITAT CONDITIONS

Over the next 50 years, the basic land/water character of the study area is not expected to change significantly. There may be localized changes in the flowing sloughs, but their basic location is not likely to change. The areas that are backwater lakes are expected to remain backwater lakes. Their character may change due to sedimentation and vegetative succession.

Most of the non-water/non-marsh areas in the study area are covered by forest vegetation. It is expected that these areas will remain wooded, though the species composition may change as these areas continue to mature.

PROJECT OBJECTIVES

5.1 INSTITUTIONAL FISH AND WILDLIFE MANAGEMENT GOALS

5.1.1 UPPER MISSISSIPPI NATIONAL WILDLIFE AND FISH REFUGE

Fish and wildlife management goals and objectives for the area fall under those defined more broadly for the Upper Mississippi River National Wildlife and Fish Refuge, and those designated specifically in the Refuge Master Plan. The management objectives of the Upper Mississippi River National Wildlife and Fish Refuge which apply most directly to the study area include:

Environmental Quality

+ Reduce the adverse impacts of resuspension and movement of sediments within the project area.

+ Eliminate or reduce adverse impacts of water quality degradation.

Migratory Birds

+ Restore species that are in critical condition (such as canvasbacks) and achieve national population or distribution objectives.

+ Maintain or improve habitat of migrating waterfowl using the Upper Mississippi River.

+ Contribute to the achievement of national population and distribution objectives identified in the North American Waterfowl Management Plan and flyway management objectives.

+ Maintain or improve habitat for other migratory birds.

Fisheries and Aquatic Resources

+ Maintain and enhance, in cooperation with the States, the habitat of fish and other aquatic life (furbearers, reptiles, amphibians, and invertebrates) on the Upper Mississippi River.

Because the study area is within the Upper Mississippi River National Wildlife and Fish Refuge, these management objectives, together with input from State and Federal agency natural resource managers, were used to guide the development of specific project objectives. However, this study is only one part of a larger cooperative natural resource management effort on the river. The long-term effectiveness of any project will eventually be evaluated from such a system-wide perspective.

5.1.2 WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Wisconsin Department of Natural Resource management goals are broadly defined in a strategic plan for Mississippi River management (Wisconsin DNR, 1992). The goals contained in the strategic plan most applicable to this study are:

+ Protect, enhance, and restore the diverse riparian, terrestrial, wetland and aquatic communities within the River corridor emphasizing a system-wide approach.

+ Reduce shoreline erosion, sedimentation and resuspension problems within the River corridor.

5.2 PROJECT GOALS AND OBJECTIVES

GOAL A: Improve habitat conditions for backwater fish species at four locations greater than 15 hectares each in the Ambrough Slough/Gremore Lake complex.

Habitat conditions for backwater fish species in the Ambrough Slough/Gremore Lake complex are suboptimal. Monitoring of winter habitat conditions shows that many areas within the complex become anoxic during the winter and experience wide diurnal dissolved oxygen swings during the summer. The dissolved oxygen depletion and diurnal lows can be attributed to one or more of the following factors: lack of adequate water depth, respiration demands of aquatic vegetation, and/or lack of flow through many of the backwater lakes. Improving habitat conditions for backwater fish species in this area is a high management priority of the Wisconsin DNR.

Providing suitable, high quality backwater fish habitat in more than one area creates a complex of greater diversity and usable habitat. While the backwater lakes in the complex share a common hydraulic connection (Ambrough Slough), each has its own unique set of environmental conditions that can impact the quality of habitat available. Providing suitable habitat at several sites ensures that the backwater fish community will be productive within the complex if one or more backwater lakes experience a decline in habitat quality due to environmental conditions that cannot be controlled.

Backwater complexes such as the Ambrough Slough/Gremore Lake complex are often referred to as "Centrarchid habitat" due to the research emphasis on these species. However, many other species of fish use protected off-channel lacustrine habitat, either exclusively or for part of their life cycle. Therefore, the habitat objectives for Goal A were developed based on existing knowledge of backwater fisheries habitat as it pertains to Centrarchids with the assumption that other species will also benefit by providing quality Centrarchid habitat.

OBJECTIVE A1: Create or enhance overwintering (November - March) habitat at four locations meeting the following criteria:

a. Dissolved oxygen levels > 3 mg/l, and preferably > 5 mg/l.*

b. Current velocity < 1.0 cm/sec over approximately 80 percent of the area.*

c. Water temperatures at the following approximate distribution:

(1) 2-4 degrees C over 35 percent of the area
(2) 1-2 degrees C over 65 percent of the area*

d. Diversity of depths with maximum "edge" along water > 1 meter deep. Water depths should have the following approximate depth distribution:

(1) 0.0 to 1.0 meter < 20 percent of the area
(2) 1.0 to 2.0 meters over 50 to 70 percent of the area
(3) >2.0 meters > 10 percent of the area

e. Structural cover present.

* These water quality parameters can vary with depth. This was taken into account in the planning of project features to meet these criteria.

Water quality standards for dissolved oxygen are 5.0 mg/l. However, study of winter dissolved oxygen requirements for Centrarchids generally show that levels greater than 3.0 mg/l are acceptable for survival. Studies have shown that the winter current velocities of less than 1.0 cm/sec are desirable for Centrarchids. Current velocities of less than 1.0 cm/sec over 80 percent of the winter habitat was considered reasonable and sufficient for fish survival.

Water temperatures of 4 degrees C over 100 percent of the water body would be the optimum condition. However, in shallow riverine backwaters this seldom occurs and likely would be impossible to accomplish. The criteria selected were considered reasonable for fish survival and within the realm of what may be practical to accomplish.

Generally, acceptable winter water temperatures are related to low current velocities. High current velocities are an indicator of flow through a backwater, and the source of this flow usually is flowing channel where the water temperatures are colder, near or at 0 degrees C in some instances. If sufficient cold water enters a backwater, over time, the backwater will be cooled to a temperature unsuitable for Centrarchids.

Water depths are related to the other criteria in that the greater the water depths, the greater the possibilities of meeting the dissolved oxygen and temperature criteria. In addition, greater depths provide additional cover for fish. In the other extreme, excessive water depths can cause stratification and associated dissolved oxygen depletion problems. The criteria selected were considered a good "mix" of depths of backwater habitats and within the realm of what may be practical to accomplish.

While water depths are one component of cover, structure in the form of aquatic vegetation, woody debris, and rock also provide cover. How important cover is to winter habitat quality relative to the other criteria is not known. However, anecdotal observations of fish habitat preferences indicates they prefer locations with structural cover if dissolved oxygen, current velocities, and water temperatures are within their tolerance ranges.

OBJECTIVE A2: Create or enhance summer habitat at several locations meeting the following criteria:

a. Dissolved oxygen levels > 5 mg/l.

b. Current velocity < 1.0 cm/sec over 40 percent of the area.

c. Open water: aquatic vegetation ratio in the range of 40:60 to 60:40.

d. Water depth > 1.0 meter over 50 percent of the area.

e. Structural cover present.

f. Within 3 kilometers of overwintering habitat.

Water quality standards for dissolved oxygen are 5.0 mg/l. This is considered a reasonable criteria for summer habitat conditions. Summer current velocities of less than 1.0 cm/sec are desirable for Centrarchids. However, the fish can more easily tolerate higher current velocities during the summer, and usually have more options in terms of moving to areas of lower current velocities. Therefore, a current velocity of less than 1.0 cm/sec over 40 percent of summer habitat was considered reasonable.

Aquatic vegetation is an important component of fish habitat as a substrate for food items and as cover from predators. Insufficient aquatic vegetation usually results in an insufficient forage base and a lack of cover for both forage species and young-of-the-year of larger species. Too much cover interferes with foraging patterns and provides too much protection for small fish from predators. Aquatic vegetation cover in the range of 40 to 60 percent is considered the optimum range for most Centrarchid species.

Water depths provide cover in the form of reduced light penetration. In addition, deeper water provide cooler waters. The criteria selected were considered reasonable for backwater habitats and within the realm of what may be practical to accomplish.

Structural cover is considered important for the reasons discussed previously.

Available evidence indicate that summer and winter habitat for Centrarchids should be within reasonable distance such that the fish can "find" the suitable winter habitat prior to the onset of ice cover. While larger Centrarchids such as the largemouth bass may migrate long distances to find suitable habitat, most Centrarchids are relatively non-migratory, remaining in relatively small areas most of their lives. Available evidence indicates that the distance between summer and winter habitats should be 3 kilometers or less.

GOAL B: Maintain and/or enhance habitat for riverine species of fish and mussels in the Ambrough Slough complex.

Riverine fish species would include, for example, redhorse, freshwater drum, catfish, shovelnose sturgeon, paddlefish, walleye, and sauger. Habitat suitable for riverine fish species were present in the deeper sloughs and associated channel borders that existed prior to inundation by the navigation pools, and persist today in the Ambrough Slough/Gremore Lake complex. Some riverine species also use aquatic vegetation communities located in the main channel border, river lake, or backwater wetlands to meet part of their life requirements.

The extent of freshwater mussel habitat in the Ambrough Slough/Gremore Lake complex is currently unknown. If further study indicates existing habitat is adequate, the goal will be to maintain this habitat. If further study indicates freshwater mussel habitat is lacking, measures to enhance this resource should be identified and evaluated.

No numerical goal has been established as no specific thresholds have been defined concerning how much habitat is required within the Upper Mississippi River to meet the needs of these species. Any habitat improvement for these species should benefit their population levels.

OBJECTIVE B1: Provide 25 to 40% cover in flowing channels within the Ambrough Slough complex.

An important component of fish habitat in flowing channels is structural cover in the form of rock, undercut banks, woody debris (logs and snags), and aquatic vegetation. Percent cover is the parameter most commonly used to represent structural cover. No single value would be optimum for all species. A range was selected to represent the preferred conditions for the common species representative of this habitat type.

OBJECTIVE B2: Protect and/or enhance existing mussel habitat in the Ambrough Slough/Gremore Lake complex as opportunities present themselves.

Information concerning existing mussel resources and habitat in the study area is limited. As more information becomes available concerning mussel resources and habitat, measures should be considered for the protection of these resources or to take advantage of opportunities for improving habitat conditions.

GOAL C: Maintain and/or enhance habitat for migratory water birds.

Habitat diversity and quality in the Ambrough Slough/Gremore Lake complex are considered good to excellent for most migratory water birds. The goal is to maintain this high level of habitat quality and take advantage of any opportunities that may arise to enhance habitat quality.

OBJECTIVE C1: Provide food resources to meet the needs of water birds during spring and fall migration through the following:

a. Maintain existing areal extent of water depths of 1.0 meter or less.

b. Maintain existing areal extent of water depths of 0.5 meter or less.

c. Maintain dissolved oxygen above 1 mg/l during later summer and winter.

The three most important sources of food for migratory water birds are submersed aquatic plants (wild celery, sago pondweed, coontail, etc.), emergent aquatic plants (arrowhead, wild rice, bulrush, smartweed, etc.), and aquatic invertebrates (mayfly larvae, fingernail clams, chironomids, etc.). There are a multitude of factors that can affect the productivity of these food resources. The above criteria were developed as they apply to a wide variety of food resources and/or are parameters that can be managed to some degree.

One of the more important factors affecting the distribution of submersed aquatic plants is the depth of the photic zone. The Ambrough Slough complex contains an abundance of shallow water within the photic zone. Maintaining the existing extent of areas less than 1.0 meter in depth should insure adequate area for the growth of submersed aquatic plants.

An important factor affecting the distribution of emergent aquatic plants is having shallow water less than 0.5 meter deep. The Ambrough Slough complex contains an abundance of shallow water with depths suitable for the growth of emergent aquatic vegetation. Maintaining the existing extent of areas less than 0.5 meter in depth should insure adequate area for the growth of emergent aquatic plants.

An important consideration in the productivity of many invertebrate food organisms is that they have sufficient dissolved oxygen for survival. A dissolved oxygen concentration of 1 mg/l is considered adequate most aquatic invertebrates for survival.

Other factors were identified by resource managers as important in the productivity of aquatic plants and aquatic invertebrates. These were current velocity and sediment composition. Current velocity requirements for the wide variety of aquatic plants found in the Ambrough Slough complex are not particularly well known, other than in a general sense. Establishing numerical current velocity criteria for aquatic plants in this complex system is considered impractical. Because aquatic plant growth in the study area is relatively good, it is assumed that the existing distribution of current velocities is within the tolerance range of the plants found there. In the planning of project features, measures that would result in significant current velocity changes will be evaluated for their potential effect on aquatic plants and aquatic invertebrates.

Sedimentation and the distribution of sediment types is generally a result of large scale hydrologic events on the Mississippi River over which there is little or no control. Establishing numerical criteria relative to sedimentation and the distribution of sediment types is considered impractical for this area. In the planning of project features, measures that would result in significant change in sedimentation rates and/or sediment types can be evaluated for their potential effect on aquatic plants and aquatic invertebrates.

GOAL D: Maintain and/or enhance habitat for migratory and resident vertebrates with emphasis on neotropical migrants and marsh and shore birds.

With a decline in habitat diversity in many of the navigation pools since inundation, there have been losses and deterioration of habitat suitable for neotropical migrants, marsh and shore birds, and turtles. No numerical goal has been established for these species or species groups as no specific thresholds have been defined within the river corridor to meet their needs. Any habitat improvement for these species should benefit their overall population levels.

Objective D1: Protect and/or enhance habitat for neotropical migrants and marsh and shore birds, as opportunities present themselves, applying the following criteria:

a. Maintain or enlarge the extent of unbroken stands of mature forest.

b. Maintain or enlarge the extent of emergent marshes.

c. Maintain or enlarge the extent of beaches/mudflats.

Generally as a group, neotropical migrants are benefited by large unbroken tracts of mature forest which minimizes nest parasitism. Management measures that foster maintaining this type of habitat should be encouraged.

Marsh birds obviously prefer emergent marsh habitat. The existing extent of marsh habitat in the Ambrough Slough complex should be maintained, and increased if at all possible.

Shore birds prefer open, low sandy beaches and mudflats for feeding, nesting, and loafing. The extent of these habitat types in the Ambrough Slough complex is somewhat limited and ephemeral, depending upon fluctuations in water levels. The extent of shore bird habitat in the Ambrough Slough complex should be maintained, and increased if at all possible.

ALTERNATIVES

6.1 PLANNING OPPORTUNITIES

While there may be some habitat deficiencies in the Ambrough Slough complex, from an overall perspective habitat quality is relatively good. The opportunity exists to maintain this high level of habitat quality before it becomes degraded.

6.2 PLANNING CONSTRAINTS

6.2.1 INSTITUTIONAL

The Ambrough Slough project area lies within the boundaries of the Upper Mississippi River National Wildlife and Fish Refuge. As such, Refuge management goals and objectives must be complied with, as well as the laws and regulations governing Refuge management.

6.2.2 ENGINEERING

Because of shallow water depths, access for construction equipment would likely be difficult in many areas. This was an important consideration in the planning and design of habitat restoration features.

6.2.3 ENVIRONMENTAL

An active bald eagle nest located within the study area. The planning of project features took into account potential impacts to this nest.

6.2.4 CULTURAL RESOURCES

The extremely rich archaeology of the islands and shorelines in the project area, which includes National Register sites and burials, means that any aspect of a project that includes bank work, significant changes in the landscape, dredging or other earth moving must be fully coordinated with the State Historic Preservation Office and the Advisory Council on Historic Preservation, and survey, evaluation, and mitigation measures may well be necessary. While the locations (but not necessarily the extent) of 14 sites are known for the project areas, it is highly likely that others exist along the shorelines of the project areas.

6.2.5 SOCIOECONOMIC/RECREATIONAL

There is residential development along the shorelines of Gremore Lake and this lake receives considerable recreational use. These existing uses were taken into consideration in the planning process.

6.3 ALTERNATIVES IDENTIFIED

6.3.1 NO ACTION

The no action alternative is defined as no implementation of a project to modify habitat conditions in the study area.

6.3.2 BACKWATER FISH SPECIES HABITAT (GOAL A)

No site-specific alternatives were identified for improving backwater fish habitat. Instead, types of habitat restoration measures were identified that appeared to have merit in alleviating backwater fish habitat deficiencies in the Ambrough Slough complex. As planning progressed, the restoration measures most appropriate for use within a particular backwater were identified and further developed into specific alternatives.

6.3.2.1 Flow Introduction

Flow introduction is primarily used to alleviate dissolved oxygen depletion problems by introducing a steady supply of oxygenated water to the water body. A difficult balance to achieve in many backwater situations during the winter is providing sufficient flow to alleviate dissolved oxygen depletion problems without increasing current velocities and/or depressing water temperatures outside the ranges suitable for overwintering fish. In some instances, it may not be possible to achieve this balance.

6.3.2.2 Flow Reduction

Flow reduction is primarily used to reduce winter current velocities and maintain winter water temperatures above 2 degrees C as much possible. As opposed to flow introduction, the difficult problem with flow reduction is in achieving suitable velocities and water temperatures without reducing dissolved oxygen concentrations to unsuitable levels.

Flow reduction may not necessarily take place right at the backwater lake in question. Flow reduction in the sloughs entering the Ambrough Slough complex may also achieve the same goals.

6.3.2.3 Increase Water Depths

Increasing water depths in shallow backwater lakes can serve a number of purposes. For summer conditions, increased depth generally provides increased cover and cooler water. Increasing depths can limit aquatic vegetation growth, which can be viewed as a positive or a negative depending upon habitat objectives.

For winter conditions, the primary purpose of increasing water depths is to increase the volume of water available to serve as a reservoir for dissolved oxygen and heat. While it may seem incongruous to speak of heat during winter conditions, maintaining water temperatures above 2 degrees C is important for fish survival.

6.3.2.4 Add Structure

Structure within a body of water serves a number of functions, as cover from predators, as a substrate for food organisms, and as shade from light. Examples of natural cover include aquatic vegetation, rocks, brush, and stumps. Rocks, logs, stumps, and brush piles can be placed in water bodies that have a deficiency of structure.

6.3.3 RIVERINE FISH SPECIES AND MUSSEL HABITAT (GOAL B)

Options for improving habitat conditions for riverine fish species in the Ambrough Slough complex are more limited than for backwater species. Riverine species tend to be more tolerant of varied habitat conditions and Ambrough Slough and other sloughs appear to have adequate water depths and flows for the riverine species that would be expected to occur there. The addition of rock and/or woody structure may improve habitat conditions for riverine species.

It is not known if mussel habitat in Ambrough Slough is limited. Aside from water quality, suitable substrate is probably the most important factor affecting habitat suitability for mussels. Affecting the presence and distribution of sand and fine material substrates in a running slough such as Ambrough Slough and others is probably not practical. The addition of gravel and small rock in selected areas may be feasible.

6.3.4 MIGRATORY HABITAT FOR WATER BIRDS (GOAL C)

The migratory habitat for water birds in the Ambrough Slough complex is considered high quality, and the goals and objectives are oriented towards maintaining existing habitat quality. No specific habitat enhancement measures were identified for this goal.

6.3.5 HABITAT FOR OTHER SPECIES OF WILDLIFE (GOAL D)

No specific habitat measures have been identified for the goals and objectives relating to neotropical migrants and marsh birds. Expanding the extent of unbroken forest for neotropical migrants is not practical within the study area because of its physical character (most or all of the non-aquatic area is already forested). Some expansion of the bottomland forest will occur naturally through the process of succession. Expanding the area of emergent marsh for marsh birds also is not practical. Again, this will likely occur naturally through the process of succession.

The opportunities for creating beach or mudflat habitat for shorebirds in the Ambrough Slough complex is very limited. Opportunities to develop this habitat type in conjunction with habitat enhancement features designed for other goals and objectives were considered.

DEVELOPMENT AND EVALUATION OF ALTERNATIVES

7.1 ALTERNATIVES FORMULATION AND SCREENING

Once the process of general alternative identification was completed, alternative formulation began and screening was conducted to eliminate those alternatives that did not appear to warrant detailed evaluation.

7.1.1 LAKE SCREENING

There are ten backwater lakes located within the study area. An initial evaluation identified that three of the lakes were poor candidates for meeting project goals and objectives for a number of reasons. Specific alternatives were not formulated for these lakes, and they were eliminated from further consideration for habitat restoration or enhancement measures.

7.1.1.1 Voth's Lake

Voth's Lake is located in the northwestern portion of the study area. This lake is relatively isolated, has good water clarity, and supports abundant aquatic vegetation. Because of its isolation and shallow depths, Voth's Lake is prone to dissolved oxygen depletion problems. Because of its isolation and aquatic vegetation, the lake provides high quality waterfowl habitat.

Improving fish habitat in Voth's lake would likely require dredging and establishing a more permanent connection to other bodies of water within the study area. It was decided that these types of measures were not appropriate for this lake because of the potential to adversely affect existing aquatic vegetation, waterfowl habitat values, and a heron rookery. In addition, because of Voth's Lake's isolation, the project goals and objectives for backwater fish species (Goal A) could likely be achieved in other lakes within the Ambrough Slough/Gremore Lake complex at less cost.

7.1.1.2 Fluke's Lake

The formation of Black Slough and ongoing changes in this area have made Fluke's Lake an isolated, shallow slough. The potential for achieving Goal A or any of the objectives under this goal in Fluke's Lake was considered very low. Thus, it was decided to eliminate Fluke's Lake from further consideration for achieving Goal A and its objectives.

7.1.1.3 Roulette Lake

Roulette Lake is very shallow. The potential for achieving Goal A or any of the objectives under this goal in Roulette Lake was considered very low without substantial dredging. Water access into Roulette Lake for construction equipment would be difficult without extensive dredging. In addition, dredging in Roulette Lake would likely be in direct conflict with the Goal C and the objectives under that goal. Thus, it was decided to eliminate Roulette Lake from further consideration for achieving Goal A and its objectives.

7.1.2 LAKE ALTERNATIVES

The identification of alternatives to be evaluated for the remaining seven backwater lakes located in the study area was based on the habitat deficiencies of each lake relative to the habitat objectives under habitat Goal A. Table 7-1 summarizes this information for each of these lakes. Based on this information it was possible to identify where to focus further study for each of the individual lakes. Table 7-2 indicates which management measures would be expected to have potential for habitat improvement in each of the lakes.

7.1.2.1 Spring Lake

Of the four management measures, dredging was considered have the most potential for improving habitat conditions in Spring Lake. For winter habitat conditions, dredging would help meet the depth and water temperature criteria, and would probably help in meeting the dissolved oxygen criteria. For summer habitat conditions, dredging would help meet the depth criteria, and would assist in meeting the aquatic vegetation criteria. Based on aerial photographs, it would appear that in many years, Spring Lake has aquatic vegetation coverage greater than 60 percent.

An infinite number of dredging alternatives could be developed for Spring Lake. It was decided to evaluate three increments of dredging for the lake. The increments were based on the depth distribution criteria contained in Objective A1. This criteria calls for 20 percent of the lake having depths of less than 1 meter, 70 percent of the lake having depths ranging from 1 to 2 meters, and 10 percent of lake having depths greater than 2 meters (the notation 20-70-10 is used for this criteria). Dredging to fully meet the depth criteria was identified as the largest increment to be evaluated. Two smaller increments of dredging were developed for evaluation, the 60-30-10 option and the 40-50-10 option, where the numbers denote the percent of the lake that would fall within the various depth ranges described above.

The outlet of Spring Lake is joined by a small channel that branches off Ambrough Slough upstream of Ambrough Slough's connection with Roulette Lake. This channel is navigable during higher flows and has enlarged over the last 10 years. At this point, this channel appears stable and would not interfere with any dredging proposed for Spring Lake.

7.1.2.2 Big Missouri Lake

Dredging and adding structure were considered to be the measures that would have the most potential for benefiting Big Missouri Lake. Dredging would contribute towards meeting the depth, water temperature, and dissolved oxygen criteria during the winter. Dredging in Big Missouri Lake was evaluated in three increments as described for Spring Lake.

Table 7-1
Screening of Backwater Lakes re: Goals and Objectives Criteria

Lake	Size Range (ha)	Meets 15-ha Criteria	Winter Criteria *				Summer Criteria			
			Dissolved Oxygen >3 mg/l	Current Velocity <1 cm/sec	Temp 35% 2-4 C 65% 1-2 C	Depth <1.0m < 20% >2.0m > 10%	Dissolved Oxygen >5 mg/l	Current Velocity <1 cm/sec	Water/Veg 40:60 to 60:40	Depth >1.0m > 50%
Big Missouri	8 - 14	marginal	probably meets	probably meets	probably does not meet	probably does not meet	probably meets	probably meets	probably meets	probably does not meet
Spring	18 - 30	yes	probably does not meet	probably meets	probably meets	does not meet	probably meets	probably meets	probably does not meet	probably does not meet
Upper Doubles	10 - 16	possibly	probably does not meet	probably meets	probably meets	does not meet	probably meets	probably meets	probably does not meet	does not meet
Lower Doubles	8 - 12	no	probably does not meet	probably does not meet	probably does not meet	does not meet	probably meets	probably meets	probably does not meet	does not meet
Fish	10 - 18	possibly	probably meets	probably does not meet	probably does not meet	does not meet	probably meets	marginal	probably meets	probably does not meet
Tilmont	34 - 42	yes	probably meets	marginal	probably does not meet	marginal	probably meets	probably meets	probably does not meet	meets
Gremore	135	yes	does not meet	meets	marginal	meets	probably meets	meets	probably meets	meets

* based on normal winter stages and discharges

meets = meets the criteria under most or all conditions; supported by data or a high level of certainty

probably meets = meets the criteria under most or all conditions; additional information or data needed

marginal = meets the criteria some of the time; level of certainity varies

probably does not meet = does not meet the criteria under most or all conditions; additional information or data needed

does not meet = does not meet the criteria under most or all conditions; supported by data or a high level of certainty

Table 7-2
Screening of Backwater Lakes re: Restoration and Enhancement Measures

Lake	Habitat Measure	Potential as Hab. Restor. Measure	Rationale
Spring	Introduce Flows	No	Potential adverse velocity and temperature effects
	Reduce Flows	No	Limited flow to lake already; may create D.O. depletion problem
	Dredging	Yes	Depth improvement; may benefit D.O. and winter water temperatures
	Add Structure	No	Lake appears to have adequate cover in the form of aquatic vegetation
Big Missouri	Introduce Flows	No	Potential adverse velocity and temperature effects
	Reduce Flows	No	Current velocity not a problem; may create D.O. depletion problem
	Dredging	Yes	Depth improvement; may benefit D.O. and winter water temperatures
	Add Structure	Yes	Lake does not appear to support abundant aquatic vegetation
Upper Doubles	Introduce Flows	No	Potential adverse velocity and temperature effects
	Reduce Flows	No	Current velocity not a problem; may create D.O. depletion problem
	Dredging	Yes	Depth improvement; may benefit D.O. and winter water temperatures
	Add Structure	No	Lake appears to have adequate cover in the form of aquatic vegetation
Lower Doubles	Introduce Flows	No	Potential adverse velocity and temperature effects
	Reduce Flows	Yes	Reduce winter current velocities; possibly improve winter temperature
	Dredging	Yes	Depth improvement; may benefit D.O. and winter water temperatures
	Add Structure	No	Lake appears to have adequate cover in the form of aquatic vegetation
Fish	Introduce Flows	No	D.O. adequate; potential adverse velocity and temperature effects
	Reduce Flows	Yes	Reduce winter current velocities; possibly improve winter temperature
	Dredging	Yes	Depth improvement; may benefit D.O. and winter water temperatures
	Add Structure	No	Lake appears to have adequate cover in the form of aquatic vegetation
Tilmont	Introduce Flows	No	D.O. adequate; potential adverse velocity and temperature effects
	Reduce Flows	Yes	Reduce winter current velocities; possibly improve winter temperature
	Dredging	Yes	Depth improvement; may benefit D.O. and winter water temperatures
	Add Structure	Yes	Lake does not appear to have much structure
Gremore	Introduce Flows	Yes	D.O. improvement desired; lake appears large enough to assimilate some flow
	Reduce Flows	No	Minimal or no flow entering lake at this time
	Dredging	Yes	Lake has adequate water depths, however, may improve D.O. conditions
	Add Structure	No	Lake appears to have adequate cover in the form of aquatic vegetation

7.1.2.3 Upper Doubles Lake

Dredging was considered to have the most potential for improving habitat conditions in Upper Doubles Lake. For winter habitat conditions, dredging would help meet the depth and water temperature criteria, and would probably help in meeting the dissolved oxygen criteria. For summer habitat conditions, dredging would help meet the depth criteria, and probably would assist in meeting the aquatic vegetation criteria. Based on aerial photographs, it would appear that in many years, Upper Doubles Lake has aquatic vegetation coverage greater than 60 percent. Dredging in Upper Doubles Lake was evaluated in three increments as described for Spring Lake.

Another alternative identified for evaluation was to reduce flows to Upper Doubles Lake by closing, or partially closing, the connection between Upper Doubles Lake and Big Missouri Lake.

7.1.2.4 Lower Doubles Lake

Dredging would have potential for improving habitat conditions in Lower Doubles Lake. For winter habitat conditions, dredging would help meet the depth and water temperature criteria, and would probably help in meeting the dissolved oxygen criteria. For summer habitat conditions, dredging would help meet the depth criteria, and probably would assist in meeting the aquatic vegetation criteria. Based on aerial photographs, it would appear that in many years, Lower Doubles Lake has aquatic vegetation coverage greater than 60 percent. However, because of its location, it would be very difficult to access this lake with dredging equipment. Therefore, it was decided not to further evaluate dredging in Lower Doubles Lake.

An alternative identified for evaluation was to reduce flows to Lower Doubles Lake by closing, or partially closing, the connection between Lower Doubles Lake and Big Missouri Lake.

7.1.2.5 Fish Lake

Dredging would benefit Fish Lake by helping meet the depth criteria and assisting in meeting the winter temperature criteria. Dredging was evaluated for Fish Lake in the same manner as described for Spring Lake.

Flow reduction has the potential for improving habitat conditions in Fish Lake. The lake is quite open on its eastern side to Ambrough Slough and to Dark Slough on the south. Fish Lake is greatly influenced by eddy flows from Ambrough and Dark Sloughs. This allows considerable water exchange, which probably is a contributing factor to excessive current velocities and low water temperatures during the winter. During high winter discharges, flow also enters Fish Lake from a connecting channel to Lower Doubles Lake to the north.

Measures identified to reduce flows into Fish Lake (aside from the Lower Doubles Lake closure noted above) included restoration of some of the islands and other land masses that used to separate the lake from Ambrough Slough.

7.1.2.6 Tilmont Lake

Dredging would benefit Tilmont Lake by helping meet the depth criteria and assisting in meeting the winter temperature criteria. Because Tilmont Lake nearly meets the 20-70-10 depth criteria now, an option meeting this criteria was the only increment of dredging selected for evaluation.

Flow reduction appeared to be a potential measure for improving habitat conditions in Tilmont Lake. The lake is quite open on it's east side to Mud Hen Slough. This allows considerable water exchange between the two, which is a contributing factor to suboptimal winter water temperatures in Tilmont Lake. Measures to reduce flows into Tilmont Lake would include restoration of the peninsula that used to separate the lake from Mud Hen Slough and closing another small opening at the head of the lake.

7.1.2.7 Gremore Lake

Gremore Lake meets most of the habitat criteria for backwater fish species, save for one significant parameter, winter dissolved oxygen. Three alternatives were identified for Gremore Lake to address the dissolved oxygen depletion problems in the lake. They include:

a. Flow introductions via one of two routes, (1) from the west at the Wisconsin DNR Ambrough Slough boat landing and (2) from the north via a natural low area.

b. Dredging to create additional volume.

c. Mechanical aeration.

7.1.3 OTHER MEASURES

Other alternatives were identified for consideration as measures that had the potential for enhancing overall habitat quality within the Ambrough Slough complex.

7.1.3.1 Ambrough Slough Entrance

The amount of flow entering Ambrough Slough during non-flood conditions appears to be controlled by old bank revetment that is functioning much as a closing dam. Breaching the old bank revetment would allow additional flow into Ambrough Slough. No specific flow objective was identified for Ambrough Slough. A decision whether to modify the amount of flow entering Ambrough Slough would need to be based primarily on whether or not this would help meet habitat objectives in the lakes within the Ambrough Slough complex, most specifically Big Missouri, Upper Doubles, Lower Doubles, and Fish Lakes.

7.1.3.2 Entrances to Sloughs at RM 641.85, 641.80, and 641.70

There are three small sloughs west of Ambrough Slough that have the same condition as exists at the head of Ambrough Slough, i.e., old bank revetment is acting as a closing dam across their entrances. The effectiveness of the old bank protection in closing off flow to these sloughs during low water periods appears greater than the situation at Ambrough Slough. Breaching the old bank revetment would allow more flow into these sloughs. No flow objective exists for these sloughs. The decision to breach would need to be made on whether allowing additional flow down these sloughs will provide any habitat benefits and the affect this may have on meeting habitat objectives in the study area lakes.

7.1.3.3 Black Slough

The entrance to Black Slough has been increasing in size, allowing additional flow into the lower portion of the Ambrough Slough complex. Placing a partial closure structure across the entrance of Black Slough would reduce the amount of flow entering the complex. There is no flow objective specifically for Black Slough. The decision whether or not to modify the amount of flow allowed into Black Slough would need to be based on whether benefits overall habitat conditions within the Ambrough Slough complex.

7.1.3.4 Habitat Channel

A "habitat channel" was constructed for the Bertrom and McCartney Lake habitat project in pool 11 as a means of improving habitat quality for riverine fish species. The basic concept is to add rock and other structure to a flowing channel to improve habitat diversity and provide conditions favored by riverine species. The construction of a habitat channel within the Ambrough Slough complex was identified as a potential habitat enhancement measure.

7.2 ALTERNATIVES EVALUATION

7.2.1 HABITAT CHANNEL

The Ambrough Slough complex contains a diversity of flowing habitats in a variety of sizes and character. In its lower reaches, Ambrough Slough is a relatively large and deep. Black Slough, Dark Slough, Mudhen Slough, and portions of upper Ambrough Slough are moderately sized channels with varying depths and substrates. The margins of these sloughs have woody structure and some localized aquatic plant growth. In the upper portions of the complex, the sloughs are smaller and contain an abundance of woody cover.

It was determined that the flowing habitats in the Ambrough Slough complex provide habitat conditions suitable for a variety of riverine fish species, and that construction of a habitat channel or the addition of structure such as fallen trees, rocks, etc., was not necessary.

7.2.2 CLOSURE STRUCTURES

Measures to modify flow were evaluated in a number of locations within the study area. The primary purpose in most instances would be to reduce winter current velocities and maintain or increase winter water temperatures.

7.2.2.1 Ambrough Slough

After a site inspection, it was determined that no modifications to the old bank revetment at the head of Ambrough Slough were necessary for habitat purposes within the Ambrough Slough complex. It did not appear that breaching this revetment to allow more flow into Ambrough Slough would provide any appreciable habitat benefits.

7.2.2.2 Entrances to Sloughs at RM 641.85, 641.80, and 641.70

After a site inspection, it was determined that no modifications to the old bank revetment at the head of these sloughs were necessary for habitat purposes within the Ambrough Slough complex. It did not appear that breaching this revetment to allow more flow into these sloughs would provide any appreciable habitat benefits.

7.2.2.3 Black Slough

Visual observations by the Wisconsin DNR, supplemented by a review of aerial photographs, indicate that the entrance to Black Slough is actively enlarging. The Wisconsin DNR is concerned that increased flow into Black Slough is detrimental to winter fish habitat conditions in Ambrough Slough and other backwater areas fed by this slough. Therefore, a partial closure structure was designed and evaluated for the Black Slough entrance.

The criterion used for the initial design of a partial closure structure was to reduce winter flows entering Black Sough by 60 percent (criterion provided by the Wisconsin DNR.) Winter flow data for Black Slough is limited, however, it appears winter flows entering Black Slough are about 8 cms at a river discharge of approximately 565 cms. The estimated water surface elevation at the Black Slough entrance at this discharge is 186.70 m. Reducing winter flows by 60 percent would require reducing these flows to about 3.2 cms. This would require a partial closure structure with a bottom width of 6 m, side slopes of 1V:3H, and a bottom elevation of 186.32 m. During low river discharge conditions, there would be less than 0.4 m of clearance over this structure, a depth normally not considered acceptable for safe small boat navigation over a fixed structure.

Increasing the weir depth to 1m to provide adequate clearance for small boats and decreasing the weir bottom width to 1.8 m would allow about 6.7 cms of flow to enter Black Slough. Aside from providing a rather narrow opening for small boats to navigate through, velocities through this weir could be excessive for small craft, especially at higher river discharges. Thus, meeting the 60 percent flow reduction criterion and at the same time maintaining safe access for small recreational craft could not be accomplished.

An alternative design was developed which would involve placing a partial closure in Black Slough that would provide safe passage for small boats. The structure would have a bottom opening width of 4 m and would provide approximately 0.9 m of clearance at low river discharges (plate 4).

<u>Costs</u>

The partial closure structure across the entrance to Black Slough would cost an estimated $82,500 (table 7-3). The average annual cost of this structure for a 50-year project life at the current interest rate of 6 5/8 percent would be $5,693.

Table 7-3
Cost Estimate for the Black Slough Partial Closure Structure

Mob/demob	$ 3,100
Geotextile	4,000
Rock	57,900
Construction subtotal	$65,000
Planning, Engineering, and Design	$11,600
Construction Management	5,900
Total Cost	$82,500

Habitat Benefits

Quantifying the habitat benefits associated with the Black Slough partial closure structure would be very difficult using a habitat based system such as Habitat Evaluation Procedures (HEP). Flows entering the lower portion of the Ambrough Slough complex via Black Slough are distributed throughout a number of sloughs and lakes, and this distribution can vary with river discharge and stage. It would take extensive hydraulic and habitat analyses to quantify the benefits of this structure. The cost of these analyses would be exorbitant in relation to the actual cost of the structure.

A reverse analysis was used to determine if it would be reasonable to assume that this structure would provide habitat benefits sufficient to justify its costs. It was assumed that the observations of the Wisconsin DNR resource managers are accurate and that increased flow entering Black Slough is detrimental to overall fish habitat values in the lower portion of the Ambrough Slough complex. The planning and implementation of previous UMRS-EMP habitat projects within the St. Paul District have indicated that costs up to approximately $2,500/average annual habitat units (AAHU) are considered reasonable and justifiable for obtaining a variety of fish habitat improvements. To be conservative, a cost of $1,500/AAHU was used in the reverse analysis as a justifiable cost threshold. At a cost of $1,500/AAHU and an average annual cost of $5,693, the Black Slough partial closure structure would need to provide about 3.8 AAHU of benefits to be considered justified.

The area of aquatic habitat influenced by Black Slough flows in the lower portion of the Ambrough Slough Complex is about 120 hectares (or 300 acres). To provide 3.8 AAHU of habitat benefits would require raising the average habitat suitability index (HSI) of this area by .013, or by preventing a .013 decline in future HSI values. An HSI change of .013 is very small. Generally, habitat suitability models are not sensitive enough to measure HSI changes this small. The conclusion is that if the Black Slough partial closure structure provides any incremental habitat improvement at all, more than 3.8 AAHU of fish habitat benefits will be generated.

Plan Selection

The habitat benefits of the Black Slough partial closure structure cannot be quantified at a study cost considered reasonable for a feature of this scale. Analysis indicates that a sufficiently large enough area would be affected by the partial closure structure such that even a marginal improvement in habitat quality over the affected area would provide sufficient habitat benefits to justify the structure's cost.

Another factor considered was the level of investment and risk. At $82,500, the partial closure structure is a relatively small investment. The risk that the structure will not function in terms of reducing flows is almost non-existent. The only risk involved is whether reducing flows will provide the expected habitat benefits. The view of the resource managers familiar with the area is that reducing flows entering Black Slough will provide the expected habitat benefits.

Based on the above, the selected plan is to construct the Black Slough partial closure structure.

7.2.2.4 Upper Doubles Lake

A small opening has eroded between Big Missouri Lake and Upper Doubles Lake. Closure of this opening would reduce current velocities in Upper Doubles Lake during the winter. A rock closure structure was designed to close off this opening (plate 5). This structure would require an estimated 180 m3 of rock fill. Access to this site for construction is somewhat restricted and dredging would be required to get rock barges and construction equipment to the site. Therefore, for cost estimating purposed, it was assumed that this structure would not be pursued unless dredging in Big Missouri Lake took place (which would provide the access to this site).

Costs

Constructing a rock closure across the opening to Upper Doubles Lake would cost an estimated $24,600 (table 7-4).

Table 7-4
Cost Estimate for the Upper Doubles Lake Closure Structure

Mob/demob	$ 3,300
Geotextile	1,500
Rock	14,600
Construction subtotal	$19,400
Planning, Engineering, and Design	$ 3,500
Construction Management	1,700
Total Cost	$24,600

The average annual cost of the Upper Doubles Lake structure over a 50-year project life is $1,697. Maintenance of this structure would be difficult because of its remote location and the need to access the site with marine equipment. Without maintenance, a 25-year project life is considered more realistic as erosion would likely result in this structure eventually being bypassed. The average annual cost of this feature over a 25-year project life would be $2,039.

Habitat Benefits

The estimated habitat benefits of the Upper Doubles Lake closure structure (as a stand-alone feature) if it functioned every winter are 0.8 AAHU (attachment 4). A review of historic water level records was used to determine if the structure would be effective every winter. High winter flows can inundate the lakes in the Ambrough Slough complex or could allow sufficient flow to enter a particular lake to create suboptimal current velocity and/or water temperature conditions. Available topographic information around Upper Doubles Lake indicates that the controlling elevation that would allow overland flow into the lake is below elevation 187.5 m. The McGregor gage was used as an indicator as to when this might occur because the water surface elevation increase from the McGregor gage to Upper Doubles Lake in probably less than 0.2 m for the river discharge ranges in question. Table 7-5 shows the number of days the water surface elevation at the McGregor gage exceeded various elevations on a monthly basis for the period 1972-1999. The most important months are December through February. November data is included because ice-over can occur in late November, and also this is an important period when backwater fish are seeking out overwintering sites. March data is included, however, a review of the records indicate most of the high water events that occur in March would be considered part of the spring breakup.

The darkly shaded winters in table 7-5 are those where it appears that there would have been sufficient episodes of high water to make the Upper Doubles Lake closure non-effective in maintaining suitable winter habitat conditions, especially for water temperature and possibly for current velocity. The lightly shaded years are those that would be considered questionable years, especially since the high water occurred predominantly in November or later during February. The winter of 1993-94 was not shaded as it appears from the actual data that the high water in February in that year was the beginning of an early spring breakup.

Based on the records for the period 1972-99, it appears that the Upper Double Lake closure would have been ineffective 9 of 27 winters (33 percent), and potentially ineffective another 4 of 27 winters (15 percent). The following summarizes the expected habitat benefits depending on the assumptions made:

functional every winter	0.8 AAHU
functional 67 percent of winters	0.5 AAHU
functional 52 percent of winters	0.4 AAHU

The following summarizes the expected cost/AAHU for the range of assumptions:

functional every winter/50-yr project life	$2,121/AAHU
functional 67 percent of winters/50-yr project life	$3,394/AAHU
functional 52 percent of winters/50-yr project life	$4,243/AAHU
functional every winter/25-year project life	$2,549/AAHU
functional 67 percent of winters/25-yr project life	$4,078/AAHU
functional 52 percent of winters/25-yr project life	$5,098/AAHU

Table 7-5
Winter Water Surface Elevations at the McGregor Gage
(Days Exceeding)

Winter	November			December			January			February			March		
	>187.25	>187.50	>187.75	>187.25	>187.50	>187.75	>187.25	>187.50	>187.75	>187.25	>187.50	>187.75	>187.25	>187.50	>187.75
1972-73	18	12	9	16	0	0	21	11	0	8	3	0	22	21	20
1973-74	0	0	0	0	0	0	0	0	0	0	0	0	8	5	0
1974-75	0	0	0	0	0	0	0	0	0	0	0	0	9	4	0
1975-76	2	0	0	1	0	0	0	0	0	10	0	0	15	10	6
1976-77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977-78	0	0	0	27	14	10	11	4	0	0	0	0	8	0	0
1978-79	0	0	0	0	0	0	0	0	0	0	0	0	14	12	10
1979-80	5	0	0	0	0	0	6	0	0	0	0	0	14	10	6
1980-81	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0
1981-82	0	0	0	0	0	0	0	0	0	0	0	0	16	10	2
1982-83	26	22	16	26	10	1	28	20	15	16	5	0	31	28	28
1983-84	7	4	3	29	26	16	21	12	0	16	14	12	19	10	7
1984-85	20	15	10	17	13	9	26	14	4	7	5	4	31	29	26
1985-86	13	8	3	27	14	4	29	5	0	10	0	0	28	17	13
1986-87	19	3	0	16	6	0	1	0	0	0	0	0	2	0	0
1987-88	0	0	0	0	0	0	0	0	0	0	0	0	19	4	0
1988-89	0	0	0	0	0	0	0	0	0	0	0	0	8	5	2
1989-90	0	0	0	0	0	0	0	0	0	0	0	0	14	12	10
1990-91	0	0	0	0	0	0	0	0	0	0	0	0	7	6	4
1991-92	20	15	12	31	29	26	8	0	0	0	0	0	28	24	22
1992-93	10	5	1	16	1	0	0	0	0	0	0	0	3	2	0
1993-94	2	0	0	0	0	0	0	0	0	9	6	1	31	31	5
1994-95	3	0	0	6	3	0	0	0	0	0	0	0	13	11	9
1995-96	17	15	13	12	0	0	1	0	0	19	9	3	31	13	6
1996-97	10	5	3	0	0	0	4	0	0	22	4	0	19	5	4
1997-98	0	0	0	0	0	0	0	0	0	7	0	0	17	12	9
1998-99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

This feature was also evaluated as an add-on feature if Upper Doubles Lake were dredged. Under this scenario, the incremental habitat unit gains associated with the closure range from 1.7 to 2.0 AAHU, depending upon the dredging alternative. Using the most optimistic assumptions (50-year project life, effective every winter, and 2.0 AAHU of benefits), the Upper Doubles Lake closure structure, would cost an estimated $849/AAHU. Using the least optimistic scenario (25-year project life, effective about 52 percent of the winters, and 1.7 AAHU of benefits), the structure would cost about $2,036/AAHU.

Plan Selection

Under the most optimistic assumptions, the Upper Doubles Lake closure structure as a stand-alone feature would cost an estimated $2,121/AAHU, while the cost of this structure would be an estimated $5,098/AAHU using the most pessimistic assumptions. Costs/AAHU greater than $2,500 to $3,000/AAHU are generally considered excessive for the type of habitat benefits this structure would provide, unless there are special circumstances justifying higher costs such as benefits to endangered species or protection of a unique habitat.

There are a number of uncertainties associated with the Upper Doubles Lake closure concerning its effective life and how often it would achieve its habitat function, i.e., keeping flows out of Upper Doubles Lake during the winter. It appears likely that the cost/AAHU for this feature will be more than $3,000/AAHU as the historic water level data indicates this structure would not be functional every winter. There are no unique or special habitat values that would be gained or protected with this structure. Therefore, this feature was not considered justified as a stand-alone feature.

If Upper Doubles Lake were dredged, the cost/AAHU for this feature would be in the range of $849 to $2,036/AAHU. Costs in this range are considered justified for the type of habitat benefits that would be provided. Therefore, the selected plan is to construct the Upper Doubles Lake closure structure if dredging in Upper Doubles Lake is pursued.

7.2.2.5 Lower Doubles Lake

An opening exists between Big Missouri Lake and Lower Doubles Lake which allows flow into Lower Doubles Lake. A partial closure of this opening would reduce current velocities in Lower Doubles Lake during the winter. (A full closure structure is not considered practical in this location.) A rock partial closure structure was designed for this opening that would reduce flows to Lower Doubles Lake to some extent during the winter.

Costs

The Lower Doubles Lake partial closure structure would cost an estimated $65,600 (table 7-6). This estimate assumes that this structure would not be constructed unless access dredging was accomplished as part of a plan to dredge Big Missouri Lake.

Table 7-6
Cost Estimate for Lower Doubles Lake Partial Closure Structure

Mob/demob	$ 6,500
Geotextile	3,300
Rock	39,500
Construction subtotal	$49,300
Plans and Specifications	$11,600
Construction Management	4,700
Total Cost	$65,600

The average annual cost of the Lower Doubles Lake structure over a 50-year project life is $4,526. Maintenance of this structure would be difficult because of its remote location and the need to access the site with marine equipment. Without maintenance, a 25-year project life is considered more realistic as erosion would likely result in this structure eventually being bypassed. The average annual cost of this feature over a 25-year project life would be $5,440.

Habitat Benefits

The estimated habitat benefits of a full closure structure at Lower Doubles Lake if it functioned every winter are 2.0 AAHU. The same analysis was conducted for this structure concerning its effectiveness as previously discussed for the Upper Doubles Lake structure. The following summarizes the findings. The expected habitat benefits would be:

functional every winter	2.0 AAHU
functional 67 percent of winters	1.3 AAHU
functional 52 percent of winters	1.0 AAHU

The following summarizes the expected cost/AAHU for the range of assumptions:

functional every winter/50-yr project life	$2,263/AAHU
functional 67 percent of winters/50-yr project life	$3,482/AAHU
functional 52 percent of winters/50-yr project life	$4,526/AAHU
functional every winter/25-year project life	$2,720/AAHU
functional 67 percent of winters/25-yr project life	$4,185/AAHU
functional 52 percent of winters/25-yr project life	$5,440/AAHU

Plan Selection

Under the most optimistic assumptions, the Lower Doubles Lake partial closure structure would cost an estimated $2,263/AAHU, while the cost would be an estimated $5,440/AAHU using the most pessimistic assumptions. Costs/AAHU greater than $2,500 to $3,000/AAHU are generally considered excessive for habitat benefits on the Upper Mississippi River unless there are special circumstances justifying higher costs such as benefits to endangered species or protection of a unique habitat.

There are a number of uncertainties associated with the Lower Doubles Lake partial closure structure concerning how often it would achieve its habitat function, i.e., keeping winter flows out of Lower Doubles Lake. Based on available information, it appears likely that the cost/AAHU for this feature will be more than $3,000/AAHU as the historic water level data indicates this structure would not be functional every winter. There are no unique or special habitat values that would be gained or protected with this structure. Therefore, this feature is not considered justified, and the selected plan is the no action alternative.

7.2.2.6 Tilmont Lake

At one time, Tilmont Lake was protected from flow from Mudhen Slough and Ambrough Slough by a peninsula of land. Erosion of this peninsula has made Tilmont Lake more open to flows from these sloughs, resulting in suboptimal winter habitat conditions due to current velocities and low water temperatures. Restoration of the peninsula was evaluated using two designs. The first design evaluated was an earthen structure constructed by sidecast excavation, seeded, and protected from erosion by rock bank protection. The second design evaluated was a sidecast earthen structure stabilized by vegetation only (plate 6). Vegetation stabilization is considered practical in this situation because the dike material will have a high fine material content which should result in rapid establishment of a good grass cover and most of the eroding flows will be parallel to the structure. Included with each design is a rock closure to close off a small opening at the head of Tilmont Lake (plate 7).

Costs

The first design (which includes rock protection) would cost an estimated $717,500 (table 7-7). It was assumed that this design would have a project life of 50 years, resulting in an average annual cost of $49,536.

Table 7-7
Cost Estimate for the Tilmont Lake Closure with Rock Protection*

Mob/demob	$ 2,900
Access dredging	75,600
Stripping	1,400
Excavation/placement	237,100
Geotextile	30,500
Rock	201,200
Topsoil	13,900
Seeding	8,400
Construction subtotal	$571,000
Plans and Specifications	$ 97,700
Construction Management	48,800
Total Cost	$717,500

* includes the small rock closure at the head of Tilmont Lake

The second design would cost an estimated $447,200 (table 7-8). Because the restored peninsula with this design would only be protected by vegetation, it was assumed its practical project life would be 25 years, resulting in an average annual cost of $37,086.

Table 7-8
Cost Estimate for the Tilmont Lake Closure without Rock Protection*

Mob/demob	$ 2,900
Access dredging	75,600
Stripping	1,400
Excavation/placement	237,100
Rock/Geotextile	13,500
Topsoil	13,900
Seeding	8,400
Construction subtotal	$352,800
Plans and Specifications	$ 63,000
Construction Management	31,400
Total Cost	$447,200

* includes the small rock closure at the head of Tilmont Lake

Habitat Benefits

The estimated habitat benefits of the Tilmont Lake structures, if they functioned every winter would be 25.6 AAHU. Tilmont Lake is surrounded by a more continuous landmass than Upper and Lower Doubles Lakes and Fish Lake. Surveys data indicates the low spot of the surrounding landmass is in the area of the proposed small rock closure. Based on the survey data and the historic water surface elevation information displayed in table 7-5, it was assumed that the Tilmont Lake closures would have been effective except for the winters of '72-73, '77-78' '82-83, '83-84, '84-85, '85-86, and '91-92. This leads to the assumption that the structure would provide benefits during approximately 75 percent of the winters, resulting in 19.2 AAHU of habitat benefits. Thus, the rock protected closure structure would cost about $2,580/AAHU, while the closure structure protected only by vegetation would cost $1,932/AAHU.

Plan Selection

The structure protected by vegetation would provide habitat benefits at about 75 percent the cost of the rock protected structure even when assuming only a 25-year project life vs. a 50-year project life for a rock protected structure. Therefore, it is the most cost-effective design.

The Tilmont Lake closure would provide habitat benefits at an estimated cost of $1,932/AAHU. This is within the range of costs considered justifiable on the Upper Mississippi River for the type of habitat benefits provided. Additional factors in favor of constructing this feature are (1) there would be no operation and maintenance required, (2) the sidecast borrow would provide habitat benefits (deeper water) not accounted for in the calculation of benefits for this feature, and (3) this feature would provide valuable constructibility and durability information concerning this type of closure for future applications within the UMRS-EMP and other habitat restoration programs. Therefore, the selected plan is the restoration of the Tilmont Lake peninsula using vegetation for stabilization.

7.2.2.7 Fish Lake

At one time, Fish Lake was more protected from flow via Ambrough Slough by islands and other landmasses. Erosion has made Fish Lake more open to Ambrough Slough flows, resulting in suboptimal winter habitat conditions due to excessive current velocities and low water temperatures. The option of constructing earthen closures to partially separate Fish Lake from Ambrough Slough was evaluated. Because the Tilmont Lake analysis showed that a closure constructed by sidecast borrow stabilized with vegetation is more cost effective than using rock stabilization, this same design was used for the Fish Lake application.

Costs

The cost of constructing the Fish Lake closures is estimated to be $496,000 (table 7-9). Because these structures would only be protected by vegetation, it is assumed their practical project life would be 25 years. The average annual cost of these structures would be $41,133.

Table 7-9
Cost Estimate for the Fish Lake Closure Structures

Mob/demob	$ 4,300
Excavation/placement	377,400
Seeding	9,500
Construction subtotal	$391,200
Plans and Specifications	$ 69,900
Construction Management	34,900
Total Cost	$496,000

Habitat Benefits

Habitat evaluation indicates these structures would provide approximately 14.1 AAHU of benefits if they functioned every winter. Fish Lake is bounded on the south by relatively low ground, making it more susceptible to overtopping flows than Tilmont Lake, for example. The same analysis was made for Fish Lake as for Upper and Lower Doubles Lakes resulting in the following:

functional every winter	14.1 AAHU
functional 67 percent of winters	9.4 AAHU
functional 52 percent of winters	7.3 AAHU

The following summarizes the expected cost/AAHU for the range of assumptions:

functional every winter	\$2,917/AAHU
functional 67 percent of winters	\$4,376/AAHU
functional 52 percent of winters	\$5,635/AAHU

Plan Selection

The following factors were most salient in the plan selection process for the Fish Lake closure structures.

a. Based on historic water level data, the closure structures would probably be functional in preventing winter habitat degradation between 50 and 67 percent of the winters, resulting in a cost per AAHU in the range of \$4,376 to \$5,635. Costs/AAHU in this range are considered excessive for the type of habitat benefits that would be provided.

b. Because Fish Lake would still remain somewhat open to Ambrough Slough, the winter habitat benefits in terms of current velocity reduction and water temperature maintenance are more likely overestimated than underestimated.

Therefore, the selected plan for the Fish Lake closure structures is the no action alternative.

7.2.3 DREDGING - INITIAL EVALUATION

The initial step in the evaluation of dredging in Spring, Big Missouri, Upper Doubles, Fish and Tilmont Lakes was to determine the optimal amount of dredging for each lake using the three increments of dredging described in section 7.1.2. These were (in ascending order) the 60-30-10, 40-50-10, and 20-70-10 options.

Factors not used to compare dredging options were the cost of dredge mobilization or placement site development. Both of these cost factors are generally applied against the first increment of dredging. However, this can skew the comparative evaluation because whichever dredging increment has to absorb the mobilization and placement site development costs is going to be the most expensive. Mobilization and placement site development costs were considered in the final portion of the evaluation process.

7.2.3.1 Spring Lake

Table 7-10 displays the information used in the initial evaluation of dredging for Spring Lake. Dredging an initial 90,000 m3 of material from Spring Lake would provide 14.1 average annual habitat units (AAHU) of benefits at an approximate cost of $1,844/AAHU. Dredging an additional 35,000 m3 would provide additional habitat benefits at a lower cost per/AAHU ($1,549). Dredging the final increment of 35,000 m3 would provide 1.7 AAHU of benefits at a cost of $4,922/AAHU, a significant increase in cost/AAHU over the initial two increments. Based on this information the first two increments of dredging for Spring Lake were carried forward for further consideration. The third increment was dropped from further consideration because of the significant increase in incremental costs. In addition, $4,922/AAHU is considered an excessive cost for the type of habitat benefits that would be provided.

Table 7-10
Spring Lake - Initial Evaluation of Dredging Options

Option	Incremental Dredging Vol (m3)	Incremental Dredging Cost	Incremental Ave An Cost	Incre. AAHU Gain	Incremental Cost/ AAHU
60-30-10	90,000	$376,700	$26,007	14.1	$ 1,844
40-50-10	35,000	$121,200	$ 8,367	5.4	$ 1,549
20-70-10	35,000	$121,200	$ 8,367	1.7	$ 4,922

7.2.3.2 Big Missouri Lake

Table 7-11 displays the information used in the initial evaluation of dredging for Big Missouri Lake. Dredging an initial 40,000 m3 of material from Big Missouri Lake would provide 7.3 average annual habitat units (AAHU) of benefits at an approximate cost of $1,753/AAHU. Dredging an additional 15,000 m3 would provide additional habitat benefits at a lower cost per/AAHU. Dredging the final increment of 10,000 m3 would provide 1.0 AAHU of benefits at a cost of $2,340/AAHU, an increase in cost/AAHU over the initial two increments. Based on this information, the first two increments of dredging for Big Missouri Lake were carried forward for more detailed evaluation. The third increment would have a higher cost per AAHU, but a cost of $2,340/AAHU was still considered within the range that may be justifiable. Therefore, the third increment was also carried forward for further consideration.

Table 7-11
Big Missouri Lake - Initial Evaluation of Dredging Options

Option	Incremental Dredging Vol (m3)	Incremental Dredging Cost	Incremental Ave An Cost	Incre. AAHU Gain	Incremental Cost/ AAHU
60-30-10	40,000	$185,400	$12,800	7.3	$ 1,753
40-50-10	15,000	$ 50,900	$ 3,514	3.0	$ 1,171
20-70-10	10,000	$ 33,900	$ 2,340	1.0	$ 2,340

7.2.3.3 Upper Doubles Lake

Table 7-12 displays the information used in the initial evaluation of dredging for Upper Doubles Lake. Dredging an initial 60,000 m3 of material from Upper Doubles Lake would provide 8.4 average annual habitat units (AAHU) of benefits at an approximate cost of $2,167/AAHU. Dredging an additional 25,000 m3 would provide additional habitat benefits at a lower cost per/AAHU. Dredging the final increment of 20,000 m3 would provide 0.6 AAHU of benefits at a cost of $7,882/AAHU, a significant increase in cost/AAHU over the initial two increments. Based on this information, the first two increments of dredging for Upper Doubles Lake were carried forward for further consideration. The third increment was dropped from further consideration because of the significant increase in incremental costs. In addition, $7,882/AAHU is considered an excessive cost for the type of habitat benefits that would be provided.

Table 7-12
Upper Doubles Lake - Initial Evaluation of Dredging Options

Option	Incremental Dredging Vol (m3)	Incremental Dredging Cost	Incremental Ave An Cost	Incre. AAHU Gain	Incremental Cost/ AAHU
60-30-10	60,000	$263,600	$18,199	8.4	$ 2,167
40-50-10	25,000	$ 85,700	$ 5,917	3.3	$ 1,793
20-70-10	20,000	$ 68,500	$ 4,729	0.6	$ 7,882

Flow reduction was evaluated for Upper Doubles Lake as a measure to reduce winter current velocities and increase winter water temperatures. An evaluation was conducted to determine how that could affect the feasibility of the dredging options. This evaluation is summarized in table 7-13. The implementation of flow reduction measures at Upper Doubles Lake would not have a significant effect on the relative costs/AAHU of the dredging increments, and thus, did not change the decision to carry only the first two dredging increments forward for further consideration.

Table 7-13
Upper Doubles Lake - Initial Evaluation of Dredging Options in Combination with Flow Reduction

Option	Incremental Dredging Vol (m3)	Incremental Dredging Cost	Incremental Ave An Cost	Incre. AAHU Gain	Incremental Cost/ AAHU
60-30-10	60,000	$263,600	$18,199	9.3	$ 1,957
40-50-10	25,000	$ 85,700	$ 5,917	3.6	$ 1,644
20-70-10	20,000	$ 68,500	$ 4,729	0.6	$ 7,882

7.2.3.4 Fish Lake

Table 7-14 displays the information used in the initial evaluation of dredging for Fish Lake. Dredging an initial 55,000 m3 of material from Fish Lake would provide 7.5 average annual habitat units (AAHU) of benefits at an approximate cost of $2,462/AAHU. Dredging an additional 20,000 m3 would provide 0.8 AAHU of additional habitat benefits at a cost of $5,912/AAHU. Dredging the final increment of 20,000 m3 would provide 0.3 AAHU of benefits at a cost of $15,763/AAHU. Based on this information, the decision was made to carry only the first increment forward for further consideration.

Table 7-14
Fish Lake - Initial Evaluation of Dredging Options

Option	Incremental Dredging Vol (m3)	Incremental Dredging Cost	Incremental Ave An Cost	Incre. AAHU Gain	Incremental Cost/ AAHU
60-30-10	55,000	$267,500	$18,468	7.5	$ 2,462
40-50-10	20,000	$ 68,500	$ 4,729	0.8	$ 5,912
20-70-10	20,000	$ 68,500	$ 4,729	0.3	$15,763

7.2.3.5 Tilmont Lake

Table 7-15 contains the initial evaluation for Tilmont Lake. Only one increment of dredging was developed for Tilmont Lake. The initial evaluation indicated that the cost/AAHU was well within the range considered acceptable for habitat restoration on the Upper Mississippi River and that the dredging of Tilmont Lake should be carried into the next stage of evaluation.

Table 7-15
Tilmont Lake - Initial Evaluation of Dredging Options

Option	Incremental Dredging Vol (m3)	Incremental Dredging Cost	Incremental Ave An Cost	Incre. AAHU Gain	Incremental Cost/ AAHU
20-70-10	45,000	$310,000	$21,402	33.1	$ 647

Flow reduction is also an option for Tilmont Lake. The potential effect flow reduction may have on the feasibility of dredging in Tilmont Lake was evaluated (table 7-16). This initial evaluation indicated that implementation of flow reduction would make dredging in Tilmont Lake less attractive. However, the cost/AAHU would still be within the range considered acceptable for Upper Mississippi River habitat restoration efforts.

Table 7-16
Tilmont Lake - Initial Evaluation of Dredging Options in Combination with Flow Reduction

Option	Incremental Dredging Vol (m3)	Incremental Dredging Cost	Incremental Ave An Cost	Incre. AAHU Gain	Incremental Cost/ AAHU
20-70-10	45,000	$310,000	$21,402	12.1	$1,769

At the conclusion of the initial incremental screening of dredging options, 4 of 13 dredging options were eliminated from further consideration. The 9 remaining increments are shown in table 7-17. Since the Tilmont Lake peninsula restoration is recommended for construction, the cost/AAHU for Tilmont Lake displayed in table 7-17 reflect this.

Table 7-17
Dredging Increments Remaining Following Initial Screening

Increment	Quantity	Cost/AAHU
Spring Lake increment #1	90,000 m3	$1,800/AAHU
Spring Lake increment #2	35,000 m3	$1,600/AAHU
Big Missouri Lake increment #1	40,000 m3	$1,800/AAHU
Big Missouri Lake increment #2	15,000 m3	$1,200/AAHU
Big Missouri Lake increment #3	10,000 m3	$2,300/AAHU
Upper Doubles Lake increment #1	60,000 m3	$2,000/AAHU
Upper Doubles Lake increment #2	25,000 m3	$1,600/AAHU
Fish Lake increment #1	55,000 m3	$2,500/AAHU
Tilmont Lake	45,000 m3	$1,800/AAHU
	375,000 m3	

7.2.4 DREDGED MATERIAL PLACEMENT

Opportunities for dredged material placement within or adjacent to the study area are limited. Four agricultural sites were identified as potential placement sites for dredged material. They are shown on plate 11.

7.2.4.1 Dillman Field

The Dillman property consists of an agricultural field located east of the Ambrough Slough complex. The site is bounded on the south by Mill Coulee Creek and on the east by railroad tracks. The practical dredged material placement capacity of this site is in the range of 300,000 to 400,000 m3, assuming the dredged material was placed to a depth of 1-2 meters.

7.2.4.2 Pedretti Field

The Pedretti property lies south of the Dillman property. It is bounded on the north by Mill Coulee Creek, on the east by railroad tracks, and on the south by a road. A portion of this property is in agricultural use. There is an active sand and gravel pit on the property, approximately 2 hectares in size and over 6 meters deep. At present, the landowner does not want dredged material placed in this pit.

The Pedretti property contains known cultural resources including an extensive (14 hectare) village occupation site that is on the National Register of Historic Places and a mound group that has not been evaluated but is undoubtedly eligible for the National Register. Dredged material could probably be placed on the site while avoiding the mound group. Mitigation of the village occupation site would be required, likely through data recovery. Mitigation of an occupation site of this size would cost in the range of $200,000 to $300,000 and take two years to complete. Therefore, the only portion of the Pedretti property considered for dredged material placement was the sand and gravel pit.

7.2.4.3 Hunzeker Field

This is a small (1-2 hectare) formerly agricultural site lying north of the Dillman Field. This site is currently vegetated by grasses. The capacity of this site is limited though it may be useful for material dredged from Spring Lake.

7.2.4.4 Toberman Field

This is a small (2-3 hectare) agricultural site lying north of the Dillman Field. In 2000 this field was planted in corn. The capacity of this site is limited though it may be useful for material dredged from Spring Lake.

7.2.5 DREDGING PLAN SELECTION

7.2.5.1 Prioritization of Dredging Increments

Follow initial screening, 9 dredging increments remained under consideration (table 7-17). The costs for all of these increments fall within the range considered justifiable for the type of habitat benefits that would be provided. Table 7-18 shows the ordering of the dredging increments based solely on cost/AAHU. (If some of the costs/AAHU appear out of order, it is because dredging the second increment in a lake cannot occur if the first increment is not dredged.)

Table 7-18
Ordering of Dredging Increments Solely on Cost/AAHU

Increment	Quantity	Cost/AAHU
Big Missouri Lake increment #1	40,000 m3	$1,753/AAHU
Big Missouri Lake increment #2	15,000 m3	$1,171/AAHU
Tilmont Lake	45,000 m3	$1,769/AAHU
Spring Lake increment #1	90,000 m3	$1,844/AAHU
Spring Lake increment #2	35,000 m3	$1,551/AAHU
Upper Doubles Lake increment #1	60,000 m3	$1,957/AAHU
Upper Doubles Lake increment #2	25,000 m3	$1,644/AAHU
Big Missouri Lake increment #3	10,000 m3	$2,340/AAHU
Fish Lake increment #1	55,000 m3	$2,462/AAHU
Total	375,000 m3	

Given the uncertainties and subjective judgements that play a part in the quantification of habitat benefits and the development of cost estimates, a difference of $100 to $300/AAHU in incremental costs was not considered significant. Therefore, the lake dredging increments were reprioritized based on the costs/AAHU and other non-quantifiable factors. Table 7-19 shows the results of the reprioritization process.

Table 7-19
Reprioritization of Dredging Increments based on Cost/AAHU and Other Non-Quantifiable Factors

Increment	Quantity	Cost/AAHU
Spring Lake increment #1	90,000 m3	$1,844/AAHU
Big Missouri Lake increment #1	40,000 m3	$1,753/AAHU
Big Missouri Lake increment #2	15,000 m3	$1,171/AAHU
Upper Doubles Lake increment #1	60,000 m3	$1,957/AAHU
Upper Doubles Lake increment #2	25,000 m3	$1,644/AAHU
Big Missouri Lake increment #3	10,000 m3	$2,340/AAHU
Fish Lake increment #1	55,000 m3	$2,462/AAHU
Tilmont Lake	45,000 m3	$1,769/AAHU
Spring Lake increment #2	35,000 m3	$1,551/AAHU
	375,000 m3	

Spring Lake was rated as the highest priority lake for dredging by Wisconsin DNR and U.S. Fish and Wildlife Service biologists. Spring Lake is the most protected of the lakes and is the least likely to be adversely affected by high river discharges during the winter. Resource agency biologists believe this is the lake that would benefit the most from dredging. The $91 cost/AAHU difference between Spring Lake increment #1 and Big Missouri Lake increment #1 is not considered significant given the level of detail of the analysis.

Spring Lake is about 22 hectares in size and lies on the boundary of the Upper Mississippi River National Wildlife and Fish Refuge, with about 60% (~ 13 hectares) of the lake lying within the Refuge and about 40% (~ 9 hectares) lying outside of the Refuge. Dredging outside of the Refuge would require a non-Federal sponsor to cost share the dredging. Dredging increment #1 would require dredging about 40% of Spring Lake, which could be accommodated within the Refuge portion of the lake. Dredging increment #2 in Spring Lake would require dredging 60% of the lake, or the entire portion of the lake lying within the Refuge. This would be nearly impossible from a practical perspective. Therefore, Spring Lake increment #2 was put at the bottom of the priority listing because this increment would require a non-Federal sponsor and no non-Federal sponsor was identified who would be interested in cost sharing this feature.

Tilmont Lake was ranked second to last even though the cost/AAHU is relatively low. Water depth is not a significant limiting factor in Tilmont Lake. In addition, borrowing material from Tilmont Lake to construct the Tilmont Lake peninsula restoration will provide additional deep water habitat in Tilmont Lake, reducing the estimated benefits associated with dredging.

Big Missouri Lake was ranked second highest priority based primarily on costs. Another consideration is that Big Missouri is slightly deeper than Upper Doubles Lake and Fish Lake and does not support as much aquatic vegetation. Dredging in Big Missouri Lake is less likely to adversely effect habitat for migratory water birds (see Goal C and Objective C1 in section 5.2).

Upper Doubles Lake was ranked above Fish Lake increment #1 and Big Missouri Lake increment #3 because of costs.

Big Missouri Lake increment #3 was ranked low because of costs.

7.2.5.2 Plan Selection

The first step in plan selection was to eliminate those dredging increments not considered prudent to pursue for one reason or another. The following dredging increments were eliminated by this process.

Spring Lake Increment #2

This increment was eliminated because it would require cost sharing and no non-Federal sponsor was identified that would be interested in cost sharing for this feature.

Tilmont Lake Increment #1

Restoration of the Tilmont Lake peninsula will result in excavation in Tilmont Lake to obtain material for the structure. This would reduce the estimated benefits associated with this dredging increment. Therefore, this increment was eliminated from further consideration.

Fish Lake Increment #1 and Big Missouri Lake Increment #3

The costs/AAHU for these increments were considered on the high side when compared to the remaining increments. For this reason, they were eliminated from further consideration.

Following the process of elimination, five dredging increments remained - Spring Lake Increment #1, Big Missouri Increments #1 and #2, and Upper Doubles Lake Increments #1 and #2. The real decision for Upper Doubles Lake and Big Missouri Lake was whether or not to pursue the first dredging increment in each of these lakes. If that decision was positive, then the second increment would also be selected because the cost/AAHU is lower.

The cost/AAHU difference for the first increment of dredging for each of the three lakes was considered relatively insignificant given the sensitivity of the analysis. In addition, the costs/AAHU were within the range considered justified for the types of habitat benefits that would be provided. Placement site capacity would not be a constraint for these increments.

As noted at the beginning of the discussion concerning the evaluation of dredging, mobilization of dredging equipment to the site and placement site preparation costs were not included because they could skew the evaluation process. Table 7-20 shows the cumulative costs of the five remaining increments without and with mobilization, placement site development, planning, engineering and design, and construction management costs.

Table 7-20
Dredging Costs with Mobilization, Placement Site Development

Increment	Incremental Dredging Vol (m3)	Incremental Dredging Cost	Incremental Ave An Cost	Incre. AAHU Gain	Incre. Cost/ AAHU
Spring Lake #1	90,000	$376,700	$26,007	14.1	$1,844
Big Missouri Lake #1	40,000	$185,400	$12,800	7.3	$1,753
Big Missouri Lake #2	15,000	$ 50,900	$ 3,514	3.0	$1,171
Upper Doubles Lake #1	60,000	$263,600	$18,199	9.3	$2,167
Upper Doubles Lake #2	25,000	$ 85,700	$ 5,917	3.6	$1,793
Subtotal	230,000	$962,300	$66,437	37.3	$1,781
Mobilization		$ 82,300			
Placement Site Development		$183,000			
Planning, Engineering, and Design		$121,700			
Construction Management		$ 65,100			
Total	230,000	$1,414,400	$97,623	37.3	$2,617

Cumulatively, with mobilization and placement site development costs included, dredging of the five remaining increments would cost an estimated $2,617/AAHU. This is within the range considered justified for the type of habitat benefits that would be provided. Therefore, the selected plan for lake dredging includes the following:

Spring Lake increment #1	90,000 m3
Big Missouri Lake increment #1	40,000 m3
Big Missouri Lake increment #2	15,000 m3
Upper Doubles Lake increment #1	60,000 m3
Upper Doubles Lake increment #2	25,000 m3

7.2.6 GREMORE LAKE

Gremore Lake suffers from dissolved oxygen depletion problems during the winter. Depending upon the nature of the winter, the problems can range from minor or negligible to severe. As noted earlier in Section 6.4.2.7, flow introductions, dredging, and mechanical aeration were identified as potential solutions to the dissolved oxygen depletion problems in Gremore Lake. Because Gremore Lake is not located within the Upper Mississippi River National Wildlife and Fish Refuge, any habitat rehabilitation or enhancement measure implemented at Gremore Lake would require cost sharing by a non-Federal sponsor. The Wisconsin DNR has agreed to serve as the non-Federal sponsor for measures implemented at Gremore Lake.

7.2.6.1 Mechanical Aeration

Mechanical aeration is a proven method of maintaining dissolved oxygen levels sufficiently high in a body of water to insure fish survival. Mechanical aeration does not aerate the entire water body. The basic concept is to keep a portion of the water body ice free to allow the water to absorb oxygen from the atmosphere. The oxygenated portion of the water body is usually localized around the area of open water.

The primary advantage of mechanical aeration is that it is relatively economical in terms of initial investment, especially where there is a ready source of power such as exists at Gremore Lake. No estimate was made of the cost installing aeration equipment at Gremore Lake. However, based on available information, it was assumed that a system could be installed for less than $100,000.

The disadvantages of mechanical aeration are higher operation and maintenance costs and the public safety concerns associated with having an open water area during the winter. The latter can be a problem even with warning signs as the fish in the lake will be attracted to the aerated zone which in turn will attract ice fishermen.

Mechanical aeration was not pursued in depth as the Wisconsin DNR indicated they would not support this alternative.

7.2.6.2 Dredging

Dredging increases the volume of a body of water, increasing the capacity to store sufficient dissolved oxygen to carry the resident fish population through the winter. The major drawback of dredging is that it is expensive and requires a disposal site for the dredged material. Another difficulty is estimating the amount of dredging required to solve the problem. Because of dredging's relatively high cost, sufficient quantity must be dredged to minimize the uncertainty associated with its effectiveness. An attempt was made to estimate the volume of dredging required based on dissolved oxygen depletion rates calculated using past winter dissolved oxygen monitoring in Gremore Lake. This analysis indicated that 700,000 to 1,000,000 m3 may have to be dredged from Gremore Lake to insure that the dissolved oxygen problem would be solved. Even if this analysis erred by 100 percent on the conservative side, the dredging required would still be in the range of 350,000 to 500,000 m3.

Based on the costs estimated for dredging in the other lakes in the Ambrough Slough area, dredging 350,000 to 500,000 m3 from Gremore Lake would likely cost $1.5 to $2.0 million. Another problem would be finding an adequate placement site for the dredged material. Based on investigations into placement site capacity for the other lakes in the area, it is unlikely that a placement site could be found for this additional quantity of dredged material.

Because of the relatively high cost of dredging, the uncertainties concerning how much dredging would be necessary, and the uncertain availability of placement sites, dredging was dropped from detailed consideration as a viable option for Gremore Lake.

7.2.6.3 Flow Introduction

Oxygenated water from Ambrough Slough could be introduced into Gremore Lake to alleviate dissolved oxygen depletion problems. Calculations indicate that introducing .08 to .11 cms should be sufficient to maintain adequate dissolved oxygen levels in Gremore Lake to insure fish survivability. This is in line with the results of monitoring studies conducted for the Finger Lakes habitat project in upper pool 5 near Wabasha, Minnesota, which indicated that only very small flows are necessary in backwater lakes to maintain adequate dissolved oxygen levels.

Two routes for introducing flow to Gremore Lake were evaluated. The northern route (plates 3 and 12) would follow a low area north of Gremore Lake. Excavation of a channel through this area would require removal of approximately 8,000 m3 of material. A culvert/control structure would be installed where the channel would cross Ambro Road, north of the lake. Some dredging would be required in Gremore Lake (2,127 m3) to convey the flow into Gremore Lake. The initial design for the control structure used a culvert with a slide gate similar to a design used on other habitat projects constructed in the St. Paul District.

The west route (plates 3 and 12) would cross Wisconsin DNR property and is the location of a boat landing and parking area. Two designs were evaluated for this route, one involving passing flow to Gremore Lake via a buried culvert and the other using an open channel. For the first design, the control structure would be located on the Ambrough Slough end of the culvert. With the second design, the structure would be placed on a culvert under Ambro Road. Both designs would require excavation in Gremore Lake (1,264 m3) to convey flows into the lake.

Because of the low head differential between Ambrough Slough and Gremore Lake, the Wisconsin DNR requested that consideration also be given to constructing the channel/culverts without a control structure. This would reduce both construction and operation and maintenance costs while sacrificing operational flexibility.

Costs

Tables 7-21 through 7-23 display the planning cost estimates used for a comparative evaluation of the three design options, both with and without a control structure.

Table 7-21
Cost Estimate - Flow Introduction to Gremore Lake by North Route

	w/Control Structure	w/o Control Structure
Mob/demob	$ 24,000	$ 24,000
Clearing and Grubbing	12,000	12,000
Channel Excavation	180,000	180,000
Culvert and Control Structure	100,000	28,000
Rock	27,000	27,000
Seeding	2,000	2,000
Construction subtotal	$345,000	$273,000
Plans and Specifications	$ 83,000	$ 66,000
Construction Management	35,000	28,000
Total Cost	$463,000	$367,000
Average Annual Cost	$ 31,966	$ 25,338

Table 7-22
Cost Estimate - Flow Introduction to Gremore Lake by West Route (Buried Culvert)

	w/Control Structure	w/o Control Structure
Mob/demob	$ 24,000	$ 24,000
Clearing and Grubbing	6,000	6,000
Channel Excavation	57,000	57,000
Culvert and Control Structure	112,000	40,000
Rock	27,000	27,000
Seeding	1,000	1,000
Construction subtotal	$227,000	$155,000
Plans and Specifications	$ 54,000	$ 37,000
Construction Management	23,000	16,000
Total Cost	$304,000	$208,000
Average Annual Cost	$ 20,988	$ 14,360

Table 7-23
Cost Estimate - Flow Introduction to Gremore Lake by West Route (Open Channel)

	w/Control Structure	w/o Control Structure
Mob/demob	$ 24,000	$ 24,000
Clearing and Grubbing	6,000	6,000
Channel Excavation	71,000	71,000
Culvert and Control Structure	100,000	26,000
Rock	27,000	27,000
Seeding	1,000	1,000
Construction subtotal	$229,000	$155,000
Plans and Specifications	$ 55,000	$ 37,000
Construction Management	23,000	16,000
Total Cost	$307,000	$208,000
Average Annual Cost	$ 21,195	$ 14,360

Elimination of the control structure reduces the estimated total cost for each option by about $100,000 and the average annual cost by about $7,000. It does not change the relative costs of the three options.

Habitat Benefits

Introducing flow to Gremore Lake to alleviate dissolved oxygen depletion problems would provide an estimate 113.5 AAHU. The cost/AAHU for the three options would be:

	w/Control Structure	wo/Control Structure
north route	$282/AAHU	$223/AAHU
west route (buried culvert)	$185/AAHU	$127/AAHU
west route (open channel)	$187/AAHU	$127/AAHU

Plan Selection

All three flow introduction options should alleviate the dissolved oxygen depletion problems within Gremore Lake at costs considered justifiable. The primary decision involved selection of the best option. The north route is more costly, primarily due to the length of channel that must be excavated. In addition, due to its orientation with Ambrough Slough, it could be more prone to sediment and debris accumulations, requiring more frequent maintenance. Therefore, the decision was made to focus on the west route.

The costs of the open channel option and the buried culvert option are approximately the same. There are maintenance concerns with the buried culvert option should the culvert accumulate sediment. It would be very difficult, if not impossible to remove accumulated sediment from a 64-meter long culvert than is entirely submerged. Allowing accumulated sediment to remain in the culvert would impair its ability to pass the design flow in this low head differential situation. Because of these operation and maintenance concerns, the open channel along the west route was selected as the recommended alternative.

The option of having a control structure was considered preferable to provide the management flexibility to regulate the flows entering Gremore Lake. A low cost stop log structure was substituted for the slide gate used in the cost estimates shown above. This reduced the estimated cost of the preferred option from approximately $307,000 to approximately $267,000.

The Wisconsin DNR would be the non-Federal cost share sponsor for this feature and would be responsible for operation and maintenance.

7.3 SUMMARY

Table 7-24 summarizes the selected plan for the various features and alternatives evaluated. It should be noted that the costs presented in table 7-24 are those used in the evaluation and selection process. The actual implementation cost of the recommended features as a combined plan is presented in Section 8 and Section 13 of this report. Those costs will vary somewhat from the costs shown in table 7-24 because of added mobilization costs, disposal site preparation costs, and indexing for year of construction.

Table 7-24
Summary of Recommendations

Feature	Est. Cost	Recommendation
Closure Structures		
Modify Ambrough Slough entrance	n.a.	No action
Modify 3 unnamed slough entrances	n.a.	No action
Black Slough partial closure structure	$ 82,500	Construct
Upper Doubles Lake closure structure	24,600	Construct
Lower Doubles Lake partial closure structure	65,600	No action
Tilmont Lake peninsula restoration	447,200	Construct
Fish Lake peninsula restoration	496,000	No action
Lake Dredging		
Spring Lake	$376,700	Dredge 90,000 m3
Big Missouri Lake	236,300	Dredge 55,000 m3
Upper Doubles Lake	349,300	Dredge 85,000 m3
Fish Lake	267,500	No action
Tilmont Lake	310,000	No action
Flow Introduction		
Channel to Gremore Lake (west route)	$267,000	Construct

SELECTED PLAN WITH DETAILED DESCRIPTION/DESIGN AND CONSTRUCTION CONSIDERATIONS

This section provides details on the selected plan. The selected features are shown in table 8-1 along with estimated implementation costs (including contingencies) as a combined plan. The costs shown in table 8-1 are fully funded costs (indexed for inflation). The detailed project cost estimate is contained in attachment 2.

Table 8-1
Summary of the Selected Plan and Costs

	Construction	PED	Con. Mgmt.	Total
Mobilization*	$ 146,000	$ 0	$ 0	$ 146,000
Black Sl. partial closure structure	69,200	12,000	6,200	87,400
Upper Doubles L. closure structure	20,600	3,600	1,800	26,000
Tilmont L. peninsula restoration	375,400	65,400	32,900	473,700
Spring L. dredging	400,800	39,100	19,800	459,700
Big Missouri L. dredging	251,400	24,500	12,400	288,300
Upper Doubles L. dredging	371,700	36,300	18,400	426,400
Channel to Gremore L.*	222,800	42,400	17,100	282,300
Disposal Site Preparation	194,700	26,400	17,700	238,800
Total	$2,052,600	$249,700	$126,300	$2,428,600

* Features cost shared by the Wisconsin Dept. of Natural Resources

8.1 BLACK SLOUGH PARTIAL CLOSURE STRUCTURE

The design of the Black Slough partial closure structure is shown on plate 4. It consists of a rock closure structure with an opening to allow a certain amount of flow and to provide an adequate opening for the passage of recreational craft. The crest of the structure will be at elevation 187.15, approximately 0.45 meters above the water surface at low river discharges. The base of the opening will be 4 meters wide and 1.2 meters below the water surface at low river discharges.

The partial closure structure will be constructed of rock underlain with geotextile. An estimated 790 m3 of rock fill will be required, along with an estimated 850 m2 of geotextile. Approximately 17 m3 of stripping will be required as part of site preparation.

Construction of the project will be via marine plant. The equipment used to strip the site and place the rock will either be barge mounted or unloaded onto the shoreline depending upon water levels and the contractor's selected method of construction. Due to the small quantity involved, the contractor would be allowed to dispose of the stripped material on-site, probably by spreading the material adjacent to the construction area.

The rock will come from a quarry. The loading site will depend upon the location of the quarry. It is expected that the rock would be loaded at a commercial facility in the Prairie du Chien area. To avoid conflicts with recreational users, loading of rock at the Ambrough Slough boat landing would not be permitted.

8.2 UPPER DOUBLES LAKE CLOSURE STRUCTURE

The design of the Upper Doubles Lake closure structure is shown on plate 5. This feature will be constructed of rock underlain with geotextile. An estimated 180 m3 of rock fill will be required, along with an estimated 300 m2 of geotextile. Approximately 15 m3 of stripping will be required as part of site preparation.

Construction of the project will be via marine plant. The equipment used to strip the site and place the rock will likely be barge mounted. Due to the small quantity involved, the contractor would be allowed to dispose of the stripped material on-site, probably by spreading the material adjacent to the construction area.

The rock will come from a quarry. The loading site will depend upon the location of the quarry. It is expected that the rock would be loaded at a commercial facility in the Prairie du Chien area. To avoid conflicts with recreational users, loading of rock at the Ambrough Slough boat landing would not be permitted.

8.3 TILMONT LAKE PENINSULA RESTORATION

The design of the Tilmont Lake peninsula restoration is shown on plate 6. The material for the peninsula restoration will be side borrowed from the Tilmont Lake side of the feature. It is estimated that 27,180 m3 of material will be required. The contractor will be required to excavate the material in a somewhat continuous linear excavation. The excavation of isolated deep holes that could become anoxic will not be permitted.

The peninsula would be seeded with grass species selected for rapid growth and dense cover properties. Willows would be planted along both sides of the restored peninsula.

The small opening at the head of Tilmont Lake would be closed with a small rock closure structure (plate 7). An estimated 162 m3 of rock and 168 m2 of geotextile would be required for this structure. A small amount of stripping would be required (29 m3). Due to the small amount involved, the contractor would be allowed to spread the stripping material adjacent to the construction area.

Access dredging would be required for this structure. The contractor would be required to place this material in an upland disposal site. It is expected that the contractor would take the material to the Prairie du Chien area for eventual use as general fill or land cover. The contractor will be provided the option of using the access dredged material for part of the peninsula if the contractor can demonstrate that the dredging operation will not disturb the soil. Analysis of the soils in this area indicate that if access dredged material is handled twice (dredged and put on a barge and then taken from the barge and placed on the peninsula), it will no longer retain its basic soil structure and will be unsuitable for use in the peninsula, i.e., it will not be stable material.

8.4 SPRING LAKE, BIG MISSOURI LAKE, AND UPPER DOUBLES LAKE DREDGING

8.4.1 DREDGING

8.4.1.1 Spring Lake

Approximately 90,000 m3 of sediments would be dredged from Spring Lake. The target depth distribution to be achieved by the dredging will be 60% of the lake less than 1m, 30% of the lake 1-2 m, and 10% of the lake greater than 2m. Spring Lake has an area of 22 hectares and for all practical purposes is less than 1 m deep throughout. Under the recommended plan, 6.6 hectares of the lake will be dredged to a depth of 1.5 m and 2.2 hectares of the lake will be dredged to 2.5 m.

A specific dredging plan will be developed during the preparation of construction plans and specifications. This plan would be developed in coordination with the Wisconsin DNR and the U.S. Fish and Wildlife Service. As noted earlier in the report, all of the dredging would occur within the Refuge or western portion of the lake. Plate 13 shows the approximate area where dredging in Spring Lake would occur.

The sediments in Spring Lake have not been analyzed. However, based on visual observations and probings, and experience with other backwater areas on the Upper Mississippi, it is assumed that the materials will be almost entirely fine silts and clays. Hydraulic dredging is the only practical and economical method for dredging these types of sediments in this setting.

8.4.1.2 Big Missouri Lake

Approximately 55,000 m3 of sediments would be dredged from Big Missouri Lake. In Big Missouri Lake, the target depth distribution to be achieved by the dredging will be 40% of the lake less than 1m, 50% of the lake 1-2 m, and 10% of the lake greater than 2m. Big Missouri Lake has an area of 13 hectares, with most of the lake being less than 1 m deep. Under the recommended plan, 6.5 hectares of the lake will be dredged to a depth of 1.5 m and 1.3 hectares of the lake will be dredged to 2.5 m.

A specific dredging plan will be developed during the preparation of construction plans and specifications. This plan would be developed in coordination with the Wisconsin DNR and the U.S. Fish and Wildlife Service. Plate 14 shows the approximate area where dredging in Big Missouri Lake is expected to occur.

The sediments in Big Missouri Lake have not been analyzed. However, based on visual observations and probings, and experience with other backwater areas on the Upper Mississippi, it is assumed that the materials will be primarily fine silts and clays. Hydraulic dredging is the only practical and economical method for dredging these types of sediments in this setting.

8.4.1.3 Upper Doubles Lake

Approximately 85,000 m3 of sediments would be dredged from Upper Doubles Lake. In Upper Doubles Lake, the target depth distribution to be achieved by the dredging will be 40% of the lake less than 1m, 50% of the lake 1-2 m, and 10% of the lake greater than 2m. Upper Doubles Lake has an area of 14 hectares, with most of the lake being less than 1 m deep. Under the recommended plan, 7.0 hectares of the lake will be dredged to a depth of 1.5 m and 1.4 hectares of the lake will be dredged to 2.5 m.

A specific dredging plan will be developed during the preparation of construction plans and specifications. This plan would be developed in coordination with the Wisconsin DNR and the U.S. Fish and Wildlife Service. Plate 14 shows the approximate area where dredging in Upper Doubles Lake is expected to occur.

The sediments in Upper Doubles Lake have not been analyzed. However, based on visual observations and probings, and experience with other backwater areas on the Upper Mississippi, it is assumed that the materials will be primarily fine silts and clays. Hydraulic dredging is the only practical and economical method for dredging these types of sediments in this setting.

8.4.2 DREDGED MATERIAL PLACEMENT

The contractor would be allowed to use any combination of the alternative placement sites considered acceptable to the Government. These sites are shown on plate 11. The site limits will be designated on the construction drawings to avoid wetlands/floodway and known cultural resources. The contractor will be responsible for containing the dredged material within the site limits. Currently available sites are the Dillman, Toberman, and Hunzeker fields. If the landowner changes his mind, the contractor would also be provided the Pedretti sand and gravel pit as an optional placement site.

The contractor would be provided with the option of discharging hydraulic effluent from the Dillman field to the creek bordering the south side of the field, directly to Ambrough Slough via a pipe, or to Ambrough Slough via overland flow through the wetlands to the west of the Dillman property. If the Hunzeker and/or Toberman fields are used, the contractor would be allowed to discharge effluent back to Spring Lake. The contract specifications would include effluent limitations and/or other conditions to be met with each method of discharge.

The contractor would be allowed to propose alternative placement sites and/or placement methods, subject to Government review and approval. Compliance with all applicable Federal, State, and local laws and regulations would be required before a contractor proposed alternative placement site would be approved.

8.5 GREMORE LAKE CHANNEL

The selected plan for introducing flow to Gremore Lake is the construction of a channel from Ambrough Slough to Gremore Lake through property owned by the Wisconsin DNR (plates 3 and 12). The channel would be located just upstream of the Wisconsin DNR boat ramp and parking lot.

Plate 8 shows the design of this feature. Because of the very small head differential between Ambrough Slough and Gremore Lake, a relatively large channel is required to convey the necessary flow into Gremore Lake. The channel would have a bottom width of 2 meters and 1V:3H side slopes. The open channel would be constructed from Ambrough Slough to Ambro Road.

A 2.1-meter diameter culvert would be placed under Ambro Road with the invert set at 185.70 m. The original design flow for this feature was 0.08 to 0.11 cms. The channel/culvert are designed to pass about 0.28 cms of flow to provide a margin of safety given the uncertainties involved in estimating flow requirements necessary to alleviate dissolved oxygen depletion problems and the low head differential noted above. A stop log control structure would be installed on the upstream end of the culvert. This would basically consist of a metal framework for the stoplogs attached to the culvert.

The open channel would continue from Ambro Road out into Gremore Lake. This channel would be wider (3 meters) and deeper (invert elevation of 184.4 m) than the upstream channel to facilitate flow into the lake and account for flow impediments such as aquatic vegetation and ice cover. This also includes 0.3 meter of overdepth dredging to account for future sedimentation.

Approximately 2,288 m3 of material would be excavated from the land portion of the channel and 1,264 m3 from within Gremore Lake. This material would be taken to whatever site(s) is selected by the contractor for disposal of material from the Spring Lake, Big Missouri Lake, and/or Upper Doubles Lake dredging.

Rock riprap underlain by geotextile would be placed on the banks of Ambro Road and within the channel above and below the culvert for erosion protection.

A guardrail would be installed along Ambro Road where it crosses the channel.

ENVIRONMENTAL ASSESSMENT

An environmental assessment has been conducted for the proposed action(s) and a discussion of the project impacts follows. As specified by Section 122 of the 1970 Rivers and Harbors Act, the categories of impacts listed in the impact assessment matrix (table 9-1) were reviewed and considered in arriving at the final determinations. In accordance with Corps of Engineers regulations (33 CFR 323.4(a)(2)), a Section 404(b)(1) evaluation was prepared (see attachment 3. Section 401 water quality certification has been applied for from the Wisconsin Department of Natural Resources. It is WDNR policy not to issue water quality certification until construction plans and specifications are available for review. They have indicated that they expect to be able to issue water quality certification at that time.

9.1 RELATIONSHIP TO ENVIRONMENTAL REQUIREMENTS

The proposed actions 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 Clean Water Act of 1977, 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 and the Farmland Protection Policy Act of 1981.

9.2 NATURAL RESOURCE EFFECTS

The significant natural resources of the project area are described in section 2.0 EXISTING SETTING.

9.2.1 BLACK SLOUGH PARTIAL CLOSURE STRUCTURE

The habitat benefits of construction of a partial closure in Black Slough are discussed in section 7.2.2.3. In general, reduced flows into Black Slough would improve conditions for backwater fish species in the lower portion of the Ambrough Slough complex. A more detailed discussion of both the adverse and positive impacts of a partial closure follows.

Table 9-1. Environmental assessment matrix, Ambrough Slough Habitat Rehabilitation and Enhancement.
Section 122 of the River and Harbor and Flood Control Act of 1970 (P.L. 91-611).

PARAMETER	MAGNITUDE OF PROBABLE EFFECTS						
	BENEFICIAL EFFECT			NO APPRECIABLE EFFECT	ADVERSE EFFECT		
	SIGNIFICANT	SUBSTANTIAL	MINOR		MINOR	SUBSTANTIAL	SIGNIFICANT
A. SOCIAL EFFECTS							
1. Noise Levels					X (during const.)		
2. Aesthetic Values					X (during const.)		
3. Recreational Opportunities			X		X (during const.)		
4. Transportation				X			
5. Public Health and Safety				X			
6. Community Cohesion (Sense of Unity)				X			
7. Community Growth & Development				X			
8. Business and Home Relocations				X			
9. Existing/Potential Land Use				X			
10. Controversy				X			
B. ECONOMIC EFFECTS							
1. Property Values				X			
2. Tax Revenues				X			
3. Public Facilities and Services				X			
4. Regional Growth				X			
5. Employment				X			
6. Business Activity				X			
7. Farmland/Food Supply				X			
8. Commercial Navigation				X			
9. Flooding Effects				X			
10. Energy Needs and Resources				X			
C. NATURAL RESOURCE EFFECTS							
1. Air Quality				X			
2. Terrestrial Habitat			X				
3. Wetlands			X				
4. Aquatic Habitat		X					
5. Habitat Diversity and Interspersion		X					
6. Biological Productivity			X				
7. Surface Water Quality					X (during const.)		
8. Water Supply				X			
9. Groundwater				X			
10. Soils				X			
11. Threatened or Endangered Species				X			
D. CULTURAL RESOURCE EFFECTS							
1. Historic Architectural Values				X			
2. Pre-Historic and Historic Archeological Values				X			

9.2.1.1 Water Quality

During construction of the partial closure, some minor impacts on water quality would occur. Disturbance of bottom substrates during rock placement would increase turbidity and suspended solids concentrations in a very localized area surrounding the project site. However, turbidity and suspended solids would likely not exceed concentrations typically seen in the river environment during high flow events. Adverse impacts on water quality would be very short-term in nature.

The long-term impacts on water quality would be positive. The partial closure structure would create conditions similar to those found in natural riffles. The turbulent flow and higher velocity conditions across the rock liner would increase mixing and provide for oxygenation of waters entering Black Slough.

9.2.1.2 Aquatic Habitat

The rock liner would provide substrate suitable for colonization by aquatic invertebrates and cover for fish species. Increased bathymetric and hydraulic diversity would result in increased habitat diversity and interspersion. Main channel border species like walleye, sauger and smallmouth bass would benefit from increased depth and substrate diversity. Also, the presence of a slightly higher velocity area across the partial closure adjacent to lower velocity habitats in Black Slough should enhance the overall suitability of Black Slough as an ambush site for predator fish species.

In addition to the localized improvements in habitat diversity in Black Slough, reduced flows into the lower Ambrough Slough complex would generally benefit habitat conditions. Lower current velocities associated with reduced flows would result in improved winter conditions for centrarchids and other backwater fish species. Overall, the partial closure would have positive impacts on aquatic habitats and habitat diversity and interspersion.

9.2.1.3 Terrestrial/Wetland Habitat

Clearing of vegetation where the partial closure would be tied into either bank of Black Slough would have very minor adverse impacts on floodplain forest habitats. Approximately 113 m^2 (less than 0.03 acre) of vegetation would be stripped. Revegetation of the stripped sites would be expected, with no long-term adverse impacts on terrestrial/wetland habitat.

9.2.1.4 Fish and Wildlife

Placement of the rock liner would cover benthic substrates and associated organisms. Mussel surveys in the rock liner footprint revealed the presence of a relatively impoverished resource. Estimated densities of less than 0.1 mussels/m2 were recorded. After project completion, the rock surfaces would provide suitable substrates for colonization by benthic invertebrates. Rapid colonization of rock surfaces by benthic invertebrates would be expected.

Increased bathymetric and hydraulic diversity at the partial closure site would benefit riverine species like walleye, saugers and smallmouth bass. Additionally, reduced flows into Lower Ambrough Slough would improve overall habitat conditions for backwater fish species.

9.2.1.5 Threatened and Endangered Species

The proposed rock liner construction would not have significant impacts on threatened and endangered species. The nearest bald eagle nest site is located approximately 3.2 kilometers downstream of Black Slough at river mile 637.2. Construction activities in Black Slough would be distant and isolated from this nesting location.

A mussel survey conducted in the footprint of the proposed rock liner on August 31, 1999, found no live Higgins' eye pearly mussels. The results of this survey have been coordinated with the Wisconsin Department of Natural Resources and the U.S. Fish and Wildlife Service. It is the St. Paul District's assessment that construction of the Black Slough partial closure would not affect threatened and endangered species. The U.S. Fish and Wildlife Service, by letter dated September 28, 1999, concurs with this opinion.

A number of State listed fish and mussel species are listed from the project area, however, a review of the habitat conditions preferred by these species and the results of the August 31, 1999, mussel survey suggest a low probability these species occur in the immediate partial closure construction area. It is the St. Paul District's conclusion the proposed Black Slough partial closure construction would have no more than minor impacts on State listed threatened and endangered species and would generally benefit these species through increased habitat diversity and interspersion.

9.2.2 UPPER DOUBLES CLOSURE STRUCTURE

The habitat benefits of construction of a closure between Big Missouri and Upper Doubles Lakes are discussed in section 7.2.2.4. In general, reduced flows into Upper Doubles from Big Missouri would improve wintertime conditions for backwater fish species in Upper Doubles Lake.

9.2.2.1 Water Quality

During construction of the closure, some minor impacts on water quality would occur. Disturbance of bottom substrates during rock placement would increase turbidity and suspended solids concentrations in a very localized area surrounding the project site. However, turbidity and suspended solids would likely not exceed concentrations typically seen in the river environment during high flow events. Adverse impacts on water quality would be very short-term in nature.

9.2.2.2 Aquatic Habitat

Reduced flow into Upper Doubles Lake would generally benefit habitat conditions for backwater fish species, however, these benefits would be relatively minor in nature. Lower current velocities associated with reduced flows would result in improved winter conditions for centrarchids and other backwater fish species. Overall, the closure would have positive impacts on aquatic habitats and habitat diversity and interspersion.

9.2.2.3 Terrestrial/Wetland Habitat

Clearing of vegetation where the closure would be tied into higher ground would have very minor adverse impacts on floodplain forest habitats. Approximately 100 m^2 (less than 0.025 acre) of vegetation would be stripped. Revegetation of the stripped sites would be expected, with no long-term adverse impacts on terrestrial/wetland habitat.

9.2.2.4 Fish and Wildlife

Placement of the rock closure would cover benthic substrates and associated organisms. Mussel surveys in Big Missouri Lake revealed the presence of a relatively impoverished resource. Therefore, the impacts of rock closure construction on freshwater mussels would be minimal. After project completion, the rock surfaces would provide suitable substrates for colonization by benthic invertebrates. Rapid colonization of rock surfaces by benthic invertebrates would be expected.

Increased substrate diversity at the partial closure site would benefit riverine species like walleye, saugers and smallmouth bass. Additionally, reduced flows into Upper Doubles Lake would improve overall habitat conditions for backwater fish species.

9.2.2.5 Threatened and Endangered Species

The proposed rock closure would not have significant impacts on threatened and endangered species. The nearest bald eagle nest site is located approximately several miles downstream of Upper Doubles Lake. Construction activities would be distant and isolated from this nesting location.

A mussel survey conducted in Big Missouri Lake, near the site of the proposed closure, found no live Higgins' eye pearly mussels and generally a very impoverished mussel resource. The results of this survey have been coordinated with the Wisconsin Department of Natural Resources and the U.S. Fish and Wildlife Service. It is the St. Paul District's assessment that construction of the Upper Doubles Lake closure would not affect threatened and endangered species. The U.S. Fish and Wildlife Service, by letter dated September 28, 1999, concurs with this opinion.

A number of State listed fish and mussel species are listed from the project area, however, a review of the habitat conditions preferred by these species and the results of the August 31, 1999, mussel survey suggest a low probability these species occur in the immediate partial closure construction area. It is the St. Paul District's conclusion the proposed closure construction would have no more than minor impacts on State listed threatened and endangered species and would generally benefit these species through increased habitat diversity and interspersion.

9.2.3 TILMONT LAKE PENINSULA RESTORATION AND ROCK CLOSURE

As discussed in Section 7.2.2.6 and attachment 4, restoring the Tilmont Lake peninsula and construction of a rock closure at the head of Tilmont Lake would have positive impacts on backwater habitats by reducing flows into Tilmont Lake during critical overwintering periods when high current velocities significantly reduce habitat suitability.

9.2.3.1 Water Quality

Detailed effects of the project on water quality are described in the attached Clean Water Act Section 404(b)(1) evaluation (attachment 3). While the peninsula construction/rock closure project would have some short-term and some persistent minor adverse water quality impacts, the long-term benefits to water quality would be positive.

Construction of the Tilmont Lake peninsula would have temporary negative impacts on water quality resulting mainly from increased turbidity and suspended solids concentrations during open water excavation and side-cast placement of construction materials (sands, silts, etc). The area has no history of contamination and no long-term significant adverse impacts on water quality would be anticipated if materials excavated from Tilmont Lake are used for peninsula construction.

Vegetation would be used to rapidly stabilize the peninsula, however, some erosion from the peninsula construction site would be expected until vegetation is established. Impacts on water quality resulting from the anticipated effects of river forces on unprotected peninsula shorelines would likely be minimal but somewhat persistent until vegetative coverage of the peninsula arrests the erosion. Although turbidity and suspended solids would likely increase as a result of these processes, the increases would likely not exceed levels typically observed in the river during spring high flow events.

Peninsula construction would reduce flows into Tilmont Lake and should improve wintertime temperature conditions for backwater fish species. Additionally, reduced sedimentation in the lake would be anticipated.

Disturbance of bottom substrates during in-water placement of rock for the closure at the head of Tilmont Lake would increase turbidity and suspended solids concentrations in a very localized area surrounding the project site. However, turbidity and suspended solids would likely not exceed concentrations typically seen in the river environment during high flow events. Adverse impacts on water quality would be very short-term in nature. In combination with peninsula restoration, the channel closure would enhance wintertime temperature and flow conditions in Tilmont Lake.

9.2.3.2 Aquatic Habitat

Approximately 1.8 hectares of contiguous impounded/secondary channel aquatic habitat would be lost by the placement of peninsula fill and rock closure materials. All of this area was actually floodplain forest habitat at one time. An estimated 520 hectares of contiguous impounded/secondary channel habitat is present in the Ambrough Slough study area (see table 4-1). Peninsula/rock closure construction would convert approximately 0.3 percent of this total to terrestrial/floodplain forest habitat. In total, approximately 732 hectares of aquatic habitat is present in the Ambrough Slough study area (see table 4-1). Peninsula/closure construction would impact approximately 0.2 percent of this total.

A number of long-term substantial benefits to aquatic habitats would be anticipated as a result of peninsula construction. Protection from wind induced waves and river currents would lead to an increase in shallow zone vegetation in areas that currently are unprotected from these forces. Reduced suspended sediments and lowered turbidity levels (as discussed above) would be realized with a resulting increase in the depth and extent of the photic zone. Improved vegetative conditions would be expected within 1 to 2 years after island construction.

Borrow materials for the proposed Tilmont Lake peninsula would come from sidecast excavation of sediments in Tilmont Lake. The deeper water created by sidecast excavation would enhance the value of Tilmont Lake for overwintering backwater fish species. Additionally, the presence of deeper water adjacent to the newly created peninsula would enhance bathymetric diversity and increase habitat diversity and interspersion.

9.2.3.3 Terrestrial/Wetland Habitat

Approximately 1.8 hectares of island/floodplain forest habitat would be created. Most of this area would be rapidly vegetated by willows and pioneering wetland species within a relatively short time frame. An estimated 969 hectares of non-aquatic habitat is present in the Ambrough Slough study area (see table 4-1). Construction of the Tilmont Lake peninsula and rock closure would increase this total to 971 hectares, a relatively minor increase.

9.2.3.4 Fish and Wildlife

Placement of sand and rock would bury aquatic invertebrates, including freshwater mussels. It is anticipated these organisms would be suffocated and perish. Mussel surveys in the footprint area of the peninsula indicate an impoverished mussel resource. The fine silt substrate present in the footprint of the proposed peninsula does not provide suitable habitat for freshwater mussels. The direct impacts of peninsula construction on freshwater mussels would be negligible. Additionally, the secondary benefits to aquatic habitats would also benefit aquatic invertebrate populations.

Use of the general project area by fish species may be reduced during peninsula/rock closure construction, especially in areas of elevated turbidity and suspended solids concentrations. Generally, the filling of aquatic habitat has adverse impacts on fish species, however, the increased protection of shallow backwater habitats afforded by peninsula/rock closure construction, projected increased abundance and interspersion of aquatic vegetation and increased bathymetric diversity resulting from sidecast excavation of peninsula construction materials would have positive effects on the suitability of the area as backwater fish habitat. Additionally, the long-term benefits to water quality would provide improved conditions for most backwater fish species.

Waterfowl and aquatic shorebirds feeding and resting in the area would be temporarily disturbed and probably avoid the area during peninsula construction. However, almost immediately after completion the peninsula would provide loafing and resting areas for waterfowl and feeding/foraging areas for shorebirds. Within 3 years of peninsula completion established vegetative communities should provide adequate nesting cover for ducks/geese. However, the low nature of the peninsula may not be conducive to waterfowl nesting considering the potential for frequent overtopping.

The sand used for peninsula construction would provide suitable habitat for turtle nesting, however, as with waterfowl frequent overtopping may be prohibitive to successful turtle nesting. Colonization of the island by reptiles and small mammals would be anticipated once vegetative communities are established.

9.2.3.5 Threatened and Endangered Species

The proposed peninsula/rock closure construction would not have significant impacts on threatened and endangered species. The nearest bald eagle nest site is located approximately 1.5 miles downstream of Tilmont Lake at river mile 637.2. Peninsula construction activities would be distant and isolated from this nesting location. Improved habitat conditions in Tilmont Lake would ultimately improve the area as a feeding site for eagles.

A number of historical and recent surveys have identified the presence of the Higgins' eye pearly mussel in the general project area. However, a mussel survey conducted in the footprint of the proposed Tilmont Lake peninsula area on August 31, 1999, found no Higgins' eye pearly mussels. The results of this survey have been coordinated with the Wisconsin Department of Natural Resources and the U.S. Fish and Wildlife Service. It is the St. Paul District's assessment that construction of the Tilmont Lake peninsula and rock closure would not affect threatened and endangered species. The U.S. Fish and Wildlife Service concurs with this opinion.

A number of State listed fish and mussel species are listed from the project area, however, a review of the habitat conditions preferred by these species and the results of the August 31, 1999, mussel survey suggest a low probability these species occur in the immediate peninsula/rock closure construction area. It is the St. Paul District's conclusion the proposed Tilmont Lake peninsula/rock closure construction would have no more than minor impacts on State listed threatened and endangered species and would generally benefit these species through increased habitat diversity and interspersion.

9.2.4 SPRING LAKE, BIG MISSOURI LAKE AND UPPER DOUBLES LAKE DREDGING

9.2.4.1 Dredging

Dredging in Spring, Big Missouri and Upper Doubles Lakes would in general have long-term benefits to natural resources in the Ambrough Slough complex. Additionally, access dredging in portions of Ambrough Slough would be necessary to complete dredging in these three lakes. Increased bathymetric diversity in Ambrough Slough would result in increased access to dredged areas in these two lakes with benefits to fish and wildlife resources.

Water Quality - Detailed effects of the project on water quality are described in the attached Clean Water Act Section 404(b)(1) evaluation (attachment 3). Increased turbidity and suspended solids levels would be expected during dredging in Spring, Big Missouri and Upper Doubles Lakes. Sediment core samples collected by the Corps of Engineers in April 1998 indicated that contaminants of concern were comparable to other backwater areas of the Upper Mississippi River. No pesticides or PCBs were present in detectable concentrations.

While reduced water quality would be expected in Spring, Big Missouri and Upper Doubles Lakes during dredging operations, the long-term impacts on water quality should be positive. Creation of deeper water areas in Spring, Big Missouri and Upper Doubles Lakes should increase the persistence of adequate dissolved oxygen levels during the winter.

Aquatic Habitat - Four factors typically used in describing aquatic habitat include depth, current velocity, substrate and cover. In combination with water quality, these factors are considered the most significant in defining the physical and hydraulic features which define suitable habitat for most fish species. Dredging would directly affect depth and substrate and indirectly affect current velocity and cover. Increased depth and the exposure of sandy substrates would result in increased bathymetric and substrate diversity. Improved conditions for overwintering backwater fish species, such as bluegills and crappies would be realized because a larger area of deep water habitat with suitable temperatures, current velocities and dissolved oxygen levels would be created.

Terrestrial/Wetland Habitat - Dredging would be conducted in aquatic habitats and would have no direct adverse impacts on terrestrial/wetland habitats, however, a pipeline would need to be extended from the dredging sites through floodplain forest/wetlands to the disposal site. Some minimal clearing of vegetation would be necessary along the pipeline route. A flexible plastic pipe is typically used to convey dredged sediments between dredging and disposal areas. This pipe can be snaked through the floodplain forest with minimal clearing of overstory vegetation necessary. Very minimal impacts on terrestrial/wetland habitats are expected.

Fish and Wildlife - Extermination of benthic invertebrates located within dredge cuts in Spring, Big Missouri and Upper Doubles Lakes and in Ambrough Slough where access dredging is necessary would be an unavoidable adverse impact of dredging. However, recent surveys of Spring and Big Missouri Lakes revealed the nearly complete absence of freshwater mussels in these lakes and low densities of freshwater mussels in Ambrough Slough. The fine silt substrates present in these backwater lakes provides poor habitat for freshwater mussels.

Fish species in Spring, Big Missouri and Upper Doubles Lakes would likely avoid use of dredging areas during project completion. Some short-term adverse impacts would be expected.

The long-term positive impacts of dredging on aquatic habitat diversity and interspersion should translate into positive effects on fish species throughout the entire Ambrough Slough complex. Three of the lakes in the complex (Spring, Big Missouri and Upper Doubles Lakes) would have habitat conditions suitable for both summer and winter use by centrarchids and other lentic fish species. The provision of suitable wintertime habitat would substantially improve the overall suitability of the Ambrough Slough complex.

Threatened and Endangered Species - The proposed dredging in Spring, Big Missouri and Upper Doubles Lakes and access dredging in Ambrough Slough would not have significant impacts on threatened and endangered species. No known active bald eagle nests are located within 2 miles of any of the dredging sites.

No endangered mussel species have been collected in recent surveys in Spring and Big Missouri Lakes and in Ambrough Slough. It is the St. Paul District's assessment the proposed dredging would have no adverse impacts on threatened or endangered species. The U.S. Fish and Wildlife Service concurs with this opinion.

A number of State listed fish and mussel species are listed from the project area, however, a review of the habitat conditions preferred by these species suggest a low probability of these species occurring in the immediate dredging locations. It is the St. Paul District's conclusion dredging Spring, Big Missouri and Upper Doubles Lakes and access dredging in Ambrough Slough would have no more than minor impacts on State listed threatened and endangered species.

9.2.4.2 Dredged Material Placement

Four potential placement sites for placement of materials dredged from Spring, Big Missouri and Upper Doubles Lakes have been identified (plate 11). It is possible that use of a combination of these sites would be necessary to provide the capacity needed to contain approximately 230,000 m^3 of dredged material. Construction of dikes would be necessary to contain/dewater hydraulically dredged materials. Depending on which sites are utilized, effluent would be routed back to the UMR via a small drainage ditch between the Dillman and Pedretti Pit sites, directly to Ambrough Slough via a pipe, to Ambrough Slough via overland flow or to Spring Lake if the Hunzeker/Toberman sites are used.

The selected disposal sites would be adequately designed to provide settling of suspended materials and produce high quality effluent. The sediments in Spring, Big Missouri and Upper Doubles Lakes are relatively clean (comparable to other Mississippi River backwaters) and no introduction or resuspension of contaminants is expected. Effluent quality will be monitored and maintained within State standards. No long-term adverse impacts on water quality are anticipated.

The current use of the Dillman, Hunzecker, and Toberman disposal sites is agriculture. Both corn and soybeans have been grown on the sites in the recent past. The disturbed nature of the sites including the lack of permanent cover limits the sites' habitat suitability. Use of the sites for dredged material disposal would not impact the sites' current low value as wildlife habitat. Upon completion of dredged material placement, the sites would be restored as desired by the current landowners. For this assessment, it is assumed use of the sites would revert back to production of agricultural crops with no long-term adverse impacts on fish and wildlife habitats.

The Pedretti Pit site is a currently active sand and gravel mine pit. The pit is filled with water and may have some marginal fisheries value, and is probably used by waterfowl on occasion. If used, the pit would likely filled level with the adjacent field surfaces, eliminating any fisheries/waterfowl uses associated with its current condition. However, the impacts of filling the pit on fish and wildlife habitat would be minimal.

No known bald eagle nests or roosts are located in the immediate vicinity. A bald eagle nest is located approximately 1.7 miles north of the Hunzeker property. The fields do not provide the kind of habitat preferred by bald eagles and no impacts on this species are expected.

Use of any of the proposed sites would have no impacts on threatened and endangered species. The U.S. Fish and Wildlife Service concurs with this opinion.

9.2.5 GREMORE LAKE CHANNEL

The habitat benefits of increasing flows into Gremore Lake are discussed in section 7.2.6.3. In general, increased flows into Gremore Lake would improve conditions for backwater fish species by alleviating dissolved oxygen depletion during the winter.

9.2.5.1 Water Quality

The long-term impacts on water quality would be positive. The inlet channel would supply oxygenated water to Gremore Lake thereby alleviating problems with low wintertime dissolved oxygen concentrations.

Some short-term adverse impacts on water quality would be expected during construction of the channel. Excavation of sediments from within Gremore Lake to connect Ambrough Slough with deeper water in Gremore would result in temporary and short-term increases in suspended solids and turbidity.

9.2.5.2 Aquatic Habitat

The current physical habitat conditions in Gremore Lake are good. Construction of an inlet channel would not adversely affect these conditions. By improving wintertime dissolved oxygen concentrations, increased utilization of Gremore Lake by bluegills would be anticipated.

9.2.5.3 Terrestrial/Wetland Habitat

Excavation of an open channel would impact less than 0.03 hectares of floodplain forest/terrestrial habitat. The area where the channel is proposed is maintained as a parking area for vehicles and boat trailers. Additionally, a number of residences in the area detract from the sites usefulness as floodplain forest habitat. The impacts on terrestrial habitats of excavating a channel through this area would be minimal.

Materials removed from the channel would be disposed of on the same agricultural field used for disposal of materials dredged from Spring, Big Missouri and Upper Doubles Lakes. Placement of materials on this site would have little or no impacts on terrestrial or wetland habitat.

9.2.5.4 Fish and Wildlife

Improved wintertime dissolved oxygen conditions in Gremore Lake would overall improve habitat conditions for centrarchids in the Ambrough Slough complex.

9.2.5.5 Threatened and Endangered Species

No known bald eagle nests or roosts are located in the immediate vicinity. The maintained nature of the parking area and the presence of nearby residences does not provide the kind of habitat preferred by bald eagles and no impacts on this species are expected. The fine silt substrates present in Gremore Lake and Ambrough Slough are poorly suited for colonization by *Lampsilis higginsi*. Excavation of the proposed channel would have no impacts on threatened and endangered species. The U.S. Fish and Wildlife Service concurs with this opinion.

9.2.6 SUMMARY AND CUMULATIVE IMPACTS DISCUSSION

Overall, the proposed project would have positive impacts on secondary channel habitat and on contiguous impounded aquatic habitat. Winter conditions for centrarchids would be enhanced in five geographically different areas of Ambrough Slough.

A multitude of factors will affect the future environment of the Upper Mississippi River and in this case the Ambrough Slough complex; continued operation and maintenance of the navigation system, hydrologic and hydraulic processes in an altered environment, commercial traffic, public use, point and non-point pollution, commercial and residential development, agricultural practices and watershed management, exotic species, and a host of other factors.

Section 4.0 of this document summarizes the historic changes that have occurred in Ambrough Slough and provides an overview of projected future conditions. The cumulative impacts of the proposed Ambrough Slough/Gremore Lake HREP have been discussed in preceding sections of this document and are summarized in table 9-1. Briefly, the proposed plan would have beneficial impacts on secondary channel and contiguous impounded aquatic habitats. The proposed plan would contribute to the goals identified in section 5.0 of this document by preserving and enhancing habitat quality and diversity within the study area.

9.3 CULTURAL RESOURCE EFFECTS

Cultural resources surveys have been completed for the Ambrough Slough project area of potential effect for cultural resources,. This includes the Dillman field, the Toberman and Hunzeker fields, and the shores and shallows of four lakes to be dredged: Spring Lake, Big Missouri Lake, Upper Doubles Lake and Tilmont Lake. The survey (F. Florin and T. Madigan, 2000. *Phase I Cultural Resources Investigation of Ambrough Slough Environmental Management Program Project, Mississippi River Pool 10, Crawford County, Wisconsin.* Hemisphere Field Services Report of Investigation Number 608. Minneapolis.) identified three archaeological sites in the Dillman field. These sites are small lithic scatters, but may be eligible for the National Register. Two sites are located on the northwestern edge on the Dillman field on a small rise, and the third, situated some 100 cm below ground surface, is in the southeastern part of the field. The Hunzeker and Toberman fields, located on an alluvial fan complex, revealed no archaeological material on the surface. Deep coring of the fans show a low potential for buried surfaces within the Toberman file. However, an archaeological site underlies the 1.5 meters of historic alluvium that makes up the fan in the Hunzeker field area.

The Dillman field, where the three small lithic scatter sites were identified, is proposed for dredged material disposal. If the dredged material disposal can be contoured around the sites, the project will have not affect any historic properties (36 CFR Part 800.4(d)(1). The site revealed by the deep coring in the Hunzeker field would not be affected by the placement of further material on the surface, as long as no deep ground disturbance is proposed.

Disturbance of the Pedretti field with its known mound sites should be avoided However, deposition of dredged material in the gravel pit on the Pedretti property should have no effect on the mound sites, as long as surface disturbance is avoided.

In accordance with Section 106 of the National Historic Preservation Act, as amended and its implementing regulations 36 CFR Part 800, documentation of this determination that no historic properties will be affected by the Ambrough Slough project is being coordinated with the Wisconsin State Historic Preseservation Office.

9.4 SOCIOECONOMIC EFFECTS

9.4.1 NOISE

During project construction, there will be noise generated by construction equipment. There are no sensitive receptors (hospitals, schools, etc.) near or adjacent to the project area. The dredge operating in Spring Lake, Big Missouri Lake, and Upper Doubles Lake will be in relatively isolated locations and should not have any noise impacts on the public.

Operations at the dredged material placement site will be closer to areas frequented by the public. However, the site is located adjacent to a busy State highway so it is unlikely that the noise associated with the operation of heavy equipment at this site would have any adverse effects.

Construction of the channel to Gremore Lake would create additional noise that could bother nearby residents. However, the construction will take place adjacent to a heavily used boat landing where there already is substantial activity during the summer months. Thus, the additional short term noise increases associated with construction of the channel are not expected to have a significant effect.

9.4.2 AESTHETICS

Construction of project features will have short-term aesthetic effects. The restored peninsula at Tilmont Lake should vegetate quickly and blend into the surroundings within a few years. The rock closures will be small and unobtrusive, and will not be very visible from any distance.

Use of the agricultural field for dredged material placement will occur next to a busy State highway. There is a lot of development occurring along this highway north of Prairie du Chien, and this activity will probably be viewed with curiosity rather than as a visual intrusion.

9.4.3 RECREATION

Construction of the Gremore Lake channel is likely to be an inconvenience to users of the Wisconsin DNR boat landing on Ambrough Slough. Available parking is likely going to be reduced, especially during construction when portions of the parking lot are likely to be used by construction equipment.

In the long term, if the project is successful in improving habitat quality for the backwater fish community within the Ambrough Slough complex, fishing opportunities and success should also increase.

SUMMARY OF PLAN ACCOMPLISHMENTS

The selected plan will substantially improve habitat conditions for the backwater fish community in the Ambrough Slough complex through a combination of flow control and dredging. Habitat conditions will be improved in five backwater lakes - Spring Lake, Big Missouri Lake, Upper Doubles Lake, Tilmont Lake, and Gremore Lake - totaling approximately 220 hectares. The habitat quality in these lakes will be increased from 35 to 67 percent, depending upon the lake. The project will generate an estimated 165 average annual habitat units of quantifiable benefits.

In addition to the direct quantifiable benefits noted above, the fishery in other lakes and sloughs in the Ambrough Slough complex will benefit. Many of the other lakes and sloughs such as Fish Lake, Lower Doubles Lake, Dark Slough, and Ambrough Slough proper provide average to good summer habitat for backwater fish species. Improvement of habitat conditions in the above five lakes will provide overwintering habitat for fish using these other water bodies. Thus, in addition to directly benefiting about 220 hectares of aquatic habitat, the area of aquatic that will be secondarily benefited is likely at least as large, if not larger, than the area directly affected.

OPERATION, MAINTENANCE, AND REHABILITATION

11.1 GENERAL

Upon completion of construction, the U.S. Fish and Wildlife Service would accept responsibility for those features of the project located within the Upper Mississippi River National Wildlife and Fish Refuge in accordance with Section 107(b) of the Water Resources Development Act of 1992. These features include the following:

Black Slough partial closure structure
Upper Doubles Lake closure structure
Tilmont Lake peninsula restoration
Spring Lake dredged area
Big Missouri Lake dredged area
Upper Doubles Lake dredged area

The operation and maintenance responsibilities of the U.S. Fish and Wildlife Service are addressed in the Memorandum of Agreement for the project (attachment 7).

The Wisconsin DNR would accept responsibility for those features of the project located outside the Upper Mississippi River National Wildlife and Fish Refuge. The only feature located outside of the Refuge is the Gremore Lake channel. The operation and maintenance responsibilities of the Wisconsin DNR are addressed in the draft Project Cooperation Agreement for the project (attachment 8).

Specific operation and maintenance requirements would be defined in project operation and maintenance (O&M) manuals which would be prepared by the Corps of Engineers, and coordinated with the U.S. Fish and Wildlife Service and the Wisconsin DNR, respectively.

11.2 OPERATION

The are no specific operational requirements associated with any of the project features that would be the responsibility of the U.S. Fish and Wildlife Service. The Service would be required to conduct periodic inspections of their portions of the project and submit reports of inspection activities and maintenance performed.

The Wisconsin DNR would be responsible for operation of the Gremore Lake feature, essentially regulating flow into Gremore Lake through use of the stoplog control structure placed on the culvert under Ambro Road. No operation plan has been established for this feature. The Wisconsin DNR would adjust the amount of flow allowed into Gremore Lake based upon water quality monitoring, time of year, and river stages. It is expected that the operation for the first few years following construction will be more frequent until experience is a gained concerning the optimum amount of flow to allow into the lake.

11.3 MAINTENANCE

The U.S. Fish and Wildlife Service will perform maintenance on the Black Slough partial closure structure as necessary for it to remain functional. No maintenance will be required on the Upper Doubles Lake closure structure, the restored Tilmont Lake peninsula, or the Tilmont Lake rock closure. These features were assumed to have a 25-year project life without maintenance. At their own discretion, the U.S. Fish and Wildlife Service may perform maintenance of these features if they determine it desirable to do so.

No maintenance will be required of the dredged areas in Spring Lake, Big Missouri Lake, and Upper Doubles Lake. The proposed dredging is designed to provide habitat benefits for a 50-project life assuming normal sedimentation. Excessive sedimentation caused by a catastrophic event such as a large flood would be covered under the "Major Rehabilitation" provision contained in the Memorandum of Agreement.

The estimated average annual operation and maintenance costs for the U.S. Fish and Wildlife Service maintained portion of the project are shown in table 11-1. The average annual costs are shown in October 1999 price levels.

Table 11-1
Average Annual Operation and Maintenance Costs - U.S. Fish and Wildlife Service

Feature	O&M Cycle	Event Cost	Average Annual Cost
a. Black Slough closure rock replacement	20-yr	$39,500	$1,004
b. Inspection and reporting	1-yr	1,500	1,500
Average annual amount			$2,504

The Wisconsin DNR will perform maintenance on the Gremore Lake channel, most of which is expected to be in the form of keeping the channel free of sediment and debris. The estimated average annual operation and maintenance costs for the Wisconsin DNR maintained portion of the project are shown in table 11-2

Table 11-2
Average Annual Operation and Maintenance Costs - Wisconsin DNR

Feature	O&M Cycle	Event Cost	Average Annual Cost
a. Rock replacement	20-yr	$ 6,500	$ 165
b. Channel cleanout	10-yr	984	72
c. Structure maintenance	25-yr	38,600	644
d. Inspection and reporting	1-yr	3,000	3,000
Average annual amount			$3,881

PROJECT PERFORMANCE EVALUATION

Project performance evaluation was designed to directly measure the degree of attainment of the project objectives. Table 12-1 summarizes the overall monitoring approach used for UMRS-EMP habitat projects. Table 12-2 summarizes the specific monitoring that would be conducted for the recommended features of the Ambrough Slough project.

Monitoring of water quality parameters (dissolved oxygen, current velocity, and temperature) would occur in the lakes targeted by the proposed restoration and enhancement features - Spring Lake, Big Missouri Lake, Upper Doubles Lake, Tilmont Lake, and Gremore Lake. Additional monitoring may be conducted in one or two of the other area lakes, such as Lower Doubles Lake or Fish Lake, to serve as a control.

Flow monitoring would be conducted at the Gremore Lake culvert and the rock closure structures at Black Slough, Upper Doubles Lake, and Tilmont Lake.

Bathymetric and aquatic vegetation surveys would be conducted in those lakes that will be dredged - Spring Lake, Big Missouri Lake, and Upper Doubles Lake. Again, comparison surveys of other lakes may also be conducted.

The Wisconsin DNR will conduct fish surveys within the Ambrough Slough complex as time and funding permit.

TABLE 12-1
UMRS-EMP Monitoring and Performance Evaluation Matrix

Type of Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source	Remarks
Problem Analysis	System-wide problem definition. Evaluate planning assumptions.	NBS	NBS (EMTC)	LTRM	Lead into pre-project monitoring; define desired conditions for plan formulation.
Pre-project Monitoring	Identify and define problems at specific sites.	Sponsor	Sponsor	Sponsor	Should attempt to begin defining baseline.
Baseline Monitoring	Establish baselines for performance evaluation.	Corps	Field stations or sponsors thru Cooperative Agreements, or Corps.*	HREP	Should be over several years to reconcile perturbations.
Data Collection for Design	1. Identify project objectives. 2. Design of project. 3. Develop Performance Evaluation Plan.	Corps	Corps	HREP	After fact sheet. Data may aid in defining baseline.
Construction Monitoring	Assure permit conditions met.	Corps	Corps	HREP	
Performance Evaluation Monitoring	Determine success of projects.	Corps	Field stations or sponsors thru Cooperative Agreements, sponsor thru O&M**, or Corps.*	HREP	After construction.
Analysis of Biological Responses to Projects	1. Determine critical impact levels, cause-effect relationships, and long-term losses of significant habitat.	NBS	NBS (EMTC)	LTRM	Biological Response Study tasks beyond scope of Performance Evaluation, Problem Analysis, and Trend Analysis.
	2. Demonstrate success or response of biota.	Corps	Corps/NBS (EMTC)/Others	HREP	

*Choice depends on logistics. When done by the States under a Cooperative Agreement, the role of the EMTC will be to: (1) advise and assist in assuring QA/QC consistency, (2) review and comment on reasonableness of cost estimates, and (3) be the financial manager. If a private firm or State is funded by contract, coordination with the EMTC is required to assure QA/QC consistency.

**Some limited reporting of information for some projects (e.g., waterfowl management areas) could be furnished by on-site personnel as part of O&M.

TABLE 12-2
POST-CONSTRUCTION MONITORING

Goal	Project Objective	Enhancement Feature	Unit of Measure	Measurement Plan	Monitoring Interval	Projected Cost/Effort
Improve habitat conditions for backwater fish species	Create overwintering habitat: a. > 3mg/l DO b. < 1 cm/sec vel. c. 2-4 degrees C over 35% of area & 1-2 degrees C over 65% of area d. 0-1 meter < 20% 1-2 meters > 70 % > 2 meters > 10%	Dredging; partial closure structures; peninsula restoration; flow introduction.	diss. oxy. (mg/l) velocity (cm/sec) temp (deg. C) discharge (m3/sec)	Monitor dissolved oxygen, current velocity, water temperature, and discharge during the winter.	1, 2, 4, 10, 20, 30, 40, and 50 years post-construction.	$8,000
			depth (meters)	Bathymetric surveys	10, 30, and 50 years post-construction.	$10,000
	Create summer habitat: a. > 5 mg/l DO b. < 1 cm/sec vel. over 40% of area c. 40-60% aquatic vegetation cover d. > 1 meter over 50% of area e. Structural cover f. Within 3 km of overwintering habitat	Dredging; partial closure structures; peninsula restoration; flow introduction.	diss. oxy. (mg/l) velocity (cm/sec) temp (deg. C) discharge (m3/sec)	Monitor dissolved oxygen, current velocity, water temperature, and discharge during the summer.	1, 2, 4, 10, 20, 30, 40, and 50 years post-construction.	$8,000
			aquatic veg. (% cover)	Aquatic plant surveys	1, 5, 10, 20, 30, 40, and 50 years post-construction.	$10,000
			depth (meters)	Bathymetric surveys	10, 30, and 50 years post-construction.	(addressed by above noted surveys)

COST ESTIMATE

The total project cost (fully funded) for the selected plan is estimated to be $2,428,600 as summarized in table 13-1. This cost does not include prior allocations of $300,000 for general design (planning). A detailed cost estimate is contained in attachment 2. The Wisconsin DNR would be responsible for 35 percent of total project costs for cost-shared features (including planning). Table 13-2 summarizes the estimated non-Federal share of project costs.

Table 13-1
Summary of the Selected Plan and Costs

	Construction	PED	Con. Mgmt.	Total
Mobilization*	$ 146,000	$ 0	$ 0	$ 146,000
Black Sl. partial closure structure	69,200	12,000	6,200	87,400
Upper Doubles L. closure structure	20,600	3,600	1,800	26,000
Tilmont L. peninsula restoration	375,400	65,400	32,900	473,700
Spring L. dredging	400,800	39,100	19,800	459,700
Big Missouri L. dredging	251,400	24,500	12,400	288,300
Upper Doubles L. dredging	371,700	36,300	18,400	426,400
Channel to Gremore L.*	222,800	42,400	17,100	282,300
Disposal Site Preparation	194,700	26,400	17,700	238,800
Total	$2,052,600	$249,700	$126,300	$2,428,600

* Features cost shared by the Wisconsin Dept. of Natural Resources

Table 13-2
Estimated Non-Federal Project Costs

Feature	Total Cost	Federal Cost	Non-Federal Cost
Planning*	$ 25,000	$ 16,250	$ 8,750
Mobilization**	$ 25,100	$ 16,315	$ 8,785
Gremore Lake Channel	$222,800	$144,820	$ 77,980
Planning, Engineering, & Design	$ 42,400	$ 27,560	$ 14,840
Construction Management	$ 17,100	$ 11,115	$ 5,985
Total	$332,400	$216,060	$116,340

* planning costs for cost shared features
** mobilization of land based plant

REAL ESTATE REQUIREMENTS

This habitat rehabilitation and enhancement project is located in pool 10 of the Upper Mississippi River in Crawford County, Wisconsin. The following features will be constructed entirely on lands owned and operated by the United States of America. These lands are administered by the U.S. Fish and Wildlife Service and are managed by the Service as part of the Upper Mississippi River National Wildlife and Fish Refuge.

Black Slough closure structure
Upper Doubles Lake closure structure
Tilmont Lake peninsula restoration
Spring Lake dredging
Big Missouri Lake dredging
Upper Doubles Lake dredging

The Gremore Lake channel would be constructed on lands owned by the State of Wisconsin and administered by the Wisconsin Department of Natural Resources, the non-Federal sponsor for this feature.

Dredged material from the dredging of Spring Lake, Big Missouri Lake, and Upper Doubles Lake would be placed on private property. Five-year permits have been obtained from the landowners for the placement of dredged material at these sites.

SCHEDULE FOR DESIGN AND CONSTRUCTION

A schedule for review and approval, major work tasks, and project construction is shown below. This schedule assumes the availability of funds to prepare plans and specifications and undertake construction will not be limiting.

Requirement	Scheduled Date
Submit final Definite Project Report to Mississippi Valley Division, U.S. Army Corps of Engineers	Jan 2000
Obtain construction approval by Mississippi Valley Division, U.S. Army Corps of Engineers	Apr 2001
Complete plans and specifications	July 2001
Advertise for bids	Aug 2001
Award Contract	Sep 2001
Complete Construction	Nov 2002

IMPLEMENTATION RESPONSIBILITIES

The responsibility of plan implementation and construction fall to the Corps of Engineers as the lead Federal agency. After construction of the project, project operation and maintenance would be required for features of the project as outlined in the OPERATION, MAINTENANCE, AND REHABILITATION section of this report. The U.S. Fish and Wildlife Service would be responsible for operation and maintenance of those features located on the Upper Mississippi National Wildlife and Fish Refuge. The Wisconsin Department of Natural Resources would be responsible for operation and maintenance of the Gremore Lake channel.

Should rehabilitation of those portions of the Ambrough Slough project located on the Refuge be needed which exceeds the annual maintenance requirements (as a result of a specific storm or flood), a mutual decision between the participating agencies will be made whether or not to rehabilitate those portions of the project. If rehabilitated, the Federal share of rehabilitation would be the responsibility of the Corps of Engineers.

Performance evaluation, which includes monitoring of physical/chemical conditions and some limited biological parameters, would be a Corps of Engineers responsibility.

Attachment 7 contains a draft copy of the formal agreement that would be entered into by the Corps of Engineers and the U.S. Fish and Wildlife Service. The Memorandum of Agreement formally establishes the relationships between the Department of the Army, represented by the Corps of Engineers, and the U.S. Fish and Wildlife Service in constructing, operating, and maintaining those features of the Ambrough Slough project located within the Refuge.

Attachment 8 contains a draft Project Cooperation Agreement (PCA) that would be entered into by the Corps of Engineers and the Wisconsin Department of Natural Resources for the construction, operation, maintenance, repair, and rehabilitation of the Gremore Lake channel feature of the Ambrough Slough project.

COORDINATION, PUBLIC VIEWS, AND COMMENTS

The planning for the Ambrough Slough project has been an interagency effort involving the St. Paul District, the U.S. Fish and Wildlife Service, and the Wisconsin and Iowa Departments of Natural Resources. Interagency coordination meetings and site visits were held on a periodic basis throughout the study phase. In additions to the meetings, informal coordination took place on an as-needed basis to address specific problems, issues, and ideas.

A public meeting was held in Prairie du Chien, Wisconsin, on 7 August 1997 to inform the public of the study and solicit input concerning fish and wildlife habitat conditions and problems within the project area. This meeting was attended by 32 private citizens, local media representatives, and representatives of the Federal and State agencies participating in the study.

A Problem Appraisal Report was completed for the project in October 1997 which addressed the existing conditions and habitat problems in the project area, identified habitat goals and objectives, and identified alternatives to be studied in detail that would address the habitat goals and objectives.

The draft Definite Project Report/Environmental Assessment was sent to Congressional interests; Federal, State and local agencies; special interest groups; interested citizens; and others as listed in attachment 9.

A public meeting on the proposed project was held in Prairie du Chien on 8 May 2000. This meeting was attended by 22 private citizens.

CONCLUSIONS

The Ambrough Slough habitat rehabilitation and enhancement project provides the opportunity to restore habitat for fish and wildlife indigenous to the Upper Mississippi River. A number of measures are aimed at correcting existing habitat problems and improving habitat conditions for the backwater fish community within the Ambrough Slough complex. The proposed dredging in Spring Lake, Big Missouri Lake, and Upper Doubles Lake will substantially improve the quality of fish habitat in these lakes during both the winter and the summer.

Construction of the proposed closure structures at Black Slough, Upper Doubles Lake, and Tilmont Lake, and restoration of the peninsula at Tilmont Lake will reduce winter flows entering Tilmont Lake, Upper Doubles Lake, and other aquatic areas within the Ambrough Slough complex, substantially improving winter habitat conditions for the backwater fish community. Construction of the Tilmont Lake peninsula restoration feature will also provide a unique opportunity to evaluate the stability of earthen structures protected only by vegetation.

Introduction of flow to Gremore Lake will alleviate winter dissolved oxygen depletion problems in the lake, resulting in a significant gain in available overwintering habitat for the local backwater fish community.

The habitat benefits that would be gained by the Upper Mississippi River System from implementation of the recommended project justify expenditure of public funds for preparation of plans and specifications and for construction.

RECOMMENDATION

I have weighed the accomplishments to be obtained from the Ambrough Slough project against its cost and have considered the alternatives, impacts, and scope of the proposed project. In my judgement, the cost the project is a justified expenditure of Federal funds. Those portions of the project located on national wildlife refuge lands would be a 100-percent Federal cost according to Section 906 (e) of Public Law. The total estimated cost of those features is $2,396,200 (including sunk general design costs of $275,000).

The remainder of the project would be cost shared 65 percent Federal and 35 percent non-Federal, with the Wisconsin Department of Natural Resources serving as the non-Federal sponsor. The total estimated cost to be cost shared is $332,400 (including sunk general design costs of $25,000). The Federal share of these costs would be $216,060, while the non-Federal share would be $116,340.

The total Federal project cost (including sunk general design costs of $291,250) will be $2,612,260. I recommend that the Ambrough Slough Project for habitat restoration and enhancement in pool 10 of the Upper Mississippi River be approved for construction.

Kenneth S. Kasprisin
Colonel, Corps of Engineers
District Engineer

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.

AMBROUGH SLOUGH
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 10, UPPER MISSISSIPPI RIVER
CRAWFORD COUNTY, WISCONSIN

The St. Paul District, Corps of Engineers in coordination with Federal and State resource management agencies has developed a habitat rehabilitation and enhancement plan for the Ambrough Slough area of pool 10 of the Upper Mississippi River. The goals of the plan include; improving habitat conditions for backwater fish species at four locations in the Ambrough Slough/Gremore Lake complex, maintaining and/or enhancing habitat for riverine species of fish and mussels in the Ambrough Slough complex, maintaining and/or enhancing habitat for migratory water birds and maintaining and/or enhancing habitat for migratory and resident vertebrates. To accomplish these goals, the following actions are proposed: 1) construction of a partial closure in Black Slough to reduce inflows into the Ambrough Slough complex, 2) construction of a closure across the channel between Big Missouri and Upper Doubles Lakes to reduce flows into and through Upper Doubles Lake, 3) construction of an island peninsula near Tilmont Lake and construction of a channel closure in Tilmont Lake, 4) dredging approximately 230,000 m^3 of sediment from three backwater lakes (Spring, Big Missouri and Upper Doubles) to increase habitat diversity and improve conditions for backwater fish species (dredged materials would be placed on upland placement sites currently being cropped, access dredging through Ambrough Slough would be necessary to enter Big Missouri and Spring Lakes), and 5) construction of a channel from Ambrough Slough to Gremore Lake to introduce oxygenated flowing water into Gremore Lake.

The finding of no significant impact is based on the following factors: (1) the proposed project would have substantial positive impacts on aquatic habitats and habitat diversity and interspersion, and minor positive impacts on terrestrial habitat, wetlands and biological productivity; (2) minor adverse impacts on water quality would occur during construction, however, these impacts would be partially mitigated or short-term in nature; (3) the project would have minor adverse impacts on the social environment through increased noise, reduced aesthetic values and reduced recreational opportunities during project construction; (4) the project would have a minor long-term beneficial effect on recreation; (5) the project would have no appreciable effects on cultural resources; and (6) coordination with the appropriate State and Federal agencies would be maintained. The environmental effects of the proposed project are discussed in the environmental assessment section (Section 9.0) of the Definite Project Report/Environmental Assessment.

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

12-21-00
Date

John W. Wenker (signature) for
Kenneth S. Kasprisin
Colonel, Corps of Engineers
District Engineer

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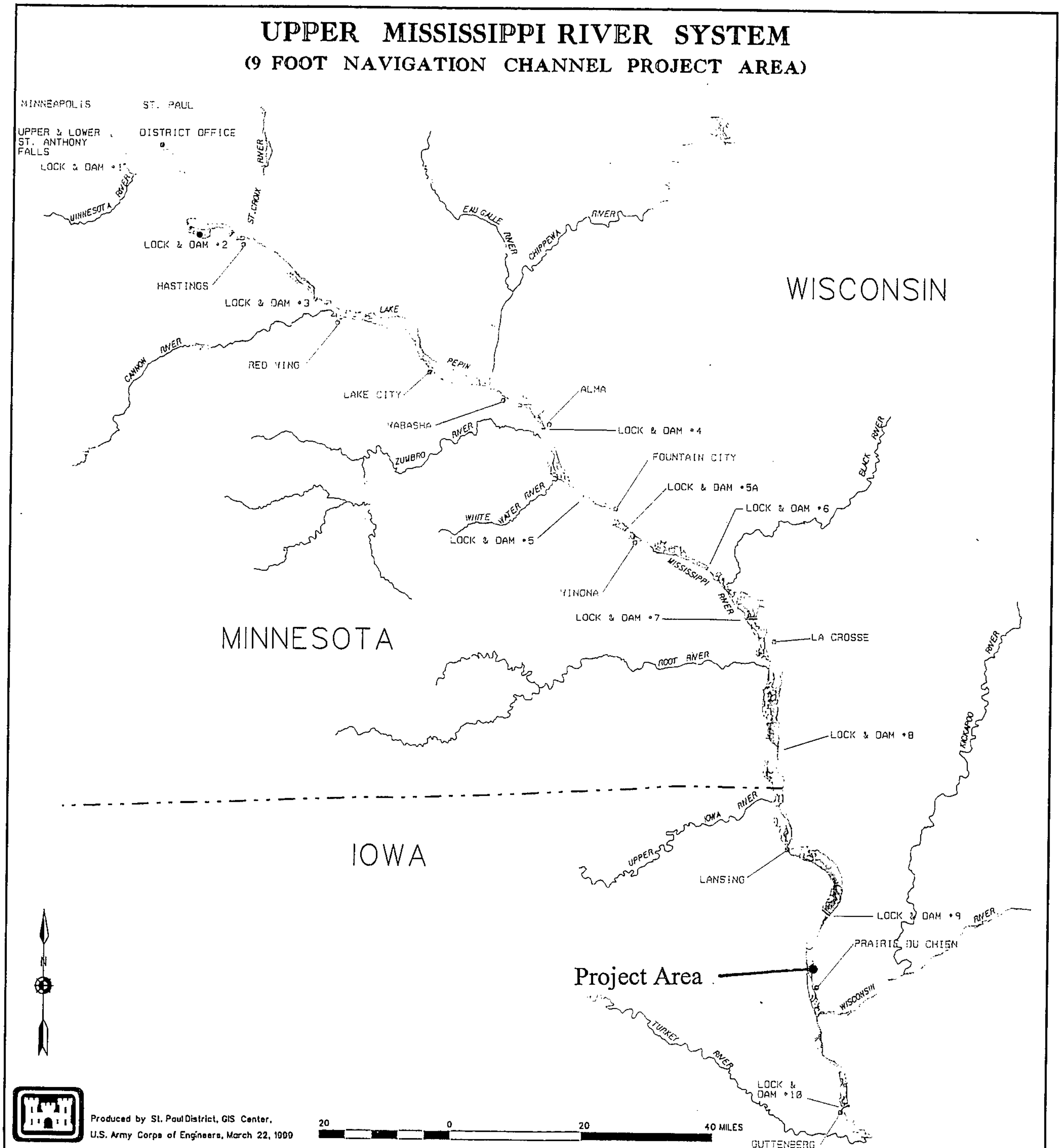
Attachment 1

Plates


UPPER MISSISSIPPI RIVER SYSTEM
(9 FOOT NAVIGATION CHANNEL PROJECT AREA)
MINNEAPOLIS
ST. PAUL
UPPER & LOWER ST. ANTHONY FALLS
DISTRICT OFFICE
LOCK & DAM #1
MINNESOTA RIVER
ST. CROIX RIVER
LOCK & DAM #2
HASTINGS
LOCK & DAM #3
LAKE PEPIN
CANNON RIVER
RED WING
LAKE CITY
EAU GALLE RIVER
CHIPPEWA RIVER
WISCONSIN
ALMA
WABASHA
LOCK & DAM #4
ZUMBRO RIVER
FOUNTAIN CITY
LOCK & DAM #5A
WHITE WATER RIVER
LOCK & DAM #5
LOCK & DAM #6
BLACK RIVER
WINONA
MISSISSIPPI RIVER
LOCK & DAM #7
LA CROSSE
MINNESOTA
ROOT RIVER
LOCK & DAM #8
KICKAPOO RIVER
IOWA
UPPER IOWA RIVER
LANSING
LOCK & DAM #9
PRAIRIE DU CHIEN
Project Area
WISCONSIN RIVER
TURKEY RIVER
LOCK & DAM #10
GUTTENBERG
N
Produced by St. Paul District, GIS Center, U.S. Army Corps of Engineers, March 22, 1000
20
0
20
40 MILES

AMBROUGH SLOUGH

RECTIFIED BASE IMAGE:
1994 AERIAL PHOTOS 1:15000
WATER SURFACE ELEVATION: 187.0

N

Produced by St. Paul District, GIS Center,
U.S. Army Corps of Engineers, February 1997.

Plate 2a

Ambrough Slough Area Looking Upsteam

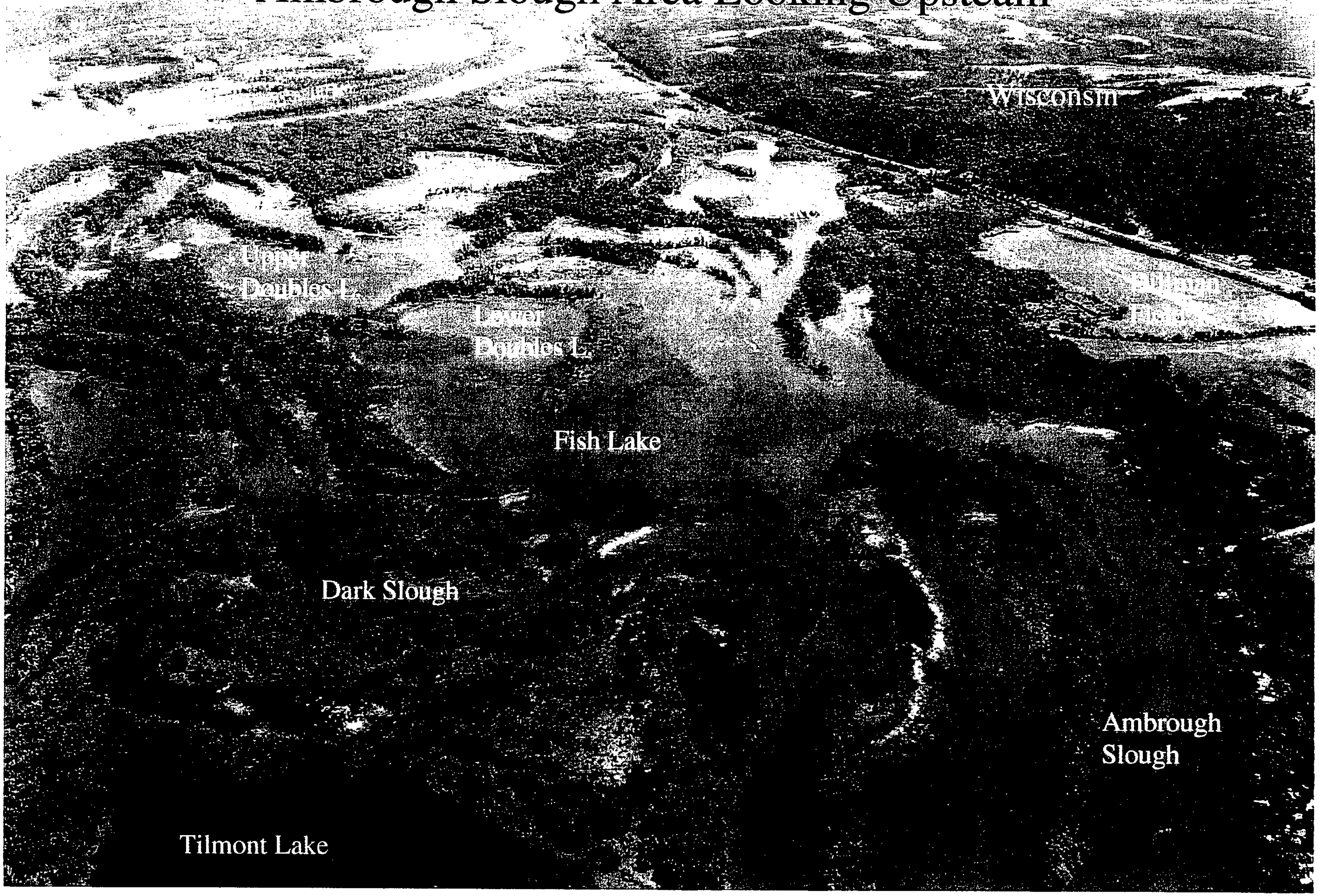


Plate 2b

Ambrough Slough Area Looking Downsteam

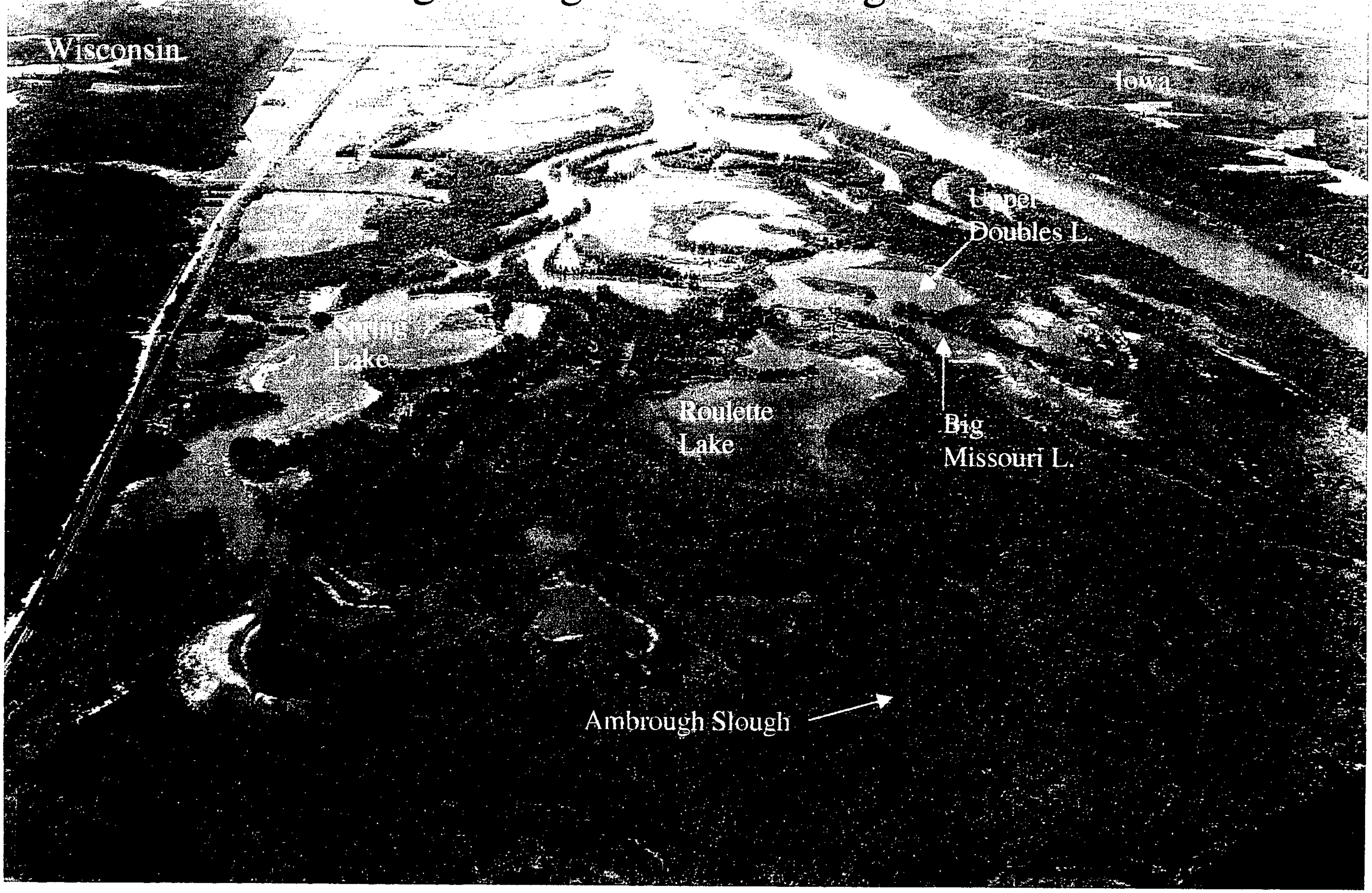


Plate 2c

N
W
E
S

AMBROUGH SLOUGH

Photobase: 1:21,120 USGS 1991-1992
Digital Ortho Quarter Quadrangle (DOQ)
Water Surface Elevation: 186.96 m

500 0 500 1000 1500 Meters

Evaluated

Evaluated & Selected

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

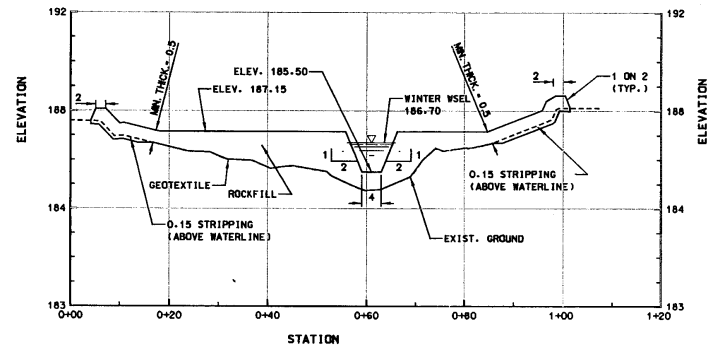
Plate 3

PLAN - BLACK SLOUGH
PARTIAL CLOSURE/CHANNEL LINER
SCALE: 1:500

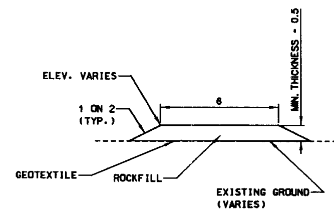
10 0 30
1:500 SCALE

NOTES:

1. UNLESS OTHERWISE NOTED, UNITS SHOWN ARE IN METERS.
2. ELEVATIONS REFER TO MEAN SEA LEVEL (N.G.V.D. 1912 ADJ.)



PROFILE - BLACK SLOUGH
PARTIAL CLOSURE/CHANNEL LINER
SCALE: NONE



TYPICAL SECTION - BLACK SLOUGH
PARTIAL CLOSURE/CHANNEL LINER
SCALE: NONE

US Army Corps of Engineers
St. Paul District

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ST. PAUL, MINNESOTA
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ST. PAUL DISTRICT

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AMBROUGH SLOUGH - DPR
SITEWORK
PLAN, PROFILE AND SECTION
BLACK SLOUGH

DRAWING NUMBER:
PLATE 4
SHT 1 OF 05

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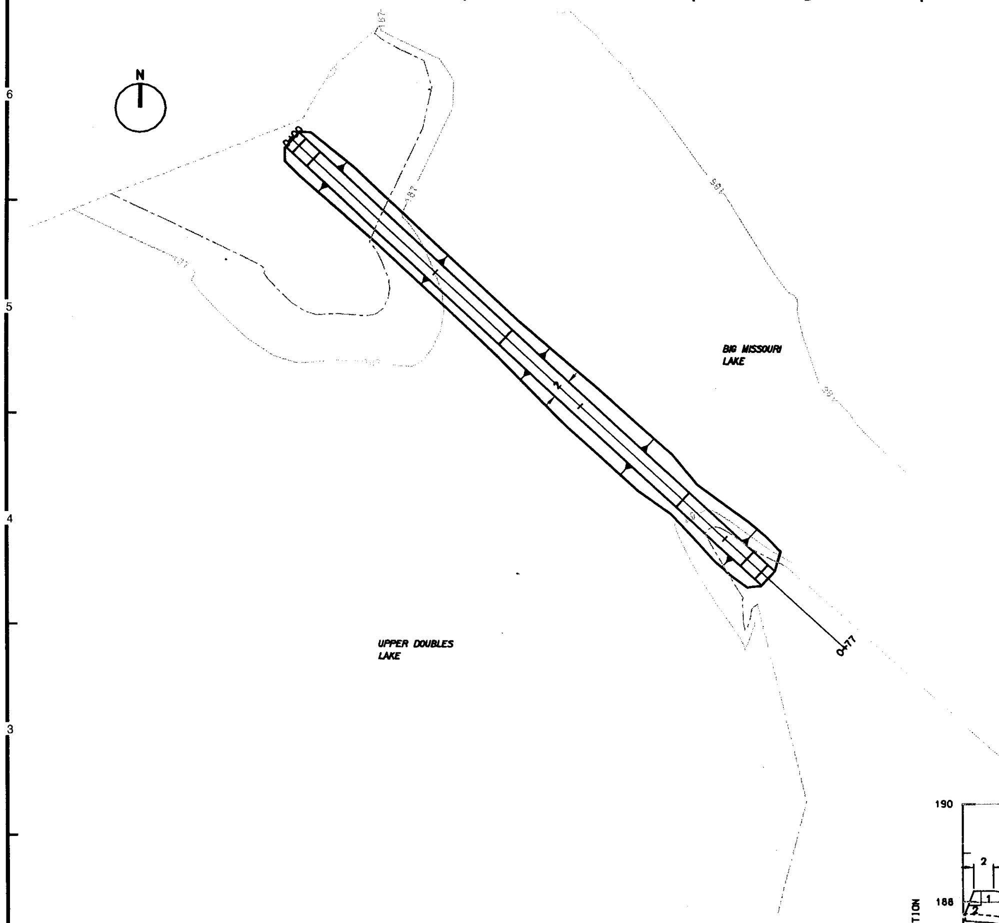

PLAN
CLOSURE - UPPER DOUBLES LAKE
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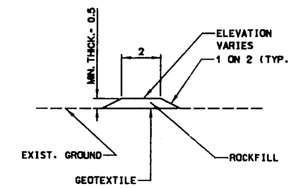

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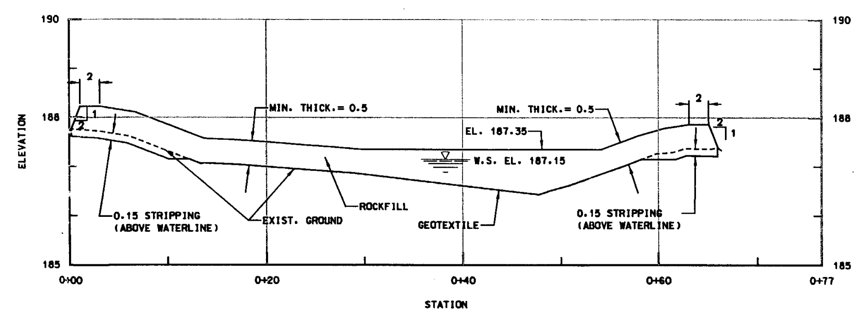

PROFILE
CLOSURE - UPPER DOUBLES LAKE
SCALE: NONE

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St. Paul District

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AMBROUGH SLOUGH - DPR
SITEWORK
PLAN, PROFILE AND SECTION
UPPER DOUBLES LAKE

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PLATE 5
SHT 2 OF 05

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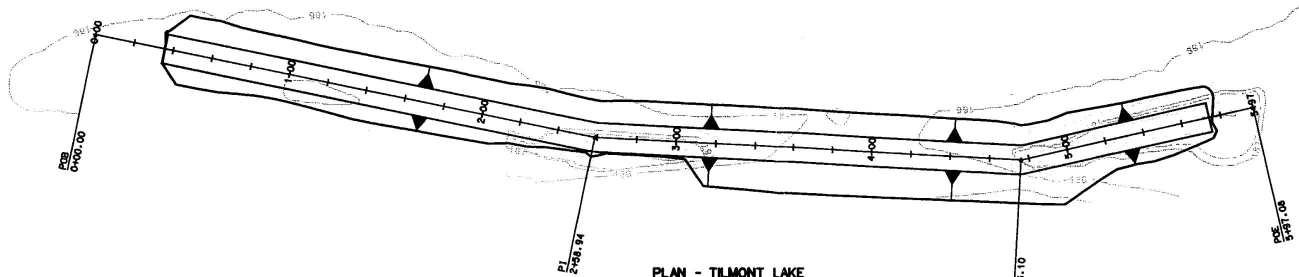
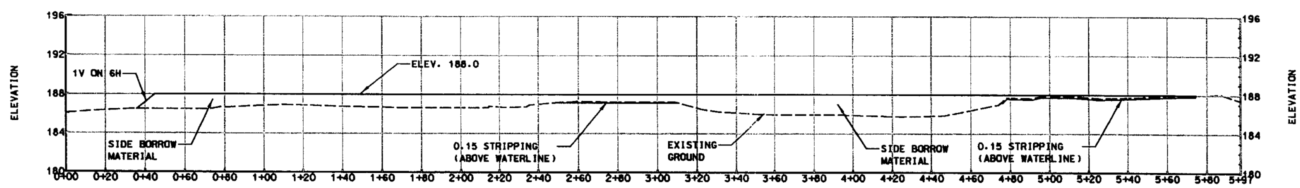


PLAN - TILMONT LAKE
LARGE CLOSURE
SCALE: 1:1250



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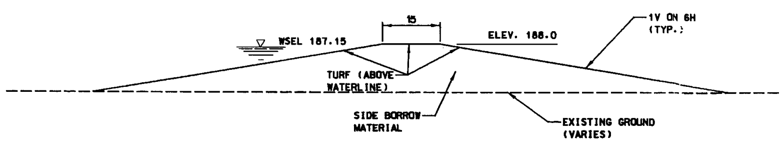
LARGE CLOSURE
SCALE: NONE



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LARGE CLOSURE
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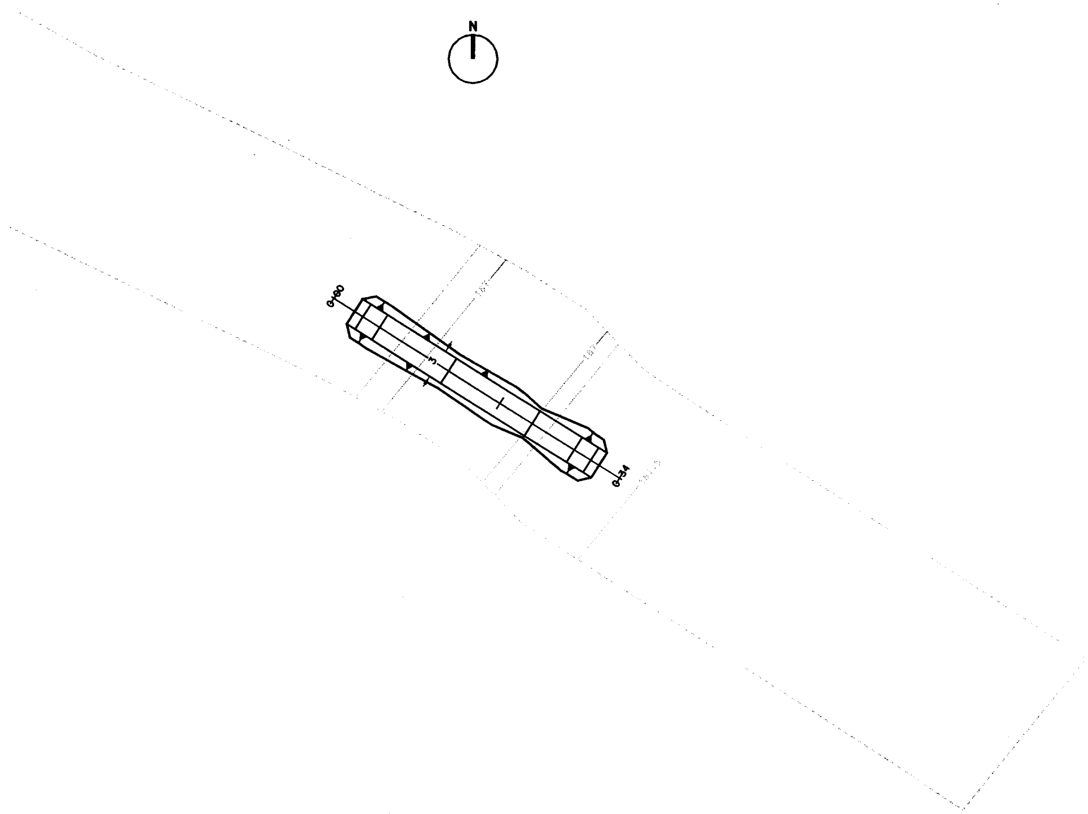
AMBROUGH SLOUGH - DPR
SITEWORK
PLAN, PROFILE AND SECTION
LARGE CLOSURE - TILMONT LAKE

DRAWING NUMBER:
PLATE 6
SHT 3 OF 05



PLAN
SMALL CLOSURE - TILMONT LAKE
SCALE: 1:250

5 0 15
1:250 SCALE

NOTES:

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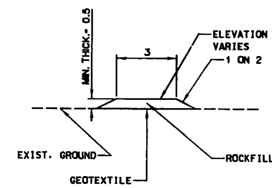

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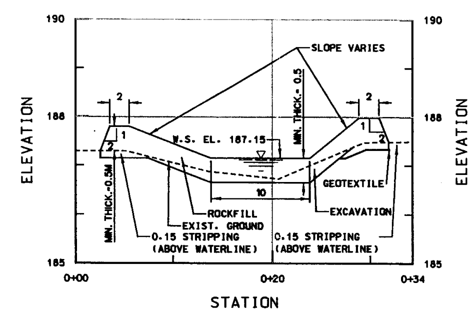

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SMALL CLOSURE - TILMONT LAKE
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St. Paul District

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AMBROUGH SLOUGH - DPR
SITEWORK
PLAN, PROFILE AND SECTION
SMALL CLOSURE - TILMONT LAKE

DRAWING NUMBER:
PLATE 7

SHT 4 OF 05

NOTES:

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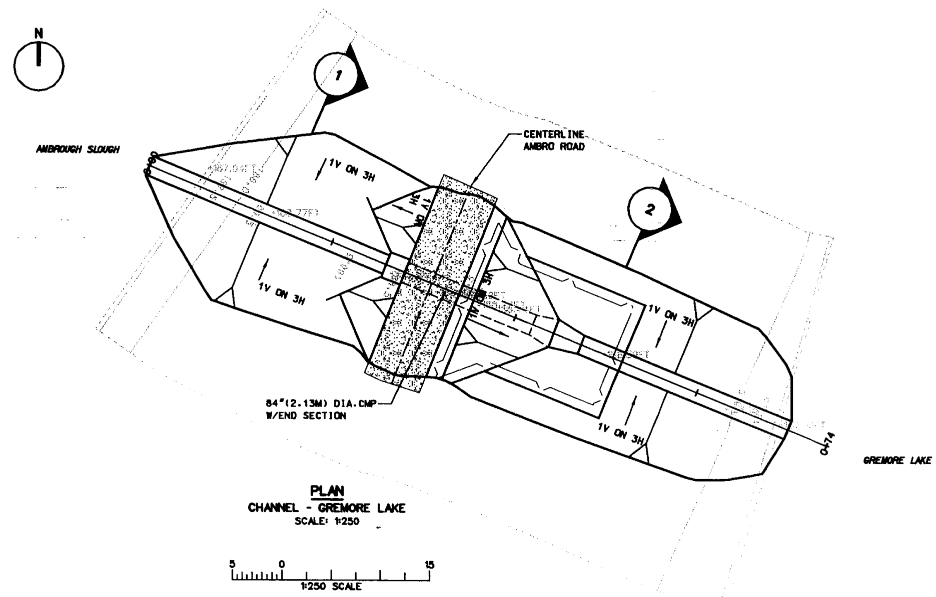
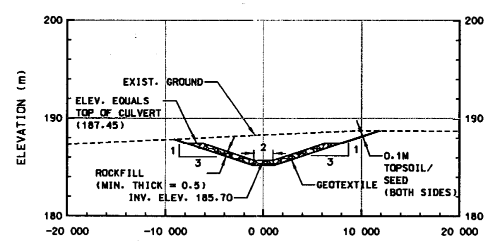


PLAN
CHANNEL - GREMORE LAKE
SCALE: 1:250



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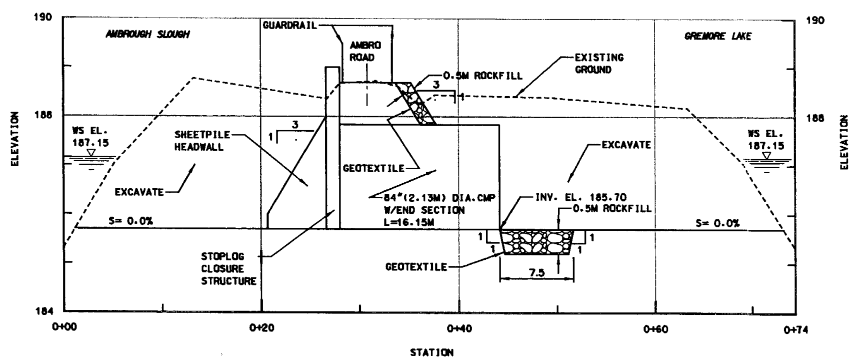

PROFILE
CHANNEL - GREMORE LAKE
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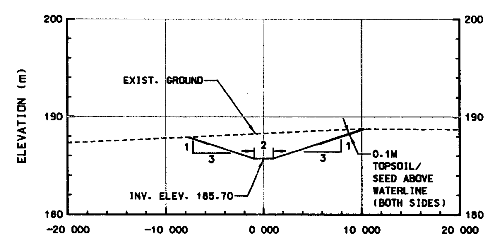

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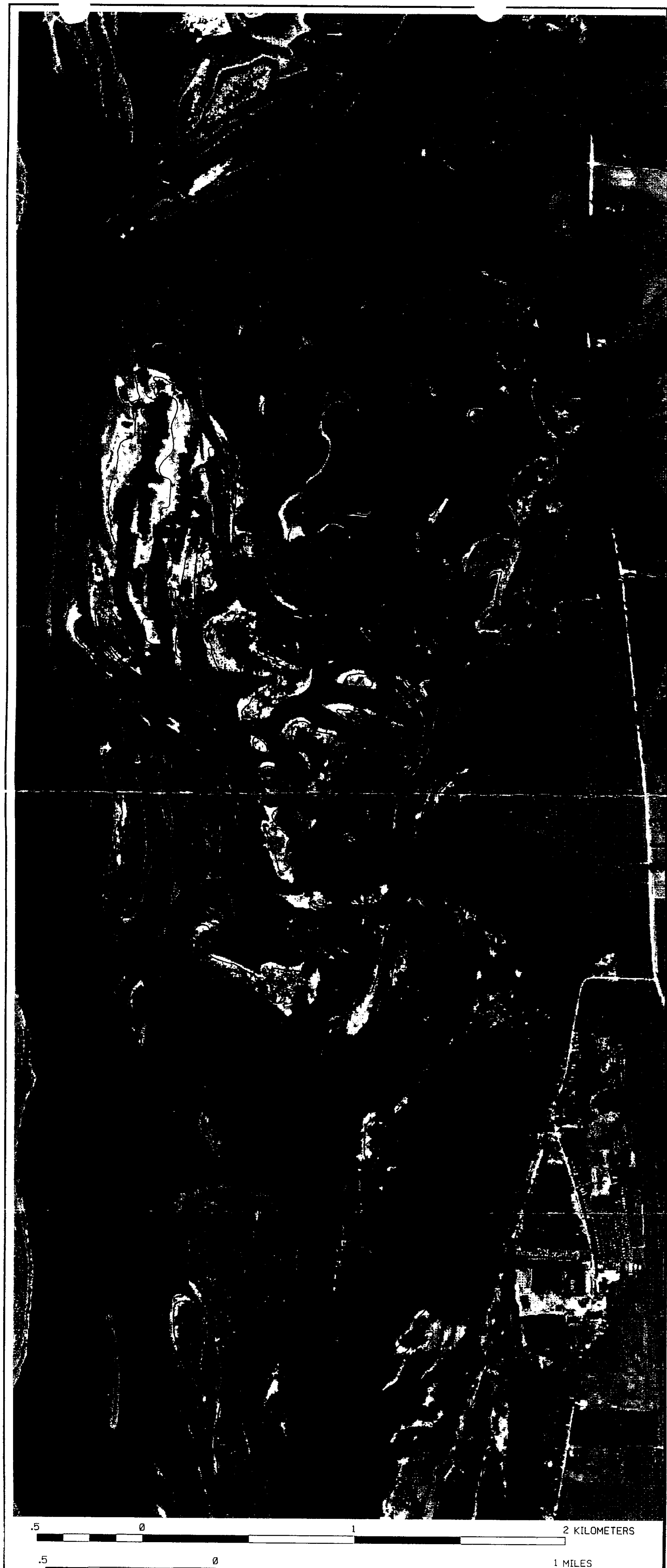
AMBROUGH SLOUGH - DPR
SITEWORK
PLAN, PROFILE AND SECTION
GREMORE LAKE CHANNEL

DRAWING NUMBER:
PLATE 8

SHT 5 OF 05

AMBROUGH SLOUGH

LAND / WATER CHANGE ANALYSIS

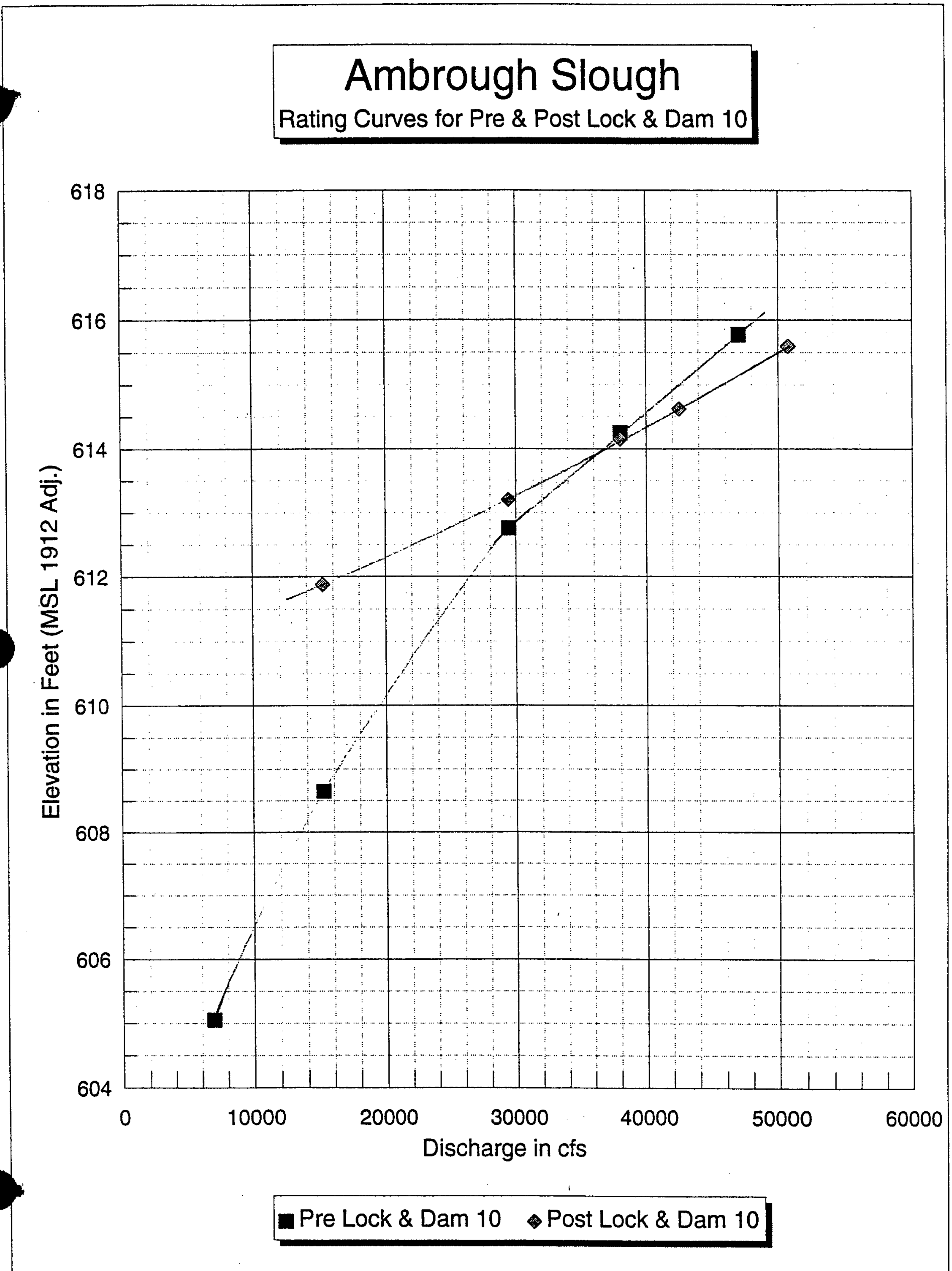


RECTIFIED BASE IMAGE:
1994 AERIAL PHOTOS 1:15000
WATER SURFACE ELEVATION: 613.4

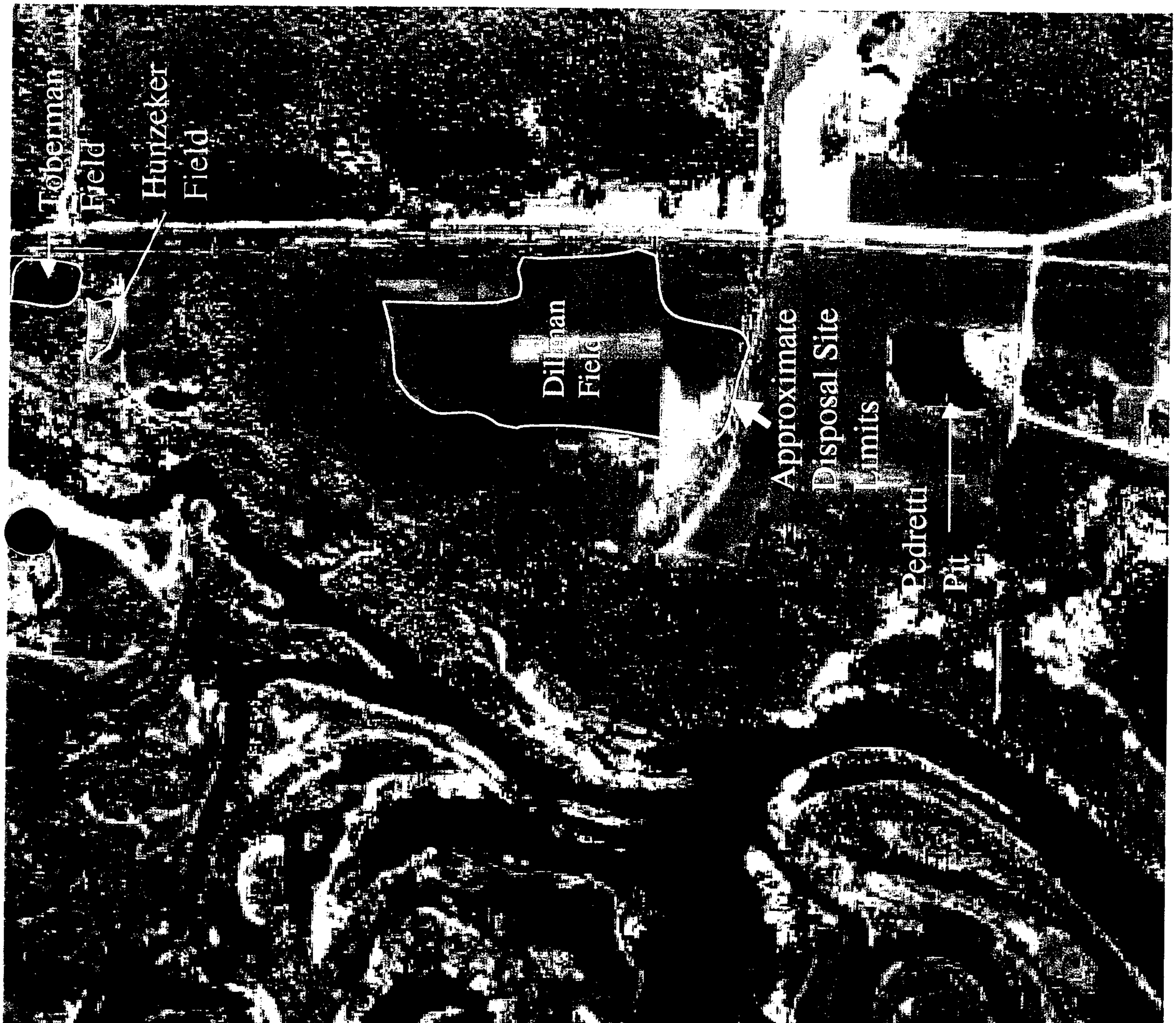
DIGITIZED LINEWORK (MAGENTA):
1940 AERIAL PHOTOS 1:22000
WATER SURFACE ELEVATION: 611.7

N

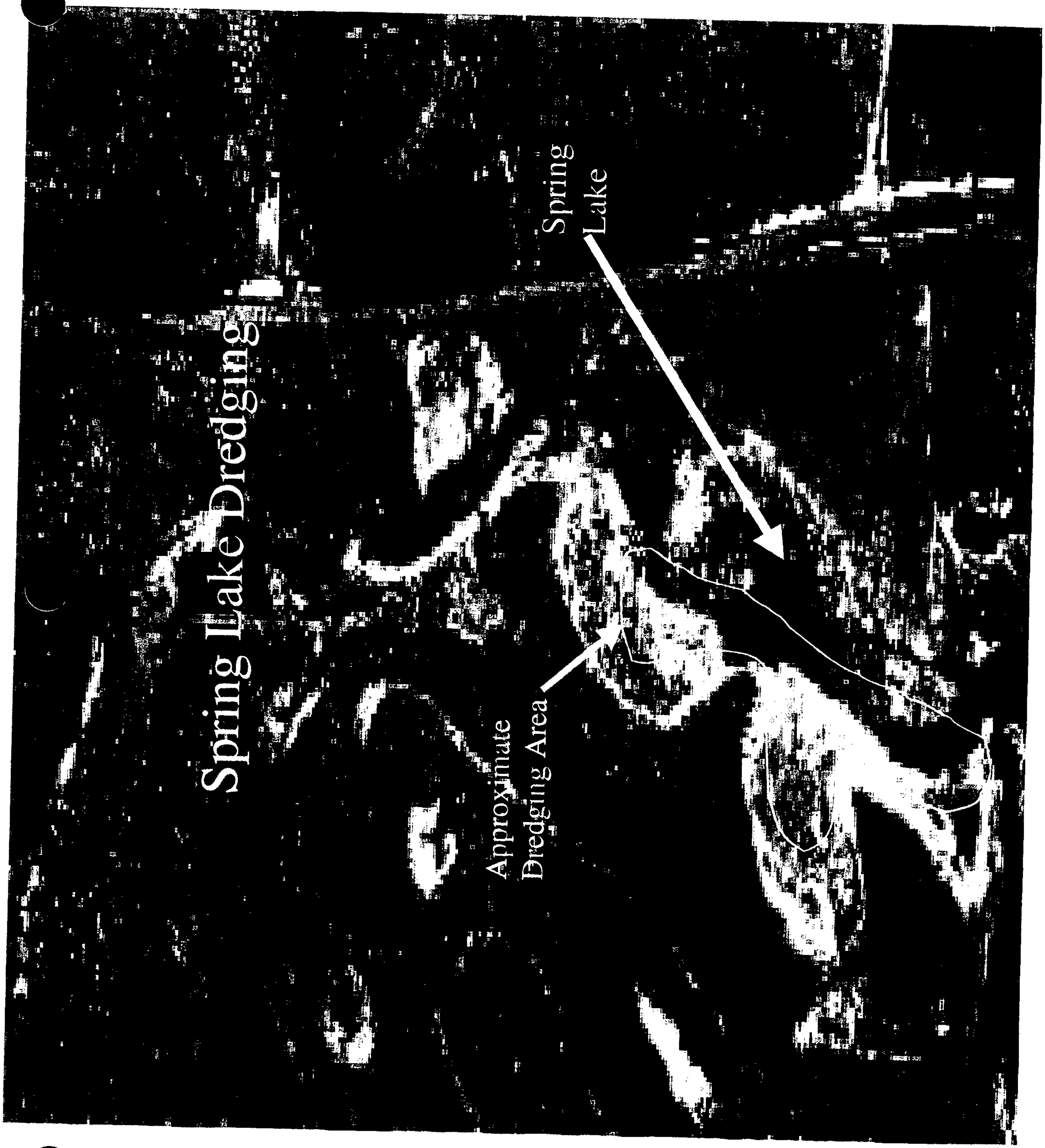
Produced by St. Paul District, GIS Center,
U.S. Army Corps of Engineers, February 1997.



Ambrough Slough
Rating Curves for Pre & Post Lock & Dam 10
Elevation in Feet (MSL 1912 Adj.)
618
616
614
612
610
608
606
604
0
10000
20000
30000
40000
50000
60000
Discharge in cfs
Pre Lock & Dam 10
Post Lock & Dam 10


Toberman Field
Hunzeker Field
Dil man
Field
Approximate Disposal Site Limits
Pedretti Pit


Gremore Lake Channel Alternatives
Iowa
West Route
Mississippi R.
Gremore
Lake
Ambrough
Slough
North Route
Wisconsin


Spring Lake Dredging
Spring Lake
Approximate Dredging Area


Big Missouri/Upper Doubles Lake Dredging
Approximate Dredging Area - Big Missouri L.
Approximate Dredging Area - Upper Doubles L.

Plate 14

Attachment 2

Cost Estimate

ATTACHMENT 2

DETAILED COST ESTIMATE

2.1 GENERAL

2.1.1. This attachment contains a summary of the detailed cost estimate prepared for the Ambrough Slough EMP project in Pool 10 of the Upper Mississippi River, near Prairie du Chien, Wisconsin. The estimate includes construction, planning, engineering and design, and construction management costs. The estimate prepared for this report was developed after review of the project plans, discussions with the design team members, and review of costs for similar construction projects. Guidance for the preparation of the estimate and attachment was obtained from ER 1110-2-1150, Engineering and Design for Civil Works Projects and ER 1110-2-1302, Civil Works Cost Engineering. The estimate was prepared using Micro-Computer Aided Cost Estimating System (MCACES) and is presented in accordance with the Civil Works Breakdown Structure as presented in the Models database for MCACES.

2.2 PRICE LEVEL

2.2.1. Project element costs are based on October 1999 prices unless noted otherwise in the project cost summary, and incorporate local wage and equipment rates. These costs are considered fair and reasonable to a prudent and capable contractor and include overhead and profit. Estimated costs on the Total Project Cost Summaries are rounded to the nearest $1,000.00.

2.3 PROJECT DESCRIPTION

2.3.1 This project consists of backwater dredging, peninsula rebuilding and construction of riprap and concrete control structures. The work is in a backwater area on the Wisconsin side of the Mississippi River, which is referred to as Ambrough Slough.

2.3.2 The purpose of this project is to improve fish and wildlife habitat in Pool 10. This will be accomplished by creating additional deep water areas by dredging, and by constructing rock fill control structures along the main channel at a location known as Black Slough, at the upper end of Tilmont Lake and at Upper Doubles Lake. Additionally, a channel and control structure will be constructed between Ambrough Slough and Gremore Lake.

2.3.3 The main report and other attachments contain more detailed descriptions of the project features and address their intended functions.

2.4 COST RELATIONSHIPS

2.4.1 Three mobilization and demobilization items were included to represent the costs associated with transporting land based equipment, as well as mechanical and hydraulic dredging plant to the project site. Land based plant will be used to construct the channel and associated control structure at Gremore Lake. Mechanical dredging plant will be used to construct the rock fill control structures at Black Slough, the north end of Tilmont Lake and Upper Doubles Lake and to rebuild the peninsula along the east side of Tilmont Lake. Mechanical dredging plant will also be used for any access dredging required. Hydraulic plant will be used for the remaining dredging portions of the project.

2.4.2 The construction costs in this estimate are based on assigning a production rate to a crew suited to accomplish the work. Material prices have been included in each feature. Costs associated with movement of equipment between individual features has been included in each feature's construction cost. Including the costs associated with movement of equipment between features in the cost for each feature, allows the individual features to be added and removed without affecting the basic mobilization and demobilization cost.

2.4.3 Hydraulic dredging costs use a split bid item type of cost breakdown. The prices shown for the initial dredging quantity include the costs associated with assembling and breaking down pipe as well as the cost for dredging. The prices shown for additional quantities include the costs for dredging only. A separate line item is shown for the disposal site. This item includes costs associated with construction of berms and a control structure.

2.5 CONTINGENCY DISCUSSION

2.5.1 After review of the project documents and discussion with the design engineers, contingencies were developed which reflect the uncertainties associated with each item. These contingencies are based on uncertainties in quantities, unit pricing and items of work not defined or recognized at the time of design. Quantity and design uncertainties are assigned by the designers, while Cost Engineering assigns unit price uncertainties. Generally, the levels of uncertainty used for the estimate are as follows:

a. For unit pricing: 5 to 15 percent

b. For quantities and unanticipated items of work: 5 to 25 percent

2.5.2 The following discussion of major project features indicates the assumptions made and the rational for contingencies. For other elements not addressed below, the assignment of contingencies is appropriate to account for the uncertainty in design and quantity calculation.

a. Feature 06, Fish and Wildlife Facilities. This project feature includes all the construction for this project.

1. The contingencies assigned to mobilization line items are primarily based on the unknown mobilization distance. A lack of bathymtric data in the areas between the river channel and the project area may also lead to some access dredging to get water born equipment into the project area.

2. The contingency assigned to the hydraulic dredging portions of the estimate is based primarily on the lack of information available on the elevation of the placement area. Dredging production is based on

approximate elevations, and will vary somewhat, based on actual lift requirements. It is expected that the contract for the dredging portions of this project will be written to specify the quantity of material to be dredged, so that the lack of available bathymettric data will not lead to higher dredging costs.

3. The contingency assigned to the rock control structures and peninsula construction are based on the limited amount of bathymetric and survey data available. Quantities and alignments of features are likely to change as new surveys and soundings are acquired. In the case of the Tilmont Lake north end closure and the Upper Doubles Lake Closure the amount of access dredging required to access the site is approximate, and is likely to change.

4. The contingencies assigned to the Gremore Lake Channel and control structure line items are based on the minimal design work that is completed, as well as a lack of survey information. What sounding information that is currently available at this site is old enough to be questionable and the earthwork quantities are based on a single profile along the anticipated alignment of the culvert and channel.

b. Feature 30, Planning, Engineering and Design.

1. Plans and Specifications. The contingency applied to this portion of the estimate was derived by applying separate contingencies to each individual feature to be designed. Lower contingencies were assigned to dredging features since the engineering effort required for this type of work is relatively consistent. A relatively high contingency was assigned to the Gremore Lake Channel and Control Structure to account for uncertainties in the design and a higher probability of increased engineering effort required. The extensive amount of design remaining raises the possibility of unanticipated work being identified during the design process.

c. Feature 31, Construction Management.

1. The contingency applied to this portion of the estimate was derived by applying separate contingencies to each individual feature to be built. Lower contingencies were assigned to dredging features since the quality assurance effort required for this type of work is relatively consistent. A relatively high contingency was assigned to the Gremore Lake Channel and Control Structure to account for uncertainties in the design and a higher probability of increased effort required. The extensive amount of design remaining raises the possibility of unanticipated work being identified during the design process.

2.6 CONSTRUCTION METHODS

2.6.1 General. Since both marine and land based equipment will be required for the project, it was generally assumed that marine equipment would be available to transport land based equipment to remote sites that would otherwise be inaccessible. Ten hour work days are assumed throughout the estimate.

2.6.2 Hydraulic Dredging. Hydraulic dredging methods were assumed to be used for all dredging except the Gremore Lake Channel and access dredging. Accommodations have been made for placement of the dredged material in an upland location, out of the floodplain.

2.6.3 Mechanical Dredging Equipment. Mechanical dredging equipment was assumed to be used for all rock placement activities and all access dredging. Additionally, mechanical equipment was assumed to be used for construction of the Tilmont Lake Peninsula Restoration since the excavated fines will be used as topsoil and the excavated sand will be used to construct the peninsula. Use of hydraulic equipment for this work could result in unworkable material and could create difficulties in meeting water quality standards.

2.6.4 Land Based Equipment. Land based equipment was assumed to be used for construction of the Gremore Lake Channel and Control Structure.

2.7 ATTACHMENTS

2.7.1 The first attachment is the Total Project Cost Summary. This shows the fully funded project cost estimate and is prepared in accordance with Project Management guidelines to include costs for construction, engineering and design, and construction management. It also includes appropriate contingencies and inflation factors to reflect fully funded project costs.

2.7.2 The second attachment is the detailed summary sheets to the Total Project Cost Summary. It shows detailed unit costs and contingencies as determined from the MCACES estimate.

AMBROUGH SLOUGH, POOL 10

****TOTAL PROJECT COST SUMMARY****

PROJECT: AMBROUGH SLOUGH
LOCATION: MISSISSIPPI RIVER, POOL 10
DATE PREPARED: NOVEMBER 1999

PREPARED BY: RICHARD H. FEMRITE, CEMVP-ED-D

REVIEWED AND APPROVED BY: MICHAEL S. DAHLQUIST, CHIEF COST/SPEC

ACCOUNT NUMBER	ITEM DESCRIPTION	ESTIMATED COSTS($) (EDP)	CONTINGENCY AMOUNT ($)	%	TOTAL EST COST (EPD)	MIDPOINT OF FEATURE	OMB (%) INFLATION (+/-)	INFLATED COST AMOUNT ($)	INFLATED CONTG. AMOUNT ($)	FULLY FUNDED COST
	CONSTRUCTION COSTS									
06.--	FISH AND WILDLIFE FACILITIES	$1,570,000	$360,000	23%	$1,930,000	AUG. 2001	6.4%	$1,670,000	$383,000	$2,053,000
	TOTAL CONSTRUCTION COSTS ====>	$1,570,000	$360,000		$1,930,000			$1,670,000	$383,000	$2,053,000
30.--	PLANNING, ENGINEERING AND DESIGN	$204,000	$37,000	18%	$241,000	OCT. 2000	3.8%	$212,000	$38,000	$250,000
31.--	CONSTRUCTION MANAGEMENT	$102,000	$18,000	18%	$120,000	AUG. 2001	4.9%	$107,000	$19,000	$126,000
	TOTAL PROJECT COSTS ====>	$1,876,000	$415,000		$2,291,000			$1,989,000	$440,000	$2,429,000

NOTES:
1. UNIT PRICES ARE AT OCTOBER 1999 PRICE LEVELS UNLESS OTHERWISE NOTED.

ACCOUNT CODE	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	%	REASON
06.--.--.--.--	FISH AND WILDLIFE FACILITIES							
06.03.--.--.--	WILDLIFE FACILITIES / SANCTUARIES							
06.03.00.--.--	MOB., DEMOB. AND PREP. WORK							
06.03.00.10.--	MOB., DEMOB. MECHANICAL PLANT	JB	1	24,060.00	24,100	7,200	30%	5,9
06.03.00.20.--	MOB., DEMOB. HYDRAULIC PLANT	JB	1	63,266.00	63,300	19,000	30%	5,9
06.03.00.30.--	MOB., DEMOB. LAND BASED PLANT	JB	1	18,900.00	18,900	4,700	25%	9
	SUBTOTAL: MOB., DEMOB. AND PREP. WORK				$106,300			
06.03.73.--.--	HABITAT AND FEEDING FACILITIES							
06.03.73.02.--	SITE WORK							
06.03.73.02.10	BLACK SLOUGH CLOSURE							
	MOBILIZATION & PREP WORK	JB	1	2,555.00	2,600	500	20%	10
	GEOTEXTILE	M2	850	3.61	3,100	900	30%	1,2,3,10
	ROCK FILL	M3	790	54.30	42,900	15,000	35%	1,2,3,10
	SUBTOTAL: BLACK SLOUGH CLOSURE				$48,600			
06.03.73.02.20	TILMONT LAKE PENINSULA RESTORATION							
	MOBILIZATION	JB	1	2,445.00	2,400	500	20%	10
	FILL - SIDECAST	M3	28,650	6.13	175,600	61,500	35%	1,2,3,4,8,10
	TOPSOIL	M3	1,275	8.39	10,700	3,200	30%	1,2,3,10
	SEED	HA	1.96	3,073.00	6,000	2,400	40%	1,2,3,10
	STRIPPING	HA	350.00	3.14	1,100	300	30%	1,2,3,10
	SUBTOTAL: TILMONT LAKE PENINSULA RESTORATION				$195,800			
06.03.73.02.30	TILMONT LAKE NORTH END CLOSURE							
	ACCESS DREDGING	M3	8,700	6.44	56,000	19,600	35%	1,5,10
	GEOTEXTILE	M2	168	4.92	800	100	15%	3,10
	ROCK FILL	M3	162	59.73	9,700	2,900	30%	3,10
	SUBTOTAL: TILMONT LAKE NORTH END CLOSURE				$66,500			
06.03.73.02.40	UPPER DOUBLES LAKE CLOSURE							
	MOBILIZATION & PREP WORK	JB	1	2,555.00	2,600	700	25%	5,10
	GEOTEXTILE	M2	300	3.61	1,100	400	35%	1,2,3,10
	ROCK FILL	M3	180	59.73	10,800	3,800	35%	1,2,3,10
	SUBTOTAL: UPPER DOUBLES LAKE CLOSURE				$14,500			
06.03.73.02.50	SPRING LAKE DREDGING							
	FIRST 90,000 M3	M3	90,000	3.64	327,600	49,100	15%	3,7
	SUBTOTAL: SPRING LAKE DREDGING				$327,600			
06.03.73.02.60	UPPER DOUBLES LAKE DREDGING							
	FIRST 60,000 M3	M3	60,000	3.82	229,200	34,400	15%	3,7
	OVER 60,000 M3	M3	25,000	2.98	74,500	11,200	15%	3,7
	SUBTOTAL: UPPER DOUBLES LAKE DREDGING				$303,700			
06.03.73.02.70	BIG MISSOURI LAKE DREDGING							
	FIRST 40,000 M3	M3	40,000	4.03	161,200	24,200	15%	3,7
	OVER 40,000 M3	M3	15,000	2.95	44,300	6,600	15%	3,7
	SUBTOTAL: BIG MISSOURI LAKE DREDGING				$205,500			

ACCOUNT CODE	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	%	REASON
06.03.73.02.80	DISPOSAL SITE PREPARATION							
	CONSTRUCT DIKE	M3	34,000	3.78	128,500	38,600	30%	2,3,8
	DISCHARGE STRUCTURE	EA	1	12,720.00	12,700	3,200	25%	4,10
	SUBTOTAL: DISPOSAL SITE PREPARATION				$141,200			
06.03.73.02.90	GREMORE LAKE CHANNEL							
	CLEARING AND GRUBBING	HA	0.5	9,678.00	4,800	1,200	25%	3,4,6,10
	CHANNEL DREDGING	M3	1264	33.47	42,300	14,800	35%	1,2,3,4,10
	CHANNEL EXCAVATION	M3	1300	8.26	10,700	2,700	25%	3,4,6,10
	CORRUGATED METAL CULVERT	M	16.2	1,301.60	21,100	6,300	30%	3,4,6,10
	CMP CONTROL STRUCTURE	EA	1	17,483.35	17,500	5,300	30%	4,10
	STEEL SHEETPILE HEADWALL	M2	96	299.34	28,700	8,600	30%	3,4,10
	ALUMINUM STOPLOGS AND HOOKS	JB	1	4,609.22	4,600	700	15%	4,10
	REPLACE PAVEMENT	M2	75	48.19	3,600	1,300	35%	3,4,10
	GUARD RAIL AND IMPACT BARRIERS	M	56	92.79	5,200	1,600	30%	3,4,10
	GEOTEXTILE	M2	255	3.65	900	200	20%	3,4,6,10
	ROCK FILL	M3	130	59.74	7,800	2,300	30%	3,4,6,10
	SEEDING	HA	0.4	11,202.81	4,500	1,400	30%	3,4,6,10
	DEWATERING	JB	1	8,111.00	8,100	3,200	40%	3,4,10
	SUBTOTAL: GREMORE LAKE CHANNEL				$159,800			
	SUBTOTAL: CONSTRUCTION COSTS				$1,570,000			
	SUBTOTAL: CONTINGENCIES					$360,000	23%	
	TOTAL 06. FISH AND WILDLIFE FACILITIES					**$1,930,000**		

REASONS FOR CONTINGENCIES:

1. LIMITED BATHYMETERY AVAILABLE
2. NO SURVEYS AVAILABLE - GROUND SURFACES ARE APPROXIMATE
3. ALIGNMENT NOT FINAL - WILL BE BASED ON FUTURE SURVEYS / SOUNDINGS
4. LIMITED DESIGN WORK COMPLETED
5. REQUIREMENTS FOR ACCESS DREDGING UNKNOWN
6. QUANTITIES BASED ON SINGLE PROFILE ALONG APPROXIMATE PIPE ALIGNMENT
7. DREDGING CONTRACT WILL SPECIFY CUBIC YARDS - NOT SPECIFIC ELEVATION AND AREA
8. NO BORINGS AVAILABLE
9. UNKNOWN MOBILIZATION DISTANCE
10. UNKNOWN UNIT PRICES

ACCOUNT CODE	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	%	REASON
30.--.--.--.--	PLANNING, ENGINEERING AND DESIGN							
30.10.--.--.--	BLACK SLOUGH CLOSURE	JB	1	9,704.00	9,700	1900	20%	1,2
30.20.--.--.--	TILMONT LAKE PENINSULA & CLOSURE	JB	1	52,484.00	52,500	10500	20%	1,2
30.30.--.--.--	UPPER DOUBLES LAKE CLOSURE	JB	1	2,877.00	2,900	600	20%	1,2
30.40.--.--.--	SPRING LAKE DREDGING	JB	1	32,760.00	32,800	4900	15%	1
30.50.--.--.--	UPPER DOUBLES LAKE DREDGING	JB	1	30,370.00	30,400	4600	15%	1
30.60.--.--.--	BIG MISSOURI LAKE DREDGING	JB	1	20,545.00	20,500	3100	15%	1
30.70.--.--.--	DISPOSAL SITE PREPARATION	JB	1	21,195.00	21,200	4200	20%	1,2
30.80.--.--.--	GREMORE LAKE CHANNEL	JB	1	33,966.00	34,000	6800	20%	1,2
	TOTAL PLANNING, ENGINEERING AND DESIGN COSTS				$204,000			
	SUBTOTAL CONTINGENCIES					$37,000	18%	
	TOTAL 30. PLANNING, ENGINEERING AND DESIGN					**$241,000**		
31.--.--.--.--	CONSTRUCTION MANAGEMENT							
31.10.--.--.--	BLACK SLOUGH CLOSURE	JB	1	4,852.00	4,900	1000	20%	1,2
31.20.--.--.--	TILMONT LAKE PENINSULA & CLOSURE	JB	1	26,242.00	26,200	5200	20%	1,2
31.30.--.--.--	UPPER DOUBLES LAKE CLOSURE	JB	1	1,439.00	1,400	300	20%	1,2
31.40.--.--.--	SPRING LAKE DREDGING	JB	1	16,380.00	16,400	2500	15%	1
31.50.--.--.--	UPPER DOUBLES LAKE DREDGING	JB	1	15,185.00	15,200	2300	15%	1
31.60.--.--.--	BIG MISSOURI LAKE DREDGING	JB	1	10,273.00	10,300	1500	15%	1
31.70.--.--.--	DISPOSAL SITE PREPARATION	JB	1	14,130.00	14,100	2800	20%	1,2
31.80.--.--.--	GREMORE LAKE CHANNEL	JB	1	13,586.00	13,600	2700	20%	1,2
	TOTAL CONSTRUCTION MANAGEMENT COSTS				$102,000			
	SUBTOTAL CONTINGENCIES					$18,000	18%	
	TOTAL 31. CONSTRUCTION MANAGEMENT					**$120,000**		

REASONS FOR CONTINGENCIES:

1. ACTUAL MANHOURS REQUIRED NOT KNOWN
2. DESIGN UNKNOWNS PRESENT INCREASED RISK OF ADDITIONAL EFFORT REQUIRED

NOTES:

A. ACCOUNT CODES 30 & 31 ESTIMATED AS A PERCENTAGE OF CONSTRUCTION COST

Attachment 3

Section 404 (b) (1) Evaluation

Section 404(b)(1) Evaluation

AMBROUGH SLOUGH HABITAT REHABILITATION AND ENHANCEMENT PROJECT POOL 10, UPPER MISSISSIPPI RIVER

I. PROJECT DESCRIPTION

A. Location

The project features described below are located in pool 10 of the Upper Mississippi River between river miles 638.0 and 641.0 (approximate). The project area includes lands and waters within the Upper Mississippi River Wildlife and Fish Refuge and is located in Crawford County, Wisconsin. The nearest community is Prairie du Chien, Wisconsin, which lies south of the project area (see plates 1 through 3).

B. General Description

The St. Paul District, Corps of Engineers in coordination with Federal and State resource management agencies has developed a habitat rehabilitation and enhancement plan for the Ambrough Slough area. The goals of the plan include improving habitat conditions for backwater fish species, maintaining and/or enhancing habitat for riverine species of fish and mussels, maintaining and/or enhancing habitat for migratory water birds and maintaining and/or enhancing habitat for migratory and resident vertebrates. To accomplish these goals, several actions which are described below are proposed. This evaluation addresses the impacts resulting from the placement of fill material (riprap and sand) in waters of the United States in compliance with Section 404 of the Clean Water Act. The fill activities addressed in this evaluation include:

CONSTRUCTION OF A PARTIAL CLOSURE IN BLACK SLOUGH - A partial closure structure as shown on plate 4 would be constructed in Black Slough. The partial closure would be constructed of rock underlain with geotextile. An estimated 790 m^3 of rock fill would be required, along with an estimated 850 m^2 of geotextile fabric. Approximately 17 m^3 of vegetation stripping would be required as part of site preparation.

Construction of the partial closure would be via marine plant. The equipment used to strip the site and place the rock would either be barge mounted or unloaded onto the shoreline depending upon water levels and the contractor's selected method of construction. Due to the small quantity, the contractor would be allowed to dispose of the stripped material on-site, probably by spreading the material adjacent to the construction area.

Rock for the partial closure would come from a local quarry. The loading site would depend upon the location of the quarry. It is expected that the rock would be loaded at a commercial facility in the Prairie du Chien area.

CONSTRUCTION OF A CLOSURE BETWEEN BIG MISSOURI AND UPPER DOUBLES LAKES - A closure as shown on plate 6 would be constructed across the channel between Big Missouri and Upper Doubles Lakes. The closure would be constructed of rock underlain with geotextile. An estimated 180 m^3 of rock fill would be required, along with an estimated 300 m^2 of geotextile fabric. Approximately 15 m^3 of vegetation stripping would be required as part of site preparation.

Construction of the closure would be via marine plant. The equipment used to strip the site and place the rock would either be barge mounted or unloaded onto the shoreline depending upon water levels and the contractor's selected method of construction. Due to the small quantity, the contractor would be allowed to dispose of the stripped material on-site, probably by spreading the material adjacent to the construction area.

Rock for the closure would come from a local quarry. The loading site would depend upon the location of the quarry. It is expected that the rock would be loaded at a commercial facility in the Prairie du Chien area.

RESTORATION OF THE TILMONT LAKE PENINSULA - A peninsula of land which has gradually eroded away between Tilmont Lake and Ambrough Slough would be restored as shown on plate 7. Material for the peninsula restoration would be excavated from the bed of Tilmont Lake and side-cast to build an emergent peninsula. An estimated 27,180 m^3 of material would be required. The contractor would be required to excavate the material in a somewhat continuous linear excavation. The excavation of isolated deep holes that could become anoxic would not be permitted.

The peninsula would be seeded with grass species selected for rapid growth and dense cover properties. Willows would be planted along both sides of the restored peninsula.

The small opening at the head of Tilmont Lake would be closed with a small rock closure structure (see plate 5). An estimated 162 m^3 of rock and 168 m^2 of geotextile would be required for this structure. A small amount of stripping would be required (29 m^3). The contractor would be allowed to spread vegetation removed during stripping adjacent to the construction area.

An estimated 8,700 m^3 of access dredging would be required to access the peninsula construction site. If the material is of suitable quality, the contractor would be allowed to incorporate this material into the Tilmont Lake peninsula. If not, the material would be placed in the disposal sites described below.

DREDGING SPRING, BIG MISSOURI AND UPPER DOUBLES LAKES - Approximately 90,000 m^3, 55,000 m^3 and 85,000 m^3 of sediments would be dredged from Spring, Big Missouri and Upper Doubles Lakes, respectively. Spring Lake has an area of 22 hectares and for all practical purposes is less than 1 m deep throughout. Approximately 6.6 hectares of the lake would be dredged to a depth of 1.5 m and 2.2 hectares of the lake would be dredged to 2.5 m.

Big Missouri Lake has an area of 13 hectares, with most of the lake being less than 1 m deep. Approximately 6.5 hectares of the lake would be dredged to a depth of 1.5 m and 1.3 hectares of the lake would be dredged to 2.5 m.

Upper Doubles Lake has an area of 14 hectares, with most of the lake being less than 1 m deep. Approximately 7 hectares of the lake would be dredged to a depth of 1.5 m and 1.4 hectares of the lake would be dredged to 2.5 m.

Specific dredging plans would be developed during the preparation of construction plans and specifications after bathymetric surveys of the lakes are conducted. Dredging plans would be developed in coordination with the Wisconsin DNR and the U.S. Fish and Wildlife Service.

Sediments in Spring, Big Missouri and Upper Doubles Lakes have been analyzed. Sediments are almost entirely fine silts and clays. Hydraulic dredging is the only practical and economical method for dredging these types of sediments in this type of setting. The dredged material would be placed on agricultural fields and/or an active sand/gravel pit lying east/southeast of Spring Lake (see plate 11).

DREDGED MATERIAL PLACEMENT - Dredged materials from Spring, Big Missouri and Upper Doubles Lakes (a total of 230,000 m^3) would be placed on agricultural fields and/or an active sand/gravel pit which is currently filled with water (see plate 11). It is possible that use of a combination of these sites would be necessary to provide the capacity needed to contain approximately 230,000 m^3 of dredged material. Construction of dikes would be necessary to contain/dewater hydraulically dredged materials. The dikes or berms would be constructed from materials taken from the fields themselves. How much of each field and/or the gravel pit is used will depend upon the wishes of the individual landowner.

The sites would be restored per the desires of the landowner. It is assumed that the placement site dikes would be graded down and seeded at a minimum.

CONSTRUCTION OF A CHANNEL FROM AMBROUGH SLOUGH TO GREMORE LAKE - A channel from Ambrough Slough to Gremore Lake through property owned by the Wisconsin DNR would be constructed to introduce flow to Gremore Lake (see plate 8). The channel would be located just upstream of the Wisconsin DNR boat ramp and parking lot (see plate 3).

An open channel would be constructed from Ambrough Slough to Ambro Road. A 2.1-meter (84-inch) diameter culvert would be placed under Ambro Road. The open channel would continue from Ambro Road out into Gremore Lake. Approximately 1,300 m^3 of material would be excavated from the land portion of the channel and 1,264 m^3 from Gremore Lake. This material would be taken to an upland site or a sand/gravel pit (see plate 11) for disposal.

C. Authority and Purpose

Under Section 1103 of the Water Resources Development Act of 1986 the Corps of Engineers is authorized to plan, construct and evaluate measures for fish and wildlife habitat rehabilitation and enhancement.

D. General Description of Dredged or Fill Material

1. Physical Characteristics

Rock for the partial closure in Black Slough, the Upper Doubles Lake closure and the head of Tilmont Lake closure would come from a local quarry. It is expected that the rock would be loaded at a commercial facility in the Prairie du Chien area. Rock gradations are provided in attachment 6 (Geotechnical Appendix).

Material for the peninsula restoration would be excavated from the bed of Tilmont Lake and side-cast to build an emergent peninsula. Sediments in Tilmont Lake are almost entirely fine silts and clays. Similarly, materials dredged from Spring, Big Missouri and Upper Doubles Lakes and excavated from Gremore Lake are expected to be primarily fine silts and clays.

2. Chemical Characteristics

Contaminant testing of sediments in Big Missouri, Spring and Tilmont Lakes was completed in June 1998. No pesticides or PCBs were detected in samples and generally, levels of metals, solids and organics were within ranges typically seen in backwaters below Lake Pepin (see Table 1 below). A slightly elevated mercury concentration was detected in the Big Missouri Lake samples, while slightly elevated zinc levels were present in both the Big Missouri and Spring Lake samples. No testing of Upper Doubles Lake sediments was completed, however, because of the proximity of Upper Doubles between Tilmont and Big Missouri Lakes, it is assumed the quality of sediments in Upper Doubles is very similar to that found in these adjacent lakes.

3. Quantity of Material

An estimated 790 m^3 of rock fill, along with an estimated 850 m^2 of geotextile fabric would be required to complete construction of the Black Slough closure. Approximately 17 m^3 of vegetation stripping would be required as part of site preparation.

An estimated 180 m^3 of rock fill, along with an estimated 300 m^2 of geotextile fabric would be required to complete construction of the Upper Doubles Lake closure. Approximately 15 m^3 of vegetation stripping would be required as part of site preparation.

Material for the Tilmont Lake peninsula restoration would be excavated from the bed of Tilmont Lake and side-cast to build an emergent peninsula. An estimated 27,180 m^3 of material would be required. An estimated 162 m^3 of rock and 168 m^2 of geotextile would be required to complete construction of the head of Tilmont Lake closure. A small amount of stripping would be required.

Approximately 90,000 m^3, 55,000 m^3 and 85,000 m^3 of sediments would be dredged from Spring, Big Missouri and Upper Doubles Lakes, respectively, and placed on upland disposal sites and/or in an active sand/gravel mine (see plate 11).

Approximately 1,300 m^3 of material would be excavated from the land portion of the Ambrough Slough/Gremore Lake channel and 1,264 m^3 from Gremore Lake. This material would be taken to the selected disposal sites.

E. Description of the Proposed Discharge Sites

1. Location

a. Black Slough Partial Closure - The opening to Black Slough is located on the left descending bank (Crawford County, WI) at river mile 639.4. A rock partial closing structure would be constructed across the mouth of Black Slough (see plate 3).

b. Upper Doubles Lake Closure – Upper Doubles Lake is located in the central portion of the Ambrough Slough complex, south of Big Missouri Lake and north of Lower Doubles Lake. A channel between Big Missouri Lake and Upper Doubles Lake would be closed with a rock structure (see plate 3).

c. Tilmont Lake Peninsula - Tilmont Lake is located on the southern end of the Ambrough Slough complex at approximately river mile 638.1. A peninsula of land historically separated Tilmont Lake from Ambrough Slough. This peninsula would be reconstructed using materials excavated from the interior of Tilmont Lake. A rock closure would be constructed at the head of Tilmont Lake to reduce flows into the lake from Ambrough Slough (see plate 3).

d. Spring, Big Missouri and Upper Doubles Lake Dredging - Spring Lake is located in the northeastern quarter of the Ambrough Slough complex. Big Missouri Lake is located approximately 1,250 meters due west of Spring Lake. Upper Doubles Lake is located immediately southwest of Big Missouri Lake. Dredging would be completed in these lakes to restore deep water aquatic habitats. Materials dredged from these lakes would be placed on upland agricultural fields or an active sand/gravel pit located east/southeast of Spring Lake and southeast of Big Missouri Lake (see plate 11).

e. Gremore Lake Channel - Gremore Lake is located in the southeast quarter of the Ambrough Slough complex. A channel connecting Ambrough Slough and Gremore Lake would be excavated to provide oxygenated water to Gremore Lake (see plate 3).

2. Size

a. Black Slough Partial Closure - Approximately 0.06 hectare of secondary channel habitat would be affected by the partial closing structure. Rock would be placed on the channel bottom converting substrate types from silt/sand to large rock. Conversion of aquatic habitat to terrestrial habitat is not anticipated (see plate 4).

b. Upper Doubles Lake Closure - Approximately 0.01 hectare of contiguous impounded habitat would be affected by the Upper Doubles closure. Rock would be placed on the lake bottom coverting substrate types from silt/sand to rock. The structure would be emergent, and would result in the permanent coversion of aquatic habitat to terrestrial habitat (see plate 6).

c. Tilmont Lake Peninsula Restoration - Approximately 1.8 hectares of contiguous impounded/secondary channel habitat would be affected by restoration of the Tilmont Lake peninsula. Materials excavated from the interior of Tilmont Lake would be placed on the river bottom converting aquatic habitat to terrestrial habitat (see plate 7). Less than 0.01 hectare of continguous impounded habitat would be affected by construction of the head of Tilmont Lake closure (see plate 5).

d. Spring, Big Missouri and Upper Doubles Lake Dredging - Approximately 6.6 hectares of contiguous impounded habitat in Spring Lake would be dredged to a depth of 1.5 m and 2.2 hectares of the lake would be dredged to a depth of 2.5 m.

Approximately 6.5 hectares of contiguous impounded habitat in Big Missouri lake would be dredged to a depth of 1.5 m and 1.3 hectares of the lake would be dredged to a depth of 2.5 m.

Approximately 7 hectares of contiguous impounded habitat in Upper Doubles Lake would be dredged to a depth of 1.5 m and 1.4 hectares of the lake would be dredged to a depth of 2.5 m.

e. Gremore Lake Channel - Less than 0.1 hectare of contiguous impounded habitat would be affected by channel excavation in Gremore Lake (see plate 8).

3. Types of Sites

Black Slough is a secondary channel of the Mississippi River with a silt/sand bottom. Tilmont, Spring, Big Missouri, Upper Doubles and Gremore Lakes are all backwater lakes with fine silt/clay bottoms and sparse vegetation. Ambrough Slough is a secondary channel of the Mississippi River.

The Dillman, Hunzeker and Toberman fields, which are proposed as possible disposal sites for materials dredged from Sping, Big Missouri, Upper Doubles and Gremore Lakes are agricultural fields. The Pedretti Pit is an active sand/gravel pit which is currently filled with water.

4. Types of Habitat

The habitat types directly affected by the proposed project include secondary channel (Black Slough closure, Tilmont Lake peninsula) and contiguous impounded aquatic habitat (Tilmont Lake peninsula construction, Spring, Big Missouri and Upper Doubles dredging, Gremore Lake channel excavation). Dredged materials would be disposed of on agricultural fields and/or in active sand/gravel pit.

Secondary channel areas provide excellent habitat for invertebrates, other benthic organisms and a variety of riverine fish species.

Shallow contiguous impounded aquatic habitat is relatively abundant in pool 10. This habitat generally lacks topographic diversity, and aquatic vegetation is sparse.

F. Description of Disposal Method

A barge-mounted crane bucket would most likely be used to place rock materials during construction of the Black Slough partial closure, Upper Doubles closure and the head of Tilmont Lake closure. This type of equipment would most likely also be used to excavate and redeposit materials during construction of the Tilmont Lake peninsula and excavate materials for the connecting channel between Ambrough Slough and Gremore Lake.

A hydraulic dredge would be used for removal of materials from Spring, Big Missouri and Upper Doubles Lakes. Dredged materials would be hydraulically placed on the selected disposal sites via pipeline. The selected disposal site would be bermed as necessary to contain the hydraulic slurry and allow for dewatering of sediments.

II. FACTUAL DETERMINATIONS

A. Physical Substrate Determinations

1. Substrate Elevation and Slope

a. Black Slough Partial Closure - Rock would be placed on the channel bottom converting substrate types from silt/clay to large rock and increasing the substrate elevation. Existing bottom elevations where the partial closure would be constructed generally range between 185.0 m and 187.0 m. The top elevation of the closure would be constructed to elevation 187.15 m. A notch would be left in the closure to allow passage of small recreational craft. The bottom elevation of the notch would be at approximately 185.5 m (see plate 4).

b. Upper Doubles Lake Closure – Rock would be placed on the river bottom converting substrate type from silt/clay to rock. The closure would be emergent, permanently converting aquatic habitats to terrestrial. Bottom elevations near the closure range between 185.5 m and 186.5 m. The rock closure would have a top elevation of 187.35 (see plate 6).

c. Tilmont Lake Peninsula - Materials excavated from the interior of Tilmont Lake would be placed on the river bottom increasing substrate elevation. Aquatic habitat would be converted to exposed sandbar/floodplain forest habitat. Additionally, deeper aquatic habitat would be created where materials are excavated from Tilmont Lake. Existing bottom elevations in the footprint of the proposed peninsula are between 185.0 m and 187.0 m. The peninsula would be constructed to a top elevation of 188.0 m (see plate 7).

The closure at the head of Tilmont Lake would be constructed to a top elevation of 187.15 m. Existing bottom elevations in the footprint of the closure are near 186.5 m (see plate 5).

d. Spring Lake/Big Missouri Lake Dredging - Approximately 6.6 hectares of contiguous impounded habitat in Spring Lake would be dredged to a depth of 1.5 m and 2.2 hectares of the lake would be dredged to a depth 2.5 m.

Approximately 6.5 hectares of contiguous impounded habitat in Big Missouri lake would be dredged to a depth of 1.5 m and 1.3 hectares of the lake would be dredged to a depth of 2.5 m.

Approximately 7 hectares of contiguous impounded habitat in Upper Doubles Lake would be dredged to a depth of 1.5 m and 1.4 hectares of the lake would be dredged to a depth of 2.5 m.

e. Gremore Lake Channel - A channel would be excavated between Ambrough Slough and Gremore Lake. The channel bottom would be excavated to a depth 1 to 2 meters below the existing lake bottom. The proposed bottom elevations of the channel would be at approximately 184.45 m (see plate 8).

f. Dredged Material Disposal – Dredged materials could be placed on any of three agricultural fields or in an active sand/gravel pit. Placement of agricultural fields would result in raise field elevations in the range of 4 to 6 feet where materials are placed. It is assumed that the sand/gravel pit would be filled to level with the adjacent field surfaces.

2. Sediment Type/Substrate Changes

Substrates in the various project sites in Ambrough Slough consist primarily of fine silts or clay. Construction of the partial closure in Black Slough and the closures in Upper Doubles and Tilmont Lakes would convert approximately 0.1 hectare of existing silt substrate to rock. Construction of the Tilmont Lake peninsula would involve excavation and sidecast placement of materials from the interior of Tilmont Lake. Substrate elevation would be affected, however, composition would remain relatively unaffected. Similarly, dredging in Spring, Big Missouri and Upper Doubles Lakes and excavation of materials from Gremore Lake would affect substrate elevations, but would not impact substrate type.

3. Dredged/Fill Material Movement

Placement of sufficiently large rock as part of the Black Slough partial closure and Upper Doubles and Tilmont Lake closures would ensure little or no post-construction movement of materials. Materials excavated from Tilmont Lake and used to construct the Tilmont Lake peninsula would be redeposited in the aquatic environment. It is anticipated that wave action would reshape parts of the peninsula. Some minimal rock protection would help stabilize the peninsula, additionally revegetation of the site should further assist in stabilization.

B. Water Circulation, Fluctuation, and Salinity Determination

1. General Water Chemistry

The use of clean fill material would preclude any significant impacts on water chemistry during project construction. Some minor, short-term decreases in water clarity are expected from the proposed fill activities. No significant impacts on water color, odor, taste, dissolved oxygen levels, temperature or nutrient levels are anticipated.

2. Current Patterns and Circulation

The Black Slough, Upper Doubles and Tilmont Lake closures would result in changed flow patterns through Ambrough Slough. The Black Slough closure would reduce flows through Black Slough by 25 to 35 percent. The Upper Doubles and Tilmont Lake closures would effectively close off flows between Big Missouri and Upper Doubles Lakes and through the small channel at the head of Tilmont Lake. The Gremore Lake Channel would introduce oxygenated water and flow into Gremore Lake.

3. Sedimentation Patterns

The proposed project features would have very minor impacts on sedimentation patterns in Ambrough Slough. The Black Slough closure would reduce flows and sediment inputs into the Ambrough Slough complex. However, reduced flows could result in greater settling of suspended sediments. Overall, the Black Slough closure would have very minor impacts on sedimentation patterns in Ambrough Slough.

C. Suspended Particulate/Turbidity Determination

1. Suspended Particulates and Turbidity

Turbidity and the concentration of suspended solids would be expected to increase temporarily during construction of all project features. However, increases would be relatively minor and restricted to a relatively localized area.

Materials would be relatively unconfined during peninsula construction and suspended solids and turbidity levels exceeding 60 mg/l and 25 NTUs, respectively, would be expected in the immediate peninsula vicinity. A relatively rapid return to ambient conditions should occur after completion of peninsula construction activities. No long-term adverse impacts on water quality are expected.

Dredging and dredged material disposal both have the potential to increase suspended solids concentrations and turbidities. At the site of dredging localized increases in these two parameters would be expected as a result of disturbance/mobilization of fine silts near the dredging site Also, return water discharged from the dredged material disposal site can result in increased suspended solids and turbidity levels in the receiving waters. However, both dredging and dredged material disposal would be controlled to minimize adverse impacts on water quality. Overall, suspended solids and turbidity concentrations are not expected to significantly exceed normal conditions.

2. Effects on Chemical and Physical Properties of the Water Column

Some minor short-term impacts on light penetration and aquatic organisms would occur during rock placement, excavation/peninsula construction and dredging activities as a result of localized turbidity plumes. However, these effects would be rapidly dissipated upon project completion. Increased bathymetric/hydraulic diversity should lead to increased mixing, with resulting improved localized dissolved oxygen levels. No effects are expected on toxic metal concentrations, pathogens, or the aesthetics of the water column.

Deposition of sand during peninsula construction would likely result in increased turbidity and suspended solids concentrations in the immediate vicinity of the island. Reduced water clarity and light penetration, and minor adverse effects on aquatic organisms would be expected. However, the completed peninsula would serve as a wind and wave barrier helping to reduce the effects of these forces on resuspension of sediments. Long-term improvements in water clarity and light penetration would be expected. These improvements would benefit aquatic plant communities and associated biota. No effects on toxic metal concentrations, pathogens or the aesthetics of the water column are anticipated.

D. Contaminant Determinations

The use of clean, quarry-run rock riprap for construction of the Black Slough, Upper Doubles and Tilmont Lake closures and clean sediments from Tilmont Lake for construction of the Tilmont Lake peninsula would not introduce contaminants into the aquatic system. Neither the materials used nor the placement method would cause relocation or increases of contaminants in the aquatic system.

E. Aquatic Ecosystem and Organism Determination

The effects of project construction are discussed in detail in Section 9.0 *Environmental Assessment* of the main report. The more important effects discussed in Section 9.0 are summarized in the following paragraphs.

1. Effects on Plankton

During construction, increases in turbidity and suspended solids near the fill activities would have a localized suppressing effect on phytoplankton productivity. However, these local effects are not considered significant. The plankton populations should recover quickly once the fill and other construction activities have ceased. In the long-term, water clarity and overall aquatic habitat quality would improve, with resulting positive effects on plankton.

2. Effects on Benthos

Placement of rock during construction of the Black Slough partial closure and the Upper Doubles and head of Tilmont Lake closures would potentially cover and smother benthic communities. However, rapid recolonization of disturbed substrates would be anticipated with resulting minimal long-term effects.

Dredging of Spring, Big Missouri and Upper Doubles Lakes and excavation of materials from Tilmont and Gremore Lakes would disturb benthic invertebrates occupying substrates in these areas. In total, approximately 25 hectares of aquatic habitat would be disturbed in these areas. Benthic organisms would be removed from these areas, however, recolonization would be anticipated over the long-term.

Approximately 1.8 hectares of shallow aquatic habitat would be covered and converted to upland habitat during peninsula construction activities in the Tilmont Lake area. Most of this acreage was actually upland habitat prior to river impoundment. All benthic organisms in the footprint of the peninsula would be buried and perish. However, the trade-off between shallow aquatic habitat and upland/island habitat is considered important for maintaining the biological diversity and productivity of Ambrough Slough. Suspended particulate plumes generated during peninsula construction operations could have minor negative effects on benthos. However, improved water clarity and habitat diversity would in the long-term increase benthic productivity in the Ambrough Slough complex.

3. Effects on Fish

Increases in turbidity and suspended solids during construction would temporarily displace fish occupying project areas. Fish are more mobile than benthic invertebrates and would likely simply avoid construction areas during project completion.

Dredging would improve habitat diversity and interspersion with resulting benefits to backwater fish communities. Increased hydraulic diversity in Black Slough and would have positive impacts on habitat suitability for a variety of secondary channel and backwater fish species. Overall, project construction would benefit aquatic habitats and associated fish populations.

4. Effects on Aquatic Food Web

The long-term effect of the project on the total productivity of the Ambrough Slough area is expected to be positive, although there would be a temporary disruption to the aquatic biota present during project construction. Reduced flows, dredging and peninsula construction would generally benefit aquatic habitats and the aquatic food web.

5. Effects on Special Aquatic Sites

The aquatic habitats affected by the proposed project include hectares of contiguous impounded habitat and a very small acreage of secondary channel habitat.

Portions of the project are located within the Upper Mississippi River Wildlife and Fish Refuge. Generally, the impacts of the project on the Refuge would be positive, with increased bathymetric diversity in four geographically different areas within the Ambrough Slough backwater complex.

6. Threatened and Endangered Species

No known Federally-listed threatened or endangered species would be affected by the project. The project has been coordinated with the U.S. Fish and Wildlife Service. The U.S. Fish and Wildlife Service concurs with this opinion (see Section 11.2.3.5 of the main report for further discussion).

7. Other Wildlife

The fill activities would not result in the significant loss of aquatic or terrestrial habitat. The general diversity and productivity of the affected areas would be enhanced/maintained. Overall the project should benefit wildlife.

8. Actions Taken to Minimize Impacts

The proposed project includes features which will generally enhance and improve aquatic habitats in the project area. Overall, the project should have positive effects on the project area; however, construction activities would be restricted during the fall and spring to minimize disturbance to migrating waterfowl.

F. Proposed Disposal Site Determination

1. Mixing Zone Determination

The proposed fill activities would have minimal mixing zones. The fill material used for the Black Slough partial closure and the Upper Doubles and head of Tilmont Lake closures would be sufficiently large and relatively clean so that very little exposed material could be suspended in the water column.

During peninsula construction in Tilmont Lake, placement of unconfined materials would generate elevated turbidity and suspended solids concentrations in the immediate project area; however, no long-term adverse impacts on water quality are expected.

As with peninsula construction, dredging in Spring, Big Missouri and Upper Doubles Lakes and excavation of the channel into Gremore Lake would generate elevated turbidity and suspended solids concentrations in the immediate dredging/excavation vicinity. Again, no long-term adverse impacts on water quality are expected.

2. Determination of Compliance with Applicable Water Quality Standards

The fill materials used for this project would be obtained from approved quarries or backwater lake dredging. The area does not have a history of contamination, which should insure that State water quality standards would not be violated because of project-related activities. Water quality certification from Wisconsin would be obtained prior to project construction.

3. Potential Effects on Human Use Characteristics

The Black Slough partial closure would be constructed to elevations adequate for providing passage of recreational boats. Use of the navigation channel would continue at current levels. No effects on municipal and private water supplies are anticipated.

Recreational access at the Gremore Lake/Ambrough Slough boat landing would be temporarily affected during the construction of the Gremore Lake/Ambrough Slough connecting channel. However, this disturbance would be short-term in nature. Upon project completion, access to the boat ramp and parking area would be fully restored.

The project should generally benefit aquatic habitats with resulting benefits to fish and wildlife species. Recreational and commercial fisheries could potentially be enhanced. Water related recreational use of the project area would not be adversely affected by the project. Improved fisheries and waterfowl habitats could lead to enhanced use of the area by the angling and hunting public. Aesthetics would not be significantly affected by the project.

G. Determination of Cumulative Effects on the Aquatic Ecosystem

Implementation of the proposed action would cause no significant cumulative impacts on the aquatic ecosystem. The increased bathymetric diversity associated with dredging, peninsula construction, and secondary channel closing would generally have positive cumulative effects on the aquatic environment.

H. Determination of Secondary Effects on the Aquatic Ecosystem

Increase bathymetric diversity and the provision of deep water winter refuges would result in long-term benefits to aquatic habitat in this area.

III. FINDING OF COMPLIANCE WITH RESTRICTIONS ON DISCHARGE

1. The proposed fill activity would comply with the Section 404(b)(1) guidelines of the Clean Water Act. The placement of fill is required to provide the desired benefits. Other alternatives would not provide the desired results.

2. The proposed fill activities would comply with all State water quality standards. The disposal operation would not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

3. Use of the selected disposal site would not harm any endangered species or their critical habitat.

4. The proposed fill activities would not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation, and commercial fishing. It would not adversely affect plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic life and other wildlife would not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity, and stability and on recreational, aesthetic, and economic values would not occur.

5. To minimize the potential for adverse impacts, the fill would be placed during periods of normal to low water levels. Since the proposed action would result in few adverse effects, no additional measures to minimize impacts would be required.

6. On the basis of this evaluation, I specify that the proposed project complies with the requirements of the guidelines for discharge of fill material.

Date 12-21-00

/ John W. Wenther
Kenneth S. Karprisin
Corps of Engineers
District Engineer

Table 1. Contaminant data for sediments present in backwater lakes of the Ambrough Slough complex, Pool 10.

Mississippi River below Lake Pepin
Background Data for Backwater Sediments

		Record #	98-6ME	98-8ME	98-9ME	Mean	Mean + 1 Std. Dev.	Mean + 2 Std. Dev.
		River Mile	Ambrough Slough Complex	Ambrough Slough Complex	Ambrough Slough Complex			
		Location	Big Missouri Lake	Spring Lake	Tilmont Lake			
		Year	1998	1998	1998			
		System	UMR	UMR	UMR			
		Habitat Type	Backwater Lake	Backwater Lake	Backwater Lake			
		Pool	10	10	10			
		Sam. Gear	Core Sample	Core Sample	Core Sample			
		Data Citation	COE	COE	COE			
CHCS	ug/kg	4,4'-DDD	<0.049	<0.081	<0.13			
	ug/kg	4,4'-DDE	<0.032	<0.052	<0.081			
	ug/kg	4,4'-DDT	<0.052	<0.086	<0.13			
	ug/kg	a-BHC	<0.032	<0.052	<0.081			
	ug/kg	b-BHC	<0.026	<0.043	<0.067			
	ug/kg	d-BHC	<0.029	<0.048	<0.074			
	ug/kg	g-BHC (lindane)	<0.024	<0.040	<0.063			
	ug/kg	a-Chlordane	<0.024	<0.040	<0.061			
	ug/kg	g-Chlordane	<0.017	<0.028	<0.043			
	ug/kg	Chlordane	<0.69	<1.1	<1.8			
	ug/kg	Oxychlordane	<0.29	<0.48	<0.74			
	ug/kg	Heptachlor	<0.025	<0.041	<0.064			
	ug/kg	Heptachlor epoxide	<0.018	<0.030	<0.047			
	ug/kg	Endrin	<0.081	<0.13	<0.21			
	ug/kg	Dieldrin	<0.066	<0.11	<0.17			
	ug/kg	Trans-nonachlor	<0.29	<0.48	<0.74			
PCBS	ug/kg	Aroclor 1016	<1.2	<2.0	<3.1			
	ug/kg	Aroclor 1221	<1.2	<2.0	<3.1			
	ug/kg	Aroclor 1232	<1.2	<2.0	<3.1			
	ug/kg	Aroclor 1242	<1.2	<2.0	<3.1			
	ug/kg	Aroclor 1248	<1.2	<2.0	<3.1			
	ug/kg	Aroclor 1254	<1.2	<2.0	<3.1			
	ug/kg	Aroclor 1260	<1.2	<2.0	<3.1			
INORGANICS	mg/kg	As (arsenic)	1.1	4.6	3.4	2.9	5.7	8.5
	mg/kg	Cd (cadmium)	0.30	0.65	1.0	0.9	2.5	4.2
	mg/kg	Cr (chromium)	16	34	37	17	27	37
	mg/kg	Cu (copper)	11	23	26	12	19	27
	mg/kg	Pb (lead)	9.0	25	27	14	21	29
	mg/kg	Mn (manganese)	550	860	740	370	657	943
	mg/kg	Hg (mercury)	0.10	0.20	0.52	0.09	0.20	0.32
	mg/kg	Ni (nickel)	13	29	28	17	31	45
	mg/kg	Zn (zinc)	39	120	120	52	81	112
	mg/kg	Nitrogen, ammonia	54	490	840			
	%	Solids, percent	69.5	42.0	27.0			
	%	Solids, total volatile	3.3	6.3	9.2			
	mg/kg	TOC as NPOC	6500	11000	20000			

Attachment 4

Habitat Evaluation Appendix

HABITAT EVALUATION PROCEDURE
USED FOR THE AMBROUGH SLOUGH/GREMORE LAKE
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

Habitat evaluation procedures (HEP) were used to evaluate the potential benefits of the alternative habitat improvement features (island construction, channel closures, dredging, etc.) for the Ambrough Slough/Gremore Lake project area of pool 10. Active participants included biologists from the St. Paul District (COE), the Upper Mississippi River Wildlife and Fish Refuge (USFWS), and the Iowa and Wisconsin Departments of Natural Resources.

METHODS

Methodology - The U.S. Fish and Wildlife Service's 1980 version of Habitat Evaluation Procedures (HEP) was used to quantify and evaluate the potential project effects and benefits. The HEP methodology utilizes a Habitat Suitability Index (HSI) to rate habitat quality on a scale of 0 to 1 (1 being optimum). The HSI is multiplied by the number of acres of available habitat to obtain Habitat Units (HU's). One HU is defined as one acre of optimum habitat. By comparing the projected HU's available without a proposed action to HU's projected to be gained with a proposed action or alternative, the benefits of different alternatives can be quantified.

Evaluation Species and Model Selection - Improving overall habitat conditions for backwater fish species in the project area is a high priority goal of both the Wisconsin and Iowa Departments of Natural Resources and the USFWS. Habitat conditions in the Ambrough Slough/Gremore Lake complex are considered suboptimal during the winter, spawning and summer growing seasons.

After a review of the available species models, the bluegill model (Stuber, et. al. 1982) was selected to quantify the benefits to backwater fish species resulting from the project. This model was in part selected because it has been modified by the St. Paul District (Palesh and Anderson 1990) to include winter habitat variables.

Data Requirements - Information is available concerning past and recent existing conditions in the Ambrough Slough/Gremore Lake area of pool 10. Land use, bathymetric, vegetation and water quality data for the project area was obtained from several sources including the Environmental Management Technical Center in LaCrosse, WI and the Wisconsin DNR. This information was used for providing model inputs for existing conditions. Trend analysis provided an indication of probable future conditions and provided a basis for identifying potential project responses.

Some hydraulic modeling was done to identify existing flow conditions in the project area and to develop design criteria for meeting the project goals. A discussion of this modeling effort is presented in the hydraulics appendix. This information was used in determining input for several of the habitat model variables.

Evaluation Area and Plan Components - The Ambrough Slough/Gremore Lake study area includes a complex of backwater lakes, sloughs and ponds lying between the main channel of the UMR and the Wisconsin uplands bordering the floodplain in Pool 10. Ambrough Slough is the main water feature of the study area. The slough branches off the main channel at river mile 641.9 and flows in a meandering pattern in a southerly direction for about 5 kilometers. The slough widens and straightens before entering the East Channel of the UMR near Prairie du Chien, WI. The primary backwater lakes found in the Ambrough Slough complex include Voth's, Big Missouri, Spring, Roulette, Upper Doubles, Lower Doubles, Fish, Fluke's, Tilmont and Gremore. Significant secondary channels include Black Slough and Dark Slough. Four basic restoration and enhancement measures were considered for each of these lakes; introduction of flow, reduction of flow, dredging and addition of structure. However, early in the project evaluation process it was determined that any actions in Voth's, Roulette and Fluke's Lakes would not be feasible. Actions in these lakes are not considered further in this evaluation. Additionally, construction of partial closing dams has been proposed in both Black Slough and Ambrough Slough, however, these actions are not evaluated as part of this HEP assessment.

Three increments of dredging were examined for each lake: the 60-30-10 level (increment 1) would result in 60% of the identified lake being 0 to 1 meter deep, 30% of the lake 1 to 2 meters deep and 10% of the lake > 2 meters deep; the 40-50-10 level (increment 2) would result in 40% of the lake being 0 to 1 meter deep, 50% of the lake 1 to 2 meters deep and 10% of the lake > 2 meters deep; the 20-70-10 level (increment 3) would result in 20% of the lake being 0 to 1 meter deep, 70% of the lake 1 to 2 meters deep and 10% of the lake > 2 meters deep. The 20-70-10 level is the level identified in objective A1 of the PAR. Flow reduction, including reconstruction of island remnants or closing of channels was analyzed for Upper and Lower Doubles, Fish and Tilmont. Flow introduction through construction of an inlet channel was analyzed for Gremore. Addition of structure like brush clusters, christmas tree piles, stake beds, etc. was analyzed for Big Missouri and Tilmont. Aeration was analyzed for Gremore Lake.

Various combinations of these project components were used to develop alternatives.

HABITAT SUITABILITY INDEX CALCULATIONS

Model matrices and Habitat Suitability Index (HSI) calculations are presented in enclosure 1 following this narrative. HSI's were calculated for bluegill for the existing conditions and for the various combinations of lake dredging, flow introduction, flow reduction and structure addition alternatives. General assumptions used in completing the evaluation include:

1. Sedimentation and hydraulic connectivity will continue to affect habitat suitability regardless of the alternative selected.

2. The bluegill model includes those features of backwaters which are important to fish species.

3. The period of analysis for this project is 50 years.

Existing Conditions - The baseline models indicate that overall the Ambrough Slough/Gremore Lake complex provides good to average summer but poor winter habitat for centrarchids. For bluegill, water depths, wintertime current velocity and water temperature are limiting variables. Additionally cover (to much vegetation and not enough stumps/logs) is somewhat limiting in the summertime. HSI's for bluegill range between 0.26 to 0.56 (Bottom Half of Lower Harper's area).

Big Missouri Lake - Big Missouri Lake lies southeasterly of Voth's Lake. Big Missouri has a direct connection to Ambrough Slough and to Upper Doubles Lake to the south. On historic aerial photographs, Big Missouri Lake ranges in size from 8 to 14 hectares (approx. 32.1 acres). Bathymetric data is available for a portion of Big Missouri Lake, indicating much of the lake is likely less than 1 meter deep. The baseline HEP conditions for Big Missiouri Lake are presented in Table BM-1. With the exception of percent cover in the form of vegetation, summertime habitat for bluegills in Big Missouri is good to excellent with an HSI of 0.80. However, wintertime conditions are only fair. With a relatively limited amount of water greater than 4 feet deep, dissolved oxygen concentrations which can fall below 5 ppm and cool water temperatures, the wintertime HSI for Big Missouri is 0.55. Overall, Big Missouri has a composite HSI of 0.66.

Spring Lake - Spring Lake is located in the northeasterly portion of the study area. Spring Lake is connected to Ambrough Slough by Spring Slough. There is a small slough feeding into Spring Lake from the north. It is likely that during high flow periods, water from the Mississippi River enters Spring Lake via this slough. Approximately one-half of Spring Lake lies outside the boundaries of the Refuge. Spring Lake ranges in size from 18 to 30 hectares (approx. 54.4 acres). No bathymetric data is available for Spring Lake, but it is likely that much of the lake is less than 1 meter deep. The baseline HEP conditions for Spring Lake are presented in Table SP-1. Spring Lake is shallow and heavily vegetated. As a result, suitability indices for percent cover (vegetation) and percent littoral area are low. However, the summertime HSI for bluegills is still relatively high at 0.77. The lack of deeper water in Spring Lake greatly limits the wintertime suitability both directly and through poor oxygen concentrations during the winter. The wintertime HSI for Spring Lake is 0.4. Overall, Spring Lake has a composite HSI of 0.56.

Upper Doubles Lake - Upper Doubles Lake is located west of Ambrough Slough and south of Big Missouri Lake. The lake has a direct connection with Big Missouri Lake and with Lower Doubles Lake. Upper Doubles Lake ranges in size from 10 to 16 hectares (approx. 34.6 acres). Bathymetric data is available for a portion of Upper Doubles Lake, indicating most of the lake is less than 1 meter deep. The baseline HEP conditions for Upper Doubles are presented in Table UD-1. Upper Doubles is also shallow and well vegetated. The lack of deep water greatly limits the wintertime suitability of this lake, while the overabundance of aquatic vegetation limits the summertime suitability. The overall composite HSI for Upper Doubles is 0.49, with a summertime HSI of 0.59 and wintertime HSI of 0.40.

Lower Doubles Lake - Lower Doubles Lake is located west of Ambrough Slough and south of Upper Doubles Lake. In addition to the connection to Upper Doubles laked noted above, the lake has a connection with Fish Lake to the south. Lower Doubles Lake ranges in size from 8 to 12 hectares (approx. 19.8 acres). Bathymetric data is available for much of Lower Doubles Lake, indicating most of the lake is less than 1 meter deep. The baseline HEP conditions for Lower Doubles are presented in Table LD-1. Lower Doubles is shallow and well vegetated. Additionally, the connection to Upper Doubles results in hydraulic connectivity between the lakes. This connection leads to relatively high current velocities in Lower Doubles which affects the wintertime suitability of this lake. Additionally, the lack of deep water greatly limits the wintertime suitability of this lake both directly and through the general loss of oxygen from the waterbody during the winter. The abundance of aquatic vegetation limits the summertime suitability. The overall composite HSI for Lower Doubles is 0.39, with a summertime HSI of 0.62 and wintertime HSI of 0.25.

Fish Lake - Fish Lake is located west of Ambrough Slough near the center of the study area. In addition to Lower Doubles Lake, Fish Lake has a direct connection with Ambrough Slough and with Dark Slough. The lake ranges in size from 10 to 18 hectares (approx. 46.9 acres). Bathymetric data is available for much of Fish Lake, indicating most of the lake is less than 1 meter deep. The baseline HEP conditions for Fish Lake are presented in Table FS-1. As with the other lakes, Fish Lake is generally shallow and well vegetated, which negatively impacts its summertime HSI. Additionally, the hydraulic connectivity Fish Lake has with Ambrough and Dark Sloughs and Lower Doubles Lake results in relatively high flows and current velocities through the lake. While this connectivity has positive impacts on wintertime dissolved oxygen concentrations, it negatively affects wintertime temperatures and current velocities. The overall composite HSI for Fish Lake is 0.43, with a summertime HSI of 0.74 and wintertime HSI of 0.25.

Tilmont Lake - Tilmont Lake is located west of Ambrough Slough in the lower portion of the study area. The lake is directly connected to Ambrough Slough and Mudhen Slough. On historic aerial photographs, the lake ranges in size from 34 to 42 hectares (approx. 86.5 acres). Bathymetric data for Tilmont Lake indicates a shallow flat basin with most of the lake being between 1.0 and 1.5 meters deep. The baseline HEP conditions for Tilmont are presented in Table TL-1. Tilmont is a somewhat deeper lake than the other complex lakes, this positively affects both its summer and winter HSI. However, the relatively open nature of the lake leads to higher current velocities and lower winter temperatures than preferred by bluegill. Overall, Tilmont has a summer HSI of 0.74, a winter HSI of 0.25 and a composite HSI of 0.43.

Gremore Lake - Gremore Lake is a 135-hectare (approx. 333.6 acres) backwater lake located east of Ambrough Slough in the lower reaches of the study area. Gremore Lake is deeper than most backwater lakes in the area, with water depths greater than 3 meters in isolated locations. Most of the lake has depths in the 1 to 2 meter range. All of Gremore Lake, except for a small portion of the northern shoreline, is located outside of the boundaries of the Refuge. The baseline HEP conditions for Gremore are presented in Table GR-1. Overall, Gremore Lake has good summertime habitat and also relatively good wintertime habitat. However, dissolved oxygen concentrations in the lake can drop below desireable levels, thereby reducing the suitability of the lake. The composite HSI for Gremore Lake is 0.59, with a summertime HSI of 0.86 and winter HSI of 0.40.

Future Without Project Conditions - If no action is taken to restore/maintain backwater habitats in the Ambrough Slough study area, the quality of habitat for centrarchids would continue to decline. Two primary factors; sedimentation and increased hydraulic connectivity, will likely affect the quality of centrarchid habitat throughout the Ambrough Slough/Gremore Lake complex. As deeper areas continue to fill with sediment and hydraulic connectivity between the various lakes in the complex increases, wintertime conditions for bluegills will decline.

Big Missouri Lake - The future without project HEP conditions for Big Missiouri Lake are presented in Table BM-1. As is the case with most of the lakes in the Ambrough Slough complex, it is projected that continued sedimentation will lead to a gradually shallowing of Big Missouri over the next 50 years. In addition to the loss of deeper water, the physical changes in habitat associated with sedimentation would likely include increased abundance of aquatic vegetation. Other habitat factors which could be affected would include increased water temperatures and seasonal declines in dissolved oxygen concentrations. Overall, it is projected that habitat suitability for bluegills would decline in Big Missouri over the next 50 years with a composite HSI of 0.56 at year 50.

Spring Lake - The future without project HEP conditions for Spring Lake are presented in Table SP-1. Spring Lake is shallow and heavily vegetated. It is anticipated that these conditions would persist well into the future if no actions were taken. As a result, suitability indices for percent cover (vegetation) and percent littoral area would remain low. The lack of deeper water in Spring Lake greatly limits the wintertime suitability both directly and through poor oxygen concentrations during the winter. These conditions are not expected to change without some type of project. Overall, the composite HSI for Spring Lake is projected to remain about average at 0.53.

Upper Doubles Lake - The future without project HEP conditions for Upper Doubles are presented in Table UD-1. Upper Doubles is shallow and well vegetated. The lack of deep water greatly limits the wintertime suitability of this lake, while the overabundance of aquatic vegetation limits the summertime suitability. With continued sedimentation in the lake, these conditions would not improve over the next 50 years. In fact, the projected without project composite HSI for Upper Doubles is 0.41 as compared to the baseline HSI of 0.49.

Lower Doubles Lake - The future without project HEP conditions for Lower Doubles are presented in Table LD-1. Lower Doubles is shallow and well vegetated. The connection between Upper and Lower Doubles leads to relatively high current velocities in Lower Doubles. Additionally, the lack of deep water greatly limits the wintertime suitability of this lake both directly and through the general loss of oxygen from the waterbody during the winter. The current HSI for Lower Doubles is low (0.39). While sedimentation and increased hydraulic connectivity would likely occur in Lower Doubles, the project impacts on habitat suitability are minimal. Overall, the projected without project HSI for Lower Doubles would remain at 0.39.

Fish Lake - The future without project HEP conditions for Fish Lake are presented in Table FS-1. As with the other lakes, Fish Lake is generally shallow and well vegetated, which negatively impacts its summertime HSI. Additionally, the hydraulic connectivity Fish Lake has with Ambrough and Dark Sloughs and Lower Doubles Lake results in relatively high flows and current velocities through the lake. These conditions are not expected to change significantly over the next 50 years. Overall, the project future composite HSI for Fish Lake would drop slightly to 0.41.

Tilmont Lake - The future without project HEP conditions for Tilmont are presented in Table TL-1. Sedimentation in Tilmont Lake is expected to gradually reduce the suitability of the lake to bluegills over the next 50 years, however, because the wintertime HSI for Tilmont is low, the overall projected future HSI would not decrease. Overall, the project future composite HSI for Tilmont would remain at 0.43.

Gremore Lake - The future without project HEP conditions for Gremore are presented in Table GR-1. Overall, Gremore Lake has good summertime habitat and also relatively good wintertime habitat. However, dissolved oxygen concentrations in the lake can drop below desireable levels, thereby reducing the suitability of the lake. It is projected that over the next 50 years, the wintertime dissolved oxygen conditions in Gremore would worsen. The project composite HSI for Gremore Lake would drop to 0.29.

Future With Project Conditions - The following discussion is a presentation of the potential effects the various enhancement measures may have on habitat quality.

Spring Lake - Of the four management measures, dredging would have the most potential for improving habitat conditions in Spring Lake. These improved conditions would be apparent immediately after completion of dredging and would persist for some time afterwards, however, sedimentation within Spring Lake would result in some reduction in habitat suitability over the long-term. As discussed previously, three increments of dredging were evaluated for each lake in the Ambrough Slough complex.

Increment 1 dredging in Spring Lake would result in increased habitat suitability for bluegills in the lake (see Table SP-2). For winter habitat conditions, increment 1 dredging would help meet the depth and dissolved oxygen criteria. For summer habitat conditions, dredging would increase depth, thereby reducing aquatic vegetation coverage and percent littoral area. The composite HSI is projected to increase over without project conditions from 0.53 to 0.8.

Increment 2 dredging would result in further improvements in habitat suitability (see Table SP-

3). For winter habitat, both depth and dissolved oxygen criteria would be fully met. Additionally, increment 2 dredging would result in improved temperature conditions in Spring Lake. For summer habitat, further reductions in percent vegetative coverage and percent littoral area would be realized. Overall, the composite HSI would increase over without project conditions from 0.53 to 0.9.

Increment 3 dredging would result in nearly ideal habitat suitability for bluegills in Spring Lake (see Table SP-4). The wintertime criteria for depth, dissolved oxygen and temperature would all be fully met, as would the summertime criteria for percent vegetative cover and percent littoral area. The composite HSI would increase over without project conditions from 0.53 to 0.9.

Big Missouri Lake - Dredging and adding structure would be the measures that would have the most potential for benefiting Big Missouri Lake. If implemented, these measure would result in immediate improvements in habitat suitability which would be somewhat diminished as the project aged.

Increment 1 dredging would substantially improve the depth, water temperature, dissolved oxygen and current velocity criteria during the winter (see Table BM-2). Reduced aquatic vegetation coverage and reduced littoral area would also be realized with resulting improved habitat suitability during summer. Overall, habitat suitability would improve with a long-term composite HSI between 0.79 and 0.81.

Increment 2 dredging would further improve winter and summer habitat conditions (see Table BM-3). Depth and dissolved oxygen conditions would be optimized during the winter, while percent littoral area would be optimized during summer. Composite habitat suitability would improve to between 0.89 and 0.9.

Increment 3 dredging would result in nearly ideal habitat suitability for bluegills in Big Missouri (see Table BM-4). The wintertime criteria for depth, dissolved oxygen and temperature would all be fully met, as would the summertime criteria for percent vegetative cover and percent littoral area. The composite HSI would increase over without project conditions from 0.56 to 0.92.

Based on aerial photos, Big Missouri Lake does not appear to support an abundance of aquatic vegetation, even in 1989 when vegetation appeared abundant in most of the lakes in the study area. Therefore, adding structure to this lake in the form of stumps, logs, or rock may prove beneficial. Table BM-5 presents the HEP analysis for adding structure to Big Missouri. While addition of structure would in general improve summer habitat conditions, structure in itself would not substantially improve winter habitat. Also, continued sedimentation within Big Missouri would result in a long-term reduction in habitat suitability. Overall, addition of structure would only result in a minor long-term improvement in the composite HSI for Big Missouri.

Combinations of increment 1, 2 and 3 dredging and addition of structure are presented in Tables BM-6 through BM-8. Basically, the addition of structure results in minor incremental improvement in HSI above those provided by dredging alone. The addition of structure adds about 0.01 to the composite HSI for any increment of dredging.

Upper Doubles Lake - Dredging would have the most potential for improving habitat conditions in Upper Doubles Lake. These improved conditions would be apparent immediately after completion of dredging and would persist for some time afterwards, however, sedimentation within Upper Doubles would result in some reduction in habitat suitability over the long-term. Flow reduction to Upper Doubles Lake by closing, or partially closing, the connections between Upper Doubles Lake and Big Missouri Lake also has potential for improving habitat conditions for centrarchids. The benefits of flow reduction into Upper Doubles would be realized almost immediately after project completion. For this analysis, it was assumed the closure would be complete and fully effective under all river conditions, however, in reality the closure could be overtopped with resulting increased flows and velocities into Upper Doubles.

For winter habitat conditions, Increment 1 dredging would improve depth, dissolved oxygen and water temperature conditions (see Table UD-2). For summer habitat conditions, dredging would reduce aquatic vegetation coverage and percent littoral area with resulting benefits to habitat suitability. Overall, habitat suitability would improve with a long-term composite HSI between 0.69 and 0.71.

Increment 2 dredging would further improve winter and summer habitat conditions (see Table UD-3). Depth and dissolved oxygen conditions would be optimized during the winter, while percent littoral area would be optimized during summer. Additional improvements in wintertime temperature conditions and summertime percent cover (vegetation) would also be realized. Composite habitat suitability would improve to between 0.79 and 0.8.

For dredging increment 3, wintertime criteria for depth and dissolved oxygen and would be fully met, as would the summertime criteria for percent vegetative cover and percent littoral area (see Table UD-4). However, winterimte criteria for current velocity would limit habitat suitability. Composite habitat suitability would improve to between 0.81 and 0.82.

Constructing a closure between Upper Doubles and Big Missouri would result in relatively minor long-term improvements in habitat conditions (see Table UD-5). Reduced flows into Upper Doubles would result in improved wintertime current velocities, however, the other wintertime factors (i.e. depth, dissolved oxygen, water temperature) would not be affected. Wintertime habitat suitability would not improve. Overall, the composite habitat suitability in Upper Doubles would improve only slightly over without project conditions.

Combinations of increment 1, 2 and 3 dredging and flow reduction are presented in Tables UD-6 through UD-8. Basically, flow reduction results in minor incremental improvement in HSI above those provided by dredging alone. Flow reduction adds about 0.05 to the composite HSI for any increment of dredging.

Lower Doubles Lake - Dredging and flow reduction have potential for improving habitat conditions in Lower Doubles Lake. Improved conditions would be apparent immediately after completion of dredging and would persist for some time afterwards, however, as with the other lakes in the Ambrough Slough complex, sedimentation within Lower Doubles would result in some reduction in habitat suitability over the long-term. Flow reduction to Lower Doubles Lake by closing, or partially closing, the connection with Upper Doubles Lake also has potential for improving habitat conditions for centrarchids. The benefits of flow reduction would be realized almost immediately after project completion, however, the effectiveness of the closure would not be complete. Under some conditions, the closure would be overtopped with resulting increased flows and velocities.

For winter habitat conditions, Increment 1 dredging would improve depth, dissolved oxygen and water temperature conditions (see Table LD-2). However, continued flow through Lower Doubles would adversely affect wintertime habitat suitability. For summer habitat conditions, dredging would reduce aquatic vegetation coverage and percent littoral area with resulting benefits to habitat suitability. Overall habitat suitability would improve with a long-term composite HSI of 0.59.

Increment 2 dredging would further improve winter and summer habitat conditions (see Table LD-3). Depth and dissolved oxygen conditions would be optimized during the winter, while percent littoral area would be optimized during summer. Additional improvements in wintertime temperature conditions and summertime percent cover (vegetation) would also be realized. Composite habitat suitability would improve to between 0.81 and 0.82.

For dredging increment 3, wintertime criteria for depth and dissolved oxygen and would be fully met, as would the summertime criteria for percent vegetative cover and percent littoral area (see Table LD-4). Further improvement in wintertime temperature conditions above those provided by increment 2 dredging would also be realized. However, winterimte criteria for current velocity would still limit habitat suitability. Composite habitat suitability would improve only slightly over increment 2 dredging suitability. A composite habitat suitability index of 0.83 is projected.

Based on monitoring it appears that some Ambrough Slough flow passes into Big Missouri Lake, on into Upper Doubles Lake, and eventually into Lower Doubles Lake. Plugging the connection between Upper and Lower Doubles Lake would benefit winter current velocity and water temperature conditions in Lower Doubles Lake (see Table LD-5). However, the lack of deeper water and potentially inadequate dissolved oxgyen concentrations in the winter would limit habitat suitability. The overall composite HSI projected in Lower Doubles lake as a result of flow reduction is 0.50.

Combinations of increment 1, 2 and 3 dredging and flow reduction are presented in Tables LD-6 through LD-8. The combination of flow reduction and dredging in Lower Doubles results in relatively substantial incremental improvement in HSI above those provided by dredging alone. Flow reduction combined with dredging increment 1 increases the composite HSI from 0.59 to 0.80, while flow reduction combined with dredging increment 2 increases the composite HSI from 0.81 to 0.88.

Fish Lake - Dredging and flow reduction were both evaluated for for potential benefits to centrarchid habitat in Fish Lake.

Increment 1 dredging would result in improved depth and temperature conditions for bluegills during the winter and improved cover conditions during the summer. However, because the lake would remain relatively open to inflows, current velocties during the winter would remain unsuitable. Overall, the composite HSI would increase from a baseline condition of 0.43 to a with project condition of 0.58 (see Table FS-2).

Increment 2 dredging would result in further improvements in the same factors as discussed for increment 1 dredging, however, again the high winter flows through the lake would adversely affect winter habitat suitability. The overall composite HSI would increase to 0.59 (see Table FS-3).

As with both increment 1 and 2 dredging, increment 3 dredging would improve winter conditions for depth and temperature, but current velocity would remain unsuitable. Composite HSI would increase to 0.60 (see Table FS-4).

As indicated above, flow reduction has the potential for improving habitat conditions in Fish Lake. The lake is quite open on it's east side to Ambrough Slough and to Dark Slough on the south. This probably allows considerable water exchange between the two, which probably is a contributing factor to excessive current velocities and low water temperatures. During high winter discharges, flow also enters Fish Lake from its connective channel to Lower Doubles Lake to the north. Reduced flows through the lake would dramatically improve winter conditions. The project composite HSI would increase from a baseline condition of 0.43 to a with project condition of 0.71 (see Table FS-5).

Combinations of increment 1, 2 and 3 dredging and flow reduction are presented in Tables FS-6 through FS-8. As would be expected, the combination of flow reduction and dredging results in relatively substantial incremental improvement in HSI above those provided by dredging alone. When compared to composite HSIs for dredging alone, the combination HSIs are typically 0.24 to 0.25 higher.

Tilmont Lake - Dredging, flow reduction and adding structure were all evaluated for Tilmont Lake.

Increment 1 dredging would help meet the depth and dissolved oxygen criteria in Tilmont Lake, however, low wintertime temperatures would continue to affect habitat suitability. The composite HSI would increase over existing conditions from 0.43 to 0.55 (see Table TL-2).

Increment 2 dredging would further improve winter and summer habitat conditions (see Table TL-3). Depth and dissolved oxygen conditions would be optimized during the winter, while percent littoral area would be optimized during summer. Additional improvements in wintertime temperature conditions and summertime percent cover (vegetation) would also be realized. Composite habitat suitability would improve to between 0.79 and 0.8.

For dredging increment 3, wintertime criteria for depth and dissolved oxygen would be fully met, as would the summertime criteria for percent vegetative cover and percent littoral area (see Table TL-4). However, winterimte criteria for current velocity would limit habitat suitability. Composite habitat suitability would improve to between 0.81 and 0.82.

Flow reduction would appear to be a potential measure for improving habitat conditions in Tilmont Lake. The lake is quite open on it's east side to Mud Hen Slough. This probably allows considerable water exchange between the two, which probably is a contributing factor to low water temperatures. Measures to reduce flows into Tilmont Lake would include restoration of the land mass that used to separate the lake from Mud Hen Slough and closing other small opening entering the lake from an upstream direction. Reduced flows into Tilmont Lake would enhance wintertime habitat suitability by reducing current velocities in overwintering areas. The projected composite HSI for Tilmont would increase over baseline conditions from 0.43 to 0.72 (see Table TL-5).

The addition of structure such as brush and/or logs would have a very minor impact on habitat suitability in Tilmont Lake. Addition of structure would improve summertime habitat conditions, however, wintertime conditions would remain relatively poor. Overall, addition of structure would only increase the composite HSI from 0.43 to 0.46 (see Table TL-6).

Combinations of increment 1, 2 and 3 dredging, flow reduction and addition of structure are presented in Tables UD-7 through UD-15. The combination of dredging and flow reduction results in relatively significant positive impacts on habitat suitability compared to simply dredging or reducing flows individually. Addition of structure in combination with other alternatives does not greatly enhance habitat suitability.

Gremore Lake - Gremore Lake meets most of the habitat criteria for backwater fish species except for one significant parameter, winter dissolved oxygen. Three alternatives were identified for Gremore Lake to address the dissolved oxygen depletion problems in the lake; flow introductions, dredging to create additional volume and mechanical aeration.

The depth conditions currently present in Gremore Lake meet the criteria defined by increment 1 dredging, therefore, this increment was not assessed and/or is evaluated under the without project condition. Increment 2 dredging would result in improved conditions for bluegills by increasing the volume of deep water available. In theory, a larger volume of water should retain dissolved oxygen better during the winter months. A composite HSI of 0.87 is projected for Gremore Lake if increment 2 dredging is completed (see Table GR-2).

Increment 3 dredging would improve the dissolved oxygen and temperature conditions in Gremore Lake, however, the overall benefits to habitat suitability would be minor. An increase of only 0.01 in the composite HSI over increment 2 dredging is projected (see Table GR-3).

Flow introduction would improve dissolved oxygen conditions in Gremore Lake but would adversely impact current velocities. The composite HSI would increase over baseline conditions from 0.59 to 0.80 (see Table GR-4).

Mechanical aeration would greatly enhance habitat suitability in Gremore Lake. Adequate dissolved oxygen would be ensured throughout the winter months. The composite HSI would increase from 0.59 to 0.87.

By meeting most if not all of the wintertime criteria (depth, dissolved oxgyen, temperature and current velocity), the combination of dredging and flow introduction and dredging and mechanical aeration nearly optimize habitat suitability in Gremore Lake (see Tables GR-5 through GR-9.

HABITAT UNIT CALCULATIONS

Habitat unit gains for the various project components and combinations are summarized in Table HEP-1.

Because Gremore Lake is larger than any of the other lakes in the Ambrough Slough complex, the largest gains in habitat units occur as a result of management measure implemented in this lake. Increment 2 dredging and mechanical aeration would result in similar habitat gains in Gremore Lake. Flow introduction would also improve habitats in Gremore Lake, however, the overall habitat gain would not be as large as that provided by dredging or aeration. Increment 3 dredging in Gremore Lake would result in a relatively small increase in habitat as compared to increment 2 dredging or the other possible alternatives. The combination of increment 2 dredging and mechanical aeration would result in the largest habitat gain (153.0 AAHU) when compared to other combined alternatives.

For dredging, the largest habitat gains would be realized in Spring, Upper Doubles and Tilmont Lake. In Spring Lake, the initial increment 1 dredging would result in a net gain of 14.1 AAHU. In Upper Doubles increment 1 dredging would result an 8.4 AAHU gain. Both increment 2 and increment 3 dredging in these lakes would result in further habitat gains, however, the incremental increase in habitat would be smaller than the initial gain. In contrast, increment 2 dredging in Tilmont Lake would have a larger incremental increase in habitat value than increment 1 dredging.

Flow reduction in Tilmont and Fish Lakes would provide relatively large gains in habitat.

The combination of dredging and flow reduction in Fish and Tilmont Lakes would provide comparitively large increases in habitat. For Tilmont Lake an incremental increase of 21 AAHU would be realized over only dredging and 6.1 AAHU over only flow reduction. Similar incremental increases would be realized in Fish Lake.

In general, it appears that dredging in Spring, Upper Doubles, Tilmont and Gremore Lakes would result in the most benefits to bluegill habitats. If dredging were combined with flow reduction in Tilmont Lake and mechanical aeration in Gremore Lake, the overall habitat benefits would be increased substantially.

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ENCLOSURE 1

HABITAT SUITABILITY INDEX MATRIXES

Bluegill Habitat

Table SP-1. Spring - Baseline: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	25%	1	25%	1	25%	1	25%	1
V3	% Cover (vegetation)	90%	0.15	90%	0.15	90%	0.15	95%	0.05
V4	% Littoral Area	90%	0.25	90%	0.25	90%	0.25	95%	0.15
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7
	Food (Cf)		0.53		0.53		0.53		0.37
	Cover (Cc)		0.58		0.58		0.58		0.53
	Water Quality (Cwq)		0.88		0.88		0.88		0.88
	Reproduction (Cr)		0.89		0.89		0.89		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.77		0.77		0.77		0.72

WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
Va	Water Depth	0%	0.4	0%	0.4	0%	0.4	0%	0.4
Vb	Dissolved Oxygen	Class C	0.40	Class C	0.40	Class C	0.40	Class C	0.40
Vc	Water Temperature	2 degrees C	0.68	2 degrees C	0.68	2 degrees C	0.68	2 degrees C	0.68
Vd	Current Velocity	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75
	Winter Cover (Cw-c)		0.40		0.40		0.40		0.40
	Winter Water Quality (Cw-wq)		0.49		0.49		0.49		0.49
	Corrected Cw-wq		0.40		0.40		0.40		0.40
	Winter Other (Cw-ot)		0.75		0.75		0.75		0.75
	Winter HSI		0.52		0.52		0.52		0.52
	Corrected Winter HSI		0.40		0.40		0.40		0.40
	Composite HSI with Winter Modifications		0.56		0.56		0.56		0.53
	Acreage		54.4		54.4		54.4		54.4
	Year		0		1		10		50
	Habitat Units (HUs)		30.2		272.0		1186.5		

1488.7

Average Annual HUs 29.8

Table SP-2. Spring - Dredging Increment 1: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	25%	1	25%	1	25%	1	25%	1
V3	% Cover (vegetation)	90%	0.15	60%	0.57	60%	0.57	65%	0.5
V4	% Littoral Area	90%	0.25	60%	1	60%	1	65%	0.85
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7
	Food (Cf)		0.53		0.83		0.83		0.79
	Cover (Cc)		0.58		0.79		0.79		0.75
	Water Quality (Cwq)		0.88		0.88		0.88		0.88
	Reproduction (Cr)		0.89		1.00		1.00		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.77		0.89		0.89		0.86
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
Va	Water Depth	0%	0.40	40%	0.87	40%	0.87	35%	0.81
Vb	Dissolved Oxygen	Class C	0.40	Class B	0.70	Class B	0.70	Class B	0.70
Vc	Water Temperature	2 degrees C	0.68	2 degrees C	0.68	2 degrees C	0.68	2 degrees C	0.68
Vd	Current Velocity	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75
	Winter Cover (Cw-c)		0.40		0.87		0.87		0.81
	Winter Water Quality (Cw-wq)		0.49		0.69		0.69		0.69
	Corrected Cw-wq		0.40		N/A		N/A		N/A
	Winter Other (Cw-ot)		0.75		0.75		0.75		0.75
	Winter HSI		0.52		0.75		0.75		0.74
	Corrected Winter HSI		0.40		N/A		N/A		N/A
	Composite HSI with Winter Modifications		0.56		0.82		0.82		0.80
	Acreage		54.4		54.4		54.4		54.4
	Year		0		1		10		50
	Habitat Units (HUs)		37.3		400.2		1755.7		

2193.3

Average Annual HUs 43.9

Table SP-3. Spring - Dredging Increment 2: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	25%	1	25%	1	25%	1	25%	1
V3	% Cover (vegetation)	90%	0.15	40%	0.87	40%	0.87	45%	0.8
V4	% Littoral Area	90%	0.25	40%	1	40%	1	45%	1
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7
	Food (Cf)		0.53		0.95		0.95		0.93
	Cover (Cc)		0.58		0.94		0.94		0.90
	Water Quality (Cwq)		0.88		0.88		0.88		0.88
	Reproduction (Cr)		0.89		1.00		1.00		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.77		0.94		0.94		0.91

WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
Va	Water Depth	0%	0.40	60%	1.00	60%	1.00	55%	1.00
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00
Vc	Water Temperature	2 degrees C	0.68	2-3 degrees C	0.75	2-3 degrees C	0.75	2-3 degrees C	0.75
Vd	Current Velocity	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75
	Winter Cover (Cw-c)		0.40		1.00		1.00		1.00
	Winter Water Quality (Cw-wq)		0.49		0.92		0.92		0.92
	Corrected Cw-wq		0.40		N/A		N/A		N/A
	Winter Other (Cw-ot)		0.75		0.75		0.75		0.75
	Winter HSI		0.52		0.89		0.89		0.89
	Corrected Winter HSI		0.40		N/A		N/A		N/A
	Composite HSI with Winter Modifications		0.56		0.92		0.92		0.90
	Acreage		54.4		54.4		54.4		54.4
	Year		0		1		10		50
	Habitat Units (HUs)		40.0		448.3		1977.3		2465.7
								Average Annual HUs	49.3

Table SP-4. Spring - Dredging Increment 3: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	25%	1	25%	1	25%	1	25%	1
V3	% Cover (vegetation)	90%	0.15	20%	1	20%	1	25%	1
V4	% Littoral Area	90%	0.25	20%	1	20%	1	25%	1
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7
	Food (Cf)		0.53		1.00		1.00		1.00
	Cover (Cc)		0.58		1.00		1.00		1.00
	Water Quality (Cwq)		0.88		0.88		0.88		0.88
	Reproduction (Cr)		0.89		1.00		1.00		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.77		0.96		0.96		0.94

WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	0%	0.40	80%	1.00	80%	1.00	75%	1.00	
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	2 degrees C	0.68	3-4 degrees C	1.00	3-4 degrees C	1.00	3-4 degrees C	1.00	
Vd	Current Velocity	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.40		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.49		1.00		1.00		1.00	
	Corrected Cw-wq		0.40		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.75		0.75		0.75		0.75	
	Winter HSI		0.52		0.93		0.93		0.93	
	Corrected Winter HSI		0.40		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.56		0.94		0.94		0.94	
	Acreage		54.4		54.4		54.4		54.4	
	Year		0		1		10		50	
	Habitat Units (HUs)		40.8		462.5		2045.6			2549.0
									Average Annual HUs	51.0

Table BM-1. Big Missouri - Baseline: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8
V3	% Cover (vegetation)	76%	0.35	76%	0.35	76%	0.35	80%	0.28
V4	% Littoral Area	76%	0.6	76%	0.6	76%	0.6	80%	0.5
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7
	Food (Cf)		0.65		0.65		0.65		0.61
	Cover (Cc)		0.58		0.58		0.58		0.54
	Water Quality (Cwq)		0.88		0.88		0.88		0.88
	Reproduction (Cr)		0.89		0.89		0.89		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.80		0.80		0.80		0.78

WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	15%	0.55	15%	0.55	15%	0.55	10%	0.51	
Vb	Dissolved Oxygen	Class B-C	0.55	Class B-C	0.55	Class C	0.40	Class C	0.40	
Vc	Water Temperature	1-2 degrees C	0.60	1-2 degrees C	0.60	1-2 degrees C	0.60	1-2 degrees C	0.60	
Vd	Current Velocity	+/- 1 cm/sec	0.50	+/- 1 cm/sec	0.50	+/- 1 cm/sec	0.50	+/- 1 cm/sec	0.50	
	Winter Cover (Cw-c)		0.55		0.55		0.55		0.51	
	Winter Water Quality (Cw-wq)		0.57		0.57		0.47		0.47	
	Corrected Cw-wq		N/A		N/A		0.40		0.40	
	Winter Other (Cw-ot)		0.50		0.50		0.50		0.50	
	Winter HSI		0.55		0.55		0.49		0.49	
	Corrected Winter HSI		N/A		N/A		0.40		0.40	
	Composite HSI with Winter Modifications		0.66		0.66		0.57		0.56	
	Acreage		32.1		32.1		32.1		32.1	
	Year		0		1		10		50	
	Habitat Units (HUs)		21.2		177.0		721.8			919.9
									Average Annual HUs	18.4

Table BM-2. Big Missouri - Dredging Increment 1: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project Year 1		Future With Project Year 10		Future With Project Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	76%	0.35	60%	0.57	60%	0.57	65%	0.5	
V4	% Littoral Area	76%	0.6	60%	1	60%	1	65%	0.85	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.65		0.77		0.77		0.74	
	Cover (Cc)		0.58		0.69		0.69		0.65	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.80		0.86		0.86		0.83	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project Year 1		Future With Project Year 10		Future With Project Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	15%	0.55	40%	0.87	40%	0.87	35%	0.81	
Vb	Dissolved Oxygen	Class B-C	0.55	Class B	0.70	Class B	0.70	Class B	0.70	
Vc	Water Temperature	1-2 degrees C	0.60	2-3 degrees C	0.75	2-3 degrees C	0.75	2-3 degrees C	0.75	
Vd	Current Velocity	+/- 1 cm/sec	0.50	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.55		0.87		0.87		0.81	
	Winter Water Quality (Cw-wq)		0.57		0.72		0.72		0.72	
	Corrected Cw-wq		N/A		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.50		0.75		0.75		0.75	
	Winter HSI		0.55		0.76		0.76		0.75	
	Corrected Winter HSI		N/A		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.66		0.81		0.81		0.79	
	Acreage		32.1		32.1		32.1		32.1	
	Year		0		1		10		50	
	Habitat Units (HUs)		23.6		234.0		1026.1			1283.7
								Average Annual HUs		25.7

Table BM-3. Big Missouri - Dredging Increment 2: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8
V3	% Cover (vegetation)	76%	0.35	40%	0.86	40%	0.86	45%	0.8
V4	% Littoral Area	76%	0.6	40%	1	40%	1	45%	1
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7
	Food (Cf)		0.65		0.88		0.88		0.86
	Cover (Cc)		0.58		0.83		0.83		0.80
	Water Quality (Cwq)		0.88		0.88		0.88		0.88
	Reproduction (Cr)		0.89		1.00		1.00		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.80		0.91		0.91		0.88

WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
Va	Water Depth	15%	0.55	60%	1.00	60%	1.00	55%	1.00
Vb	Dissolved Oxygen	Class B-C	0.55	Class A	1.00	Class A	1.00	Class A	1.00
Vc	Water Temperature	1-2 degrees C	0.60	2-3 degrees C	0.75	2-3 degrees C	0.75	2-3 degrees C	0.75
Vd	Current Velocity	+/- 1 cm/sec	0.50	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75
	Winter Cover (Cw-c)		0.55		1.00		1.00		1.00
	Winter Water Quality (Cw-wq)		0.57		0.92		0.92		0.92
	Corrected Cw-wq		N/A		N/A		N/A		N/A
	Winter Other (Cw-ot)		0.50		0.75		0.75		0.75
	Winter HSI		0.55		0.89		0.89		0.89
	Corrected Winter HSI		N/A		N/A		N/A		N/A
	Composite HSI with Winter Modifications		0.66		0.90		0.90		0.89
	Acreage		32.1		32.1		32.1		32.1
	Year		0		1		10		50
	Habitat Units (HUs)		25.0		260.2		1148.0		

1433.3

Average Annual HUs 28.7

Table BM-4. Big Missouri - Dredging Increment 3: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	76%	0.35	20%	1	20%	1	25%	1	
V4	% Littoral Area	76%	0.6	20%	1	20%	1	25%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.65		0.93		0.93		0.93	
	Cover (Cc)		0.58		0.90		0.90		0.90	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.80		0.93		0.93		0.91	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	15%	0.55	80%	1.00	80%	1.00	75%	1.00	
Vb	Dissolved Oxygen	Class B-C	0.55	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	1-2 degrees C	0.60	3-4 degrees C	1.00	3-4 degrees C	1.00	3-4 degrees C	1.00	
Vd	Current Velocity	+/- 1 cm/sec	0.50	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.55		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.57		1.00		1.00		1.00	
	Corrected Cw-wq		N/A		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.50		0.75		0.75		0.75	
	Winter HSI		0.55		0.93		0.93		0.93	
	Corrected Winter HSI		N/A		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.66		0.93		0.93		0.92	
	Acreage		32.1		32.1		32.1		32.1	
	Year		0		1		10		50	
	Habitat Units (HUs)		25.5		268.9		1189.1			1483.5
								Average Annual HUs		29.7

Table BM-5. Big Missouri - Addition of Structure: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	20%	1	20%	1	20%	1	
V3	% Cover (vegetation)	76%	0.35	76%	0.35	76%	0.35	80%	0.28	
V4	% Littoral Area	76%	0.6	76%	0.6	76%	0.6	80%	0.5	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7	
	Food (Cf)		0.65		0.70		0.70		0.65	
	Cover (Cc)		0.58		0.68		0.68		0.64	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		0.89		0.89		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.80		0.83		0.83		0.81	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	15%	0.55	15%	0.55	15%	0.55	10%	0.51	
Vb	Dissolved Oxygen	Class B-C	0.55	Class B-C	0.55	Class C	0.40	Class C	0.40	
Vc	Water Temperature	1-2 degrees C	0.60	1-2 degrees C	0.60	1-2 degrees C	0.60	1-2 degrees C	0.60	
Vd	Current Velocity	+/- 1 cm/sec	0.50	+/- 1 cm/sec	0.50	+/- 1 cm/sec	0.50	+/- 1 cm/sec	0.50	
	Winter Cover (Cw-c)		0.55		0.55		0.55		0.51	
	Winter Water Quality (Cw-wq)		0.57		0.57		0.47		0.47	
	Corrected Cw-wq		N/A		N/A		0.40		0.40	
	Winter Other (Cw-ot)		0.50		0.50		0.50		0.50	
	Winter HSI		0.55		0.55		0.49		0.49	
	Corrected Winter HSI		N/A		N/A		0.40		0.40	
	Composite HSI with Winter Modifications		0.66		0.67		0.58		0.57	
	Acreage		32.1		32.1		32.1		32.1	
	Year		0		1		10		50	
	Habitat Units (HUs)		21.4		180.5		736.3			938.2
								Average Annual HUs		18.8

Table BM-6. Big Missouri - Dredging Increment 1 with Addition of Structure: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	20%	1	20%	1	20%	1	
V3	% Cover (vegetation)	76%	0.35	60%	0.57	60%	0.57	65%	0.5	
V4	% Littoral Area	76%	0.6	60%	1	60%	1	65%	0.85	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.65		0.83		0.83		0.79	
	Cover (Cc)		0.58		0.79		0.79		0.75	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.80		0.89		0.89		0.86	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	15%	0.55	40%	0.87	40%	0.87	35%	0.81	
Vb	Dissolved Oxygen	Class B-C	0.55	Class B	0.70	Class B	0.70	Class B	0.70	
Vc	Water Temperature	1-2 degrees C	0.60	2-3 degrees C	0.75	2-3 degrees C	0.75	2-3 degrees C	0.75	
Vd	Current Velocity	+/- 1 cm/sec	0.50	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.55		0.87		0.87		0.81	
	Winter Water Quality (Cw-wq)		0.57		0.72		0.72		0.72	
	Corrected Cw-wq		N/A		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.50		0.75		0.75		0.75	
	Winter HSI		0.55		0.76		0.76		0.75	
	Corrected Winter HSI		N/A		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.66		0.82		0.82		0.80	
	Acreage		32.1		32.1		32.1		32.1	
	Year		0		1		10		50	
	Habitat Units (HUs)		23.8		238.1		1044.6			1306.5
									Average Annual HUs	26.1

Table BM-7. Big Missouri - Dredging Increment 2 with Addition of Structure: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	20%	1	20%	1	20%	1	
V3	% Cover (vegetation)	76%	0.35	40%	0.86	40%	0.86	45%	0.8	
V4	% Littoral Area	76%	0.6	40%	1	40%	1	45%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.65		0.95		0.95		0.93	
	Cover (Cc)		0.58		0.93		0.93		0.90	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.80		0.94		0.94		0.91	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	15%	0.55	60%	1.00	60%	1.00	55%	1.00	
Vb	Dissolved Oxygen	Class B-C	0.55	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	1-2 degrees C	0.60	2-3 degrees C	0.75	2-3 degrees C	0.75	2-3 degrees C	0.75	
Vd	Current Velocity	+/- 1 cm/sec	0.50	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.55		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.57		0.92		0.92		0.92	
	Corrected Cw-wq		N/A		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.50		0.75		0.75		0.75	
	Winter HSI		0.55		0.89		0.89		0.89	
	Corrected Winter HSI		N/A		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.66		0.91		0.91		0.90	
	Acreage		32.1		32.1		32.1		32.1	
	Year		0		1		10		50	
	Habitat Units (HUs)		25.3		264.3		1166.3			1455.9
								Average Annual HUs		29.1

Table BM-8. Big Missouri - Dredging Increment 3 with Addition of Structure: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	20%	1	20%	1	20%	1	
V3	% Cover (vegetation)	76%	0.35	20%	1	20%	1	25%	1	
V4	% Littoral Area	76%	0.6	20%	1	20%	1	25%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.65		1.00		1.00		1.00	
	Cover (Cc)		0.58		1.00		1.00		1.00	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.80		0.96		0.96		0.94	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	15%	0.55	80%	1.00	80%	1.00	75%	1.00	
Vb	Dissolved Oxygen	Class B-C	0.55	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	1-2 degrees C	0.60	3-4 degrees C	1.00	3-4 degrees C	1.00	3-4 degrees C	1.00	
Vd	Current Velocity	+/- 1 cm/sec	0.50	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.55		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.57		1.00		1.00		1.00	
	Corrected Cw-wq		N/A		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.50		0.75		0.75		0.75	
	Winter HSI		0.55		0.93		0.93		0.93	
	Corrected Winter HSI		N/A		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.66		0.94		0.94		0.94	
	Acreage		32.1		32.1		32.1		32.1	
	Year		0		1		10		50	
	Habitat Units (HUs)		25.8		272.9		1207.1			1505.8
								Average Annual HUs		30.1

Table LD-1. Lower Doubles - Baseline: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	100%	0.01	100%	0.01	100%	0.01	100%	0.01	
V4	% Littoral Area	100%	0.01	100%	0.01	100%	0.01	100%	0.01	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7	
	Food (Cf)		0.20		0.20		0.20		0.20	
	Cover (Cc)		0.41		0.41		0.41		0.41	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		0.89		0.89		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.62		0.62		0.62		0.62	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	0%	0.40	0%	0.40	0%	0.40	0%	0.40	
Vb	Dissolved Oxygen	Class C	0.40	Class C	0.40	Class C	0.40	Class C	0.40	
Vc	Water Temperature	<1 degree C	0.25	<1 degree C	0.25	<1 degree C	0.25	<1 degree C	0.25	
Vd	Current Velocity	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	
	Winter Cover (Cw-c)		0.40		0.40		0.40		0.40	
	Winter Water Quality (Cw-wq)		0.35		0.35		0.35		0.35	
	Corrected Cw-wq		0.25		0.25		0.25		0.25	
	Winter Other (Cw-ot)		0.43		0.43		0.43		0.43	
	Winter HSI		0.38		0.38		0.38		0.38	
	Corrected Winter HSI		0.25		0.25		0.25		0.25	
	Composite HSI with Winter Modifications		0.39		0.39		0.39		0.39	
	Acreage		19.8		19.8		19.8		19.8	
	Year		0		1		10		50	
	Habitat Units (HUs)		7.8		70.1		311.5			389.4
									Average Annual HUs	7.8

Table LD-2. Lower Doubles - Dredging Increment 1: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8
V3	% Cover (vegetation)	100%	0.01	60%	0.57	60%	0.57	65%	0.8
V4	% Littoral Area	100%	0.01	60%	1	60%	1	65%	0.85
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7
	Food (Cf)		0.20		0.77		0.77		0.86
	Cover (Cc)		0.41		0.69		0.69		0.80
	Water Quality (Cwq)		0.88		0.88		0.88		0.88
	Reproduction (Cr)		0.89		1.00		1.00		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.62		0.86		0.86		0.88
WITH WINTER HSI MODIFICATIONS		**Existing Conditions**		**Future With Project - Year 1**		**Future With Project - Year 10**		**Future With Project - Year 50**	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
Va	Water Depth	0%	0.40	40%	0.87	40%	0.87	35%	0.81
Vb	Dissolved Oxygen	Class C	0.40	Class B	0.70	Class B	0.70	Class B	0.70
Vc	Water Temperature	<1 degree C	0.25	< 1 degrees C	0.40	< 1 degrees C	0.40	< 1 degrees C	0.40
Vd	Current Velocity	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43
	Winter Cover (Cw-c)		0.40		0.87		0.87		0.81
	Winter Water Quality (Cw-wq)		0.35		0.60		0.60		0.60
	Corrected Cw-wq		0.25		0.40		0.40		0.40
	Winter Other (Cw-ot)		0.43		0.43		0.43		0.43
	Winter HSI		0.38		0.61		0.61		0.60
	Corrected Winter HSI		0.25		0.40		0.40		0.40
	Composite HSI with Winter Modifications		0.39		0.59		0.59		0.59
	Acreage		19.8		19.8		19.8		19.8
	Year		0		1		10		50
	Habitat Units (HUs)		9.7		104.6		468.0		

582.3

Average Annual HUs 11.6

Table LD-3. Lower Doubles - Dredging Increment 2: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	100%	0.01	40%	0.87	40%	0.87	45%	0.8	
V4	% Littoral Area	100%	0.01	40%	1	40%	1	45%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0,75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.20		0.89		0.89		0.86	
	Cover (Cc)		0.41		0.84		0.84		0.80	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.62		0.91		0.91		0.88	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	0%	0.42	60%	1.00	60%	1.00	55%	1.00	
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	<1 degree C	0.25	1 degree C	0.50	1 degree C	0.50	1 degree C	0.50	
Vd	Current Velocity	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	
	Winter Cover (Cw-c)		0.42		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.35		0.83		0.83		0.83	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.43		0.43		0.43		0.43	
	Winter HSI		0.39		0.74		0.74		0.74	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.39		0.82		0.82		0.81	
	Acreage		19.8		19.8		19.8		19.8	
	Year		0		1		10		50	
	Habitat Units (HUs)		12.0		146.3		645.3			803.6
								Average Annual HUs		16.1

Table LD-4. Lower Doubles - Dredging Increment 3: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	100%	0.01	20%	1	20%	1	25%	1	
V4	% Littoral Area	100%	0.01	20%	1	20%	1	25%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.20		0.93		0.93		0.93	
	Cover (Cc)		0.41		0.90		0.90		0.90	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.62		0.93		0.93		0.91	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	0%	0.42	80%	1.00	80%	1.00	75%	1.00	
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	<1 degree C	0.25	1-2 degrees C	0.60	1-2 degrees C	0.60	1-2 degrees C	0.60	
Vd	Current Velocity	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	
	Winter Cover (Cw-c)		0.42		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.35		0.87		0.87		0.87	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.43		0.43		0.43		0.43	
	Winter HSI		0.39		0.75		0.75		0.75	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.39		0.84		0.84		0.83	
	Acreage		19.8		19.8		19.8		19.8	
	Year		0		1		10		50	
	Habitat Units (HUs)		12.2		149.3		660.2			821.6
								Average Annual HUs		16.4

Table LD-5. Lower Doubles - Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8
V3	% Cover (vegetation)	100%	0.01	100%	0.01	100%	0.01	100%	0.01
V4	% Littoral Area	100%	0.01	100%	0.01	100%	0.01	100%	0.01
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7
	Food (Cf)		0.20		0.20		0.20		0.20
	Cover (Cc)		0.41		0.41		0.41		0.41
	Water Quality (Cwq)		0.88		0.88		0.88		0.88
	Reproduction (Cr)		0.89		0.89		0.89		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.62		0.62		0.62		0.62

WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	0%	0.40	0%	0.40	0%	0.40	0%	0.40	
Vb	Dissolved Oxygen	Class C	0.40	Class C	0.40	Class C	0.40	Class C	0.40	
Vc	Water Temperature	<1 degree C	0.25	1-2 degrees C	0.60	1-2 degrees C	0.60	1-2 degrees C	0.60	
Vd	Current Velocity	1 cm/sec	0.43	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.40		0.40		0.40		0.40	
	Winter Water Quality (Cw-wq)		0.35		0.47		0.47		0.47	
	Corrected Cw-wq		0.25		0.40		0.40		0.40	
	Winter Other (Cw-ot)		0.43		0.75		0.75		0.75	
	Winter HSI		0.38		0.51		0.51		0.51	
	Corrected Winter HSI		0.25		0.40		0.40		0.40	
	Composite HSI with Winter Modifications		0.39		0.50		0.50		0.50	
	Acreage		19.8		19.8		19.8		19.8	
	Year		0		1		10		50	
	Habitat Units (HUs)		8.8190134		88.7		394.0			491.5
								Average Annual HUs		9.8

Table LD-6. Lower Doubles - Dredging Increment 1 with Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	100%	0.01	60%	0.57	60%	0.57	65%	0.8	
V4	% Littoral Area	100%	0.01	60%	1	60%	1	65%	0.85	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.20		0.77		0.77		0.86	
	Cover (Cc)		0.41		0.69		0.69		0.80	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.62		0.86		0.86		0.88	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	0%	0.40	40%	0.87	40%	0.87	35%	0.81	
Vb	Dissolved Oxygen	Class C	0.40	Class B	0.70	Class B	0.70	Class B	0.70	
Vc	Water Temperature	<1 degree C	0.25	1-2 degrees C	0.60	1-2 degrees C	0.60	1-2 degrees C	0.60	
Vd	Current Velocity	1 cm/sec	0.43	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.40		0.87		0.87		0.81	
	Winter Water Quality (Cw-wq)		0.35		0.67		0.67		0.67	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.43		0.75		0.75		0.75	
	Winter HSI		0.38		0.73		0.73		0.72	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.39		0.80		0.80		0.80	
	Acreage		19.8		19.8		19.8		19.8	
	Year		0		1		10		50	
	Habitat Units (HUs)		11.8		141.7		631.1			784.6
									Average Annual HUs	15.7

Table LD-7. Lower Doubles - Dredging Increment 2 with Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	100%	0.01	40%	0.87	40%	0.87	45%	0.8	
V4	% Littoral Area	100%	0.01	40%	1	40%	1	45%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.20		0.89		0.89		0.86	
	Cover (Cc)		0.41		0.84		0.84		0.80	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.62		0.91		0.91		0.88	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	0%	0.42	60%	1.00	60%	1.00	55%	1.00	
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	<1 degree C	0.25	2 degrees C	0.68	2 degrees C	0.68	2 degrees C	0.68	
Vd	Current Velocity	1 cm/sec	0.43	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.42		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.35		0.89		0.89		0.89	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.43		0.75		0.75		0.75	
	Winter HSI		0.39		0.88		0.88		0.88	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.39		0.90		0.90		0.88	
	Acreage		19.8		19.8		19.8		19.8	
	Year		0		1		10		50	
	Habitat Units (HUs)		12.8		159.6		703.9			876.2
									Average Annual HUs	17.5

Table LD-8. Lower Doubles - Dredging Increment 3 with Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	100%	0.01	20%	1	20%	1	25%	1	
V4	% Littoral Area	100%	0.01	20%	1	20%	1	25%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.20		0.93		0.93		0.93	
	Cover (Cc)		0.41		0.90		0.90		0.90	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.62		0.93		0.93		0.91	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	0%	0.42	80%	1.00	80%	1.00	75%	1.00	
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	<1 degree C	0.25	2-3 degrees C	0.75	2-3 degrees C	0.75	2-3 degrees C	0.75	
Vd	Current Velocity	1 cm/sec	0.43	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.42		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.35		0.92		0.92		0.92	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.43		0.75		0.75		0.75	
	Winter HSI		0.39		0.89		0.89		0.89	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.39		0.91		0.91		0.90	
	Acreage		19.8		19.8		19.8		19.8	
	Year		0		1		10		50	
	Habitat Units (HUs)		12.9		162.3		717.7			892.9
									Average Annual HUs	17.9

Table UD-1. Upper Doubles - Baseline: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4	
V3	% Cover (vegetation)	95%	0.05	95%	0.05	95%	0.05	100%	0.01	
V4	% Littoral Area	95%	0.1	95%	0.1	95%	0.1	100%	0.01	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7	
	Food (Cf)		0.27		0.27		0.27		0.16	
	Cover (Cc)		0.23		0.23		0.23		0.21	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		0.89		0.89		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.59		0.59		0.59		0.53	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	3%	0.42	3%	0.42	3%	0.42	0%	0.40	
Vb	Dissolved Oxygen	Class C	0.40	Class C	0.40	Class C	0.40	Class D	0.10	
Vc	Water Temperature	1 degree C	0.50	1 degree C	0.50	1 degree C	0.50	1 degree C	0.50	
Vd	Current Velocity	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	
	Winter Cover (Cw-c)		0.42		0.42		0.42		0.40	
	Winter Water Quality (Cw-wq)		0.43		0.43		0.43		0.23	
	Corrected Cw-wq		0.40		0.40		0.40		0.10	
	Winter Other (Cw-ot)		0.43		0.43		0.43		0.43	
	Winter HSI		0.43		0.43		0.43		0.31	
	Corrected Winter HSI		0.40		0.40		0.40		0.10	
	Composite HSI with Winter Modifications		0.49		0.49		0.49		0.41	
	Acreage		34.6		34.6		34.6		34.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		16.8		151.3		617.7			785.8
									Average Annual HUs	15.7

Table UD-2. Upper Doubles - Dredging Increment 1: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4	
V3	% Cover (vegetation)	95%	0.05	60%	0.57	60%	0.57	65%	0.5	
V4	% Littoral Area	95%	0.1	60%	1	60%	1	65%	0.85	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.27		0.61		0.61		0.59	
	Cover (Cc)		0.23		0.49		0.49		0.45	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.59		0.78		0.78		0.75	
WITH WINTER HSI MODIFICATIONS		**Existing Conditions**		**Future With Project - Year 1**		**Future With Project - Year 10**		**Future With Project - Year 50**		
Variable	**Description**	**DATA**	**HSI**	**DATA**	**HSI**	**DATA**	**HSI**	**DATA**	**HSI**	
Va	Water Depth	3%	0.42	40%	0.87	40%	0.87	35%	0.81	
Vb	Dissolved Oxygen	Class C	0.40	Class B	0.70	Class B	0.70	Class B	0.70	
Vc	Water Temperature	1 degree C	0.50	1-2 degrees C	0.60	1-2 degrees C	0.60	1-2 degrees C	0.60	
Vd	Current Velocity	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	
	Winter Cover (Cw-c)		0.42		0.87		0.87		0.81	
	Winter Water Quality (Cw-wq)		0.43		0.67		0.67		0.67	
	Corrected Cw-wq		0.40		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.43		0.43		0.43		0.43	
	Winter HSI		0.43		0.64		0.64		0.63	
	Corrected Winter HSI		0.40		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.49		0.71		0.71		0.69	
	Acreage		34.6		34.6		34.6		34.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		20.6		220.2		964.9			1205.8
									Average Annual HUs	24.1

Table UD-3. Upper Doubles - Dredging Increment 2: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4	
V3	% Cover (vegetation)	95%	0.05	40%	0.87	40%	0.87	45%	0.8	
V4	% Littoral Area	95%	0.1	40%	1	40%	1	45%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.27		0.70		0.70		0.68	
	Cover (Cc)		0.23		0.64		0.64		0.60	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.59		0.84		0.84		0.81	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	3%	0.42	60%	1.00	60%	1.00	55%	1.00	
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	1 degree C	0.50	2 degrees C	0.68	2 degrees C	0.68	2 degrees C	0.68	
Vd	Current Velocity	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	
	Winter Cover (Cw-c)		0.42		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.43		0.89		0.89		0.89	
	Corrected Cw-wq		0.40		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.43		0.43		0.43		0.43	
	Winter HSI		0.43		0.77		0.77		0.77	
	Corrected Winter HSI		0.40		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.49		0.80		0.80		0.79	
	Acreage		34.6		34.6		34.6		34.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		22.3		249.5		1099.5			1371.2
								Average Annual HUs		27.4

Table UD-4. Upper Doubles - Dredging Increment 3: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4	
V3	% Cover (vegetation)	95%	0.05	20%	1	20%	1	25%	1	
V4	% Littoral Area	95%	0.1	20%	1	20%	1	25%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.27		0.74		0.74		0.74	
	Cover (Cc)		0.23		0.70		0.70		0.70	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.59		0.86		0.86		0.84	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	3%	0.42	80%	1.00	80%	1.00	75%	1.00	
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	1 degree C	0.50	2-3 degrees C	0.75	2-3 degrees C	0.75	2-3 degrees C	0.75	
Vd	Current Velocity	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	
	Winter Cover (Cw-c)		0.42		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.43		0.92		0.92		0.92	
	Corrected Cw-wq		0.40		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.43		0.43		0.43		0.43	
	Winter HSI		0.43		0.78		0.78		0.78	
	Corrected Winter HSI		0.40		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.49		0.82		0.82		0.81	
	Acreage		34.6		34.6		34.6		34.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		22.5		254.1		1123.9			1400.5
								Average Annual HUs		28.0

Table UD-5. Upper Doubles - Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4	
V3	% Cover (vegetation)	95%	0.05	95%	0.05	95%	0.05	100%	0.01	
V4	% Littoral Area	95%	0.1	95%	0.1	95%	0.1	100%	0.01	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7	
	Food (Cf)		0.27		0.27		0.27		0.16	
	Cover (Cc)		0.23		0.23		0.23		0.21	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		0.89		0.89		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.59		0.59		0.59		0.53	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	3%	0.42	3%	0.42	3%	0.42	0%	0.40	
Vb	Dissolved Oxygen	Class C	0.40	Class C	0.40	Class C	0.40	Class C	0.40	
Vc	Water Temperature	1 degree C	0.50	1-2 degrees C	0.60	1-2 degrees C	0.60	1-2 degrees C	0.60	
Vd	Current Velocity	1 cm/sec	0.43	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.42		0.42		0.42		0.40	
	Winter Water Quality (Cw-wq)		0.43		0.47		0.47		0.47	
	Corrected Cw-wq		0.40		0.40		0.40		0.40	
	Winter Other (Cw-ot)		0.43		0.75		0.75		0.75	
	Winter HSI		0.43		0.51		0.51		0.51	
	Corrected Winter HSI		0.40		0.40		0.40		0.40	
	Composite HSI with Winter Modifications		0.49		0.49		0.49		0.46	
	Acreage		34.6		34.6		34.6		34.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		16.8		151.3		655.4			823.5
									Average Annual HUs	16.5

Table UD-6. Upper Doubles - Dredging Increment 1 with Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4	
V3	% Cover (vegetation)	95%	0.05	60%	0.57	60%	0.57	65%	0.5	
V4	% Littoral Area	95%	0.1	60%	1	60%	1	65%	0.85	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.27		0.61		0.61		0.59	
	Cover (Cc)		0.23		0.49		0.49		0.45	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.59		0.78		0.78		0.75	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	3%	0.42	40%	0.87	40%	0.87	35%	0.81	
Vb	Dissolved Oxygen	Class C	0.40	Class B	0.70	Class B	0.70	Class B	0.70	
Vc	Water Temperature	1 degree C	0.50	1-2 degrees C	0.60	1-2 degrees C	0.60	1-2 degrees C	0.60	
Vd	Current Velocity	1 cm/sec	0.43	<1 cm/sec	0.75	<1 cm/sec	0.75	<1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.42		0.87		0.87		0.81	
	Winter Water Quality (Cw-wq)		0.43		0.67		0.67		0.67	
	Corrected Cw-wq		0.40		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.43		0.75		0.75		0.75	
	Winter HSI		0.43		0.73		0.73		0.72	
	Corrected Winter HSI		0.40		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.49		0.76		0.76		0.74	
	Acreage		34.6		34.6		34.6		34.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		21.5		236.1		1034.4			1292.0
								Average Annual HUs		25.8

Table UD-7. Upper Doubles - Dredging Increment 2 with Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4
V3	% Cover (vegetation)	95%	0.05	40%	0.87	40%	0.87	45%	0.8
V4	% Littoral Area	95%	0.1	40%	1	40%	1	45%	1
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7
	Food (Cf)		0.27		0.70		0.70		0.68
	Cover (Cc)		0.23		0.64		0.64		0.60
	Water Quality (Cwq)		0.88		0.88		0.88		0.88
	Reproduction (Cr)		0.89		1.00		1.00		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.59		0.84		0.84		0.81
WITH WINTER HSI MODIFICATIONS		**Existing Conditions**		**Future With Project - Year 1**		**Future With Project - Year 10**		**Future With Project - Year 50**	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
Va	Water Depth	3%	0.42	60%	1.00	60%	1.00	55%	1.00
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00
Vc	Water Temperature	1 degree C	0.50	2 degrees C	0.68	2 degrees C	0.68	2 degrees C	0.68
Vd	Current Velocity	1 cm/sec	0.43	<1 cm/sec	0.75	<1 cm/sec	0.75	<1 cm/sec	0.75
	Winter Cover (Cw-c)		0.42		1.00		1.00		1.00
	Winter Water Quality (Cw-wq)		0.43		0.89		0.89		0.89
	Corrected Cw-wq		0.40		N/A		N/A		N/A
	Winter Other (Cw-ot)		0.43		0.75		0.75		0.75
	Winter HSI		0.43		0.88		0.88		0.88
	Corrected Winter HSI		0.40		N/A		N/A		N/A
	Composite HSI with Winter Modifications		0.49		0.86		0.86		0.84
	Acreage		34.6		34.6		34.6		34.6
	Year		0		1		10		50
	Habitat Units (HUs)		23.3		267.4		1178.7		1469.4
								Average Annual HUs	29.4

Table UD-8. Upper Doubles - Dredging Increment 3 with Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4	
V3	% Cover (vegetation)	95%	0.05	20%	1	20%	1	25%	1	
V4	% Littoral Area	95%	0.1	20%	1	20%	1	25%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.27		0.74		0.74		0.74	
	Cover (Cc)		0.23		0.70		0.70		0.70	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.59		0.86		0.86		0.84	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	3%	0.42	80%	1.00	80%	1.00	75%	1.00	
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	1 degree C	0.50	2-3 degrees C	0.75	2-3 degrees C	0.75	2-3 degrees C	0.75	
Vd	Current Velocity	1 cm/sec	0.43	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.42		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.43		0.92		0.92		0.92	
	Corrected Cw-wq		0.40		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.43		0.75		0.75		0.75	
	Winter HSI		0.43		0.89		0.89		0.89	
	Corrected Winter HSI		0.40		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.49		0.87		0.87		0.87	
	Acreage		34.6		34.6		34.6		34.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		23.5		272.4		1204.8			1500.8
									Average Annual HUs	30.0

Table FS-1. Fish - Baseline: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	90%	0.15	90%	0.15	90%	0.15	95%	0.05	
V4	% Littoral Area	90%	0.25	90%	0.25	90%	0.25	95%	0.15	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7	
	Food (Cf)		0.49		0.49		0.49		0.34	
	Cover (Cc)		0.48		0.48		0.48		0.43	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		0.89		0.89		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.74		0.74		0.68	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	12%	0.53	12%	0.53	12%	0.53	10%	0.51	
Vb	Dissolved Oxygen	Class A	1	Class A	1	Class A	1	Class A	1	
Vc	Water Temperature	<1 degree C	0.25	<1 degree C	0.25	<1 degree C	0.25	<1 degree C	0.25	
Vd	Current Velocity	> 1 cm/sec	0.25	> 1 cm/sec	0.25	> 1 cm/sec	0.25	> 1 cm/sec	0.25	
	Winter Cover (Cw-c)		0.53		0.53		0.53		0.51	
	Winter Water Quality (Cw-wq)		0.75		0.75		0.75		0.75	
	Corrected Cw-wq		0.25		0.25		0.25		0.25	
	Winter Other (Cw-ot)		0.25		0.25		0.25		0.25	
	Winter HSI		0.52		0.52		0.52		0.52	
	Corrected Winter HSI		0.25		0.25		0.25		0.25	
	Composite HSI with Winter Modifications		0.43		0.43		0.43		0.41	
	Acreage		46.9		46.9		46.9		46.9	
	Year		0		1		10		50	
	Habitat Units (HUs)		20.2		181.4		790.3			991.9
									Average Annual HUs	19.8

Table FS-2. Fish - Dredging Increment 1: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	90%	0.15	60%	0.57	60%	0.57	65%	0.5	
V4	% Littoral Area	90%	0.25	60%	1	60%	1	65%	0.85	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.49		0.77		0.77		0.74	
	Cover (Cc)		0.48		0.69		0.69		0.65	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.86		0.86		0.83	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	12%	0.53	40%	0.87	40%	0.87	35%	0.81	
Vb	Dissolved Oxygen	Class A	1	Class A	1	Class A	1	Class A	1	
Vc	Water Temperature	<1 degree C	0.25	< 1 degree C	0.4	< 1 degree C	0.4	< 1 degree C	0.4	
Vd	Current Velocity	> 1 cm/sec	0.25	> 1 cm/sec	0.25	> 1 cm/sec	0.25	> 1 cm/sec	0.25	
	Winter Cover (Cw-c)		0.53		0.87		0.87		0.81	
	Winter Water Quality (Cw-wq)		0.75		0.8		0.8		0.8	
	Corrected Cw-wq		0.25		0.4		0.4		0.4	
	Winter Other (Cw-ot)		0.25		0.25		0.25		0.25	
	Winter HSI		0.52		0.61		0.61		0.60	
	Corrected Winter HSI		0.25		0.4		0.4		0.4	
	Composite HSI with Winter Modifications		0.43		0.59		0.59		0.58	
	Acreage		46.9		46.9		46.9		46.9	
	Year		0		1		10		50	
	Habitat Units (HUs)		23.8		247.9		1091.9			1363.6
								Average Annual HUs		27.3

Table FS-3. Fish - Dredging Increment 2: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	90%	0.15	40%	0.87	40%	0.87	45%	0.8	
V4	% Littoral Area	90%	0.25	40%	1	40%	1	45%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	1	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.49		0.89		0.89		0.86	
	Cover (Cc)		0.48		0.84		0.84		0.80	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		1.00		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.75		0.91		0.91		0.88	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	12%	0.53	60%	1	60%	1	55%	1	
Vb	Dissolved Oxygen	Class A	1	Class A	1	Class A	1	Class A	1	
Vc	Water Temperature	<1 degree C	0.25	< 1 degree C	0.4	< 1 degree C	0.4	< 1 degree C	0.4	
Vd	Current Velocity	> 1 cm/sec	0.25	> 1 cm/sec	0.25	> 1 cm/sec	0.25	> 1 cm/sec	0.25	
	Winter Cover (Cw-c)		0.53		1		1		1	
	Winter Water Quality (Cw-wq)		0.75		0.8		0.8		0.8	
	Corrected Cw-wq		0.25		0.4		0.4		0.4	
	Winter Other (Cw-ot)		0.25		0.25		0.25		0.25	
	Winter HSI		0.52		0.63		0.63		0.63	
	Corrected Winter HSI		0.25		0.4		0.4		0.4	
	Composite HSI with Winter Modifications		0.43		0.60		0.60		0.59	
	Acreage		46.9		46.9		46.9		46.9	
	Year		0		1		10		50	
	Habitat Units (HUs)		24.3		255.0		1124.3			1403.6
									Average Annual HUs	28.1

4-45

Table FS-4. Fish - Dredging Increment 3: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8
V3	% Cover (vegetation)	90%	0.15	20%	1	20%	1	25%	1
V4	% Littoral Area	90%	0.25	20%	1	20%	1	25%	1
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7
	Food (Cf)		0.49		0.93		0.93		0.93
	Cover (Cc)		0.48		0.90		0.90		0.90
	Water Quality (Cwq)		0.88		0.88		0.88		0.88
	Reproduction (Cr)		0.89		1.00		1.00		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.74		0.93		0.93		0.91

WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	12%	0.53	80%	1	80%	1	75%	1	
Vb	Dissolved Oxygen	Class A	1	Class A	1	Class A	1	Class A	1	
Vc	Water Temperature	<1 degree C	0.25	<1 degree C	0.4	<1 degree C	0.4	<1 degree C	0.4	
Vd	Current Velocity	> 1 cm/sec	0.25	> 1 cm/sec	0.25	> 1 cm/sec	0.25	> 1 cm/sec	0.25	
	Winter Cover (Cw-c)		0.53		1		1		1	
	Winter Water Quality (Cw-wq)		0.75		0.8		0.8		0.8	
	Corrected Cw-wq		0.25		0.4		0.4		0.4	
	Winter Other (Cw-ot)		0.25		0.25		0.25		0.25	
	Winter HSI		0.52		0.63		0.63		0.63	
	Corrected Winter HSI		0.25		0.4		0.4		0.4	
	Composite HSI with Winter Modifications		0.43		0.61		0.61		0.60	
	Acreage		46.9		46.9		46.9		46.9	
	Year		0		1		10		50	
	Habitat Units (HUs)		24.4		257.6		1139.1			1421.0
									Average Annual HUs	28.4

Table FS-5. Fish - Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8
V3	% Cover (vegetation)	90%	0.15	90%	0.15	90%	0.15	95%	0.05
V4	% Littoral Area	90%	0.25	90%	0.25	90%	0.25	95%	0.15
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7
	Food (Cf)		0.49		0.49		0.49		0.34
	Cover (Cc)		0.48		0.48		0.48		0.43
	Water Quality (Cwq)		0.88		0.88		0.88		0.88
	Reproduction (Cr)		0.89		0.89		0.89		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.74		0.74		0.74		0.68

WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
Va	Water Depth	12%	0.53	12%	0.53	12%	0.53	10%	0.51
Vb	Dissolved Oxygen	Class A	1	Class A	1	Class A	1	Class A	1
Vc	Water Temperature	<1 degree C	0.25	1-2 degrees C	0.6	1-2 degrees C	0.6	1-2 degrees C	0.6
Vd	Current Velocity	> 1 cm/sec	0.25	<1 cm/sec	0.75	<1 cm/sec	0.75	<1 cm/sec	0.75
	Winter Cover (Cw-c)		0.53		0.53		0.53		0.51
	Winter Water Quality (Cw-wq)		0.75		0.87		0.87		0.87
	Corrected Cw-wq		0.25		N/A		N/A		N/A
	Winter Other (Cw-ot)		0.25		0.75		0.75		0.75
	Winter HSI		0.52		0.74		0.74		0.73
	Corrected Winter HSI		0.25		N/A		N/A		N/A
	Composite HSI with Winter Modifications		0.43		0.74		0.74		0.71
	Acreage		46.9		46.9		46.9		46.9
	Year		0		1		10		50
	Habitat Units (HUs)		27.4		311.9		1355.8		1695.1
								Average Annual HUs	33.9

Table FS-6. Fish - Dredging Increment 1 with Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	90%	0.15	60%	0.57	60%	0.57	65%	0.5	
V4	% Littoral Area	90%	0.25	60%	1	60%	1	65%	0.85	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.49		0.77		0.77		0.74	
	Cover (Cc)		0.48		0.69		0.69		0.65	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.86		0.86		0.83	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	12%	0.53	40%	0.87	40%	0.87	35%	0.81	
Vb	Dissolved Oxygen	Class A	1	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	<1 degree C	0.25	1-2 degrees C	0.60	1-2 degrees C	0.60	1-2 degrees C	0.60	
Vd	Current Velocity	> 1 cm/sec	0.25	<1 cm/sec	0.75	<1 cm/sec	0.75	<1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.53		0.87		0.87		0.81	
	Winter Water Quality (Cw-wq)		0.75		0.87		0.87		0.87	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.25		0.75		0.75		0.75	
	Winter HSI		0.52		0.84		0.84		0.82	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.43		0.85		0.85		0.83	
	Acreage		46.9		46.9		46.9		46.9	
	Year		0		1		10		50	
	Habitat Units (HUs)		30.0		358.5		1572.2			1960.7
								Average Annual HUs		39.2

Table FS-7. Fish - Dredging Increment 2 with Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8
V3	% Cover (vegetation)	90%	0.15	40%	0.87	40%	0.87	45%	0.8
V4	% Littoral Area	90%	0.25	40%	1	40%	1	45%	1
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	1	Class A	1	Class A	1	Class B	0.7
	Food (Cf)		0.49		0.89		0.89		0.86
	Cover (Cc)		0.48		0.84		0.84		0.80
	Water Quality (Cwq)		0.88		0.88		0.88		0.88
	Reproduction (Cr)		1.00		1.00		1.00		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.75		0.91		0.91		0.88

WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
Va	Water Depth	12%	0.53	60%	1.00	60%	1.00	55%	1.00
Vb	Dissolved Oxygen	Class A	1	Class A	1.00	Class A	1.00	Class A	1.00
Vc	Water Temperature	<1 degree C	0.25	2 degrees C	0.68	2 degrees C	0.68	2 degrees C	0.68
Vd	Current Velocity	> 1 cm/sec	0.25	<1 cm/sec	0.75	<1 cm/sec	0.75	<1 cm/sec	0.75
	Winter Cover (Cw-c)		0.53		1.00		1.00		1.00
	Winter Water Quality (Cw-wq)		0.75		0.89		0.89		0.89
	Corrected Cw-wq		0.25		N/A		N/A		N/A
	Winter Other (Cw-ot)		0.25		0.75		0.75		0.75
	Winter HSI		0.52		0.88		0.88		0.88
	Corrected Winter HSI		0.25		N/A		N/A		N/A
	Composite HSI with Winter Modifications		0.43		0.90		0.90		0.88
	Acreage		46.9		46.9		46.9		46.9
	Year		0		1		10		50
	Habitat Units (HUs)		31.2		378.1		1667.2		

2076.5

Average Annuals HUs 41.5

Table FS-8. Fish - Dredging Increment 3 with Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	90%	0.15	20%	1	20%	1	25%	1	
V4	% Littoral Area	90%	0.25	20%	1	20%	1	25%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.49		0.93		0.93		0.93	
	Cover (Cc)		0.48		0.90		0.90		0.90	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.93		0.93		0.91	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	12%	0.53	80%	1.00	80%	1.00	75%	1.00	
Vb	Dissolved Oxygen	Class A	1.00	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	<1 degree C	0.25	2-3 degrees C	0.75	2-3 degrees C	0.75	2-3 degrees C	0.75	
Vd	Current Velocity	> 1 cm/sec	0.25	<1 cm/sec	0.75	<1 cm/sec	0.75	<1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.53		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.75		0.92		0.92		0.92	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.25		0.75		0.75		0.75	
	Winter HSI		0.52		0.89		0.89		0.89	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.43		0.91		0.91		0.90	
	Acreage		46.9		46.9		46.9		46.9	
	Year		0		1		10		50	
	Habitat Units (HUs)		31.4		384.4		1700.0			2115.8
									Average Annual HUs	42.3

Table TL-1. Tilmont - Baseline: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4	
V3	% Cover (vegetation)	68%	0.45	68%	0.45	68%	0.45	70%	0.42	
V4	% Littoral Area	68%	0.8	68%	0.8	68%	0.8	70%	0.75	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7	
	Food (Cf)		0.56		0.56		0.56		0.55	
	Cover (Cc)		0.43		0.43		0.43		0.41	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		0.89		0.89		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.74		0.74		0.73	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	35%	0.81	35%	0.81	35%	0.81	30%	0.75	
Vb	Dissolved Oxygen	Class A-B	0.85	Class A-B	0.85	Class B	0.7	Class B	0.7	
Vc	Water Temperature	<1 degree C	0.25	<1 degree C	0.25	<1 degree C	0.25	<1 degree C	0.25	
Vd	Current Velocity	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	
	Winter Cover (Cw-c)		0.81		0.81		0.81		0.75	
	Winter Water Quality (Cw-wq)		0.65		0.65		0.55		0.55	
	Corrected Cw-wq		0.25		0.25		0.25		0.25	
	Winter Other (Cw-ot)		0.5		0.5		0.5		0.5	
	Winter HSI		0.64		0.64		0.59		0.58	
	Corrected Winter HSI		0.25		0.25		0.25		0.25	
	Composite HSI with Winter Modifications		0.43		0.43		0.43		0.43	
	Acreage		86.5		86.5		86.5		86.5	
	Year		0		1		10		50	
	Habitat Units (HUs)		37.2		335.2		1485.9			1858.3
									Average Annual HUs	37.2

Table TL-2. Tilmont - Dredging Increment 1: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4	
V3	% Cover (vegetation)	68%	0.45	60%	0.57	60%	0.57	65%	0.5	
V4	% Littoral Area	68%	0.8	60%	1	60%	1	65%	0.85	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.56		0.61		0.61		0.59	
	Cover (Cc)		0.43		0.49		0.49		0.45	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.78		0.78		0.75	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	35%	0.81	40%	0.87	40%	0.87	35%	0.81	
Vb	Dissolved Oxygen	Class A-B	0.85	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	<1 degree C	0.25	<1 degree C	0.40	<1 degree C	0.40	<1 degree C	0.40	
Vd	Current Velocity	+/- 1 cm/sec	0.50	+/- 1 cm/sec	0.50	+/- 1 cm/sec	0.50	+/- 1 cm/sec	0.50	
	Winter Cover (Cw-c)		0.81		0.87		0.87		0.81	
	Winter Water Quality (Cw-wq)		0.65		0.80		0.80		0.80	
	Corrected Cw-wq		0.25		0.40		0.40		0.40	
	Winter Other (Cw-ot)		0.50		0.50		0.50		0.50	
	Winter HSI		0.64		0.73		0.73		0.71	
	Corrected Winter HSI		0.25		0.40		0.40		0.40	
	Composite HSI with Winter Modifications		0.43		0.56		0.56		0.55	
	Acreage		86.5		86.5		86.5		86.5	
	Year		0		1		10		50	
	Habitat Units (HUs)		42.8		435.7		1917.7			2396.2
									Average Annual HUs	47.9

Table TL-3. Tilmont - Dredging Increment 2: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4	
V3	% Cover (vegetation)	68%	0.45	40%	0.87	40%	0.87	45%	0.8	
V4	% Littoral Area	68%	0.8	40%	1	40%	1	45%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.56		0.70		0.70		0.68	
	Cover (Cc)		0.43		0.64		0.64		0.60	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.84		0.84		0.81	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	35%	0.81	60%	1	60%	1	55%	1	
Vb	Dissolved Oxygen	Class A-B	0.85	Class A	1	Class A	1	Class A	1	
Vc	Water Temperature	<1 degree C	0.25	1 degree C	0.5	1 degree C	0.5	1 degree C	0.5	
Vd	Current Velocity	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	
	Winter Cover (Cw-c)		0.81		1		1		1	
	Winter Water Quality (Cw-wq)		0.65		0.8333333		0.8333333		0.8333333	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.5		0.5		0.5		0.5	
	Winter HSI		0.64		0.77		0.77		0.77	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.43		0.80		0.80		0.79	
	Acreage		86.5		86.5		86.5		86.5	
	Year		0		1		10		50	
	Habitat Units (HUs)		53.3		624.6		2752.8			3430.7
								Average Annual HUs		68.6

Table TL-4. Tilmont - Dredging Increment 3: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4	
V3	% Cover (vegetation)	68%	0.45	20%	1	20%	1	25%	1	
V4	% Littoral Area	68%	0.8	20%	1	20%	1	25%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.56		0.74		0.74		0.74	
	Cover (Cc)		0.43		0.70		0.70		0.70	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.86		0.86		0.84	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	35%	0.81	80%	1	80%	1	75%	1	
Vb	Dissolved Oxygen	Class A-B	0.85	Class A	1	Class A	1	Class A	1	
Vc	Water Temperature	<1 degree C	0.25	1-2 degrees C	0.6	1-2 degrees C	0.6	1-2 degrees C	0.6	
Vd	Current Velocity	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	
	Winter Cover (Cw-c)		0.81		1		1		1	
	Winter Water Quality (Cw-wq)		0.65		0.8666667		0.8666667		0.8666667	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.5		0.5		0.5		0.5	
	Winter HSI		0.64		0.78		0.78		0.78	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.43		0.82		0.82		0.81	
	Acreage		86.5		86.5		86.5		86.5	
	Year		0		1		10		50	
	Habitat Units (HUs)		54.1		638.4		2823.3			3515.7
								Average Annual HUs		70.3

Table TL-5. Tilmont - Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4	
V3	% Cover (vegetation)	68%	0.45	68%	0.45	68%	0.45	70%	0.42	
V4	% Littoral Area	68%	0.8	68%	0.8	68%	0.8	70%	0.75	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7	
	Food (Cf)		0.56		0.56		0.56		0.55	
	Cover (Cc)		0.43		0.43		0.43		0.41	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		0.89		0.89		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.74		0.74		0.73	
WITH WINTER HSI MODIFICATIONS		**Existing Conditions**		**Future With Project - Year 1**		**Future With Project - Year 10**		**Future With Project - Year 50**		
Variable	**Description**	**DATA**	**HSI**	**DATA**	**HSI**	**DATA**	**HSI**	**DATA**	**HSI**	
Va	Water Depth	35%	0.81	35%	0.81	35%	0.81	30%	0.75	
Vb	Dissolved Oxygen	Class A-B	0.85	Class A-B	0.85	Class B	0.7	Class B	0.7	
Vc	Water Temperature	<1 degree C	0.25	1-2 degrees C	0.6	1-2 degrees C	0.6	1-2 degrees C	0.6	
Vd	Current Velocity	+/- 1 cm/sec	0.5	<1 cm/sec	0.75	<1 cm/sec	0.75	<1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.81		0.81		0.81		0.75	
	Winter Water Quality (Cw-wq)		0.65		0.7666667		0.6666667		0.6666667	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.5		0.75		0.75		0.75	
	Winter HSI		0.64		0.77		0.72		0.71	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.43		0.76		0.73		0.72	
	Acreage		86.5		86.5		86.5		86.5	
	Year		0		1		10		50	
	Habitat Units (HUs)		51.4		579.2		2511.1			3141.7
								Average Annual HUs		62.8

Table TL-6. Tilmont - Addition of Structure: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	20%	1	20%	1	20%	1	
V3	% Cover (vegetation)	68%	0.45	68%	0.45	68%	0.45	70%	0.42	
V4	% Littoral Area	68%	0.8	68%	0.8	68%	0.8	70%	0.75	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7	
	Food (Cf)		0.56		0.77		0.77		0.75	
	Cover (Cc)		0.43		0.73		0.73		0.71	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		0.89		0.89		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.85		0.85		0.85	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	35%	0.81	35%	0.81	35%	0.81	30%	0.75	
Vb	Dissolved Oxygen	Class A-B	0.85	Class A-B	0.85	Class B	0.7	Class B	0.7	
Vc	Water Temperature	<1 degree C	0.25	<1 degree C	0.25	<1 degree C	0.25	<1 degree C	0.25	
Vd	Current Velocity	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	
	Winter Cover (Cw-c)		0.81		0.81		0.81		0.75	
	Winter Water Quality (Cw-wq)		0.65		0.65		0.55		0.55	
	Corrected Cw-wq		0.25		0.25		0.25		0.25	
	Winter Other (Cw-ot)		0.5		0.5		0.5		0.5	
	Winter HSI		0.64		0.64		0.59		0.58	
	Corrected Winter HSI		0.25		0.25		0.25		0.25	
	Composite HSI with Winter Modifications		0.43		0.46		0.46		0.46	
	Acreage		86.5		86.5		86.5		86.5	
	Year		0		1		10		50	
	Habitat Units (HUs)		38.6		359.4		1594.5			1992.5
									Average Annual HUs	39.9

Table TL-7. Tilmont - Dredging Increment 1 with Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4	
V3	% Cover (vegetation)	68%	0.45	60%	0.57	60%	0.57	65%	0.5	
V4	% Littoral Area	68%	0.8	60%	1	60%	1	65%	0.85	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.56		0.61		0.61		0.59	
	Cover (Cc)		0.43		0.49		0.49		0.45	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.78		0.78		0.75	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	35%	0.81	40%	0.87	40%	0.87	35%	0.81	
Vb	Dissolved Oxygen	Class A-B	0.85	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	<1 degree C	0.25	1-2 degrees C	0.60	1-2 degrees C	0.60	1-2 degrees C	0.60	
Vd	Current Velocity	+/- 1 cm/sec	0.50	<1 cm/sec	0.75	<1 cm/sec	0.75	<1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.81		0.87		0.87		0.81	
	Winter Water Quality (Cw-wq)		0.65		0.87		0.87		0.87	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.50		0.75		0.75		0.75	
	Winter HSI		0.64		0.84		0.84		0.82	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.43		0.81		0.81		0.79	
	Acreage		86.5		86.5		86.5		86.5	
	Year		0		1		10		50	
	Habitat Units (HUs)		53.6		630.2		2761.3			3445.1
								Average Annual HUs		68.9

Table TL-8. Tilmont - Dredging Increment 2 with Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4	
V3	% Cover (vegetation)	68%	0.45	40%	0.87	40%	0.87	45%	0.8	
V4	% Littoral Area	68%	0.8	40%	1	40%	1	45%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.56		0.70		0.70		0.68	
	Cover (Cc)		0.43		0.64		0.64		0.60	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.84		0.84		0.81	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	35%	0.81	60%	1	60%	1	55%	1	
Vb	Dissolved Oxygen	Class A-B	0.85	Class A	1	Class A	1	Class A	1	
Vc	Water Temperature	<1 degree C	0.25	2 degrees C	0.6	2 degrees C	0.6	2 degrees C	0.6	
Vd	Current Velocity	+/- 1 cm/sec	0.5	<1 cm/sec	0.75	<1 cm/sec	0.75	<1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.81		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.65		0.87		0.87		0.87	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.5		0.75		0.75		0.75	
	Winter HSI		0.64		0.87		0.87		0.87	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.43		0.85		0.85		0.84	
	Acreage		86.5		86.5		86.5		86.5	
	Year		0		1		10		50	
	Habitat Units (HUs)		55.5		663.6		2924.4			3643.5
								Average Annual HUs		72.9

Table TL-9. Tilmont - Dredging Increment 3 with Flow Reduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	5%	0.4	5%	0.4	5%	0.4	5%	0.4
V3	% Cover (vegetation)	68%	0.45	20%	1	20%	1	25%	1
V4	% Littoral Area	68%	0.8	20%	1	20%	1	25%	1
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7
	Food (Cf)		0.56		0.74		0.74		0.74
	Cover (Cc)		0.43		0.70		0.70		0.70
	Water Quality (Cwq)		0.88		0.88		0.88		0.88
	Reproduction (Cr)		0.89		1.00		1.00		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.74		0.86		0.86		0.84
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
Va	Water Depth	35%	0.81	80%	1	80%	1	75%	1
Vb	Dissolved Oxygen	Class A-B	0.85	Class A	1	Class A	1	Class A	1
Vc	Water Temperature	<1 degree C	0.25	2-3 degrees C	0.75	2-3 degrees C	0.75	2-3 degrees C	0.75
Vd	Current Velocity	+/- 1 cm/sec	0.5	<1 cm/sec	0.75	<1 cm/sec	0.75	<1 cm/sec	0.75
	Winter Cover (Cw-c)		0.81		1		1		1
	Winter Water Quality (Cw-wq)		0.65		0.9166667		0.9166667		0.9166667
	Corrected Cw-wq		0.25		N/A		N/A		N/A
	Winter Other (Cw-ot)		0.5		0.75		0.75		0.75
	Winter HSI		0.64		0.89		0.89		0.89
	Corrected Winter HSI		0.25		N/A		N/A		N/A
	Composite HSI with Winter Modifications		0.43		0.87		0.87		0.87
	Acreage		86.5		86.5		86.5		86.5
	Year		0		1		10		50
	Habitat Units (HUs)		56.5		681.0		3012.0		

3749.5

Average Annual HUs 75.0

Table TL-10. Tilmont - Dredging Increment 1 with Structure: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	20%	1	20%	1	20%	1	
V3	% Cover (vegetation)	68%	0.45	60%	0.57	60%	0.57	65%	0.5	
V4	% Littoral Area	68%	0.8	60%	1	60%	1	65%	0.85	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.56		0.83		0.83		0.79	
	Cover (Cc)		0.43		0.79		0.79		0.75	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.89		0.89		0.86	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	35%	0.81	40%	0.87	40%	0.87	35%	0.81	
Vb	Dissolved Oxygen	Class A-B	0.85	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	<1 degree C	0.25	<1 degree C	0.40	<1 degree C	0.40	<1 degree C	0.40	
Vd	Current Velocity	+/- 1 cm/sec	0.50	+/- 1 cm/sec	0.50	+/- 1 cm/sec	0.50	+/- 1 cm/sec	0.50	
	Winter Cover (Cw-c)		0.81		0.87		0.87		0.81	
	Winter Water Quality (Cw-wq)		0.65		0.80		0.80		0.80	
	Corrected Cw-wq		0.25		0.40		0.40		0.40	
	Winter Other (Cw-ot)		0.50		0.50		0.50		0.50	
	Winter HSI		0.64		0.73		0.73		0.71	
	Corrected Winter HSI		0.25		0.40		0.40		0.40	
	Composite HSI with Winter Modifications		0.43		0.60		0.60		0.59	
	Acreage		86.5		86.5		86.5		86.5	
	Year		0		1		10		50	
	Habitat Units (HUs)		44.5		465.2		2050.0			2559.7
								Average Annual HUs		51.2

Table TL-11. Tilmont - Dredging Increment 2 with Structure: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	20%	1	20%	1	20%	1	
V3	% Cover (vegetation)	68%	0.45	40%	0.87	40%	0.87	45%	0.8	
V4	% Littoral Area	68%	0.8	40%	1	40%	1	45%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.56		0.95		0.95		0.93	
	Cover (Cc)		0.43		0.94		0.94		0.90	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.94		0.94		0.91	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	35%	0.81	60%	1.00	0.60	1.00	0.55	1.00	
Vb	Dissolved Oxygen	Class A-B	0.85	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	<1 degree C	0.25	1 degree C	0.50	1 degree C	0.50	1 degree C	0.50	
Vd	Current Velocity	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.50	+/- 1 cm/sec	0.50	+/- 1 cm/sec	0.50	
	Winter Cover (Cw-c)		0.81		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.65		0.83		0.83		0.83	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.5		0.50		0.50		0.50	
	Winter HSI		0.64		0.77		0.77		0.77	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.43		0.85		0.85		0.84	
	Acreage		86.5		86.5		86.5		86.5	
	Year		0		1		10		50	
	Habitat Units (HUs)		55.4		661.7		2918.4			3635.4
								Average Annual HUs		72.7

Table TL-12. Tilmont - Dredging Increment 3 with Structure: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	20%	1	20%	1	20%	1	
V3	% Cover (vegetation)	68%	0.45	20%	1	20%	1	25%	1	
V4	% Littoral Area	68%	0.8	20%	1	20%	1	25%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.56		1.00		1.00		1.00	
	Cover (Cc)		0.43		1.00		1.00		1.00	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.96		0.96		0.94	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	35%	0.81	80%	1	80%	1	75%	1	
Vb	Dissolved Oxygen	Class A-B	0.85	Class A	1	Class A	1	Class A	1	
Vc	Water Temperature	<1 degree C	0.25	1-2 degrees C	0.6	1-2 degrees C	0.6	1-2 degrees C	0.6	
Vd	Current Velocity	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	+/- 1 cm/sec	0.5	
	Winter Cover (Cw-c)		0.81		1		1		1	
	Winter Water Quality (Cw-wq)		0.65		0.8666667		0.8666667		0.8666667	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.5		0.5		0.5		0.5	
	Winter HSI		0.64		0.78		0.78		0.78	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.43		0.87		0.87		0.86	
	Acreage		86.5		86.5		86.5		86.5	
	Year		0		1		10		50	
	Habitat Units (HUs)		56.1		674.6		2983.3			3713.9
									Average Annual HUs	74.3

Table TL-13. Tilmont - Dredging Increment 1 with Flow Reduction and Structure: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	5%	0.4	20%	1	20%	1	20%	1
V3	% Cover (vegetation)	68%	0.45	60%	0.57	60%	0.57	65%	0.5
V4	% Littoral Area	68%	0.8	60%	1	60%	1	65%	0.85
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7
	Food (Cf)		0.56		0.83		0.83		0.79
	Cover (Cc)		0.43		0.79		0.79		0.75
	Water Quality (Cwq)		0.88		0.88		0.88		0.88
	Reproduction (Cr)		0.89		1.00		1.00		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.74		0.89		0.89		0.86

WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
Va	Water Depth	35%	0.81	40%	0.87	40%	0.87	35%	0.81
Vb	Dissolved Oxygen	Class A-B	0.85	Class A	1.00	Class A	1.00	Class A	1.00
Vc	Water Temperature	<1 degree C	0.25	1-2 degrees C	0.60	1-2 degrees C	0.60	1-2 degrees C	0.60
Vd	Current Velocity	+/- 1 cm/sec	0.50	<1 cm/sec	0.75	<1 cm/sec	0.75	<1 cm/sec	0.75
	Winter Cover (Cw-c)		0.81		0.87		0.87		0.81
	Winter Water Quality (Cw-wq)		0.65		0.87		0.87		0.87
	Corrected Cw-wq		0.25		N/A		N/A		N/A
	Winter Other (Cw-ot)		0.50		0.75		0.75		0.75
	Winter HSI		0.64		0.84		0.84		0.82
	Corrected Winter HSI		0.25		N/A		N/A		N/A
	Composite HSI with Winter Modifications		0.43		0.86		0.86		0.84
	Acreage		86.5		86.5		86.5		86.5
	Year		0		1		10		50
	Habitat Units (HUs)		56.0		672.9		2951.8		

3680.7

Average Annual HUs 73.6

Table TL-14. Tilmont - Dredging Increment 2 with Flow Reduction and Structure: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	20%	1	20%	1	20%	1	
V3	% Cover (vegetation)	68%	0.45	40%	0.87	40%	0.87	45%	0.8	
V4	% Littoral Area	68%	0.8	40%	1	40%	1	45%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.56		0.95		0.95		0.93	
	Cover (Cc)		0.43		0.94		0.94		0.90	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.94		0.94		0.91	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	35%	0.81	60%	1	60%	1	55%	1	
Vb	Dissolved Oxygen	Class A-B	1	Class A	1	Class A	1	Class A	1	
Vc	Water Temperature	<1 degree C	0.25	2 degrees C	0.68	2 degrees C	0.68	2 degrees C	0.68	
Vd	Current Velocity	+/- 1 cm/sec	0.5	<1 cm/sec	0.75	<1 cm/sec	0.75	<1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.81		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.75		0.89		0.89		0.89	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.5		0.75		0.75		0.75	
	Winter HSI		0.69		0.88		0.88		0.88	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.43		0.91		0.91		0.90	
	Acreage		86.5		86.5		86.5		86.5	
	Year		0		1		10		50	
	Habitat Units (HUs)		58.0		708.3		3123.9			3890.2
								Average Annual HUs		77.8

Table TL-15. Tilmont - Dredging Increment 3 with Flow Reduction and Structure: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	5%	0.4	20%	1	20%	1	20%	1	
V3	% Cover (vegetation)	68%	0.45	20%	1	20%	1	25%	1	
V4	% Littoral Area	68%	0.8	20%	1	20%	1	25%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class B	0.75	Class B	0.75	Class B	0.75	Class B	0.75	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.56		1.00		1.00		1.00	
	Cover (Cc)		0.43		1.00		1.00		1.00	
	Water Quality (Cwq)		0.88		0.88		0.88		0.88	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.74		0.96		0.96		0.94	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	35%	0.81	80%	1	80%	1	75%	1	
Vb	Dissolved Oxygen	Class A-B	1	Class A	1	Class A	1	Class A	1	
Vc	Water Temperature	<1 degree C	0.25	2-3 degrees C	0.75	2-3 degrees C	0.75	2-3 degrees C	0.75	
Vd	Current Velocity	+/- 1 cm/sec	0.5	<1 cm/sec	0.75	<1 cm/sec	0.75	<1 cm/sec	0.75	
	Winter Cover (Cw-c)		0.81		1		1		1	
	Winter Water Quality (Cw-wq)		0.75		0.9166667		0.9166667		0.9166667	
	Corrected Cw-wq		0.25		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.5		0.75		0.75		0.75	
	Winter HSI		0.69		0.89		0.89		0.89	
	Corrected Winter HSI		0.25		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.43		0.92		0.92		0.92	
	Acreage		86.5		86.5		86.5		86.5	
	Year		0		1		10		50	
	Habitat Units (HUs)		58.6		719.6		3182.7			3960.9
								Average Annual HUs		79.2

Table GR-1. Gremore - Baseline: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	65%	0.5	65%	0.5	65%	0.5	70%	0.42	
V4	% Littoral Area	65%	0.85	65%	0.85	65%	0.85	70%	0.75	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class A	1	Class A	1	Class A	1	Class A	1	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7	
	Food (Cf)		0.74		0.74		0.74		0.70	
	Cover (Cc)		0.65		0.65		0.65		0.61	
	Water Quality (Cwq)		0.97		0.97		0.97		0.97	
	Reproduction (Cr)		0.89		0.89		0.89		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.86		0.86		0.86		0.84	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	50%	1.00	50%	1.00	50%	1.00	45%	0.95	
Vb	Dissolved Oxygen	Class C	0.40	Class C	0.40	Class C	0.40	Class D	0.10	
Vc	Water Temperature	3 degrees C	0.85	3 degrees C	0.85	3 degrees	0.85	3 degrees	0.85	
Vd	Current Velocity	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		1.00		1.00		1.00		0.95	
	Winter Water Quality (Cw-wq)		0.55		0.55		0.55		0.35	
	Corrected Cw-wq		0.40		0.40		0.40		0.10	
	Winter Other (Cw-ot)		0.75		0.75		0.75		0.75	
	Winter HSI		0.69		0.69		0.69		0.54	
	Corrected Winter HSI		0.40		0.40		0.40		0.10	
	Composite HSI with Winter Modifications		0.59		0.59		0.59		0.29	
	Acreage		333.6		333.6		333.6		333.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		195.3		1758.1		5840.5			7794.0
								Average Annual HUs		155.9

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Table GR-2. Gremore - Dredging Increment 2: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	35%	0.94	25%	1	25%	1	30%	1	
V4	% Littoral Area	35%	1	25%	1	25%	1	30%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class A	1	Class A	1	Class A	1	Class A	1	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.91		0.93		0.93		0.93	
	Cover (Cc)		0.87		0.90		0.90		0.90	
	Water Quality (Cwq)		0.97		0.97		0.97		0.97	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.93		0.96		0.96		0.94	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	50%	1.00	60%	1.00	60%	1.00	60%	1.00	
Vb	Dissolved Oxygen	Class C	0.40	Class B	0.70	Class B	0.70	Class B	0.70	
Vc	Water Temperature	3 degrees C	0.85	3 degrees C	0.85	3 degrees	0.85	3 degrees	0.85	
Vd	Current Velocity	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		1.00		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.55		0.75		0.75		0.75	
	Corrected Cw-wq		0.40		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.75		0.75		0.75		0.75	
	Winter HSI		0.69		0.81		0.81		0.81	
	Corrected Winter HSI		0.40		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.61		0.88		0.88		0.87	
	Acreage		333.6		333.6		333.6		333.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		248.5		2639.8		11674.8			14563.1
									Average Annual HUs	291.3

Table GR-3. Gremore - Dredging Increment 3: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	65%	0.5	20%	1	20%	1	25%	1	
V4	% Littoral Area	65%	0.85	20%	1	20%	1	25%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class A	1	Class A	1	Class A	1	Class A	1	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.74		0.93		0.93		0.93	
	Cover (Cc)		0.65		0.90		0.90		0.90	
	Water Quality (Cwq)		0.97		0.97		0.97		0.97	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.86		0.96		0.96		0.94	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	50%	1.00	80%	1.00	80%	1.00	75%	1.00	
Vb	Dissolved Oxygen	Class C	0.40	Class B	0.70	Class B	0.70	Class B	0.70	
Vc	Water Temperature	3 degrees C	0.85	3-4 degrees C	1.00	3-4 degrees C	1.00	3-4 degrees C	1.00	
Vd	Current Velocity	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		1.00		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.55		0.80		0.80		0.80	
	Corrected Cw-wq		0.40		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.75		0.75		0.75		0.75	
	Winter HSI		0.69		0.83		0.83		0.83	
	Corrected Winter HSI		0.40		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.59		0.89		0.89		0.88	
	Acreage		333.6		333.6		333.6		333.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		246.7		2682.8		11864.7			14794.1
									Average Annual HUs	295.9

Table GR-4. Gremore - Flow Introduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8
V3	% Cover (vegetation)	65%	0.5	65%	0.5	65%	0.5	70%	0.42
V4	% Littoral Area	65%	0.85	65%	0.85	65%	0.85	70%	0.75
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class A	1	Class A	1	Class A	1	Class A	1
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7
	Food (Cf)		0.74		0.74		0.74		0.70
	Cover (Cc)		0.65		0.65		0.65		0.61
	Water Quality (Cwq)		0.97		0.97		0.97		0.97
	Reproduction (Cr)		0.89		0.89		0.89		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.86		0.86		0.86		0.84

WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	50%	1.00	50%	1.00	50%	1.00	45%	0.95	
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	3 degrees C	0.85	2-3 degrees C	0.75	2-3 degrees C	0.75	2-3 degrees C	0.75	
Vd	Current Velocity	< 1 cm/sec	0.75	1 cm/sec	0.43	1 cm/sec	0.43	1 cm/sec	0.43	
	Winter Cover (Cw-c)		1.00		1.00		1.00		0.95	
	Winter Water Quality (Cw-wq)		0.55		0.92		0.92		0.92	
	Corrected Cw-wq		0.40		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.75		0.43		0.43		0.43	
	Winter HSI		0.69		0.78		0.78		0.77	
	Corrected Winter HSI		0.40		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.59		0.82		0.82		0.80	
	Acreage		333.6		333.6		333.6		333.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		233.6		2447.6		10789.0			13470.3
								Average Annual HUs		269.4

Table GR-5. Gremore - Aeration: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	65%	0.5	65%	0.5	65%	0.5	70%	0.42	
V4	% Littoral Area	65%	0.85	65%	0.85	65%	0.85	70%	0.75	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class A	1	Class A	1	Class A	1	Class A	1	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class B	0.7	Class B	0.7	Class B	0.7	
	Food (Cf)		0.74		0.74		0.74		0.70	
	Cover (Cc)		0.65		0.65		0.65		0.61	
	Water Quality (Cwq)		0.97		0.97		0.97		0.97	
	Reproduction (Cr)		0.89		0.89		0.89		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.86		0.86		0.86		0.84	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future Without Project - Year 1		Future Without Project - Year 10		Future Without Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	50%	1.00	50%	1.00	50%	1.00	45%	0.95	
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	3 degrees C	0.85	3 degrees C	0.85	3 degrees	0.85	3 degrees	0.85	
Vd	Current Velocity	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		1.00		1.00		1.00		0.95	
	Winter Water Quality (Cw-wq)		0.55		0.95		0.95		0.95	
	Corrected Cw-wq		0.40		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.75		0.75		0.75		0.75	
	Winter HSI		0.69		0.91		0.91		0.90	
	Corrected Winter HSI		0.40		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.59		0.88		0.88		0.87	
	Acreage		333.6		333.6		333.6		333.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		244.7		2647.4		11669.7			14561.9
									Average Annual HUs	291.2

Table GR-6. Gremore - Dredging Increment 2 with Flow Introduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	35%	0.94	25%	1	25%	1	30%	1	
V4	% Littoral Area	35%	1	25%	1	25%	1	30%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class A	1	Class A	1	Class A	1	Class A	1	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.91		0.93		0.93		0.93	
	Cover (Cc)		0.87		0.90		0.90		0.90	
	Water Quality (Cwq)		0.97		0.97		0.97		0.97	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.93		0.96		0.96		0.94	
WITH WINTER HSI MODIFICATIONS		**Existing Conditions**		**Future With Project - Year 1**		**Future With Project - Year 10**		**Future With Project - Year 50**		
Variable	**Description**	**DATA**	**HSI**	**DATA**	**HSI**	**DATA**	**HSI**	**DATA**	**HSI**	
Va	Water Depth	50%	1.00	60%	1.00	60%	1.00	60%	1.00	
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	3 degrees C	0.85	2-3 degrees C	0.75	2-3 degrees	0.75	2-3 degrees	0.75	
Vd	Current Velocity	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		1.00		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.55		0.92		0.92		0.92	
	Corrected Cw-wq		0.40		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.75		0.75		0.75		0.75	
	Winter HSI		0.69		0.89		0.89		0.89	
	Corrected Winter HSI		0.40		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.61		0.92		0.92		0.92	
	Acreage		333.6		333.6		333.6		333.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		256.0		2775.6		12275.4			15307.1
									Average Annual HUs	306.1

Table GR-7. Gremore - Dredging Increment 3 with Flow Introduction: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	65%	0.5	20%	1	20%	1	25%	1	
V4	% Littoral Area	65%	0.85	20%	1	20%	1	25%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class A	1	Class A	1	Class A	1	Class A	1	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.74		0.93		0.93		0.93	
	Cover (Cc)		0.65		0.90		0.90		0.90	
	Water Quality (Cwq)		0.97		0.97		0.97		0.97	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.86		0.96		0.96		0.94	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	50%	1.00	80%	1.00	80%	1.00	75%	1.00	
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	3 degrees C	0.85	3 degrees C	0.85	3 degrees C	0.85	3 degrees C	0.85	
Vd	Current Velocity	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		1.00		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.55		0.95		0.95		0.95	
	Corrected Cw-wq		0.40		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.75		0.75		0.75		0.75	
	Winter HSI		0.69		0.91		0.91		0.91	
	Corrected Winter HSI		0.40		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.59		0.93		0.93		0.92	
	Acreage		333.6		333.6		333.6		333.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		253.3		2800.5		12385.5			15439.3
								Average Annual HUs		308.8

Table GR-8. Gremore - Dredging Increment 2 with Aeration: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1	
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8	
V3	% Cover (vegetation)	35%	0.94	25%	1	25%	1	30%	1	
V4	% Littoral Area	35%	1	25%	1	25%	1	30%	1	
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1	
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1	
V8	Min. Dissolved Oxygen (DO) - Summer	Class A	1	Class A	1	Class A	1	Class A	1	
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1	
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1	
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7	
	Food (Cf)		0.91		0.93		0.93		0.93	
	Cover (Cc)		0.87		0.90		0.90		0.90	
	Water Quality (Cwq)		0.97		0.97		0.97		0.97	
	Reproduction (Cr)		0.89		1.00		1.00		0.89	
	Other (Cot)		1.00		1.00		1.00		1.00	
	HSI		0.93		0.96		0.96		0.94	
WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50		
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	
Va	Water Depth	50%	1.00	60%	1.00	60%	1.00	60%	1.00	
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00	
Vc	Water Temperature	3 degrees C	0.85	3 degrees C	0.85	3 degrees	0.85	3 degrees	0.85	
Vd	Current Velocity	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	
	Winter Cover (Cw-c)		1.00		1.00		1.00		1.00	
	Winter Water Quality (Cw-wq)		0.55		0.95		0.95		0.95	
	Corrected Cw-wq		0.40		N/A		N/A		N/A	
	Winter Other (Cw-ot)		0.75		0.75		0.75		0.75	
	Winter HSI		0.69		0.91		0.91		0.91	
	Corrected Winter HSI		0.40		N/A		N/A		N/A	
	Composite HSI with Winter Modifications		0.61		0.93		0.93		0.92	
	Acreage		333.6		333.6		333.6		333.6	
	Year		0		1		10		50	
	Habitat Units (HUs)		257.4		2800.5		12385.5			15443.4
									Average Annual HUs	308.9

Table GR-9. Gremore - Dredging Increment 3 with Aeration: Habitat Suitability Index (HSI) Model for Bluegills.

EXISTING HSI BLUEGILL MODEL (non-winter)		Existing Condition		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	% Pool Area	100%	1	100%	1	100%	1	100%	1
V2	% Cover (logs & brush)	15%	0.8	15%	0.8	15%	0.8	15%	0.8
V3	% Cover (vegetation)	65%	0.5	20%	1	20%	1	25%	1
V4	% Littoral Area	65%	0.85	20%	1	20%	1	25%	1
V5	Avg. Total Dissolved Solids (TDS)	NF	1	NF	1	NF	1	NF	1
V6	Avg. Turbidity	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1	< 20 ppm	1
V7	pH Range	Class A	1	Class A	1	Class A	1	Class A	1
V8	Min. Dissolved Oxygen (DO) - Summer	Class A	1	Class A	1	Class A	1	Class A	1
V9	Salinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V10	Max. Avg. Midsummer Temp. (Adult)	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8	28-29 degrees C	0.8
V11	Avg. Water Temp. (Spawning)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V12	Max. Early Summer Temp. (Fry)	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1	22-25 degrees C	1
V13	Max. Midsummer Temp. (Juvenile)	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9	29 degrees C	0.9
V14	Avg. Current Velocity	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V15	Avg. Current Velocity (Spawning)	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1	< 12 cm/sec	1
V16	Avg. Current Velocity (Fry)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V17	Avg. Current Velocity (Juvenile)	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1	< 4.5 cm/sec	1
V18	Stream Gradient	NF	1	NF	1	NF	1	NF	1
V19	Reservoir Drawdown	NF	1	NF	1	NF	1	NF	1
V20	Substrate Composition	Class B	0.7	Class A	1	Class A	1	Class B	0.7
	Food (Cf)		0.74		0.93		0.93		0.93
	Cover (Cc)		0.65		0.90		0.90		0.90
	Water Quality (Cwq)		0.97		0.97		0.97		0.97
	Reproduction (Cr)		0.89		1.00		1.00		0.89
	Other (Cot)		1.00		1.00		1.00		1.00
	HSI		0.86		0.96		0.96		0.94

WITH WINTER HSI MODIFICATIONS		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
Va	Water Depth	50%	1.00	80%	1.00	80%	1.00	75%	1.00
Vb	Dissolved Oxygen	Class C	0.40	Class A	1.00	Class A	1.00	Class A	1.00
Vc	Water Temperature	3 degrees C	0.85	3-4 degrees C	1.00	3-4 degrees C	1.00	3-4 degrees C	1.00
Vd	Current Velocity	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75	< 1 cm/sec	0.75
	Winter Cover (Cw-c)		1.00		1.00		1.00		1.00
	Winter Water Quality (Cw-wq)		0.55		1.00		1.00		1.00
	Corrected Cw-wq		0.40		N/A		N/A		N/A
	Winter Other (Cw-ot)		0.75		0.75		0.75		0.75
	Winter HSI		0.69		0.93		0.93		0.93
	Corrected Winter HSI		0.40		N/A		N/A		N/A
	Composite HSI with Winter Modifications		0.59		0.94		0.94		0.94
	Acreage		333.6		333.6		333.6		333.6
	Year		0		1		10		50
	Habitat Units (HUs)		255.3		2836.7		12545.3		15637.3
								Average Annual HUs	312.7

Table HEP-1. Summary of habitat gains for various project alternatives - Ambrough Slough/Gremore Lake HREP.

AAHU

Waterbody	No Action	Dredging			Flow Reduction	Flow Introduction	Add Structure	Aeration	Dredging + Flow Reduction			Dredging + Flow Introduction			Dredging + Structure			Dredging + Aeration			Dredging + Flow Reduction + Structure		
		60-30-10	40-50-10	20-70-10					60-30-10	40-50-10	20-70-10	60-30-10	40-50-10	20-70-10	60-30-10	40-50-10	20-70-10	60-30-10	40-50-10	20-70-10	60-30-10	40-50-10	20-70-10
Spring	29.8	43.9	49.3	51.0	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Big Missouri	18.4	25.7	28.7	29.7	not evaluated	not evaluated	18.8	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	26.1	29.1	30.1	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Upper Doubles	15.7	24.1	27.4	28.0	16.5	not evaluated	not evaluated	not evaluated	25.8	29.4	30.0	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Lower Doubles	7.8	11.6	16.1	16.4	9.8	not evaluated	not evaluated	not evaluated	15.7	17.5	17.9	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Fish	19.8	27.3	28.1	28.4	33.9	not evaluated	not evaluated	not evaluated	39.2	41.5	42.3	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Tilmont	37.2	47.9	68.6	70.3	62.8	not evaluated	39.9	not evaluated	68.9	72.9	75.0	not evaluated	not evaluated	not evaluated	51.2	72.7	74.3	not evaluated	not evaluated	not evaluated	73.6	77.8	79.2
Gremore	155.9	not evaluated	291.3	295.9	not evaluated	269.4	not evaluated	291.2	not evaluated	not evaluated	not evaluated	not evaluated	306.1	308.8	not evaluated	not evaluated	not evaluated	not evaluated	308.9	312.7	not evaluated	not evaluated	not evaluated

Net gain in AAHU over No Action

Waterbody	No Action	Dredging			Flow Reduction	Flow Introduction	Add Structure	Aeration	Dredging + Flow Reduction			Dredging + Flow Introduction			Dredging + Structure			Dredging + Aeration			Dredging + Flow Reduction + Structure		
		60-30-10	40-50-10	20-70-10					60-30-10	40-50-10	20-70-10	60-30-10	40-50-10	20-70-10	60-30-10	40-50-10	20-70-10	60-30-10	40-50-10	20-70-10	60-30-10	40-50-10	20-70-10
Spring	0.0	14.1	19.5	21.2	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Big Missouri	0.0	7.3	10.3	11.3	not evaluated	not evaluated	0.4	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	7.7	10.7	11.7	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Upper Doubles	0.0	8.4	11.7	12.3	0.8	not evaluated	not evaluated	not evaluated	10.1	13.7	14.3	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Lower Doubles	0.0	3.8	8.3	8.6	2.0	not evaluated	not evaluated	not evaluated	7.9	9.7	10.1	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Fish	0.0	7.5	8.3	8.6	14.1	not evaluated	not evaluated	not evaluated	19.4	21.7	22.5	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Tilmont	0.0	10.7	31.4	33.1	25.6	not evaluated	2.7	not evaluated	31.7	35.7	37.8	not evaluated	not evaluated	not evaluated	14.0	35.5	37.1	not evaluated	not evaluated	not evaluated	36.4	40.6	42.0
Gremore	0.0	not evaluated	135.4	140.0	not evaluated	113.5	not evaluated	135.3	not evaluated	not evaluated	not evaluated	not evaluated	150.2	152.9	not evaluated	not evaluated	not evaluated	not evaluated	153.0	156.8	not evaluated	not evaluated	not evaluated

Attachment 5

Hydraulics Appendix

HYDRAULICS APPENDIX

TABLE OF CONTENTS

GENERAL

Ambrough Slough is a side channel of the Mississippi River located on the Wisconsin side of the main channel in Pool 10 about 2.7 kilometers north of Prairie du Chien, WI. The Ambrough Slough project area enters a 1012 hectare backwater complex comprised of 6 backwater lakes, Black Slough and numerous smaller sloughs, it is located from about River Mile 642 to River Mile 638 (See Plate 1). The site lies within the Upper Mississippi River Wildlife and Fish Refuge.

The main objective is to improve summer and winter habitat conditions for fishery resources by reducing winter current velocity, increasing depth and winter flow introduction. Alternatives evaluated to address habitat objectives included constructing a rock channel liner at the entrance to Black Slough, dredging of several backwater lakes, construction of rock partial closures to several backwater lakes, rebuilding a barrier island to Tilmont Lake and flow introduction into Gremore Lake. The U.S. Fish and Wildlife Service (FWS) or the Wisconsin Department of Natural Resources (WDNR) will manage various features of the project.

EXISTING PHYSICAL CONDITIONS

MISSISSIPPI RIVER HYDROLOGY

All of the Mississippi River hydrology data provided here was obtained from the St. Paul District Water Control Center.

Discharge-frequency information at Lock and Dam 9 and the corresponding water surface elevations at Lock and Dam 9, McGregor, Iowa gage, and the interpolated elevation at River Miles 642.0, 640.0, and 638.0 are shown in Table 1 below.

TABLE 1 DISCHARGE-FREQUENCY-ELEVATION AT THE PROJECT AREA

L&D 9 Flow (cms)	Frequency	Flood	Water Surface Elevation (m) at Dam 9 TW	RM 642	RM 640	RM 638	McGregor
3,964.5	20%	5 yr	190.38	190.07	189.96	189.85	189.60
3,624.7	25%	4 yr	190.14	189.82	189.71	189.60	189.36
3,030.0	33%	3 yr	189.65	189.34	189.23	189.12	188.89
2,775.2	50%	2 yr	189.42	189.11	189.00	188.90	188.66
2,293.7	67%	1.5 yr	188.92	188.63	188.53	188.42	188.20
1,925.6	80%	1.25 yr	188.58	188.30	188.20	188.10	187.88
1,387.6	95%	1.05 yr	187.85	187.63	187.56	187.48	187.32

Stage-duration information at the project area, river mile 640, on a monthly basis during the winter months is shown in Table 2 below. The stages at the project area were interpolated for the same percent duration from the gages at Lock and Dam 9 tailwater and McGregor, Iowa.

TABLE 2 STAGE-DURATION AT AMBROUGH SLOUGH, RM 640.0
Percent of Time Elevation Exceeded

Percent	Stage (m) January	February	October	November	December
25	187.42	187.31	187.55	187.55	187.58
30	187.34	187.25	187.46	187.47	187.48
40	187.23	187.13	187.29	187.33	187.34
50	187.07	187.03	187.12	187.21	187.20
60	186.96	186.97	186.92	187.07	187.04
70	186.87	186.91	186.75	186.89	186.91
80	186.71	186.82	186.59	186.75	186.74
90	186.59	186.66	186.46	186.58	186.51

Discharge-duration information at Lock and Dam 9 is shown in Table 3 on the next page.

TABLE 3. LOCK AND DAM 9 DISCHARGE DURATION

Percent of Time at or Above Indicated Discharge

Discharge	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
5664													
5522													
5381					0.13	0.14	0.27						
5239					0.54	0.28	0.40						0.10
5098					0.81	0.42	0.67						0.16
4956				0.14	0.94	0.56	0.81						0.21
4814				0.56	0.94	0.56	0.94		0.14				0.26
4673				0.56	1.21	0.69	1.08		0.28	0.27			0.34
4531				0.83	1.34	0.69	1.21		0.28	0.40			0.40
4390			0.27	0.97	1.48	0.83	1.34		0.28	0.67			0.49
4248			0.54	1.39	1.48	0.97	1.48		0.28	0.81			0.58
4106			1.21	1.67	1.61	0.97	2.02		0.42	0.94			0.74
3965			1.48	1.94	1.75	0.97	2.55		0.42	0.94			0.84
3823			1.75	2.78	1.75	1.11	2.82		0.56	1.08			0.99
3682			2.15	3.33	2.69	1.11	2.96		0.56	1.21			1.18
3540			2.55	4.58	4.17	1.11	3.09		0.69	1.21			1.46
3398			2.82	7.08	5.38	1.11	3.23		0.69	1.34			1.81
3257			3.23	8.89	6.18	1.94	3.36		0.69	1.48			2.16
3115			3.90	12.50	7.80	2.50	3.49		0.69	2.28			2.77
2974			4.57	17.50	10.22	2.78	3.90		0.83	2.82			3.56
2832			5.78	23.3	14.4	2.92	4.84	0.27	0.83	3.36			4.66
2690			7.39	27.8	21.0	4.03	5.78	0.81	0.83	3.63			5.96
2549			9.54	32.8	27.6	6.53	6.32	1.61	0.97	4.57			7.52
2407		0.15	11.8	39.2	32.8	9.17	6.99	3.09	1.67	5.11	0.56		9.25
2266		0.44	14.9	46.0	39.0	11.9	8.74	4.84	2.64	6.45	0.97	0.27	11.4
2124		1.47	17.2	53.5	45.2	15.1	12.6	5.78	3.47	7.66	2.92	0.54	13.8
1982		1.62	19.5	61.9	50.1	19.6	15.6	6.59	5.69	10.1	6.11	1.35	16.6
1841		2.65	22.6	65.8	54.2	22.4	17.7	6.85	6.94	11.6	7.92	1.49	18.4
1699		2.80	26.2	69.9	57.7	25.0	19.8	8.47	9.58	12.6	9.44	1.89	20.3
1558		2.80	29.7	73.5	60.9	31.7	26.5	10.6	13.9	17.3	12.1	2.44	23.5
1416	0.27	2.95	34.0	77.1	63.2	38.3	32.1	12.9	18.8	20.3	16.3	4.60	26.8
1274	0.54	3.10	38.4	80.1	67.1	49.3	39.4	19.4	25.4	26.3	21.0	5.68	31.4
1133	2.69	4.57	45.0	83.2	72.2	62.9	45.7	25.3	31.7	33.1	31.7	8.66	37.3
991	4.97	5.90	52.4	87.9	76.1	71.3	54.3	34.1	39.4	40.3	44.6	17.3	44.2
850	15.7	9.44	60.2	94.6	82.1	76.3	62.1	45.4	50.1	52.3	56.5	33.7	53.4
708	31.6	21.8	66.9	96.9	86.8	80.3	71.4	58.5	61.3	62.6	68.5	48.3	63.1
566	55.4	52.1	84.3	98.6	91.9	87.2	77.4	71.6	76.8	73.4	85.7	62.4	76.5
425	79.6	84.5	94.5	99.4	97.0	94.4	87.1	84.3	88.2	87.1	93.3	85.7	89.6
283	96.8	97.6	100	100	100	98.8	97.2	95.3	95.4	98.3	98.9	96.6	97.9
142	100	100	100	100	100	100	100	100	100	100	100	100	100
0	100	100	100	100	100	100	100	100	100	100	100	100	100

Period of Record 1972-1995

AMBROUGH SLOUGH AND BLACK SLOUGH HYDROLOGY

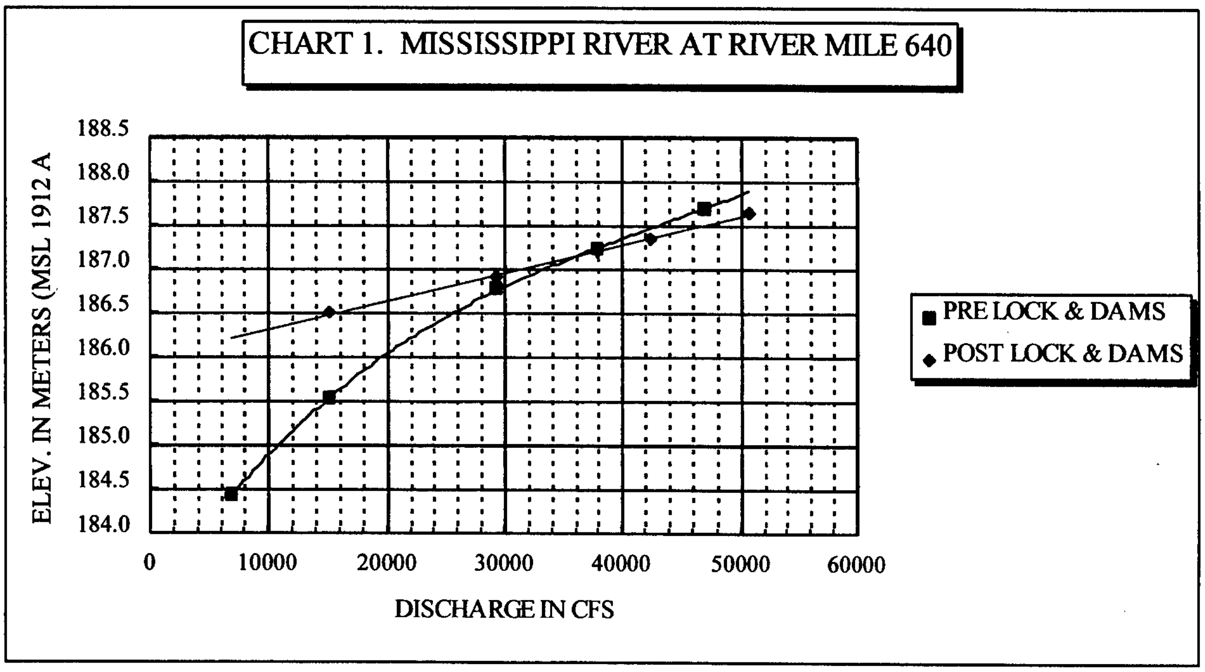
Ambrough and Black Sloughs are directly connected to the Mississippi River main channel. Because of this connection, their water levels fluctuate just like the water levels on the main channel of the Mississippi River.

A review of the historical changes of Ambrough Slough was conducted using available historical maps and aerial photographs. Ambrough Slough appears to have remained relatively stable with negligible changes in its channel alignment since 1894, the date of the oldest available mapping.

The current connection of Black Slough with the main channel of the Mississippi River wasn't present on the 1894 Mississippi River Commission Map. In the October 1938 aerial photograph, one year after Lock and Dam 10 was in operation, the connection of Black Slough with the main channel of the Mississippi River is barely evident and very small. The aerial photographs taken in May and September 1973 show that the entrance to Black Slough had grown considerably and appeared even larger than the entrance to Ambrough Slough. The September 1989 aerial photographs show that Black Slough had cut through to Fluke's Lake.

HYDRODYNAMICS

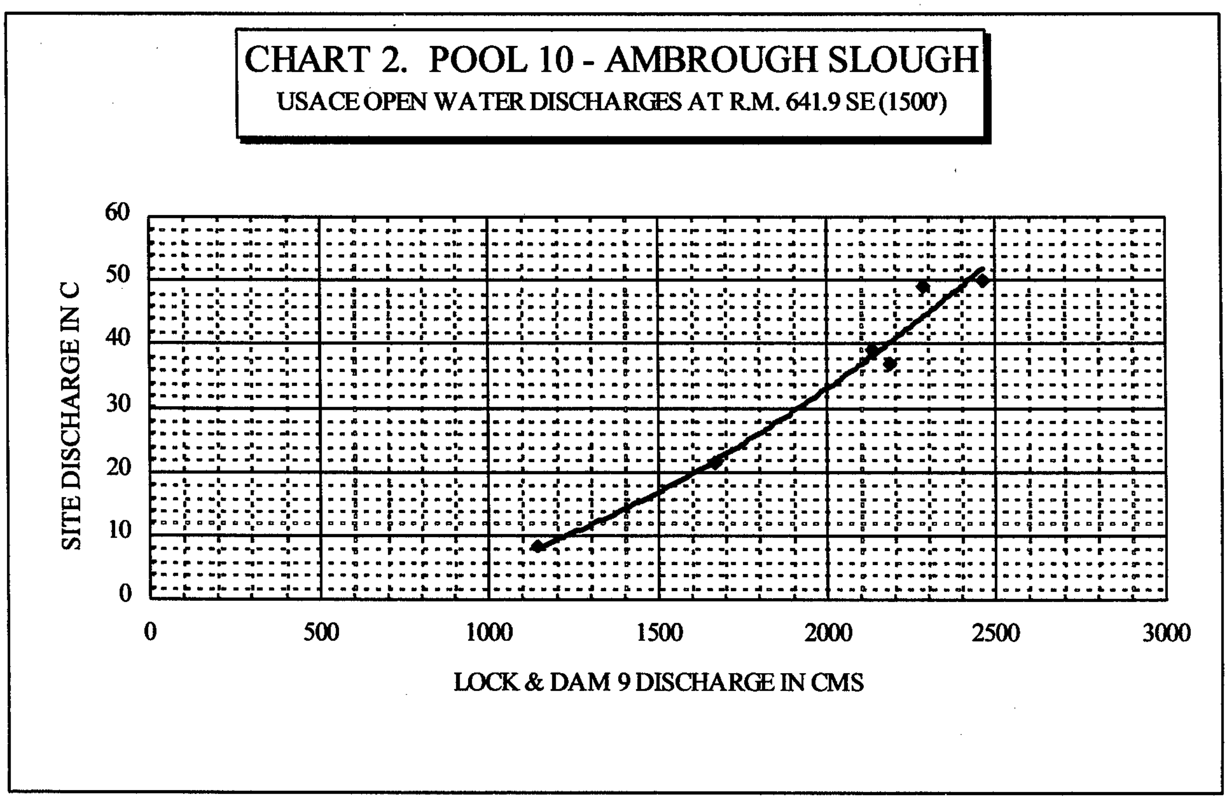
The Ambrough Slough project area was considered an excellent habitat area right after the Locks and Dams were put into operation. Chart 1 below illustrates how the operation of the Locks and Dams affected Mississippi River hydrodynamics.



DISCHARGE DISTRIBUTION

The St. Paul District from May 1995 through May 1999 made discharge measurements during the open water season. The Wisconsin Department of Natural Resources (WDNR) made discharge measurements of Ambrough Slough as part of their winter water quality monitoring in January 1989, 1991, 1997 and February 1996. A location map of the discharge measurements made in the project area is shown in Plate 2. All of the discharge measurements made at the project area are shown in Table 4 on the following page. Discharge measurements taken by the St. Paul District included every channel with measurable flow off the main channel of the Mississippi River.

Rating curves were developed for the two main sloughs, Ambrough Slough and Black Slough, in the project area. Ambrough Slough is further broken down into an open water rating curve at the mouth using COE data, Chart 2, and a winter rating curve at the boat landing site using WDNR data, Chart 3. An open water Black Slough rating curve is shown as Chart 4. A second order polynominal trendline was fitted to the data on each curve.



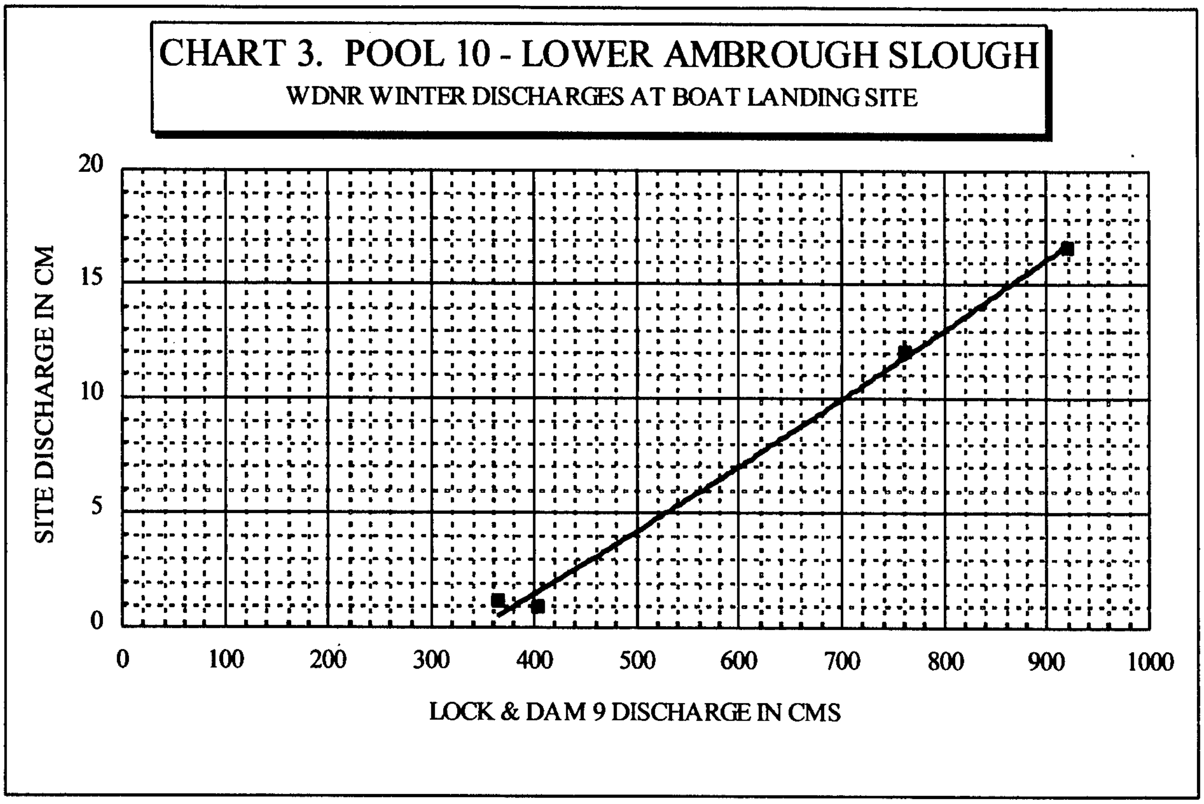


CHART 3. POOL 10 - LOWER AMBROUGH SLOUGH
WDNR WINTER DISCHARGES AT BOAT LANDING SITE
SITE DISCHARGE IN CM
0
5
10
15
20
0
100
200
300
400
500
600
700
800
900
1000
LOCK & DAM 9 DISCHARGE IN CMS

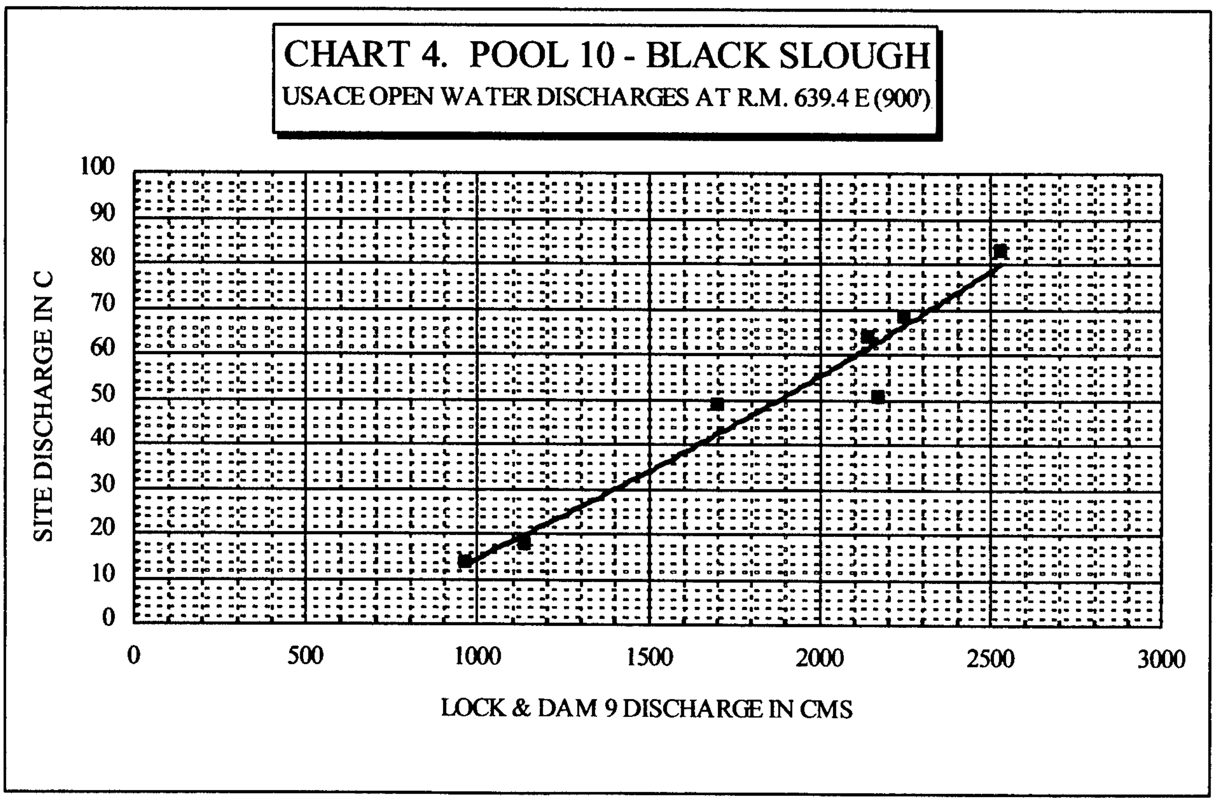


CHART 4. POOL 10 - BLACK SLOUGH
USACE OPEN WATER DISCHARGES AT R.M. 639.4 E (900')
SITE DISCHARGE IN C
0
10
20
30
40
50
60
70
80
90
100
0
500
1000
1500
2000
2500
3000
LOCK & DAM 9 DISCHARGE IN CMS

TABLE 4. DISCHARGE MEASUREMENTS

Site	Date	Data Source	L&D 9 Discharge	Site Discharge	% of L&D 9 Discharge	Description
642.1SE900	05/17/95	COE	75500	380	0.50%	
642.1SE900	07/18/95	COE	40400	1	0.00%	
642.1SE900	05/29/96	COE	80800	630	0.78%	
642.1SE900	06/25/96	COE	77150	540	0.70%	
642.1SE900	10/23/96	COE	34100	0	0.00%	
642.1SE900	07/10/97	COE	59000	90	0.15%	
641.9SE1500	05/17/95	COE	75500	1378	1.83%	
641.9SE1500	07/18/95	COE	40300	293	0.73%	
641.9SE1500	05/29/96	COE	80775	1730	2.14%	
641.9SE1500	06/25/96	COE	77200	1309	1.70%	Ambrough Slough
641.9SE1500	10/23/96	COE	34100	*		
641.9SE1500	07/10/97	COE	59000	752	1.27%	
641.9SE1500	05/19/99	COE	86950	1770	2.04%	
E of Roulette	01/14/97	WDNR	32500	252	0.78%	Ambrough Slough
641.85SE800	05/17/95	COE	75600	659	0.87%	
641.85SE800	07/18/95	COE	40200	*		
641.85SE800	05/29/96	COE	80750	818	1.01%	
641.85SE800	06/25/96	COE	77200	654	0.85%	
641.85SE800	10/23/96	COE	34100	*		
641.85SE800	07/10/97	COE	59100	359	0.61%	
641.8SE600	05/17/95	COE	75500	320	0.42%	
641.8SE600	07/18/95	COE	40200	*		
641.8SE600	05/29/96	COE	80775	301	0.37%	
641.8SE600	06/25/96	COE	77200	269	0.35%	
641.8SE600	10/23/96	COE	34100	0	0.00%	
641.8SE600	07/10/97	COE	59250	68	0.11%	
641.7SE600	05/17/95	COE	75600	95	0.13%	
641.7SE600	07/18/95	COE	40200	*		
641.7SE600	10/23/96	COE	34100	0	0.00%	
641.7SE600	05/29/96	COE	80725	234	0.29%	
641.7SE600	06/25/96	COE	77200	253	0.33%	
641.7SE600	07/10/97	COE	59250	11	0.02%	
640.9	05/29/96	COE	80700	72360	89.67%	
640.9	06/25/96	COE	76025	55693	73.26%	Main Channel
640.9	07/09/97	COE	60000	56295	93.83%	
640.0E800	05/30/96	COE	79650	230	0.29%	
640.0E800	06/26/96	COE	76800	159	0.21%	
640.0E800	07/10/97	COE	59400	*		
639.6	04/17/97	COE	200400	130816	65.28%	Main Channel
639.6E2200	04/17/97	COE	200800	14968	7.45%	
639.6E4800	04/17/97	COE	201300	47169	23.43%	
639.4E900	05/17/95	COE	75550	2260	2.99%	
639.4E900	07/18/95	COE	40200	622	1.55%	
639.4E900	05/30/96	COE	79200	2417	3.05%	Black Slough
639.4E900	06/26/96	COE	76600	1787	2.33%	
639.4E900	10/23/96	COE	34050	485	1.42%	
639.4E900	07/09/97	COE	60100	1720	2.86%	
639.4E900	05/20/99	COE	89400	2935	3.28%	
Lower Ambrough Slough	01/15/97	WDNR	32500	587	1.81%	Ambrough Slough
	02/14/96	WDNR	26900		0.00%	
	01/20/89	WDNR	14300	30	0.21%	
	01/10/91	WDNR	12900	40.8	0.32%	

* Flow present, although too shallow for boat to make measurement.

DESIGN OF HYDRAULIC FEATURES

The main habitat deficiencies of the Ambrough Slough complex are of several types; lack of adequate water depth, lack of flow through backwater lakes, dissolved oxygen depletion, low water temperatures, too high current velocity and lack of adequate structural cover. The types of hydraulic features considered in the design to alleviate these problems were; closure structures, dredging, and flow introduction or aeration.

CLOSURE STRUCTURES

Closure structures can help reduce the current velocity and increase water temperatures by reducing the flow of cold water into the backwater lakes or slough.

BLACK SLOUGH

The entrance to Black Slough has been actively enlarging since the creation of Pool 10. As a result, flows into Black Slough have increased significantly. These increased flows can adversely affect downstream winter fish habitat. A closure structure at the entrance to Black Slough would reduce the winter flows into the backwaters and stabilize the entrance to prevent further enlargement.

The initial design criteria for the Black Slough closure was a decrease in winter flows by 60 percent or a return to the flows in the 1988-1991 time frame. There are no direct discharge measurements of the winter flow in Black Slough. The best information available was the open water discharge measurements by the St. Paul District. A typical total Mississippi River winter flow of about 623 cms was determined by examining discharge duration information at Lock and Dam 9. The existing condition discharge at the Black Slough entrance was determined by using the open water rating curve and extrapolating down to get a site discharge of about 7.9 cms. (Discharge measurements have been taken at the entrance to Black Slough, however, because of the old bank revetment at the entrance, measurements couldn't be taken when the main channel discharge was below approximately 1,133 cms.) The resulting typical winter water surface elevation was 186.69 m (determined by interpolation between the Lock and Dam 9 tailwater and the McGregor, IA gage). The design discharge would be 3.2 cms. All attempts at designing a closure to meet the 60 percent winter flow reduction resulted in a cross section that would be too small to allow for safe pasage of watercraft.

The final design includes a 4 m wide channel with an invert elevation of 185.5 m. A cross section of the proposed partial closure is shown on Plate 3. The partial closure will be constructed of rock with a minimum thickness of 0.5 m and a minimum elevation outside of the channel section of 187.15 m to be effective for more typical winter flows. The ends of the partial closure have a raised tie-in to help keep flow from eroding around the edges of the rock.

The existing measured channel velocities at the entrance to Black Slough range from an average of 0.37 – 2.34 fps and maximum velocities ranging from 1.32 – 3.31 fps. Since the winter flow in Black Slough is much less than the measured discharges, the velocities should be lower as well. Velocities through the partial closure should not increase above the ranges stated above for main channel discharges above1,133 cms. This partial closure design should satisfy boater safety concerns.

There is insufficient information available at Black Slough to accurately calculate the new expected discharge, channel slope, or velocities. The proposed partial closure would result in a typical winter flow area reduction of about 90% at the entrance to Black Slough. However, downstream of the entrance the cross sections are smaller and would only be an 80% reduction of flow area.

UPPER DOUBLES LAKE

The closure at Upper Doubles Lake is designed to protect the lake from flows entering it from Big Missouri Lake. The closure consists of a 2m wide rock weir with raised tie-ins to help keep flow from eroding around the edges of the rock. The design criterion for the closure was for a complete winter closure. A complete winter closure would require building a closure that would not overtop during winter, however; the existing ground surface at the lakes is too low to build a closure to meet that criterion. The highest elevation the closure could be built to would be to match existing ground. Past closure design experience has shown that earth closures are susceptible to blowouts. To avoid this the closures were designed with rock. A rock closure would resist blowouts, but must be built lower than the existing ground to prevent water from circumventing the closure and eroding the existing ground. The top elevation of the closure was set 0.15 m lower than the existing ground at the tie-ins. The top elevation of the closure at Upper Doubles Lake was set at 187.35 m, which would overtop during 63 percent of the winters. The partial closure will be constructed with a minimum rock thickness of 0.5 m A cross section of the closure is shown on Plate 5.

LOWER DOUBLES LAKE

The closure at Lower Doubles Lake is designed to protect the lake from flows entering it from Big Missouri Lake. The closure consists of a 2m wide rock liner with raised tie-ins to help keep flow from eroding around the edges of the rock. The design criterion for the closure was for a complete winter closure. A complete winter closure would require building a closure that would not overtop during winter, however; the existing ground surface at the lakes is too low to build a closure to meet that criterion. The highest elevation the closure could be built to would be to match existing ground. The top elevation of the closure was set 0.15 m lower than the existing ground at the tie-ins. The minimum top elevation of the closure at Lower Doubles Lake was set at 187.35 m, which would overtop during 63 percent of the winters. The partial closure will be constructed with a minimum rock thickness of 0.5 m. The minimum top elevation of 187.35 m would create a small weir section in the middle of the liner, with a rock thickness larger than the minimum of 0.5m.

TILMONT LAKE

Two closures at Tilmont Lake were considered, a small one at the North end of the lake and a large one along the East side of the lake. The large closure is really not a closure because there will still be an opening into the lake, rather it is a rebuilding of the island peninsula that separates and protects the lake from flow in Mudhen and Ambrough Sloughs. The entrance to the lake will be reduced to a size typical of the historic opening shortly after inundation.

The small (north) closure is very similar to the closures at Upper and Lower Doubles Lakes. It will consist of a 3m wide rock weir with raised tie-ins to the existing ground. The design criterion for the closures was for a complete winter closure. A complete winter closure would require building a closure that would not overtop during winter, however; the existing ground surface at the lakes is too low to build a closure to meet that criterion. The highest elevation the closure could be built to would be to match existing ground. The top elevation of the closure was set at 187.15m, 0.15 m lower than the existing ground at the tie-ins. A closure at 187.15m would overtop during 70 percent of winters. The partial closure will be constructed of rock with a minimum thickness of 0.5 m. A cross section of the closure is shown on Plate 4.

The peninsula protecting Tilmont Lake from flows in Mudhen and Ambrough Sloughs had eroded over time. A rebuilding of the peninsula was needed to protect Tilmont Lake. Three materials were considered for construction of the Tilmont Lake peninsula; side cast material, sand and rock. The side cast material and sand cross sections would have a top elevation of 188.0 m, and the rock cross section would have a top elevation of 187.15m. The peninsula will be a simple trapezoid cross section with a top elevation of 188.0 m, width of 15 m and side slopes of 1V on 6H. It will be constructed by taking material from inside Tilmont Lake and side casting it into the trapezoidal section. The new peninsula will be planted with willows n the side slopes and built on the remains of the old peninsula, but set back away from Mudhen Slough. The flow in Mudhen Slough will be parallel to the peninsula. Bank protection other than the willow plantings should not be needed to protect the peninsula for its design life. A cross section and profile of the peninsula is shown on Plate 6.

FISH LAKE

The closure at Fish Lake is really not a closure because there would still be an opening into the lake, rather it is a rebuilding of the island peninsulas that used to separate and protect the lake from flow in Ambrough Slough. The entrance to the lake will be reduced to a size typical of the historic opening shortly after inundation.

No survey or bathymetric data was available for the design of the Fish Lake peninsula. The Fish Lake peninsula was designed assuming 0.6 m deep water and using the same cross section as the Tilmont Lake peninsula.

DREDGING

Dredging was considered as a project feature to increase water depths and to provide deep-water connectivity within backwater lakes. No hydraulic analysis was involved in the design of the dredging, see the main report and Appendix 4 for more information.

GREMORE LAKE

AERATION

Aeration of Gremore Lake was considered as a project feature to increase the dissolved oxygen within the lake. No hydraulic analysis was involved in the design of the aeration, see the main report and Appendix 4 for more information.

FLOW INTRODUCTION

A channel and culvert system was designed to introduce flow into Gremore Lake to alleviate winter dissolved oxygen problems. The channel and culvert system would be constructed through the peninsula of land that separates Gremore Lake from Ambrough Slough to the west. The culvert will be placed under the road that leads to the end of the peninsula and channels will be excavated on either side of the road. The initial design called for only a culvert, but part of the culvert was replaced with open channels to allow for easier maintenance access.

The criterion for flow introduction was 0.28 – 0.42 cms during typical winter conditions. There is an extremely low head of water, 0.003 m, across the peninsula at Gremore Lake. Because of this low head a completely submerged, 1.2 m diameter culvert would be needed to meet the flow requirements. However, to make it possible for maintenance workers to get inside the culvert to remove debris, the culvert diameter was increased to 2.13 m (see Plate 7). The invert elevation of 185.7 was determined based on the need to do maintenance work and convey 0.28 - 0.42 cms during low flow conditions. A stoplog control structure will be placed on the upstream end of the culvert to reduce discharge if that becomes necessary. End sections will be placed on the culvert and the channel on either side of the culvert will be 2 m wide (width of the end sections) and have 1V on 3H side slopes. A horizontal riprap liner on the downstream side of the culvert was designed using guidance in TR H-74-9. The riprap in the exit channel was placed up to the elevation of the top of the culvert. Riprap was also placed on the top 1 m of the downstream slope of the embankment for protection during overtopping. Because of the extreme low head across the peninsula, almost the entire embankment will be submerged by the time overtopping occurs so the rock is only needed at the top of the embankment slope. The riprap thickness will be 0.5 m

DREDGING

Dredging of Gremore Lake was considered as a project feature to increase water depths and to provide a connection between the culvert and deep-water within the lake. One option considered was to construct a mixing cell that would contain warm water at the beginning of the winter that theoretically would mix with the cold water entering Gremore Lake from the the culvert. However, an analysis based on the Richardson number, which considers flow inertia and flow buoyancy, indicates that mixing would be limited, due to the extremely low flows.

REFERENCES

1. Problem Appraisal Report for Ambrough Slough Habitat Rehabilitation and Enhancement Project, U. S. Army Corps of Engineers, St. Paul District, October 1997.

2. Technical Report H-74-9, Practical Guidance for Design of Lined Channel Expansions at Culvert Outlets, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, 1974.

3. Great I, Study of the Upper Mississippi River, Technical Appendix, Volume 4, September 1980.

4. Mississippi River Island Designs 1987 to 1996 for Environmental Management Program, Habitat Rehabilitation and Enhancement Project Engineering and Design, U. S. Army Corps of Engineers, St. Paul District, January 1997.

5. Mississippi River Shoreline Stabilization Designs 1987 to 1996 for Environmental Management Program, Habitat Rehabilitation and Enhancement Project Engineering and Design, U. S. Army Corps of Engineers, St. Paul District, December 1996.

6. Technical Manual 5-820-4, Drainage for Areas Other Than Airfields, Headquarters, Department of the Army, October 1983.

PLATE 1

AMBROUGH SLOUGH PROJECT AREA MAP

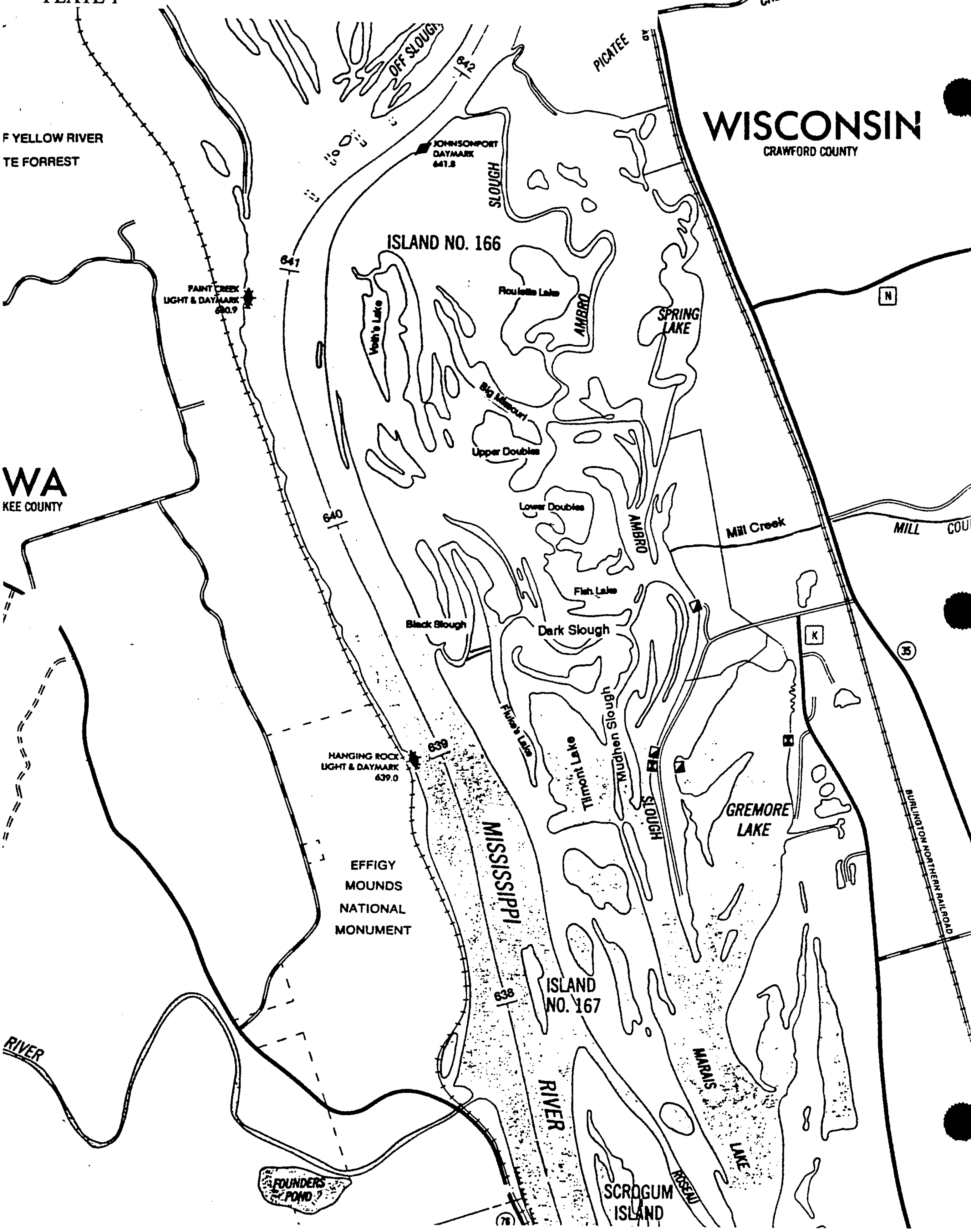
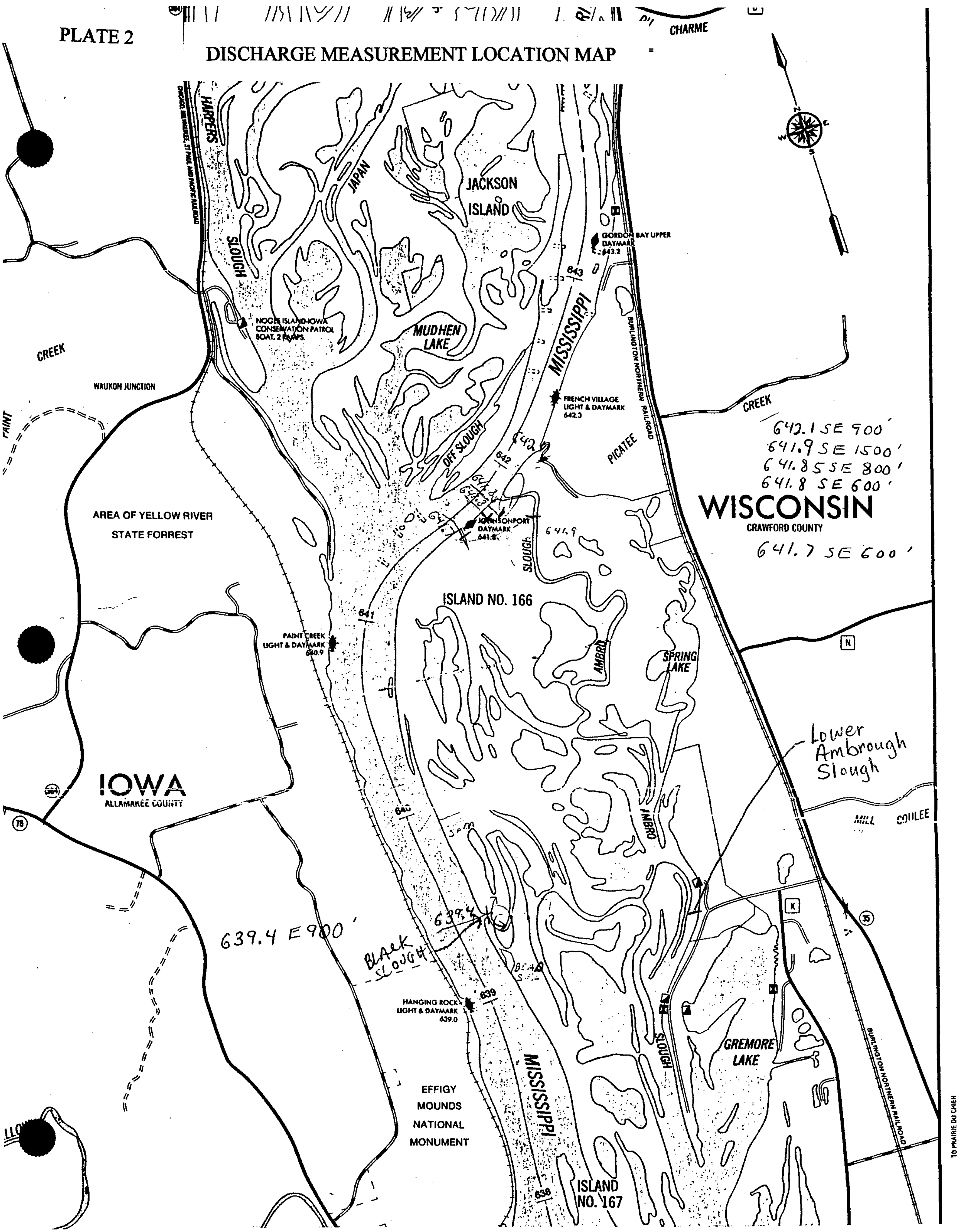


PLATE 2

DISCHARGE MEASUREMENT LOCATION MAP



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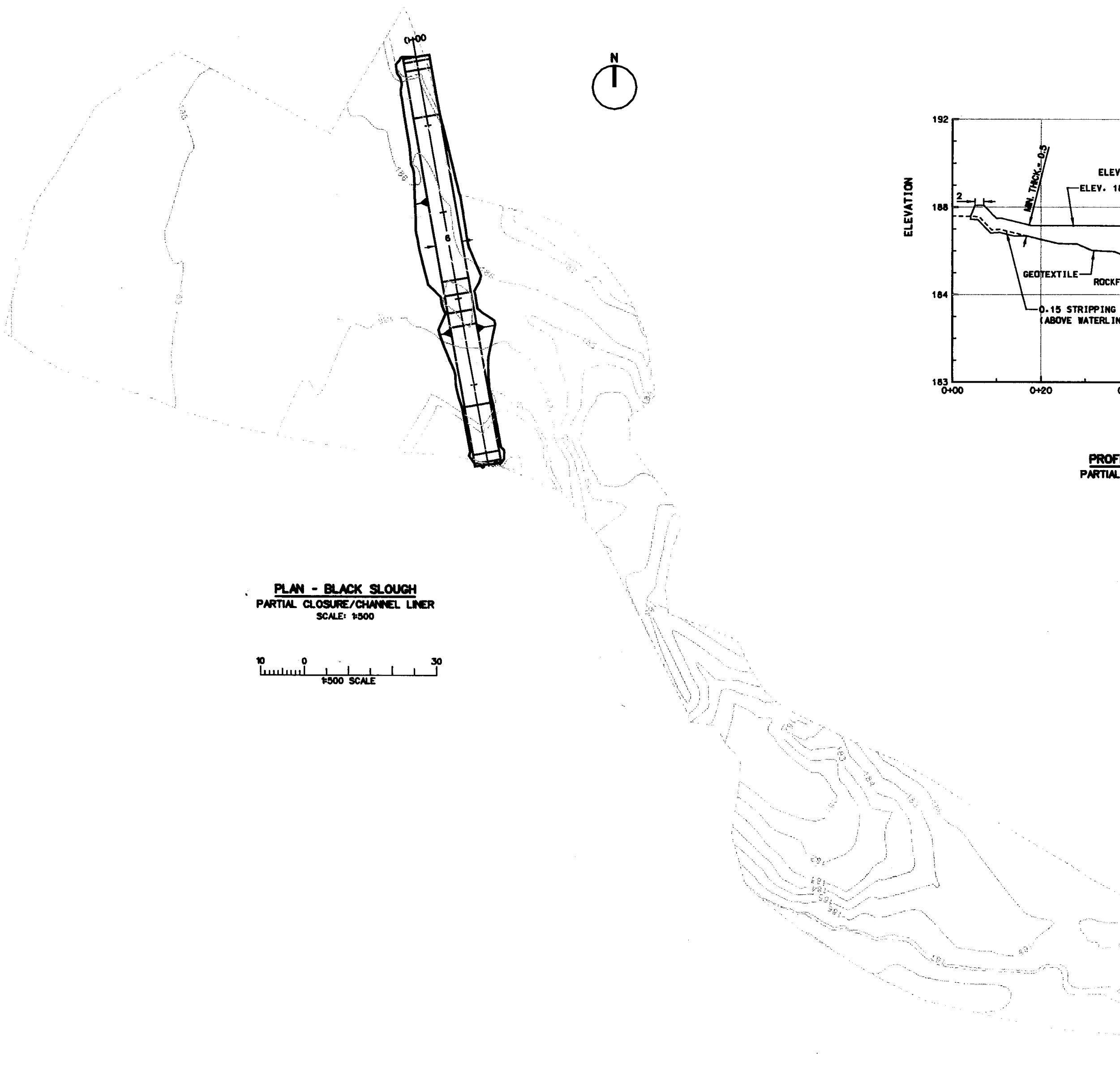
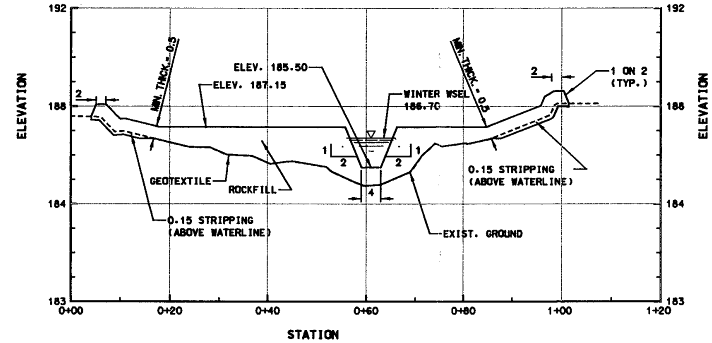
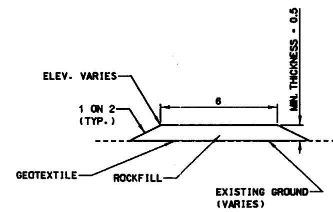


PLAN - BLACK SLOUGH
PARTIAL CLOSURE/CHANNEL LINER
SCALE: 1:500



PROFILE - BLACK SLOUGH
PARTIAL CLOSURE/CHANNEL LINER
SCALE: NONE



TYPICAL SECTION - BLACK SLOUGH
PARTIAL CLOSURE/CHANNEL LINER
SCALE: NONE

US Army Corps of Engineers
St. Paul District

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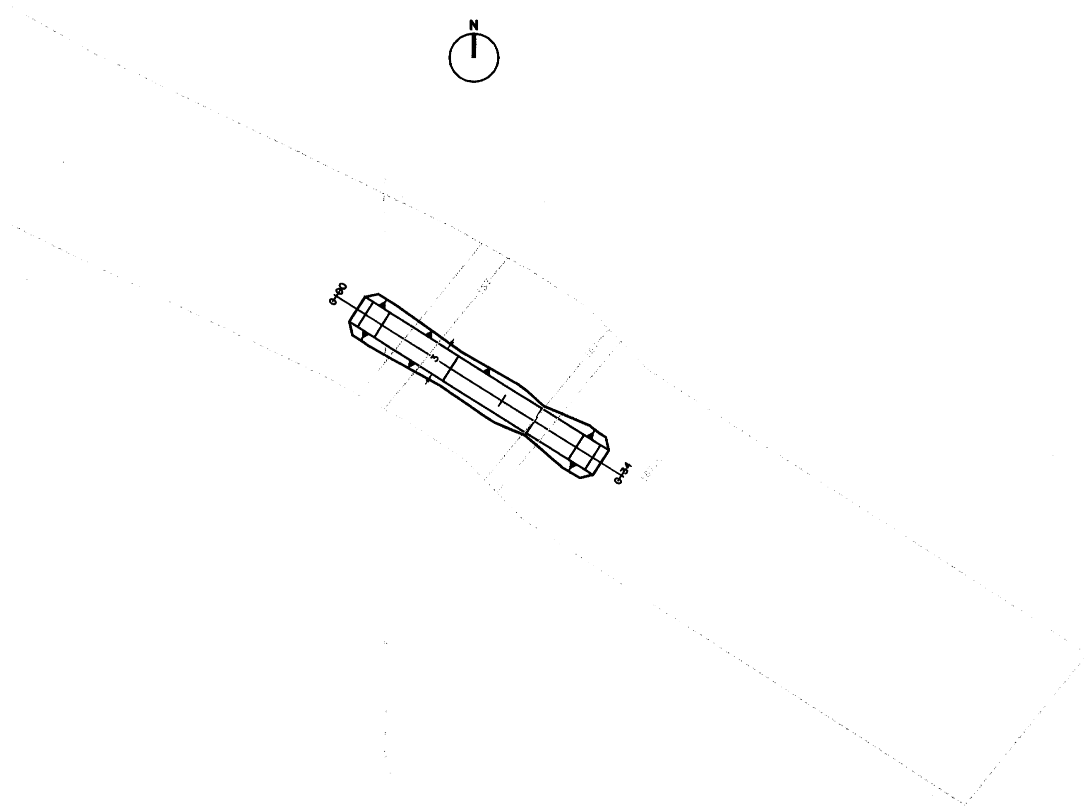
AMBROUGH SLOUGH - DPR
SITEWORK
PLAN, PROFILE AND SECTION
BLACK SLOUGH

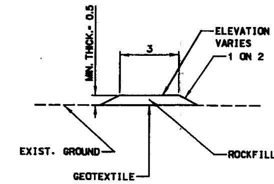
DRAWING NUMBER:
PLATE 3
SHT 1 OF 05

NOTES:

1. UNLESS OTHERWISE NOTED, UNITS SHOWN ARE IN METERS.
2. ELEVATIONS REFER TO MEAN SEA LEVEL (N.G.V.D. 1912 ADJ.)



PLAN
SMALL CLOSURE - TILMONT LAKE
SCALE: 1:250



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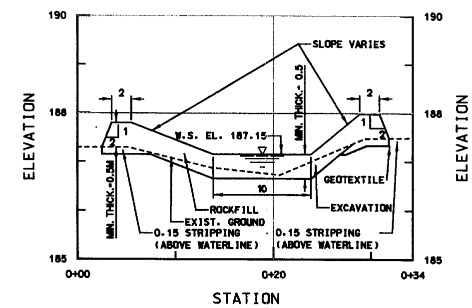

PROFILE
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SCALE: NONE

US Army Corps of Engineers
St. Paul District

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AMBROUGH SLOUGH - DPR
SITEWORK
PLAN, PROFILE AND SECTION
SMALL CLOSURE - TILMONT LAKE

DRAWING NUMBER:
PLATE 4
SHT 2 OF 05

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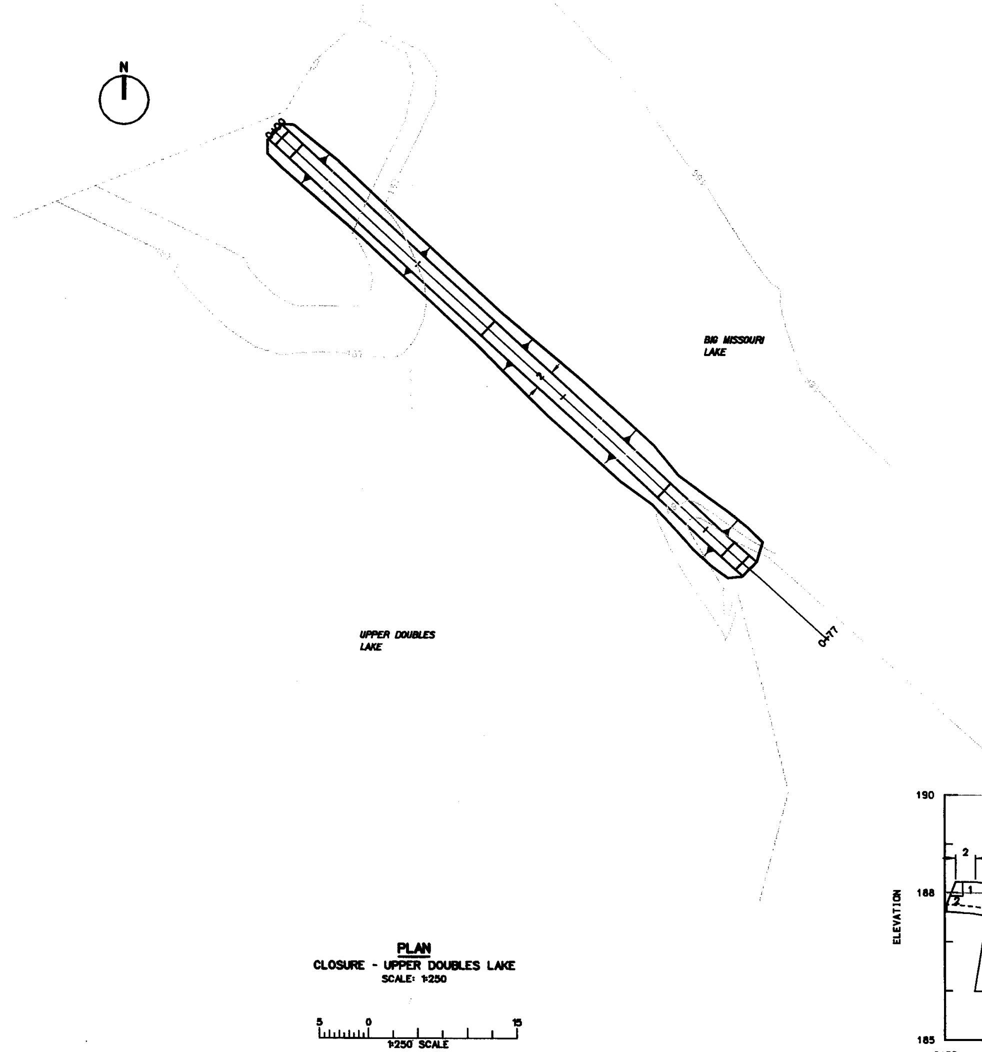
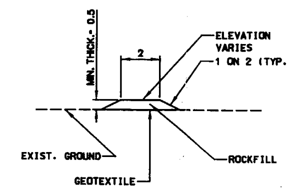
2. ELEVATIONS REFER TO MEAN SEA LEVEL (N.G.V.D. 1912 ADJ.)



PLAN
CLOSURE - UPPER DOUBLES LAKE
SCALE: 1:250



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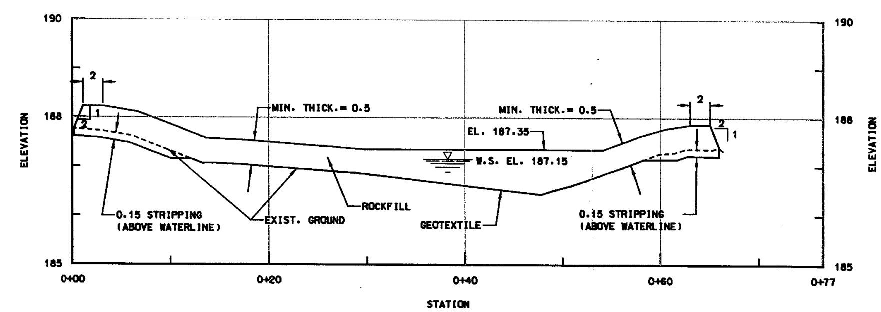

PROFILE
CLOSURE - UPPER DOUBLES LAKE
SCALE: NONE

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St. Paul District

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AMBROUGH SLOUGH - DPR
SITEWORK
PLAN, PROFILE AND SECTION
UPPER DOUBLES LAKE

DRAWING NUMBER:
PLATE 5
SHT 3 OF 05

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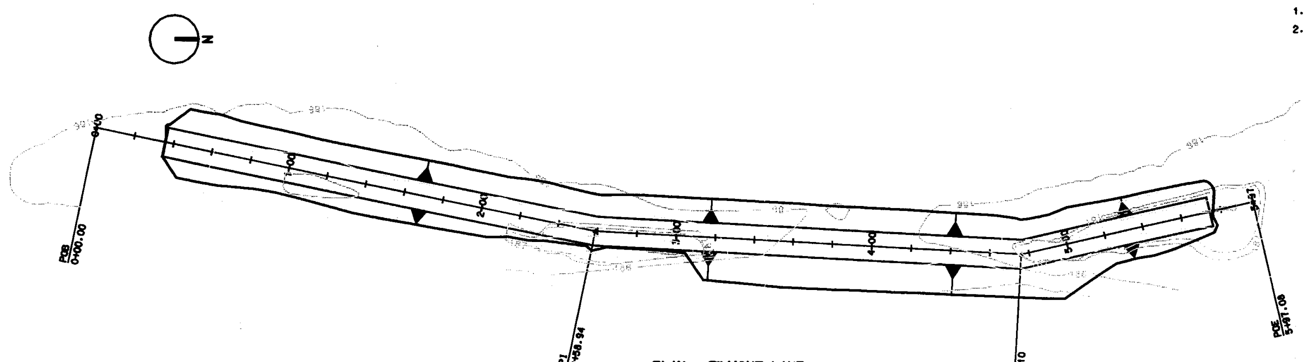
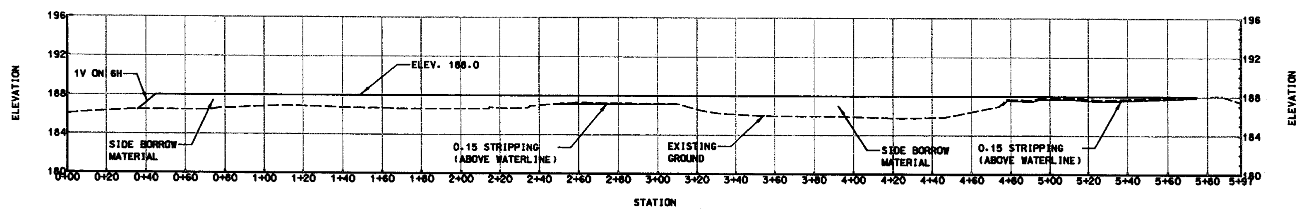
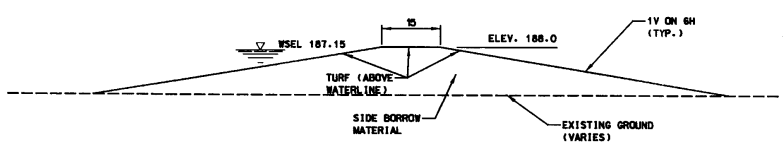


PLAN - TILMONT LAKE
LARGE CLOSURE
SCALE: 1:1250

25 0 75
1:1250 SCALE



PROFILE - TILMONT LAKE
LARGE CLOSURE
SCALE: NONE



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LARGE CLOSURE
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St. Paul District

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PLAN, PROFILE AND SECTION
LARGE CLOSURE - TILMONT LAKE

DRAWING NUMBER:
PLATE 6
SHT 4 OF 05

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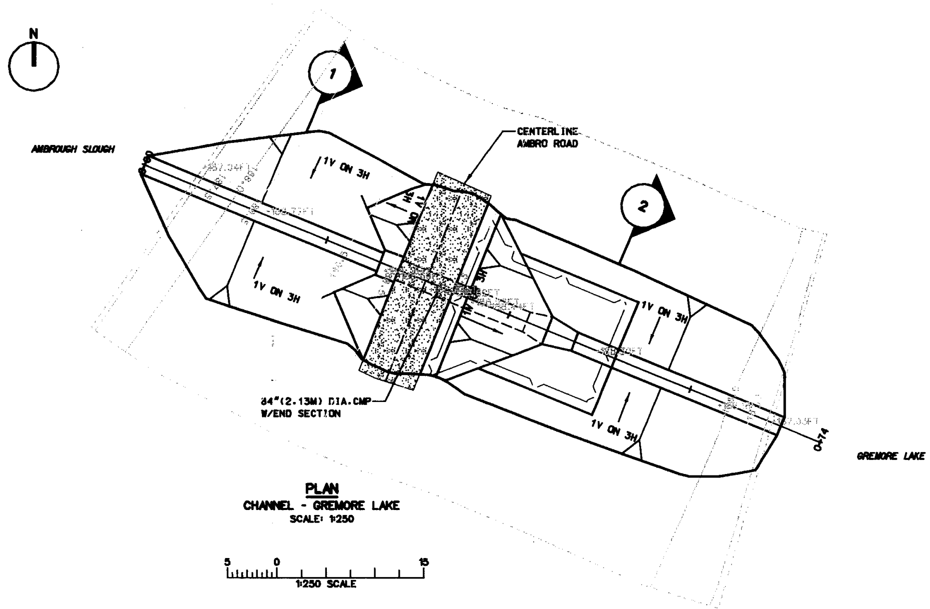
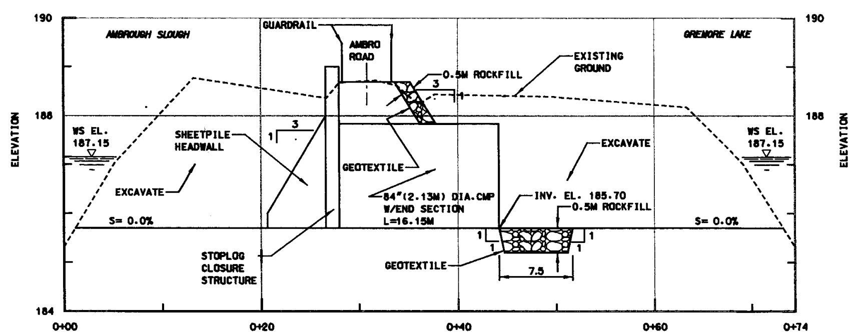


PLAN
CHANNEL - GREMORE LAKE
SCALE: 1:250



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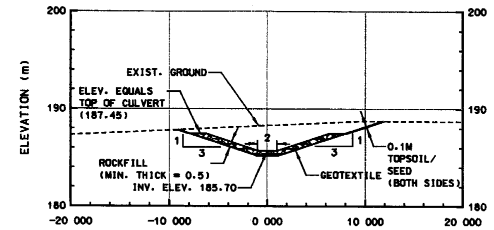

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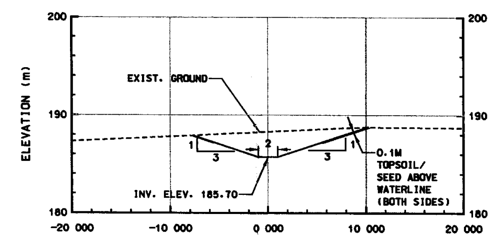

SECTION (1)
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SCALE: NONE

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St. Paul District

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AMBROUGH SLOUGH - DPR
SITEWORK
PLAN, PROFILE AND SECTION
GREMORE LAKE CHANNEL

DRAWING NUMBER:
PLATE 7
SHT 5 OF 05

Attachment 6

Geotechnical Appendix

TABLE OF CONTENTS

DEFINITE PROJECT REPORT/ENVIRONMENTAL ASSESSMENT
AMBROUGH SLOUGH EMP
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 10, UPPER MISSISSIPPI RIVER
CRAWFORD COUNTY, WISCONSIN
ATTACHMENT NO. 6
GEOLOGY AND GEOTECHNICAL DESIGN

1. GENERAL:

The geologic information was taken from The Physical Geography of Wisconsin, by Lawerence Martin, Wisconsin Geological and Natural History Survey[3] and U.S.G.S. Hydrologic Investigations Atlas HA-474, by Young and Borman[4].

2. PHYSIOGRAPHY:

The Ambrough Slough, Habitat Rehabilitation and Enhancement Project (HREP) is located in the vicinity of river mile 640, just upstream from Prairie du Chien, Wisconsin in Crawford County. Along this portion of its course, the Mississippi River Valley is located in the Central Lowlands Physiographic Province of the U.S. This physiographic province may be further subdivided into the Western Uplands Physiographic Region of Wisconsin. Approximately ¾ of the Wisconsin Western Uplands was never overridden by ice during Pleistocene glaciation. This unique, unglaciated region is known as the Driftless Area. Topographic features evident in the Driftless Area today are thought to reflect conditions as they were over much of Wisconsin prior to glaciation.

3. The uplands region adjacent to the river has been dissected into a system of ridges and valleys with practically no broad upland areas remaining. Crawford County is dominated by this ridge and valley topography, with ridge top elevations from 1100 to 1250 feet. The steep sided valleys are known locally as coulees.

4. The Mississippi River lies in a broad, bedrock gorge or trench. The gorge is a relatively youthful, U-shaped feature with steep-sided limestone bluffs rising 400-500 feet above river level on either side. At the project location, the gorge is about 2 miles across. The river gradient is quite low, averaging less than 2 inches per mile during typical flow conditions. The side channels, meanders, and sloughs (Ambrough Slough is a good example) that typify low gradient conditions are still present at the project location. Well-developed sand and gravel terraces parallel the river, and a remnant of one is located in the Prairie du Chien area. The Mississippi

River's confluence with the Wisconsin River and its associated delta is just downstream from the project location.

5. GENERAL GEOLOGY:

Although the Mississippi River gorge probably existed as long as 180 million years ago, the major geologic event that created the valley we see today occurred approximately 10,000 years ago, near the end of Pleistocene glaciation. During this period the Mississippi gorge was filled with glacial outwash sand and gravel deposits. After deposition of the outwash sediments, large volumes of meltwater from the southward outflow of glacial Lake Agassiz eroded the sands and gravels while simultaneously scouring and deepening the bedrock valley. As the meltwaters diminished, the deeply eroded gorge filled with up to 60 meters (200 feet) of river sands, gravels, clays, and silts. The large supply of sediment from the Mississippi headwaters and its tributary streams, coupled with a diminished water supply at the end of glacial melting, led to the development of a braided stream environment. Numerous channels, swampy depressions, natural levees, islands, and shallow lakes characterized river conditions, at that time. Completion of Lock and Dam No. 10 (in 1937) flooded the area and partly obscured the braided stream characteristics. Lake-type sediments now form a relatively thin, stratified, veneer of organics, silts, sands, and clays over most of the present river bottom.

6. Bedrock exposures are readily observable along the Mississippi River bluffs. Ordovician Period dolomites and limestones of the Prairie du Chien Formation cap the bluffs and ridges. In descending order, the underlying cap rocks are the Jordan Sandstone, the St. Lawrence Formation dolomites and siltstones, the Franconia Formation sandstones, and the Dresbach Formation sandstones of the Cambrian Period.

7. The bedrock Mississippi gorge is entrenched into the lowermost Cambrian Period rock, the Dresbach Formation. This unit is comprised of marine-deposited quartz sandstones. The sandstone is relatively easy to erode, and this erodibility helps to account for the wide, U-shaped geometry of the bedrock gorge. Older Precambrian sedimentary and crystalline rocks lie below the Dresbach Formation and are assumed to be thousands of feet thick.

8. The structural geology of this portion of the Mississippi gorge has not been determined in detail. The sedimentary rocks dip gently and thicken to the southwest, conforming to the Precambrian basement. Solution weathering in the Ordovician Period dolomites is common. Stress relief joints that tend to parallel the trend of the Mississippi gorge may also be observed in the river bluffs. This region is considered structurally stable and without tectonic disturbances of regional or local magnitude.

9. GENERAL GEOTECHNICAL DESIGN:

The Geotechnical Design philosophy used for Environmental Management Program (EMP) projects is different than that used for flood control projects. The acceptable level of risk is higher for EMP's because their design purpose is to create animal habitat and their design life of 50 years as opposed flood control which protects lives and property, and has a design life of 100 years. For this reason, less data are required (only one strength test was done for Ambrough Slough, strength correlation was used for other areas) and experimental methods of construction (the side casting of saturated fined-grained material) are used.

10. SELECTED PLAN SUMMARY:

The Executive Summary (the first page of this report) summarizes the selected plan's features and their purposes. Plate 8 is an aerial photo with the various sloughs, lakes, and features labeled. Detailed plans of the selected plan are shown on Plates 3 through 7. The geotechnical parts of these features are as follows:

Feature	Locations	Geotechnical Part
Partial Closure	Black Slough Tilmont Lake Upper Doubles	Construction Materials – Geotextile and 0.5 meter min. thickness rockfill.
Peninsula Restoration	Tilmont Lake	Construction Materials – sidecast existing soil.
Channel	Gilmore Lake	Cut Slope. Erosion Protection from from overtopping of road: Geotextile. 0.5 meter min.thickness rockfill.
Stop Log Structure and Culvert	Gilmore Lake	Embankment Slope. Erosion Protection from downstream of the culvert: Geotextile. 0.5 meter min. thickness rockfill.

11. SUBSURFACE INVESTIGATIONS:

A total of 14 borings were obtained for the Ambrough Slough EMP project which were obtained by the St. Paul District of the Corps of Engineers (COE). The locations for all the borings taken are shown on Plate 6-17 with the logs shown on Plates 6-1 and 6-2. Borings 98-1M through 98-7M were taken near the alignment of the proposed islands in 1998. Five additional borings were obtained in 1999 to get more information on the material to be side cast. The 14 borings and 2 test-pit excavations revealed soils typical of the slough, lake and back channel environment. Soft silt and clay (fines) were ubiquitous in the upper layer and averaged 2.75-meters (9-feet) thick. The thickness of the fines ranged from 1 to 6 meters (3.5 to over 20 feet). The boring depths ranged from 1 to 6.5 meters (3.5 to 20.5 feet) and averaged 4.5-meters (15-feet) below the ground surface. Six of the borings had loose, silty-fine sands underlying fines ranging in thickness from 1.3 to 3 meters (4.2 to 9.9 feet). Two of the deeper borings showed another sequence of 0.9 to 1.2 meters (3 to 4 feet) of soft fines over 0.9 to 1.2 meters (3 to 4 feet) of loose sand. Testing completed on the samples taken from this subsurface investigation was as follows:

Testing Summary		
Type of Test	Number of Tests Completed	Results
Atterbergs w/moisture content	10	AVERAGE M_C= 34, LL= 41.8, PL= 21.8, PI= 20.1
Sieve analysis w/hydrometer	7	Average Percent Clay=19% Average C_u=174
Specific gravity	5	Range G_S= 2.62-2.68
Consolidation test	1	e_0= 0.885, C_C= 0.16, P_C= 80 kN/m^2 (0.82 TSF)
Triaxial Q-test	1	c= 40 kN/m^2 (0.41 tsf)
Triaxial R_{bar}-test	1	ϕ=16.2°, c=27 kN/m^2 (0.28 tsf) ϕ'=34.0°, c'=0 kN/m^2
Greater then no. 200 sieve	2	Average 10.2%

12. SLOPE STABILITY:

Tilmont Lake peninsula restoration: A slope stability analysis using EM 1110-2-1913 was completed for only Case I: End-of-Construction conditions. This being the worst case because if the peninsula is stable at the end-of-construction, as the foundation consolidates the peninsula's factor-of-safety will only increase because of the foundation material's increasing strength. The proposed construction technique may disturb the construction soil, making its shear strength difficult to estimate which is why a reliability analysis of the stability of the proposed peninsula cross section was done according to J. M. Duncan's technique[2]. This analysis used the computer program UTEXAS3 and the soil stratigraphy from boring 98-3M. The one shear-strength test used was a single unconsolidated-undrained compression test with a confinement of 46 kPa resulted in a shear strength of 39 kPa which is shown on Plate 6-3. Results of the reliability and UTEXAS3 analyses are shown on Plates 6-4 through 6-6. All of the sections were stable assuming a shear strength of 20 kPa with a factor-of-safety of 1.9. Only one sample was tested, though, so the soil strength of 39 kPa was considered to be the maximum conceivable. The reliability analysis result was the island has a 2.0%-chance of the factor-of-safety being greater than one.

Gremore Lake Channel: A slope stability analysis was completed on the cut slope conditions for Case I: End-of-Construction and Case III: Intermediate River Stage. These are the only cases that apply. A reliability analysis of the Case III condition of the proposed channel cross section was done because no R or S-tests were completed, however, only one analysis was done for Case I with minimum shear strengths used. This analysis used the computer program UTEXAS3 and the soil stratigraphy from boring 99-14M and 99-16TP with R and S range of strengths obtained from "Shear Strength Correlations for Geotechnical Engineering" by J. M. Duncan[1]. Results of the reliability for Case III analyses are shown on Plates 6-4A through 6-6A. The reliability analysis result was the island has a 0.1%-chance of the factor-of-safety being greater than one. The result of the Case I analysis, using a minimum shear strength of the clay of 10 kPa and 15 kPa for the silty sand, was the critical circular failure surface had a factor-of-safety of 1.4.

13. SETTLEMENT:

Settlement was analyzed for only the Tilmont Lake peninsula restoration because the other features of the project will add little or no stress to the foundation soil. The potential settlement of the islands was estimated using the CSETT computer program. The consolidation test results are shown on Plate 6-7 with the CSETT assumptions and results shown on Plate 6-8 through 6-12. Assuming the soil stratigraphy of boring no. 98-3M the most likely value of settlement was 8.3 cm. A Taylor's series reliability analysis according to J. M. Duncan[2] was completed which is shown on Plates 6-13 through 6-15. The results of the analysis were that there is a 5% chance of an ultimate settlement of 18.5-cm. This analysis also showed that there is a 35% chance of only 5.5-cm or less of settlement. Environmental projects have vegetation on the created islands that need to be within a certain distance from the waterWith this high of a risk of a very low settlement, this feature will not be over built. A displacement of 0.5 m will be assumed at the Tilmont Lake peninsula restoration feature and 0.15 m on all other features.

14. MATERIAL SOURCES:

All non-rock construction will use adjacent borrow. Except for the culvert at Gilmore Lake will be backfilled with pervious fill.

15. CONSTRUCTIBILITY:

This project proposes constructing the Tilmont Lake peninsula restoration by mechanically dredging the material adjacent to its alignment and side casting it. This technique of construction has advantages and disadvantaged:

Advantages	Disadvantages
Eliminates the need for finding a pervious borrow site.	Requires a large and costly mechanical dredge.
The hydraulic environment is low energy and good for sidecasting. The DNR has agreed that the USFWS does not have to maintain it.	The soil will be saturated and extremely soft making it difficult to protect and maintain.
Simultaneously creates terrestrial area and bathymetric diversity.	

Geotextile was used as a filter instead of a granular filter underneath all erosion protection to ease the construction of the filters in the remote areas where access is very difficult. The geotextile was also used in less remote areas because using a small amount of granular filter would be expensive.

16. CONSTRUCTION RECOMMENDATIONS:

Constructing the Tilmont Lake peninsula restoration is the only feature of this project the will require specialized construction equipment for it to be constructible. The bucket used to side cast the peninsula material must have at least 5.4-m^3 capacity. This is to minimize disturbance of the borrow material which will maximize the strength it retains. The borrow has a sensitivity of 3 to 4 making its disturbed strength too weak even to maintain the design slope of 1 on 6. Even with a 5.4-m^3 capacity bucket the material must be placed carefully. The peninsula should be built in one pass, and the excavation must start no closer to the toe of the peninsula than 10-m with an excavation slope of 1on 4.

17. ROCK SOURCES:

Riprap is available locally. Numerous limestone and dolomite quarries have been developed near the Mississippi River valley. Acceptable quality rock for this project is available within a 10-mile radius of the Ambrough Slough project.

18. ROCK GRADATION:

The calculation of the minimum weight of the 50 percent less-than-by-weight rock for the rockfill is explained in the Hydraulic Appendix. The selected gradation is shown on Plate 6-16 and in the table below.

Table: Rock Gradation

Percent Less-than-by-Weight:	Maximum (kg.)	Minimum (kg.):
100	136	45
50	54	18
15	12	4

19. FUTURE WORK:

The only geotechnical or geologic work anticipated to complete the plans and specifications for this project, is deciding the details of the rock placement, input to the specifications, and review of the whole package.

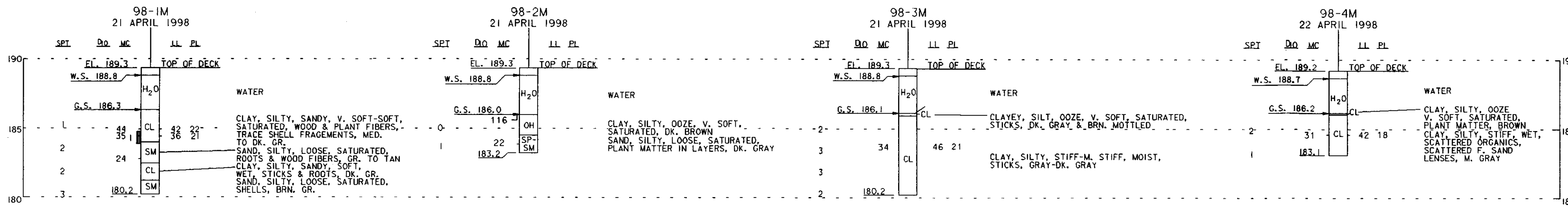
BIBLIOGRAPHY

1. **Duncan, J. M., R. C. Horz, and T. L. Yang** (1989). *Shear Strength Correlations for Geotechnical Engineering*, Virginia Tech Department of Civil Engineering, p. 89.

2. **Duncan, J. M.** (1999). *Factors of Safety and Reliability in Geotechnical Engineering*, American Society of Engineers. Pre-publication copy.

3. **Martin, Lawrence**. *The Physical Geography of Wisconsin*, Wisconsin Geological and Natural History Survey, (1932)

4. **Young, H. L., and R. G. Borman,** *Water Resources of Wisconsin – Trempealeau-Black River Basing*, U.S.G.S Hydrologic Investigations Atlas (1973)



NOTES (98-1M)

1. BORING TAKEN FROM FLOATING PLANT.
2. 4" (102 mm) STEEL PIPE CASING SET TO EL. 184.770 m. HOLE STABILIZED WITH DRILLING FLUID BELOW EL. 184.770 m.
3. 3" (76 mm) SHELBY TUBE TAKEN IN OFFSET HOLE.
4. ALL CASING REMOVED. HOLE BACKFILLED WITH HEAVY BENTONITE DRILLING FLUID.

NOTES (98-2M)

1. BORING TAKEN FROM FLOATING PLANT.
2. 4" (102 mm) STEEL PIPE CASING SET TO EL. 184.770 m.
3. HOLE ALLOWED TO CAVE WHEN CASING WAS REMOVED.

NOTES (98-3M)

1. BORING TAKEN FROM FLOATING PLANT.
2. 4" (102 mm) STEEL PIPE CASING SET TO EL. 184.770 m. HOLE STABILIZED WITH BENTONITE DRILLING FLUID BELOW EL. 184.770 m.
3. ALL CASING REMOIVED HOLE BACKFILLED WITH HEAVY BENTONITE DRILL FLUID.

NOTES (98-4M)

1. BORING TAKEN FROM FLOATING PLANT.
2. 4" (102 mm) STEEL PIPE CASING SET TO EL. 184.648 m.
3. ALL CASING REMOVED. HOLE ALLOWED TO CAVE.

GENERAL BORING LEGEND

84-1M	YEAR OF BORING-BORING NUMBER, BORING TYPE (EG: M=MACHINE, A=AUGER, TP=TEST PIT, P=PIEZOMETER).
1 MAY 1984	DATE OF BORING
G.S. 331.165	GROUND SURFACE ELEVATION IN METERS AT BORING
GW	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURE, LITTLE OR NO FINES
GP	POORLY GRADED GRAVELS, LITTLE OR NO FINES
GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SM	SILTY SANDS, SAND - SILT MIXTURES
SC	CLAYEY SANDS, SAND - CLAY MIXTURES
ML	INORGANIC SILTS, LIQUID LIMIT LESS THAN 50
MH	INORGANIC SILTS, LIQUID LIMIT GREATER THAN 50
CL	INORGANIC CLAYS, LOW TO MED. PLASTICITY, LIQUID LIMIT LESS THAN 50
CH	INORGANIC CLAYS, HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
OL	ORGANIC SILTS OR CLAYS, LOW PLASTICITY, LIQUID LIMIT LESS THAN 50
OH	ORGANIC SILTS OR CLAYS, MED. TO HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
PT	PEAT
SP-SM	BORDERLINE MATERIAL
SP& SM	STRATIFIED MATERIAL
1	LOCATION AND SAMPLE NUMBER FOR UNDISTURBED SAMPLE
	NO RECOVERY
W.L. 221.643	WATER LEVEL IN METERS ON DATE OF BORING
213.702	ELEVATION IN METERS AT BOTTOM OF BORING

GENERAL BORING NOTES

1. GENERAL: THE UNIFIED SOIL CLASSIFICATION SYSTEM IS USED TO IDENTIFY BASIC SOIL TYPE. THE LEGEND REPRESENTS ONLY THE BASIC SOILS. TO COMPLETE THE CLASSIFICATION, PERTINENT INFORMATION IS ADDED TO THE RIGHT OF THE BORING STAFF. NOTES PERTAINING TO A SPECIFIC BORING ARE SHOWN BELOW THE BORING STAFF.
2. MOISTURE CONTENT: THE NATURAL MOISTURE CONTENT IN PERCENT OF DRY WEIGHT (MC) IS SHOWN TO THE LEFT OF THE BORING STAFF.
3. BLOW COUNT (SPT): BLOW COUNTS ARE SHOWN TO THE LEFT OF THE BORING STAFF AND, EXCEPT AS NOTED, ARE THE NUMBER OF BLOWS NECESSARY TO DRIVE THE SAMPLER USED A DISTANCE OF 12" (305 mm). STANDARD BLOW COUNTS ARE FOR A STANDARD PENETRATION TEST (SPT) USING A 1⅜" X 2" (35 mm X 51 mm) SAMPLER, 140 LB. (63 KG) HAMMER AND A 30" (762 mm) DROP. FOR NON-STANDARD BLOW COUNTS, SAMPLER SIZE, HAMMER WEIGHT AND HEIGHT OF DROP ARE AS SHOWN.
4. ATTERBERG LIMITS: LIQUID LIMIT (LL) AND PLASTIC LIMIT (PL) ARE SHOWN TO THE RIGHT OF THE BORING STAFF.
5. D_{10} SIZE: THE GRAIN SIZE IN MILLIMETERS OF WHICH 10% OF THE SAMPLE IS FINER IS SHOWN TO THE LEFT OF THE BORING STAFF.
6. ELEVATIONS IN METERS REFERENCED TO N.G.V.D., (1912 ADJUSTED).
7. THE BORINGS SHOW SUMMARIES OF INFORMATION RECORDED ON THE ORIGINAL FIELD LOGS. THESE LOGS ARE AVAILABLE FOR INSPECTION AT THE ST. PAUL DISTRICT OFFICE. ARRANGEMENTS TO INSPECT LOGS CAN BE MADE BY CALLING (612) 290-5599.

US Army Corps of Engineers St. Paul District

Symbol	Description	Date	Appr.

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CHECKED:	AE APPROVING OFFICIAL:

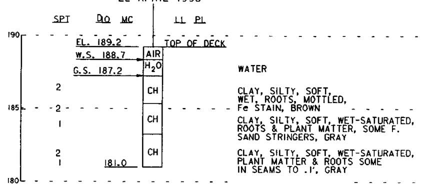
DEPARTMENT OF THE ARMY
ST. PAUL, MINNESOTA
CORPS OF ENGINEERS
ST. PAUL DISTRICT

AMBROUGH SLOUGH - DPR
GEOLOGIC DATA
BORING LOGS 98-1M THRU 98-4M

DRAWING NUMBER: PLATE NO. G-1

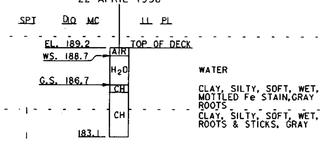
SHT 1 OF 2

98-5M
22 APRIL 1998



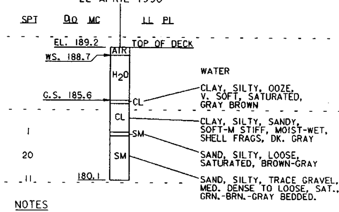
NOTES
1. BORING TAKEN FROM FLOATING PLANT.
2. 4" (102 mm) STEEL PIPE CASING SET TO EL. 186.2 m. HOLE STABILIZED WITH H_2O BELOW CASING.
3. ALL CASING REMOVED. HOLE ALLOWED TO CAVE.

98-6M
22 APRIL 1998



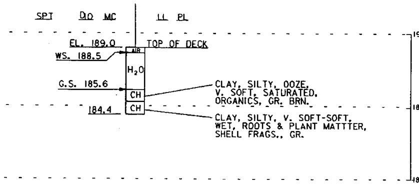
NOTES
1. BORING TAKEN FROM FLOATING PLANT.
2. 4" (102 mm) STEEL PIPE CASING SET TO EL. 186.2 m. HOLE STABILIZED WITH H_2O BELOW CASING.
3. ALL CASING REMOVED AND HOLE ALLOWED TO CAVE.

98-7M
22 APRIL 1998



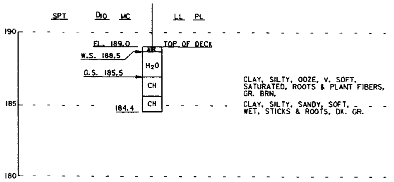
NOTES
1. BORING TAKEN FROM FLOATING PLANT.
2. 4" (102 mm) STEEL PIPE CASING SET TO EL. 184.7 m. HOLE STABILIZED WITH DRILLING FLUID BELOW CASING.
3. ALL CASING REMOVED AND BORING ALLOWED TO CAVE.

98-8M
23 APRIL 1998



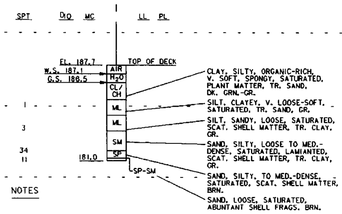
NOTES
1. BORING TAKEN FROM FLOATING PLANT.
2. 4" (102 mm) STEEL PIPE CASING SET TO EL. 184.6 m. HOLE STABILIZED WITH DRILLING FLUID BELOW CASING.
3. ALL CASING REMOVED AND BORING ALLOWED TO CAVE.

98-9M
23 APRIL 1998



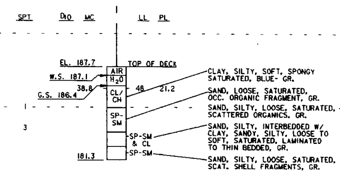
NOTES
1. BORING TAKEN FROM FLOATING PLANT.
2. 4" (102 mm) STEEL PIPE CASING SET TO EL. 184.6 m. HOLE STABILIZED WITH DRILLING FLUID BELOW CASING.
3. ALL CASING REMOVED AND BORING ALLOWED TO CAVE.

99-10M
14 SEPTEMBER 1999



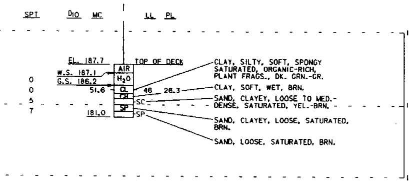
NOTES
1. BORING TAKEN FROM FLOATING PLANT.
2. 4" (102 mm) ALUMINUM PIPE CASING SET TO EL. 184.6 m. HOLE STABILIZED WITH DRILLING FLUID BELOW CASING.
3. ALL CASING REMOVED AND BORING ALLOWED TO CAVE.

99-11M
15 SEPTEMBER 1999



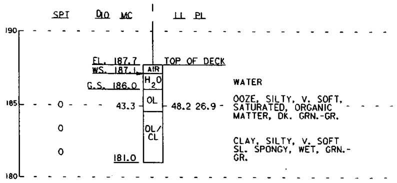
NOTES
1. BORING TAKEN FROM FLOATING PLANT.
2. 4" (102 mm) ALUMINUM PIPE CASING SET TO EL. 184.6 m. HOLE STABILIZED WITH DRILLING FLUID BELOW CASING.
3. ALL CASING REMOVED AND BORING ALLOWED TO CAVE.

99-12M
15 SEPTEMBER 1999



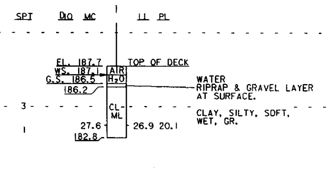
NOTES
1. BORING TAKEN FROM FLOATING PLANT.
2. 4" (102 mm) ALUMINUM PIPE CASING SET TO EL. 184.6 m. HOLE STABILIZED WITH DRILLING FLUID BELOW CASING.
3. ALL CASING REMOVED AND BORING ALLOWED TO CAVE.

99-13M
16 SEPTEMBER 1999



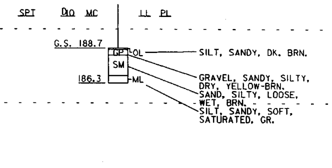
NOTES
1. BORING TAKEN FROM FLOATING PLANT.
2. 4" (102 mm) ALUMINUM PIPE CASING SET TO EL. 184.6 m. HOLE STABILIZED WITH DRILLING FLUID BELOW CASING.
3. ALL CASING REMOVED AND BORING ALLOWED TO CAVE.

99-14M
16 SEPTEMBER 1999



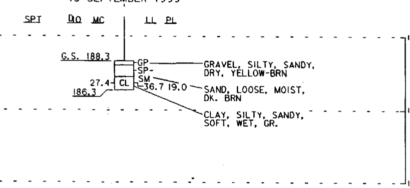
NOTES
1. BORING TAKEN FROM FLOATING PLANT.
2. 4" (102 mm) ALUMINUM PIPE CASING SET TO EL. 184.6 m. HOLE STABILIZED WITH DRILLING FLUID BELOW CASING.
3. ALL CASING REMOVED AND BORING ALLOWED TO CAVE.

99-15TP
16 SEPTEMBER 1999



NOTES
1. WATER LEVEL NOT DETERMINED.
2. BACKHOE USED FOR TESTPIT EXCAVATION.
3. PIT BACKFILLED WITH EXCAVED MATERIAL.

99-16TP
16 SEPTEMBER 1999



NOTES
1. WATER LEVEL NOT DETERMINED.
2. BACKHOE USED FOR TESTPIT EXCAVATION.
3. PIT BACKFILLED WITH EXCAVED MATERIAL.

US Army Corps of Engineers
St. Paul District

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DEPARTMENT OF THE ARMY
ST. PAUL, MINNESOTA
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ST. PAUL DISTRICT

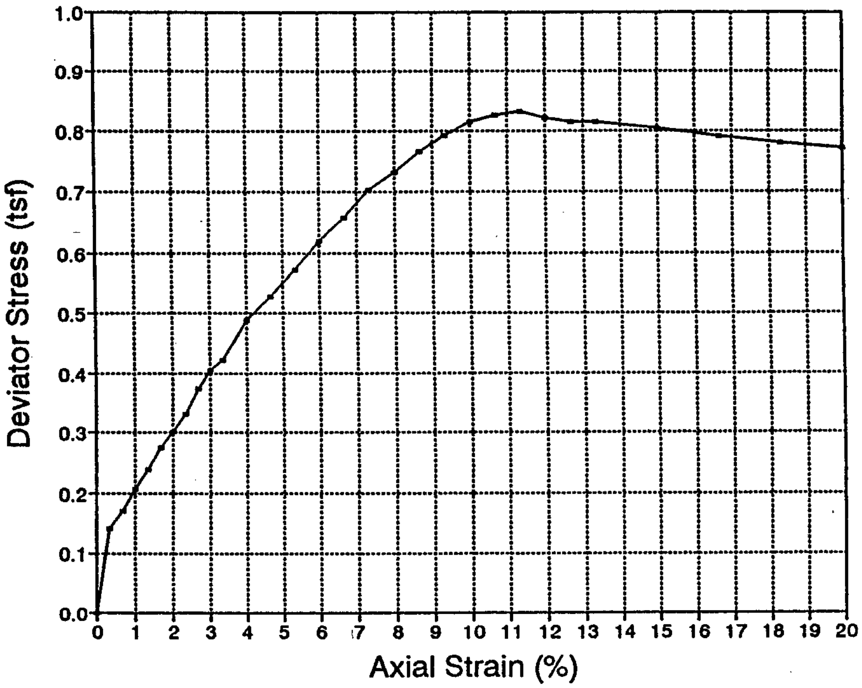
AMBROUGH SLOUGH - DPR
GEOLOGIC DATA
BORING LOGS 98-5M THRU 98-7M AND 99-8M THRU 99-16M

DRAWING NUMBER:
PLATE NO. G-2
SHT 2 OF 2

Confined - STRESS/STRAIN CURVES - Unconfined

Project: Ambroughs Slough EMP - Contract # DACW37-98-M-0434

Location: ______ **Date:** 05/29/98 **Job No:** 3275



Boring No.: 98-1MU **Sample No** 1

Depth(ft): 13.0-14.8 (Middle)

Soil Type: Lean Clay w/Organics & Traces of Sand (CL/OL)

Type of Specimen: 3T

Diam.(in): 1.42 **Ht. (in):** 3.00

Test Type: Unconsolidated Undrained

Confining Pressure: 0.50 (tsf)

Max. Deviator Stress: 0.83 (tsf)

WC (%) 33.6

Yd (pcf) 88.8

LL (%) 29.9

PL (%) 21.0

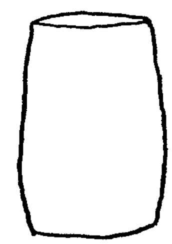
PI 8.9

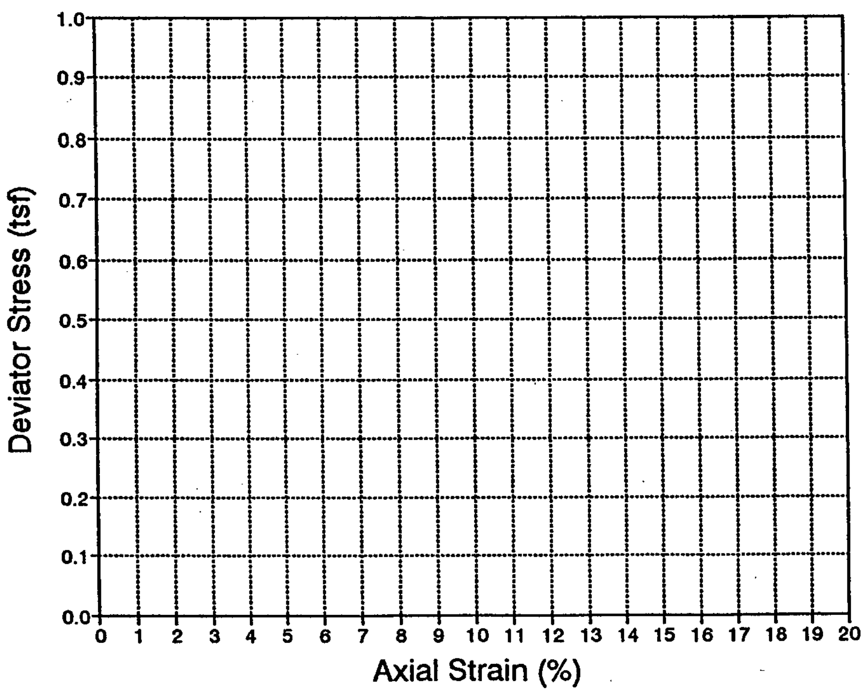
Gs (*) 2.65

Hand Vane Shear (tsf) ______

*. = Estimated Value

Sketch of Specimen After Failure





Boring No.: ______ **Sample No** ______

Depth(ft): ______

Soil Type: ______

Type of Specimen: ______

Diam.(in): ______ **Ht. (in):** ______

Test Type: ______

Confining Pressure: ______ (tsf)

Max. Deviator Stress: ______ (tsf)

WC (%) ______

Yd (pcf) ______

LL (%) ______

PL (%) ______

PI ______

Gs (*) ______

Hand Vane Shear (tsf) ______

Sketch of Specimen After Failure

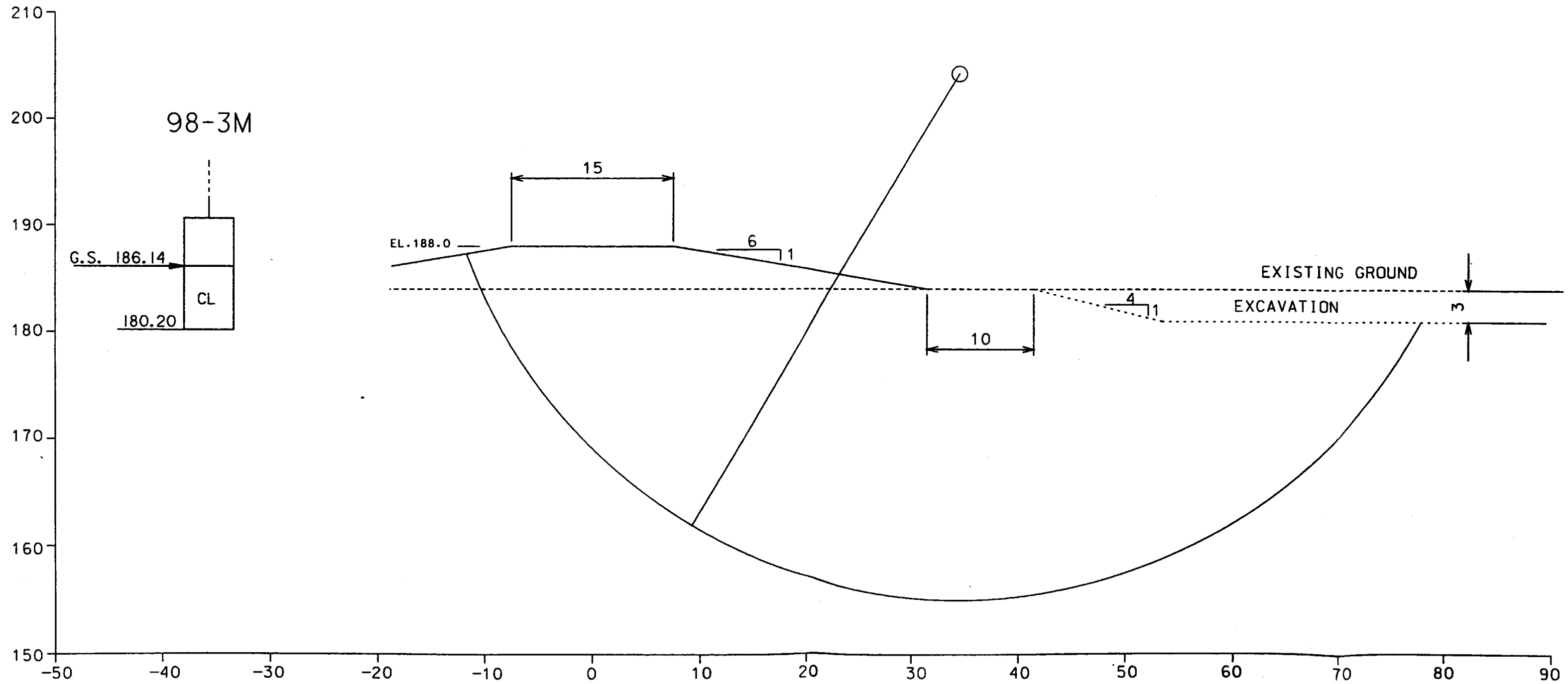
PLATE 6-3

NOTES:
1. UNLESS OTHERWISE NOTED, UNITS SHOWN ARE IN METERS.
2. ELEVATIONS REFER TO MEAN SEA LEVEL (N.G.V.D. 1912 ADJ.)

SOIL NO.	DESCRIPTION	UNIT WEIGHT (kN/m3) MOIST	UNIT WEIGHT (kN/m3) SATURATED	ESTIMATED Q-STRENGTHS C (kPa)	ESTIMATED Q-STRENGTHS PHI
1	SIDE BORROW	17.4	17.4	20	0
2	SOFT CLAY	17.7	17.7	20	0

CRITICAL CIRCULAR FAILURE

CENTER COORDINATES X	CENTER COORDINATES Y	RADIUS	FACTOR OF SAFETY
34.5	204.2	49.2	1.9



DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT

AMBROUGH SLOUGH - DPR
STABILITY ANALYSIS
TILMONT LAKE

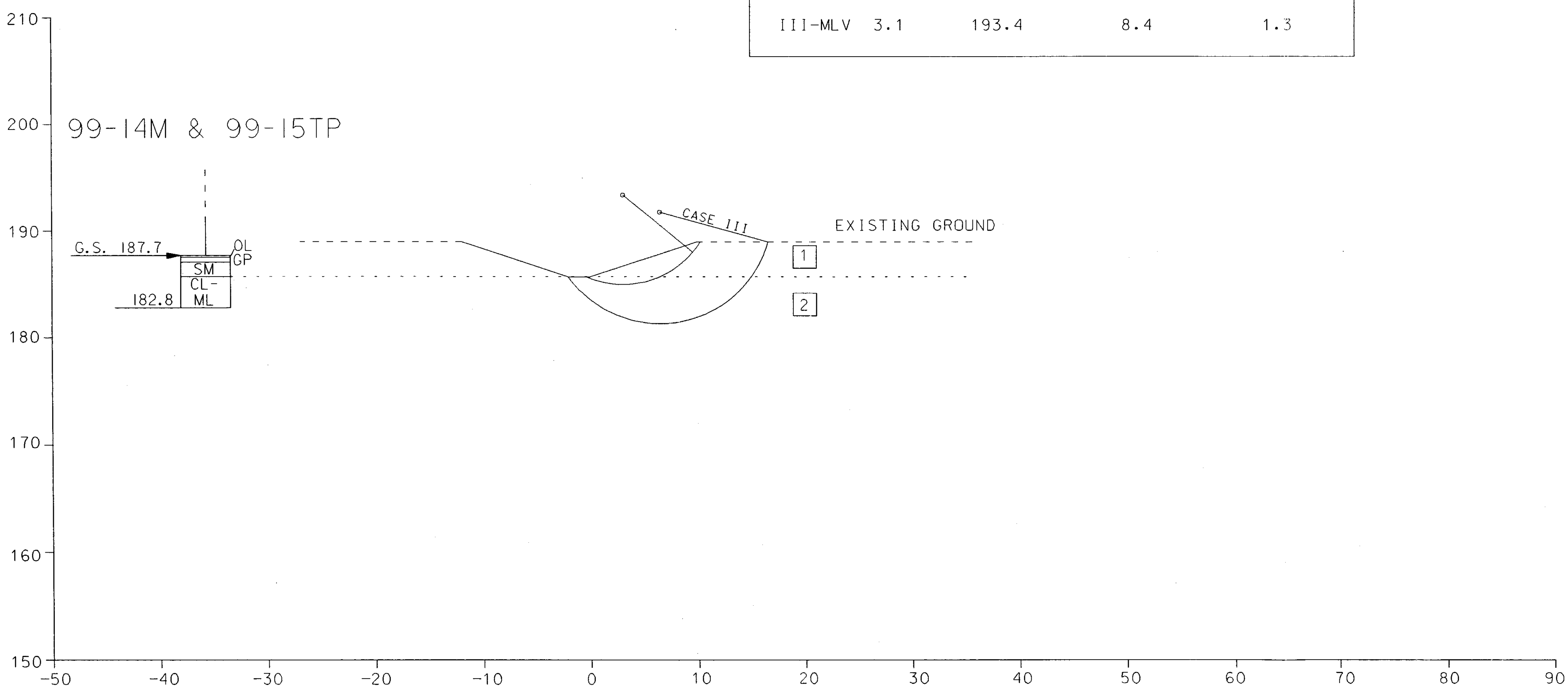
PLATE 6-4

NOTES:
1. UNLESS OTHERWISE NOTED, UNITS SHOWN ARE IN METERS.
2. ELEVATIONS REFER TO MEAN SEA LEVEL (N.G.V.D. 1912 ADJ.)

SOIL NO.	DESCRIPTION	UNIT WEIGHT (kN/m3)		ESTIMATED R-STRENGTHS		ESTIMATED S-STRENGTHS		ESTIMATED Q-STRENGTHS	
		MOIST	SATURATED	C (kPa)	PHI	C (kPa)	PHI	C (kPa)	PHI
1	SM	17.9	17.9	19	35	30	0	15	0
2	CL-ML	17.9	17.9	19	10	20	0	10	0

CRITICAL CIRCULAR CIRCULAR FAILURE

CASE	CENTER COORDINATES X	CENTER COORDINATES Y	RADIUS	FACTOR OF SAFETY
I	6.5	191.8	10.5	1.4
III-MLV	3.1	193.4	8.4	1.3



US Army Corps of Engineers
St. Paul District

Symbol	Description	Date	Appr.

DEPARTMENT OF THE ARMY
ST. PAUL, MINNESOTA
CORPS OF ENGINEERS
ST. PAUL DISTRICT

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SCALE: AS SHOWN | DATE: 01/00 | CADD FILE NAME: STABGREM.DGN | SOL. NO: NA | AE APPROVING OFFICIAL:

AMBROUGH SLOUGH - DPR
STABILITY ANALYSIS
GREMORE LAKE CHANNEL

DRAWING NUMBER:
PLATE
6-4A
SHT OF

Taylor's Series Reliability: for Slope Stability

$kN := 1000 \cdot newton$

$kPa := 1000 \cdot Pa$

1.) Determine most likely factor of safety. That is F_{mlv}

Using a UTEXAS3 analysis and the unconsolidated-undrained strength of 20 kPa and a bouyant unit weight of 7.9 kN/cubic meters :

$F_{mlv} := 1.926$

2.) Estimate standard deviations of parameters that involve uncertainty.

Unconsolidated-undrained shear strength:

Highest Conceivable Value $HCV := 40 \cdot kPa$

Lowest Conceivable Value $LCV := 5 \cdot kPa$

$\sigma_{su} := \frac{HCV - LCV}{6}$ $\sigma_{su} = 5.83 \cdot kPa$

Wet unit weight of soil:

Highest Conceivable Value $HCV := 20 \cdot \frac{kN}{m^3}$

Lowest Conceivable Value $LCV := 15 \cdot \frac{kN}{m^3}$

$\sigma_{\gamma} := \frac{HCV - LCV}{6}$ $\sigma_{\gamma} = 0.833 \cdot \frac{kN}{m^3}$

3.) Compute Coefficient of Variation (COV):

Unconsolidated-undrained shear strength:

$F_{sup} := 2.487$

$F_{sum} := 1.364$

$\Delta F_{su} := F_{sup} - F_{sum}$

Unit weight of soil:

$F_{\gamma p} := 1.767$

$F_{\gamma m} := 2.116$

$\Delta F_{\gamma} := F_{\gamma p} - F_{\gamma m}$

3.) Compute Coefficient of Variation (continued):

$$\sigma_F := \left[\left(\frac{\Delta F_{su}}{2}\right)^2 + \left(\frac{\Delta F_{\gamma}}{2}\right)^2\right]^{.5} \qquad \sigma_F = 0.588$$

$$COV := \frac{\sigma_F}{F_{mlv}} \cdot 100 \qquad COV = 30.5\%$$

4.) Compute Probability of Failure (Pf):

The Probability that the Factor of Safety is less than 1.0 is 2.0%

Taylor's Series Reliability: for Gremore Slope Stability

$kN := 1000 \cdot newton$

$kPa := 1000 \cdot Pa$

1.) Determine most likely factor of safety. That is F_{mlv}

Using a UTEXAS3 analysis and the consolidated-undrained strength of 10 kPa with a phi of 16 deg,a consolidated-drained strength of 0 kPa with a phi of 30 deg and a bouyant unit weight of 16.0 kN/cubic meters :

$F_{mlv} := 1.286$

2.) Estimate standard deviations of parameters that involve uncertainty.

Consolidated-undrained (R-test) shear strength:

Highest Conceivable Value $HCV := 18 \cdot kPa$

Lowest Conceivable Value $LCV := 2 \cdot kPa$

$\sigma_{cRmlv} := \frac{HCV + LCV}{2}$

$\sigma_{cR} := \frac{HCV - LCV}{6}$ $\sigma_{cR} = 2.67 \cdot kPa$ $\sigma_{cRmlv} = 10 \cdot kPa$

Consolidated-undrained (R-test) phi:

Highest Conceivable Value $HCV := 30 \cdot deg$

Lowest Conceivable Value $LCV := 8 \cdot deg$

$\sigma_{\phi R} := \frac{HCV - LCV}{6}$ $\sigma_{\phi R} = 3.67 \cdot deg$ $\sigma_{\phi Rmlv} := \frac{HCV + LCV}{2}$

$\sigma_{\phi Rmlv} = 19 \cdot deg$

Consolidated-drained (S-test) shear strength is assumed equal to 0 kPa

Consolidated-drained (S-test) phi:

Highest Conceivable Value $HCV := 30 \cdot deg$

Lowest Conceivable Value $LCV := 10 \cdot deg$

$\sigma_{\phi S} := \frac{HCV - LCV}{6}$ $\sigma_{\phi S} = 3.33 \cdot deg$ $\sigma_{\phi Smlv} := \frac{HCV + LCV}{2}$

$\sigma_{\phi Smlv} = 20 \cdot deg$

Bouyant unit weight of soil:

Highest Conceivable Value $HCV := 22 \cdot \frac{kN}{m^3}$

Lowest Conceivable Value $LCV := 13.75 \cdot \frac{kN}{m^3}$

$\gamma_{mlv} := \frac{HCV + LCV}{2}$

$\sigma_{\gamma} := \frac{HCV - LCV}{6}$ $\sigma_{\gamma} = 1.38 \cdot \frac{kN}{m^3}$

$\gamma_{mlv} = 17.875 \cdot \frac{kN}{m^3}$

3.) Compute Coefficient of Variation (COV)

3.) Compute Coefficient of Variation (COV):

Consolidated-undrained (R-test) phi:

$F_{\phi Rp} := 1.392$

$F_{\phi Rm} := 1.286$

$\Delta F_{\phi R} := F_{\phi Rp} - F_{\phi Rm}$

Consolidated-undrained (R-test) shear strength:

$F_{cRp} := 1.286$

$F_{cRm} := 1.286$

$\Delta F_{cR} := F_{cRp} - F_{cRm}$

Consolidated-drained (S-test) phi:

$F_{\phi Sp} := 1.404$

$F_{\phi Sm} := 1.233$

$\Delta F_{\phi S} := F_{\phi Sp} - F_{\phi Sm}$

Unit weight of soil:

$F_{\gamma p} := 1.286$

$F_{\gamma m} := 1.286$

$\Delta F_{\gamma} := F_{\gamma p} - F_{\gamma m}$

3.) Compute Coefficient of Variation (continued):

$$\sigma_F := \left[\left(\frac{\Delta F_{cR}}{2}\right)^2 + \left(\frac{\Delta F_{\phi R}}{2}\right)^2 + \left(\frac{\Delta F_{\phi S}}{2}\right)^2 + \left(\frac{\Delta F_{\gamma}}{2}\right)^2\right]^{.5}$$

$\sigma_F = 0.101$

$$COV := \frac{\sigma_F}{F_{mlv}} \cdot 100$$

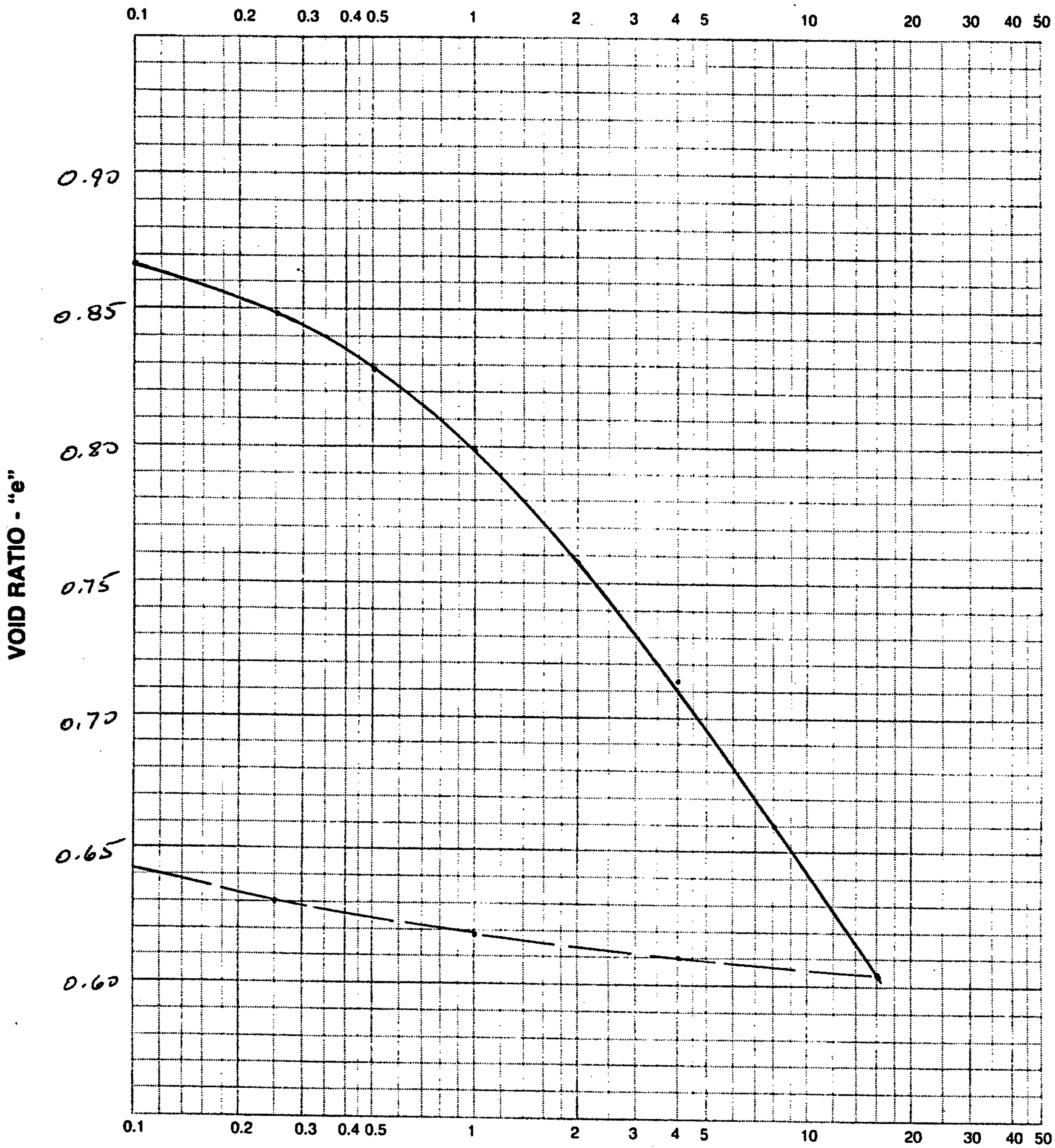
$COV = 7.8\ \%$

4.) Compute Probability of Failure (Pf):

The Probability that the Factor of Safety is less than 1.0 is 0.1%

CONSOLIDATION TEST

VOID RATIO VS. LOG OF PRESSURE



Project AMBROUGHS SLOUGH LEMP

Date 5-30-98 Job No. 3275 Boring No. 98-1MU Sample No. 1 Depth (ft.) 13.0-14.8

Soil Type LEAN CLAY w/ ORGANICS & TRACES OF SAND (CL/OL)

Initial Water Content (%) 34.7 Dry Density (pcf) 87.6 Liquid Limit 36.3 Plastic Limit 21.5 Plasticity Index 14.8

Specific Gravity 2.65 Organic Content (%) ______ Initial Specimen Height (in.) 0.805 Diameter 2.499

Preconsolidation Pressure (Pc) 0.82 tsf Compression Index (Cc) 0.16 Recompression Index (Cr) ≃0.03

Remarks: e_0 = 0.885

PROGRAM CSETT - VERTICAL STRESS INDUCTION AND SETTLEMENT PROGRAM
DATE: 99/08/23 TIME: 10.36.12

I. INPUT DATA

1. TITLE - Ambrough Slough CSETT input file = 1m618.prn

2. BOUSSINESQ SOLUTION WILL BE USED TO COMPUTE INDUCED STRESSES.
THE MAXIMUM DEPTH TO WHICH THE ANALYSIS WILL BE EXTENDED
IS 60.00 FEET.

3. 2-DIMENSIONAL PRESSURE LOAD DATA
NONE

4. 2-DIMENSIONAL SOIL LOAD DATA

PROFILE NUMBER 1 :NUMBER OF POINTS= 6
BEGINNING TIME OF APPLICATION = .0000 YRS.
ENDING TIME OF APPLICATION = .0000 YRS.
EFFECTIVE UNIT WEIGHT OF SOIL LOAD= 122.00 PCF

POINT NO.	X (FT.)	Y (FT.)
1	-999.00	613.80
2	20.00	613.80
3	47.00	618.30
4	63.00	618.30
5	90.00	613.80
6	999.00	613.80

5. 3-DIMENSIONAL RECTANGULAR LOAD DATA
NONE

6. 3-DIMENSIONAL IRREGULAR LOAD DATA
NONE

7. EXCAVATION DATA
NONE

8. SOIL DATA

STRATA NO.	EL. OF TOP OF STRATUM (FEET NGVD)	DRAINAGE CONDITION	EFF UNIT WEIGHT (PCF)	RECOMPR. INDEX	COEF.OF CONSOL. (SQFT/YR)	POISSON'S RATIO
1	613.80	S	46.60	.03000	**********	.32000
2	610.00	S	46.60	.03000	**********	.32000
3	608.00	S	46.60	.03000	**********	.32000
4	606.00	S	51.60	.03000	**********	.32000
5	603.00	S	51.60	.03000	**********	.32000
6	600.00	S	51.60	.03000	**********	.32000

9. STRESS-STRAIN DATA

STRATUM NO. 1

VOID RATIO	PRESSURE (PSF)
.8850	30.0000
.8650	214.3301
.6750	2143.3000

STRATUM NO. 2

VOID RATIO	PRESSURE (PSF)
.8850	30.0000
.8650	541.4654
.6750	5414.6500

STRATUM NO. 3

VOID RATIO	PRESSURE (PSF)
.8850	30.0000
.8650	802.2630
.6750	8022.6300

STRATUM NO. 4

VOID RATIO	PRESSURE (PSF)
.8850	30.0000
.8650	1097.2130
.6750	10972.1000

STRATUM NO. 5

VOID RATIO	PRESSURE (PSF)
.8850	30.0000
.8650	1451.1520
.6750	14511.5000

STRATUM NO. 6

VOID RATIO	PRESSURE (PSF)
.8850	30.0000
.8650	2218.0210
.6750	22180.2000

10. TIME SEQUENCE FOR CONSOLIDATION CALCULATIONS

TIME RATE OF CONSOLIDATION CALCULATIONS WILL BE MADE
AT TIMES (YRS):

```
                  .50
                 1.00
                 2.00
                 4.00
                10.00
                20.00
                40.00
```

11. OUTPUT CONTROL DATA

```
 XXL=      .0000 FT.
 XUL=    55.0000 FT.
DELX=     5.0000 FT.
```

PROGRAM CSETT - VERTICAL STRESS INDUCTION AND SETTLEMENT PROGRAM
DATE: 99/09/11 TIME: 12.14.46

II. OUTPUT SUMMARY.

1. TITLE- Ambrough Slough CSETT input file = 1m618.prn

2. SUMMARY OF TIME SETTLEMENT DATA.

PLANE OF INTEREST: XRIGHT= .0
XLEFT= 55.0
DELX= 5.0

TIME (YR)	X= .0	X= 5.0	X= 10.0	X= 15.0	X= 20.0	X= 25.0
ULT.	.000	.000	.000	.000	.010	.038
.50	.000	.000	.000	.000	.010	.038
1.00	.000	.000	.000	.000	.010	.038
2.00	.000	.000	.000	.000	.010	.038
4.00	.000	.000	.000	.000	.010	.038
10.00	.000	.000	.000	.000	.010	.038
20.00	.000	.000	.000	.000	.010	.038
40.00	.000	.000	.000	.000	.010	.038

TIME (YR)	X= 30.0	X= 35.0	X= 40.0	X= 45.0	X= 50.0	X= 55.0
ULT.	.090	.147	.203	.248	.270	.273
.50	.090	.147	.203	.248	.270	.273
1.00	.090	.147	.203	.248	.270	.273
2.00	.090	.147	.203	.248	.270	.273
4.00	.090	.147	.203	.248	.270	.273
10.00	.090	.147	.203	.248	.270	.273
20.00	.090	.147	.203	.248	.270	.273
40.00	.090	.147	.203	.248	.270	.273

Taylor's Series Reliability: for Settlement

$kN := 1000 \cdot newton$

$kPa := 1000 \cdot Pa$

1.) Determine most likely settlement. That is S_{mlv}

Using a CSETT settlement analysis with the following parameters:

$P_c := 78.54 \cdot kPa$ $C_c := .19$ $C_r := .03$ $C_v := .012 \cdot \frac{cm^2}{sec}$ $e := .885$

$S_{mlv} := 8.3 \cdot cm$

2.) Estimate standard deviations of parameters that involve uncertainty.

Preconsolidation pressure (P_c kPa):

Highest Conceivable Value $HCV := 113.8 \cdot kPa$

Lowest Conceivable Value $LCV := 75.9 \cdot kPa$

$\sigma_{pc} := \frac{HCV - LCV}{6}$ $\sigma_{pc} = 6.32 \cdot kPa$

Compression Index (C_c):

Highest Conceivable Value $HCV := 1$

Lowest Conceivable Value $LCV := .1$

$\sigma_{Cc} := \frac{HCV - LCV}{6}$ $\sigma_{Cc} = 0.15$

Recompression Index (C_r):

Highest Conceivable Value $HCV := .1$

Lowest Conceivable Value $LCV := .01$

$\sigma_{Cc} := \frac{HCV - LCV}{6}$ $\sigma_{Cc} = 0.015$

Void Ratio (e):

Highest Conceivable Value $HCV := 2.4$

Lowest Conceivable Value $LCV := .5$

$\sigma_e := \frac{HCV - LCV}{6}$ $\sigma_e = 0.317$

3.) Compute Coefficient of Variation (COV):

Preconsolidation Pressure (P_c kPa):

$S_{pcp} := 7.6 \cdot cm$

$S_{pcm} := 8.7 \cdot cm$

$\Delta S_{pc} := S_{pcp} - S_{pcm}$

Compression Index (C_c):

$S_{Ccp} := 13.5 \cdot cm$

$S_{Ccm} := 3.1 \cdot cm$

$\Delta S_{Cc} := S_{Ccp} - S_{Ccm}$ $\quad$ $\Delta S_{Cc} = 10.4 \cdot cm$

Recompression Index (C_r):

$S_{Crp} := 8.3 \cdot cm$

$S_{Crm} := 8.3 \cdot cm$

$\Delta S_{Cr} := S_{Crp} - S_{Crm}$

Void Ratio (e):

$S_{ep} := 7.1 \cdot cm$

$S_{em} := 10.0 \cdot cm$

$\Delta S_e := S_{ep} - S_{em}$

3.) Compute Coefficient of Variation (continued):

$$\sigma_S := \left[\left(\frac{\Delta S_{pc}}{2}\right)^2 + \left(\frac{\Delta S_{Cc}}{2}\right)^2 + \left(\frac{\Delta S_{Cr}}{2}\right)^2 + \left(\frac{\Delta S_{e}}{2}\right)^2\right]^{.5} \qquad \sigma_S = 5.4 \cdot cm$$

$$COV := \frac{\sigma_S}{S_{mlv}} \cdot 100$$

$$COV = 65\%$$

4.) Compute Possible Settlement (PS):

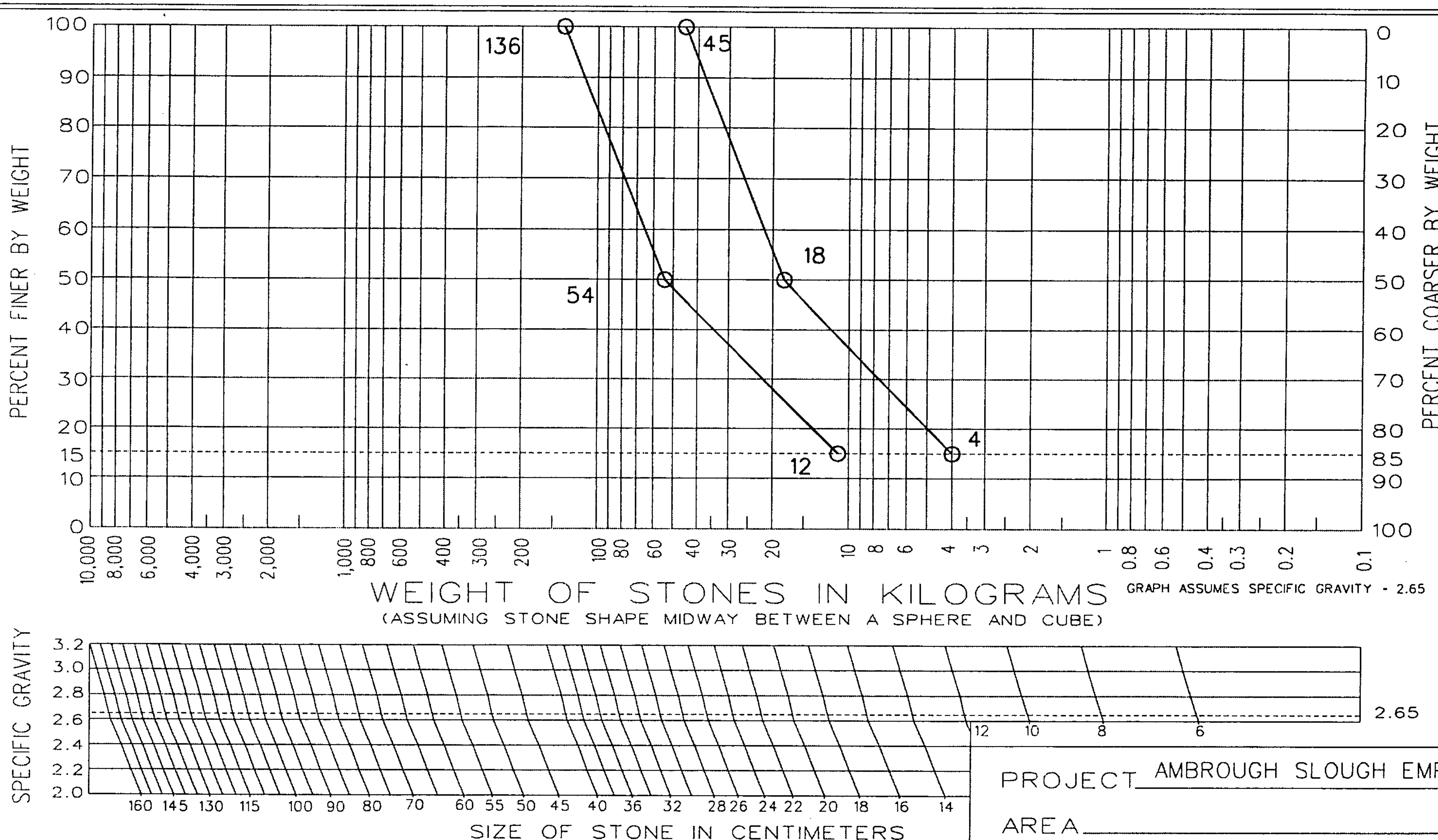
The settlement ratio (SR) with a probability of occurrence of 5% and a COV of 65%
is $SR := 2.23$ This yields a PS of the following:

$$PS := SR \cdot S_{mlv} \qquad PS = 18.5 \cdot cm$$

5.) Compute risk of Small Settlement (SS): $SS := 5.5 \cdot cm$

A settlement of 5.5 cm will have a FS of $FS := \frac{S_{mlv}}{SS}$ $FS = 1.5$

With a COV of 65% there is a 35% chance of 5.5 cm of settlement.



SPECIFIC GRAVITY OF STONE =

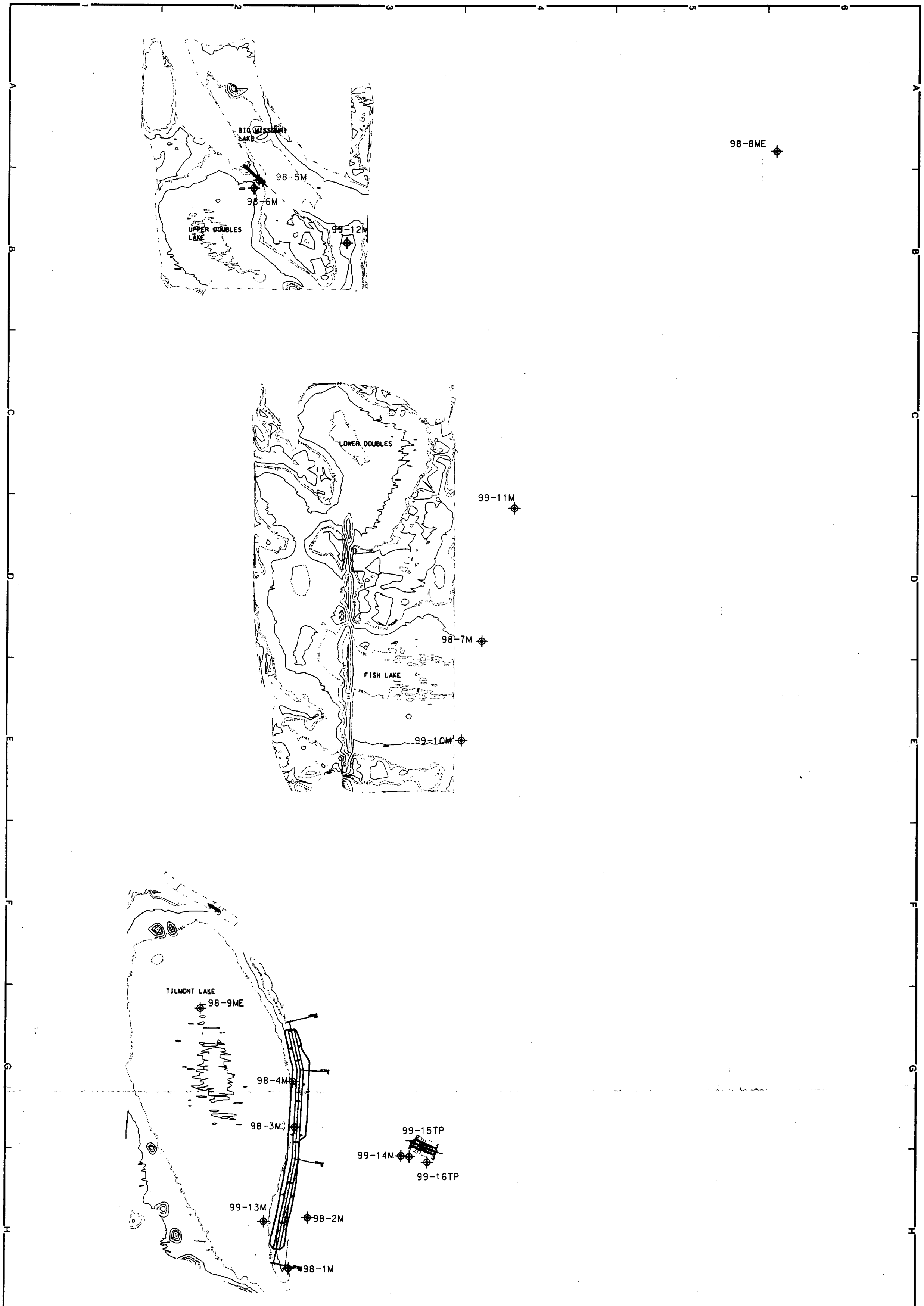
PROJECT AMBROUGH SLOUGH EMP

AREA

DATE AUG. 1999

RIPRAP OR ROCKFILL GRADATION CURVES

FORM 4055 JULY 1998 *COMPUTER GENERATED*



AMBROUGH SLOUGH - DPR

BORING LOCATIONS

BORING LOCATIONS OF BORINGS 98-1M THROUGH 99-16TP

DEPARTMENT OF THE ARMY
ST. PAUL, MINNESOTA
CORPS OF ENGINEERS
ST. PAUL DISTRICT

ED-D	DESIGNED: JJF	SCALE:	DATE: 11/99
	CHECKED: TLW	CADD FILE NAME: MAP.DGN	
	DRAWN: JJF	SOL. NO:	
ED-H	DESIGNED:	AE APPROVING OFFICIAL:	
	CHECKED:		

Symbol	Description	Date	Appr.

DRAWING NUMBER: PLATE 6-17

SHT OF

US Army Corps of Engineers St. Paul District

Attachment 7

Memorandum of Agreement

MEMORANDUM OF AGREEMENT
BETWEEN
THE UNITED STATES FISH AND WILDLIFE SERVICE
AND
THE DEPARTMENT OF THE ARMY
FOR
ENHANCING FISH AND WILDLIFE RESOURCES
OF THE
UPPER MISSISSIPPI RIVER SYSTEM
AMBROUGH SLOUGH PROJECT
CRAWFORD COUNTY, WISCONSIN

I. PURPOSE

The purpose of this memorandum of agreement (MOA) is to establish the relationships, arrangements, and general procedures under which the U.S. Fish and Wildlife Service (USFWS) and the Department of the Army (DOA) will operate in constructing, operating, maintaining, repairing, and rehabilitating the East Channel Projects separable element of the Upper Mississippi River System - Environmental Management Program (UMRS-EMP).

II. BACKGROUND

Section 1103 of the Water Resources Development Act of 1986, Public Law 99-662, authorizes construction of measures for the purpose of enhancing fish and wildlife resources in the Upper Mississippi River System. The project area is managed by the USFWS and is on land managed as a national wildlife refuge. Under conditions of Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662, all construction costs of those fish and wildlife features for the East Channel projects are 100 percent Federal, and pursuant to Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-580, all costs of operation and maintenance for the East Channel projects are 100 percent Federal.

III. GENERAL SCOPE

The project to be accomplished pursuant to this MOA shall consist of rehabilitating and improving the fish and wildlife habitat in upper pool 10 of the Mississippi River. A rock partial closure structures would be placed at the head of Black Slough to reduce flows entering the Ambrough Slough complex via this slough. Small rock closures would be constructed at Upper Doubles Lake and Tilmont Lake to close off small openings to these lakes to reduce flow entering the lakes during the winter. An eroded peninsula on the east side of Tilmont Lake would be restored to reduce the water exchange between Ambrough Slough and Tilmont Lake to improve winter fish habitat conditions. Dredging would occur in Spring Lake, Big Missouri Lake, and Upper Doubles Lake to improve habitat conditions for the backwater fish community in the Ambrough Slough complex.

IV. RESPONSIBILITIES

A. DOA is responsible for:

1. Construction: Construction of the project which constructing rock closures at Black Slough, Upper Doubles Lake, and Tilmont Lake; restoration of an eroded peninsula at Tilmont Lake; and dredging in Spring Lake, Big Missouri Lake, and Upper Doubles Lake.

2. Major Rehabilitation: The Federal share of any mutually agreed upon rehabilitation of the project that exceeds the annual operation and maintenance requirements identified in the Definite Project Report and that is needed as a result of specific storm or flood events.

3. Construction Management: Subject to and using funds appropriated by the Congress of the United States, and in accordance with Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662, DOA will construct the Ambrough Slough project as described in the Definite Project Report/Environmental Assessment, Ambrough Slough Habitat Rehabilitation and Enhancement Projects, dated December 2000, applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. The USFWS will be afforded the opportunity to review and comment on all modifications and change orders prior to the issuance to the contractor of a Notice to Proceed. If DOA encounters potential delays related to construction of the project, DOA will promptly notify

USFWS of such delays.

4. Maintenance of Records. The DOA will keep books, records, documents, and other evidence pertaining to costs and expenses incurred in connection with construction of the project to the extent and in such detail as will properly reflect total costs. The DOA shall maintain such books, records, documents, and other evidence for a minimum of three years after completion of construction of the project and resolution of all relevant claims arising therefrom, and shall make available at its offices, at reasonable times, such books, records, documents, and other evidence for inspection and audit by authorized representatives of the USFWS.

B. USFWS is responsible for operation, maintenance, and repair: Upon completion of construction as determined by the District Engineer, St. Paul, the USFWS shall accept the project and shall operate, maintain, and repair the project as defined in the Definite Project Report/Environmental Assessment entitled "Ambrough Slough Habitat Rehabilitation and Enhancement Project," dated December 2000, in accordance with Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-580.

V. MODIFICATION AND TERMINATION

This MOA may be modified or terminated at any time by mutual agreement of the parties. Any such modification or termination must be in writing. Unless otherwise modified or terminated, this MOA shall remain in effect for a period of no more than 50 years after initiation of construction of the project.

VI. REPRESENTATIVES

The following individuals or their designated representatives shall have authority to act under this MOA for their respective parties.

USFWS: Regional Director
U.S. Fish and Wildlife Service
Bishop Henry Whipple Federal Building
1 Federal Drive
Fort Snelling, Minnesota 55111-4056

DOA: District Engineer
U.S. Army Corps of Engineers, St. Paul District
Army Corps of Engineers Centre
190 Fifth Street East
St. Paul, Minnesota 55101-1638

VII. EFFECTIVE DATE OF MOA

This MOA shall become effective when signed by the appropriate representatives of both parties.

THE DEPARTMENT OF THE ARMY	THE U.S. FISH AND WILDLIFE SERVICE
BY: ________________________	BY: ________________________
(signature)	(signature)
KENNETH S. KASPRISIN	WILLIAM F. HARTWIG
Colonel, Corps of Engineers	Regional Director
St. Paul District	U.S. Fish and Wildlife Service
DATE: ____________________	DATE: ____________________

Attachment 8

Project Cooperation Agreement

DRAFT
(December 2000)

PROJECT COOPERATION AGREEMENT BETWEEN THE DEPARTMENT OF THE ARMY AND THE STATE OF WISCONSIN FOR CONSTRUCTION OF THE GREMORE LAKE CHANNEL FEATURE OF THE AMBROUGH SLOUGH HABITAT REHABILITATION AND ENHANCEMENT PROJECT AT POOL 10, UPPER MISSISSIPPI RIVER, CRAWFORD COUNTY, WISCONSIN

THIS AGREEMENT is entered into this ______ day of ____________, 2001, by and between the **DEPARTMENT OF THE ARMY** (hereinafter the "Government"), represented by the U.S. Army Engineer for the St. Paul District (hereinafter the "District Engineer"), and the **STATE OF WISCONSIN**, represented by the Secretary, Wisconsin Department of Natural Resources (hereinafter the Non-Federal Sponsor).

WITNESSETH, THAT:

WHEREAS, construction of the Ambrough Slough Habitat Rehabilitation and Enhancement Project at Pool 10, Upper Mississippi River, Crawford County, Wisconsin was approved under the terms of the Upper Mississippi River System Environmental Management Program, as authorized by Section 1103(e) of the Water Resources Development Act of 1986, Public Law 99-662, as amended;

WHEREAS, the Government and the Non-Federal Sponsor desire to enter into a Project Cooperation Agreement for construction of the Gremore Lake Channel feature of the Ambrough Slough Habitat Rehabilitation and Enhancement Project in Pool 10, Upper Mississippi River, Crawford County, Wisconsin (hereinafter the "Project", as defined in Article I.A. of this Agreement);

WHEREAS, Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662, as amended, specifies the cost sharing requirements applicable to construction of the Project.

WHEREAS, Section 906(e) provides that the first costs for enhancement of fish and wildlife resources shall be a Federal cost when certain specified circumstances are present;

WHEREAS, Section 509(e) of the Water Resources Development Act of 1999, Public Law 106-53, further provides that when such specified circumstances are not present, 35 percent of the first cost of enhancement of fish and wildlife resources shall be provided by the Non-Federal Interest;

WHEREAS, the Government and the Non-Federal Sponsor agree that the specified circumstances referred to in Subsection 906(e) of Public Law 99-662 are not present;

WHEREAS, Section 1103(e)(7)(a) of the Water Resources Development Act of 1986, Public Law 99-662, as amended by Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-580, specifies that the cost of operation and maintenance is the responsibility of the agency that manages the land for fish and wildlife purposes, the Non-Federal Sponsor will provide 100 percent of the cost of operation and maintenance of the Project;

WHEREAS, Section 221 of the Flood Control Act of 1970, Public Law 91-611, as amended, provides that the Secretary of the Army shall not commence construction of any water resources project, or separable element thereof, until each non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

WHEREAS, Section 1103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, establishes the maximum amount of costs for the habitat rehabilitation and enhancement component of the Upper Mississippi River System Environmental Management Program;

WHEREAS, the Non-Federal Sponsor does not qualify for a reduction of the maximum non-Federal cost share pursuant to the guidelines that implement Section 103(m) of the Water Resources Development Act of 1986, Public Law 99-662, as amended;

WHEREAS, the Government and the Non-Federal Sponsor have the full authority and capability to perform as hereinafter set forth and intend to cooperate in cost-sharing and financing of the construction of the Project in accordance with the terms of this Agreement.

NOW, THEREFORE, the Government and the Non-Federal Sponsor agree as follows:

ARTICLE I - DEFINITIONS AND GENERAL PROVISIONS

For purposes of this Agreement:

A. The term "Project" shall mean that portion of habitat rehabilitation and enhancement in the vicinity of Ambrough Slough near Prairie du Chien, Wisconsin, located on lands outside the Upper Mississippi River National Wildlife and Fish Refuge. Features included are a channel with a culvert and control structure that would convey water from Ambrough Slough to Gremore Lake. These features are generally described in the Definite Project Report/Environmental Assessment (DPR), dated December 2000, and approved by Commander, Mississippi Valley Division on __ ________ 2001

B. The term "total project costs" shall mean all costs incurred by the Non-Federal Sponsor and the Government in accordance with the terms of this Agreement directly related to construction of the Project. Subject to the provisions of this Agreement, the term shall include, but is not necessarily limited to: feasibility phase planning costs; preconstruction engineering and design costs; engineering and design costs during construction; the costs of investigations to identify the existence and extent of hazardous substances in accordance with Article XV.A. of this Agreement; costs of historic preservation activities in accordance with Article XVIII.A. of this Agreement; actual construction costs; supervision and administration costs; costs of participation of the Project Coordination Team in accordance with Article V of this Agreement; costs of contract dispute settlements or awards; the value of lands, easements, rights-of-way, relocations, and suitable borrow and dredged or excavated material disposal areas acquired after the effective date of this Agreement for which the Government affords credit in accordance with Article IV of this Agreement; and costs of audit in accordance with Article X of this Agreement. The term does not include any costs for operation and maintenance; the value of lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas acquired before the effective date of this Agreement; any costs due to betterments; or any costs of dispute resolution under Article VII of this Agreement.

C. The term "financial obligation for construction" shall mean a financial obligation of the Government, other than an obligation pertaining to the provision of lands, easements, rights-of-way, relocations, and borrow and dredged or excavated material disposal areas, that results or would result in a cost that is or would be included in total project costs.

D. The term "non-Federal proportionate share" shall mean the ratio of the Non-Federal Sponsor's total cash contribution required in accordance with Article II.D.2. of this Agreement to total financial obligations for construction, as projected by the Government.

E. The term "period of construction" shall mean the time from the date the Government first notifies the Non-Federal Sponsor in writing, in accordance with Article VI.B. of this Agreement, of the scheduled date for issuance of the solicitation for the first construction contract to the date that the District Engineer notifies the Non-Federal Sponsor in writing of the Government's determination that construction of the Project is complete.

F. The term "fiscal year" shall mean one fiscal year of the Government. The Government fiscal year begins on October 1 and ends on September 30.

G. The term "functional portion of the Project" shall mean a portion of the Project that is suitable for tender to the Non-Federal Sponsor to operate and maintain in advance of completion of the entire Project. For a portion of the Project to be suitable for tender, the District Engineer must notify the Non-Federal Sponsor in writing of the Government's determination that the portion of the Project is complete and can function independently and for a useful purpose, although the balance of the Project is not complete.

H. The term "betterment" shall mean a change in the design and construction of an element of the Project resulting from the application of standards that the Government determines exceed those that the Government would otherwise apply for accomplishing the design and construction of that element.

ARTICLE II - OBLIGATIONS OF THE GOVERNMENT AND THE NON-FEDERAL SPONSOR

A. The Government, subject to receiving funds appropriated by the Congress of the United States (hereinafter, the "Congress") and using those funds and funds provided by the Non-Federal Sponsor, shall expeditiously construct the Project (including raising of existing roads), applying those procedures usually applied to Federal projects, pursuant to Federal laws, regulations, and policies.

1. The Government shall afford the Non-Federal Sponsor the opportunity to review and comment on the solicitations for all contracts, including relevant plans and specifications, prior to the Government's issuance of such solicitations. The Government shall not issue the solicitation for the first construction contract until the Non-Federal Sponsor has confirmed in writing its willingness to proceed with the Project. To the extent possible, the Government shall afford the Non-Federal Sponsor the opportunity to review and comment on all contract modifications, including change orders, prior to the issuance to the contractor of a Notice to Proceed. In any instance where providing the Non-Federal Sponsor with notification of a contract modification or change order is not possible prior to issuance of the Notice to Proceed, the Government shall provide such notification in writing at the earliest date possible. To the extent possible, the Government also shall afford the Non-Federal Sponsor the opportunity to review and comment on all contract claims prior to resolution thereof. The Government shall consider in good faith the comments of the Non-Federal Sponsor, but the contents of solicitations, award of contracts, execution of contract modifications, issuance of change orders, resolution of contract claims, and performance of all work on the Project (whether the work is performed under contract or by Government personnel), shall be exclusively within the control of the Government.

2. Throughout the period of construction, the District Engineer shall furnish the Non-Federal Sponsor with a copy of the Government's Written Notice of Acceptance of Completed Work for each contract for the Project.

3. Notwithstanding paragraph A.1. of this Article, if, upon the award of any contract for construction of the Project, cumulative financial obligations for construction would exceed $500,000, the Government and the Non-Federal Sponsor agree to defer award of that

contract and all subsequent contracts for construction of the Project until such time as the Government and the Non-Federal Sponsor agree to proceed with further contract awards for the Project, but in no event shall the award of contracts be deferred for more than three years. Notwithstanding this general provision for deferral of contract awards, the Government, after consultation with the Non-Federal Sponsor, may award a contract or contracts after the Assistant Secretary of the Army (Civil Works) makes a written determination that the award of such contract or contracts must proceed in order to comply with law or to protect life or property from imminent and substantial harm.

B. The Non-Federal Sponsor will not request the Government to accomplish betterments under this agreement.

C. When the District Engineer determines that the entire Project is complete or that a portion of the Project has become a functional portion of the Project, the District Engineer shall so notify the Non-Federal Sponsor in writing and furnish the Non-Federal Sponsor with an Operation and Maintenance Manual (hereinafter the "O&M Manual") and with copies of all of the Government's Written Notices of Acceptance of Completed Work for all contracts for the Project or the functional portion of the Project that have not been provided previously. Upon such notification, the Non-Federal Sponsor shall operate and maintain the entire Project or the functional portion of the Project in accordance with Article VIII of this Agreement.

D. The Non-Federal Sponsor shall contribute 35 percent of total project costs in accordance with the provisions of this paragraph.

1. In accordance with Article III of this Agreement, the Non-Federal Sponsor shall provide all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas that the Government determines the Non-Federal Sponsor must provide for the construction, operation, and maintenance of the Project.

2. If the Government projects that the value of the Non-Federal Sponsor's contributions under paragraph D.1. of this Article and Articles V, X, and XV.A. of this Agreement will be less than 35 percent of total project costs, the Non-Federal Sponsor shall provide an additional cash contribution, in accordance with Article VI.B. of this Agreement, in the amount necessary to make the Non-Federal Sponsor's total contribution equal to 35 percent of total project costs.

3. If the Government determines that the value of the Non-Federal Sponsor's contributions provided under paragraphs D.1. and D.2. of this Article and Articles V, X, and XV.A. of this Agreement has exceeded 35 percent of total project costs, the Government, subject to the availability of funds, shall reimburse the Non-Federal Sponsor for any such value in excess of 35 percent of total project costs. After such a determination, the Government, in its sole discretion, may provide any remaining Project lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas and perform any remaining Project relocations on behalf of the Non-Federal Sponsor.

E. The Non-Federal Sponsor will not request the Government to provide lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas or perform relocations on behalf of the Non-Federal Sponsor under this agreement.

F. The Government shall perform a final accounting in accordance with Article VI.D. of this Agreement to determine the contributions provided by the Non-Federal Sponsor in accordance with paragraphs B., D., and E. of this Article and Articles V, X, and XV.A. of this Agreement and to determine whether the Non-Federal Sponsor has met its obligations under paragraphs B., D., and E. of this Article.

G. The Non-Federal Sponsor shall not use Federal funds to meet the Non-Federal Sponsor's share of total project costs under this Agreement unless the Federal granting agency verifies in writing that the expenditure of such funds is expressly authorized by statute.

ARTICLE III - LANDS, RELOCATIONS, DISPOSAL AREAS, AND PUBLIC LAW 91-646 COMPLIANCE

A. The Government, after consultation with the Non-Federal Sponsor, shall determine the lands, easements, and rights-of-way required for the construction, operation, and maintenance of the Project, including those required for relocations, borrow materials, and dredged or excavated material disposal. The Government in a timely manner shall provide the Non-Federal Sponsor with general written descriptions, including maps as appropriate, of the lands, easements, and rights-of-way that the Government determines the Non-Federal Sponsor must provide, in detail sufficient to enable the Non-Federal Sponsor to fulfill its obligations under this paragraph, and shall provide the Non-Federal Sponsor with a written notice to proceed with acquisition of such lands, easements, and rights-of-way. Prior to the end of the period of construction, the Non-Federal Sponsor shall acquire all lands, easements, and rights-of-way set forth in such descriptions. Furthermore, prior to issuance of the solicitation for each construction contract, the Non-Federal Sponsor shall provide the Government with authorization for entry to all lands, easements, and rights-of-way the Government determines the Non-Federal Sponsor must provide for that contract. For so long as the Project remains authorized, the Non-Federal Sponsor shall ensure that lands, easements, and rights-of-way that the Government determines to be required for the operation and maintenance of the Project and that were provided by the Non-Federal Sponsor are retained in public ownership for uses compatible with the authorized purposes of the Project.

B. The Government, after consultation with the Non-Federal Sponsor, shall determine the relocations necessary for the construction, operation, and maintenance of the Project, including those necessary to enable the removal of borrow materials and the proper disposal of dredged or excavated material. The Government in a timely manner shall provide the Non-Federal Sponsor with general written descriptions, including maps as appropriate, of such relocations in detail sufficient to enable the Non-Federal Sponsor to fulfill its obligations under this paragraph, and shall provide the Non-Federal Sponsor with a written notice to proceed with such relocations. Prior to the end of the period of construction, the Non-Federal Sponsor shall perform or ensure the performance of all relocations as set forth in such descriptions. Furthermore, prior to issuance of the solicitation for each Government construction contract, the Non-Federal Sponsor shall prepare or ensure the preparation of plans and specifications for, and perform or ensure the performance of, all relocations the Government determines to be necessary for that contract.

C. The Non-Federal Sponsor in a timely manner shall provide the Government with such documents as are sufficient to enable the Government to determine the value of any contribution provided pursuant to paragraphs A. or B. of this Article for items identified within paragraphs A. or B. of this Article acquired after the effective date of this Agreement. Upon receipt of such documents the Government, in accordance with Article IV of this Agreement and in a timely manner, shall determine the value of such contribution, include such value in total project costs, and afford credit for such value toward the Non-Federal Sponsor's share of total project costs.

D. The Non-Federal Sponsor shall comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 C.F.R. Part 24, in acquiring lands, easements, and rights-of-way required for the construction, operation, and maintenance of the Project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and shall inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

ARTICLE IV - CREDIT FOR VALUE OF LANDS, RELOCATIONS, AND DISPOSAL AREAS

A. The Non-Federal Sponsor shall receive credit toward its share of total project costs for the value of the lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas that the Non-Federal Sponsor must provide pursuant to Article III of this Agreement, and for the value of the relocations that the Non-Federal Sponsor must perform or for which it must ensure performance pursuant to Article III of this Agreement. The Non-Federal Sponsor also shall not receive credit for the value of lands, easements, rights-of-way, relocations, or borrow and dredged or excavated material disposal areas to the extent that such items are provided using Federal funds unless the Federal granting agency verifies in writing that such credit is expressly authorized by statute. The Non-Federal Sponsor shall not receive credit for the value of any lands, easements, rights-of-way, relocations, or borrow and dredged or excavated material disposal areas that have been provided previous as an item of cooperation for another Federal project.

B. For the sole purpose of affording credit in accordance with this Agreement, the value of lands, easements, and rights-of-way, including those necessary for relocations, borrow materials, and dredged or excavated material disposal acquired after the effective date of this Agreement, shall be the fair market value of the real property interests, plus certain incidental costs of acquiring those interests, as determined in accordance with the provisions of this paragraph.

1. Date of Valuation. The fair market value of lands, easements, or rights-of-way acquired by the Non-Federal Sponsor after the effective date of this Agreement shall be the fair market value of such real property interests as of the date the Non-Federal Sponsor provides the Government with authorization for entry thereto.

2. General Valuation Procedure. Except as provided in paragraph B.3. of this Article, the fair market value of lands, easements, or rights-of-way shall be determined in accordance with paragraph B.2.a. of this Article, unless thereafter a different amount is determined to represent fair market value in accordance with paragraph B.2.b. of this Article.

a. The Non-Federal Sponsor shall obtain, for each real property interest, an appraisal that is prepared by a qualified appraiser who is acceptable to the Non-Federal Sponsor and the Government. The appraisal must be prepared in accordance with the applicable rules of just compensation, as specified by the Government. The fair market value shall be the amount set forth in the Non-Federal Sponsor's appraisal, if such appraisal is approved by the Government. In the event the Government does not approve the Non-Federal Sponsor's appraisal, the Non-Federal Sponsor may obtain a second appraisal, and the fair market value shall be the amount set forth in the Non-Federal Sponsor's second appraisal, if such appraisal is approved by the Government. In the event the Government does not approve the Non-Federal Sponsor's second appraisal, or the Non-Federal Sponsor chooses not to obtain a second appraisal, the Government shall obtain an appraisal, and the fair market value shall be the amount set forth in the Government's appraisal, if such appraisal is approved by the Non-Federal Sponsor. In the event the Non-Federal Sponsor does not approve the Government's appraisal, the Government, after consultation with the Non-Federal Sponsor, shall consider the Government's and the Non-Federal Sponsor's appraisals and determine an amount based thereon, which shall be deemed to be the fair market value.

b. Where the amount paid or proposed to be paid by the Non-Federal Sponsor for the real property interest exceeds the amount determined pursuant to paragraph B.2.a. of this Article, the Government, at the request of the Non-Federal Sponsor, shall consider all factors relevant to determining fair market value and, in its sole discretion, after consultation with the Non-Federal Sponsor, may approve in writing an amount greater than the amount determined pursuant to paragraph B.2.a. of this Article, but not to exceed the amount actually paid or proposed to be paid. If the Government approves such an amount, the fair market value shall be the lesser of the approved amount or the amount paid by the Non-Federal Sponsor, but no less than the amount determined pursuant to paragraph B.2.a. of this Article.

3. Eminent Domain Valuation Procedure. Lands, easements, or rights-of-way will not be acquired under eminent domain for this project.

4. Incidental Costs. For lands, easements, or rights-of-way acquired by the Non-Federal Sponsor any time after the effective date of this Agreement, the value of the interest shall include the documented incidental costs of acquiring the interest, as determined by the Government, subject to an audit in accordance with Article X.C. of this Agreement to determine reasonableness, allocability, and allowability of costs. Such incidental costs shall include, but not necessarily be limited to, closing and title costs, appraisal costs, survey costs, attorney's fees, plat maps, mapping costs, and recording costs, as well as the actual amounts expended for payment of any Public Law 91-646 relocation assistance benefits provided in accordance with Article III.E. of this Agreement.

C. After consultation with the Non-Federal Sponsor, the Government shall determine the value of relocations in accordance with the provisions of this paragraph.

1. For a relocation other than a highway, the value shall be only that portion of relocation costs that the Government determines is necessary to provide a functionally equivalent facility, reduced by depreciation, as applicable, and by the salvage value of any removed items.

2. For a relocation of a highway, the value shall be only that portion of relocation costs that would be necessary to accomplish the relocation in accordance with the design standard that the State of Wisconsin would apply under similar conditions of geography and traffic load, reduced by the salvage value of any removed items.

3. Relocation costs shall include, but not necessarily be limited to, actual costs of performing the relocation; planning, engineering and design costs; supervision and administration costs; and documented incidental costs associated with performance of the relocation, but shall not include any costs due to betterments, as determined by the Government, nor any additional cost of using new material when suitable used material is available. Relocation costs shall be subject to an audit in accordance with Article X.C. of this Agreement to determine reasonableness, allocability, and allowability of costs.

ARTICLE V - PROJECT COORDINATION TEAM

A. To provide for consistent and effective communication, the Non-Federal Sponsor and the Government, not later than 30 calendar days after the effective date of this Agreement, shall appoint named senior representatives to a Project Coordination Team. Thereafter, the Project Coordination Team shall meet regularly until the end of the period of construction. The Government's Project Manager and a counterpart named by the Non-Federal Sponsor shall co-chair the Project Coordination Team.

B. The Government's Project Manager and the Non-Federal Sponsor's counterpart shall keep the Project Coordination Team informed of the progress of construction and of significant pending issues and actions, and shall seek the views of the Project Coordination Team on matters that the Project Coordination Team generally oversees.

C. Until the end of the period of construction, the Project Coordination Team shall generally oversee the Project, including issues related to design; plans and specifications; scheduling; real property and relocation requirements; real property acquisition; contract awards and modifications; contract costs; the Government's cost projections; final inspection of the entire Project or functional portions of the Project; preparation of the proposed O&M Manual; anticipated requirements and needed capabilities for performance of operation and maintenance of the Project; and other related matters. This oversight shall be consistent with a project management plan developed by the Government after consultation with the Non-Federal Sponsor.

D. The Project Coordination Team may make recommendations that it deems warranted to the District Engineer on matters that the Project Coordination Team generally oversees, including suggestions to avoid potential sources of dispute. The Government in good faith shall consider the recommendations of the Project Coordination Team. The Government, having the legal authority and responsibility for construction of the Project, has the discretion to accept, reject, or modify the Project Coordination Team's recommendations.

E. The costs of participation in the Project Coordination Team shall be included in total project costs and cost shared in accordance with the provisions of this Agreement.

ARTICLE VI - METHOD OF PAYMENT

A. The Government shall maintain current records of contributions provided by the parties and current projections of total project costs and costs due to betterments. At least quarterly, the Government shall provide the Non-Federal Sponsor with a report setting forth all contributions provided to date and the current projections of total project costs, of total costs due to betterments, of the components of total project costs, of each party's share of total project costs, of the Non-Federal Sponsor's total cash contributions required in accordance with Articles II.B., II.D., and II.E. of this Agreement, and of the non-Federal proportionate share. On the effective date of this Agreement, total project costs are projected to be $332,400 and the Non-Federal Sponsor's cash contribution required under Article II.D. of this Agreement is projected to be $116,340. Such amounts are estimates subject to adjustment by the Government and are not to be construed as the total financial responsibilities of the Government and the Non-Federal Sponsor.

B. The Non-Federal Sponsor shall provide the cash contribution required under Article II.D.2. of this Agreement in accordance with the following provisions: Not less than 30 calendar days prior to the scheduled date for issuance of the solicitation for the first construction contract, the Government shall notify the Non-Federal Sponsor in writing of such scheduled date and the funds the Government determines to be required from the Non-Federal Sponsor to meet its projected cash contribution under Article II.D.2. of this Agreement. Not later than such scheduled date, the Non-Federal Sponsor shall provide the Government with the full amount of the required funds by delivering a check payable to "FAO, USAED, St. Paul" to the District Engineer, or his designee. The Government shall draw from the funds provided by the Non-

Federal Sponsor such sums as the Government, after consideration of any credit afforded pursuant to Article II.D. 4. of this Agreement, deems necessary to cover: (a) the non-Federal proportionate share of financial obligations for construction incurred prior to the commencement of the period of construction; and (b) the non-Federal proportionate share of financial obligations for construction as they are incurred during the period of construction. In the event the Government determines that the Non-Federal Sponsor must provide additional funds to meet the Non-Federal Sponsor's cash contribution, the Government shall notify the Non-Federal Sponsor in writing of the additional funds required. Within 60 calendar days thereafter, the Non-Federal Sponsor shall provide the Government with a check for the full amount of the additional required funds.

C. In advance of the Government incurring any financial obligation associated with additional work under Article II.B. or II.E. of this Agreement, the Non-Federal Sponsor shall provide the Government with the full amount of the funds required to pay for such additional work by delivering a check payable to "FAO, USAED, St. Paul" to the District Engineer, or his designee. The Government shall draw from the funds provided by the Non-Federal Sponsor such sums as the Government deems necessary to cover the Government's financial obligations for such additional work as they are incurred. In the event the Government determines that the Non-Federal Sponsor must provide additional funds to meet its cash contribution, the Government shall notify the Non-Federal Sponsor in writing of the additional funds required. Within 30 calendar days thereafter, the Non-Federal Sponsor shall provide the Government with a check for the full amount of the additional required funds.

D. Upon completion of the Project or termination of this Agreement, and upon resolution of all relevant claims and appeals, the Government shall conduct a final accounting and furnish the Non-Federal Sponsor with the results of the final accounting. The final accounting shall determine total project costs, each party's contribution provided thereto, and each party's required share thereof. The final accounting also shall determine costs due to betterments and the Non-Federal Sponsor's cash contribution provided pursuant to Article II.B. of this Agreement.

1. In the event the final accounting shows that the total contribution provided by the Non-Federal Sponsor is less than its required share of total project costs plus costs due to any betterments provided in accordance with Article II.B. of this Agreement, the Non-Federal Sponsor shall, no later than 90 calendar days after receipt of written notice, make a cash payment to the Government of whatever sum is required to meet the Non-Federal Sponsor's required share of total project costs plus costs due to any betterments provided in accordance with Article II.B. of this Agreement.

2. In the event the final accounting shows that the total contribution provided by the Non-Federal Sponsor exceeds its required share of total project costs plus costs due to any betterments provided in accordance with Article II.B. of this Agreement, the Government shall, subject to the availability of funds, refund the excess to the Non-Federal Sponsor no later than 90 calendar days after the final accounting is complete. In the event existing funds are not available

to refund the excess to the Non-Federal Sponsor, the Government shall seek such appropriations as are necessary to make the refund.

ARTICLE VII - DISPUTE RESOLUTION

As a condition precedent to a party bringing any suit for breach of this Agreement, that party must first notify the other party in writing of the nature of the purported breach and seek in good faith to resolve the dispute through negotiation. If the parties cannot resolve the dispute through negotiation, they may agree to a mutually acceptable method of non-binding alternative dispute resolution with a qualified third party acceptable to both parties. The parties shall each pay 50 percent of any costs for the services provided by such a third party as such costs are incurred. The existence of a dispute shall not excuse the parties from performance pursuant to this Agreement.

ARTICLE VIII - OPERATION AND MAINTENANCE (O&M)

A. Upon notification in accordance with Article II.C. of this Agreement and for so long as the Project remains authorized, the Non-Federal Sponsor shall operate and maintain the portion of the entire Project or the portion of the functional portion of the Project which is defined to be the responsibility of the Non-Federal Sponsor in accordance with Section 107(b) of the Water Resources Development Act of 1992, at no cost to the Government, in a manner compatible with the Project's authorized purposes and in accordance with applicable Federal and State laws as provided in Article XI of this Agreement and specific directions prescribed by the Government in the O&M Manual and any subsequent amendments thereto.

B. The Non-Federal Sponsor hereby gives the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the Non-Federal Sponsor owns or controls for access to the Project for the purpose of inspection and, if necessary, for the purpose of completing, operating and maintaining the Project. If an inspection shows that the Non-Federal Sponsor for any reason is failing to perform its obligations under this Agreement, the Government shall send a written notice describing the non-performance to the Non-Federal Sponsor. If, after 30 calendar days from receipt of notice, the Non-Federal Sponsor continues to fail to perform, then the Government shall have the right to enter, at reasonable times and in a reasonable manner, upon property that the Non-Federal Sponsor owns or controls for access to the Project for the purpose of completing, operating and maintaining the Project. No completion, operation or maintenance by the Government shall operate to relieve the Non-Federal Sponsor of responsibility to meet the Non-Federal Sponsor's obligations as set forth in this Agreement, or to preclude the Government from pursuing any other remedy at law or equity to ensure faithful performance pursuant to this Agreement.

ARTICLE IX - INDEMNIFICATION

The Non-Federal Sponsor shall hold and save the Government free from all damages arising from the construction, operation, and maintenance of the Project and any Project-related betterments, except for damages due to the fault or negligence of the Government or its contractors.

ARTICLE X - MAINTENANCE OF RECORDS AND AUDIT

A. Not later than 60 calendar days after the effective date of this Agreement, the Government and the Non-Federal Sponsor shall develop procedures for keeping books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to this Agreement. These procedures shall incorporate, and apply as appropriate, the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Non-Federal Governments at 32 C.F.R. Section 33.20. The Government and the Non-Federal Sponsor shall maintain such books, records, documents, and other evidence in accordance with these procedures and for a minimum of three years after the period of construction and resolution of all relevant claims arising therefrom. To the extent permitted under applicable Federal laws and regulations, the Government and the Non-Federal Sponsor shall each allow the other to inspect such books, documents, records, and other evidence.

B. Pursuant to 32 C.F.R. Section 33.26, the Non-Federal Sponsor is responsible for complying with the Single Audit Act of 1984, 31 U.S.C. Sections 7501-7507, as implemented by Office of Management and Budget (OMB) Circular No. A-128 and Department of Defense Directive 7600.10. Upon request of the Non-Federal Sponsor and to the extent permitted under applicable Federal laws and regulations, the Government shall provide to the Non-Federal Sponsor and independent auditors any information necessary to enable an audit of the Non-Federal Sponsor's activities under this Agreement. The costs of any non-Federal audits performed in accordance with this paragraph shall be allocated in accordance with the provisions of OMB Circulars A-87 and A-133, and such costs as are allocated to the Project shall be included in total project costs and cost shared in accordance with the provisions of this Agreement.

C. In accordance with 31 U.S.C. Section 7503, the Government may conduct audits in addition to any audit that the Non-Federal Sponsor is required to conduct under the Single Audit Act. Any such Government audits shall be conducted in accordance with Government Auditing Standards and the cost principles in OMB Circular No. A-87 and other applicable cost principles and regulations. The costs of Government audits performed in accordance with this paragraph shall be included in total project costs and cost shared in accordance with the provisions of this Agreement.

ARTICLE XI - FEDERAL AND STATE LAWS

In the exercise of their respective rights and obligations under this Agreement, the Non-Federal Sponsor and the Government agree to comply with all applicable Federal and State laws and regulations and local ordinances, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive

5500.11 issued pursuant thereto, as well as Army Regulations 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

ARTICLE XII - RELATIONSHIP OF PARTIES

A. In the exercise of their respective rights and obligations under this Agreement, the Government and the Non-Federal Sponsor each act in an independent capacity, and neither is to be considered the officer, agent, or employee of the other.

B. In the exercise of its rights and obligations under this Agreement, neither party shall provide, without the consent of the other party, any contractor with a release that waives or purports to waive any rights such other party may have to seek relief or redress against such contractor either pursuant to any cause of action that such other party may have or for violation of any law.

ARTICLE XIII - OFFICIALS NOT TO BENEFIT

No member of or delegate to the Congress, nor any resident commissioner, shall be admitted to any share or part of this Agreement, or to any benefit that may arise therefrom.

ARTICLE XIV - TERMINATION OR SUSPENSION

A. If at any time the Non-Federal Sponsor fails to fulfill its obligations under Article II.B., II.D., II.E., VI, or XVIII.C. of this Agreement, the Assistant Secretary of the Army (Civil Works) shall terminate this Agreement or suspend future performance under this Agreement unless he determines in writing that continuation of work on the Project is in the interest of the United States or is necessary in order to satisfy agreements with any other non-Federal interests in connection with the Project.

B. If the Government fails to receive annual appropriations in amounts sufficient to meet Project expenditures for the then-current or upcoming fiscal year, the Government shall so notify the Non-Federal Sponsor in writing, and 60 calendar days thereafter either party may elect without penalty to terminate this Agreement or to suspend future performance under this Agreement. In the event that either party elects to suspend future performance under this Agreement pursuant to this paragraph, such suspension shall remain in effect until such time as the Government receives sufficient appropriations or until either the Government or the Non-Federal Sponsor elects to terminate this Agreement.

C. In the event that either party elects to terminate this Agreement pursuant to this Article or Article XV of this Agreement, both parties shall conclude their activities relating to the Project and proceed to a final accounting in accordance with Article VI.D. of this Agreement.

D. Any termination of this Agreement or suspension of future performance under this Agreement in accordance with this Article or Article XV of this Agreement shall not relieve the parties of liability for any obligation previously incurred. Any delinquent payment shall be charged interest at a rate, to be determined by the Secretary of the Treasury, equal to 150 per centum of the average bond equivalent rate of the 13-week Treasury bills auctioned immediately prior to the date on which such payment became delinquent, or auctioned immediately prior to the beginning of each additional 3-month period if the period of delinquency exceeds 3 months.

ARTICLE XV - HAZARDOUS SUBSTANCES

A. After execution of this Agreement and upon direction by the District Engineer, the Non-Federal Sponsor shall perform, or cause to be performed, any investigations for hazardous substances that the Government or the Non-Federal Sponsor determines to be necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (hereinafter "CERCLA"), 42 U.S.C. Sections 9601-9675, that may exist in, on, or under lands, easements, and rights-of-way that the Government determines, pursuant to Article III of this Agreement, to be required for the construction, operation, and maintenance of the Project. However, for lands that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigations unless the District Engineer provides the Non-Federal Sponsor with prior specific written direction, in which case the Non-Federal Sponsor shall perform such investigations in accordance with such written direction. All actual costs incurred by the Non-Federal Sponsor for such investigations for hazardous substances shall be included in total project costs and cost shared in accordance with the provisions of this Agreement, subject to an audit in accordance with Article X.C. of this Agreement to determine reasonableness, allocability, and allowability of costs.

B. In the event it is discovered through any investigation for hazardous substances or other means that hazardous substances regulated under CERCLA exist in, on, or under any lands, easements, or rights-of-way that the Government determines, pursuant to Article III of this Agreement, to be required for the construction, operation, and maintenance of the Project, the Non-Federal Sponsor and the Government shall provide prompt written notice to each other, and the Non-Federal Sponsor shall not proceed with the acquisition of the real property interests until both parties agree that the Non-Federal Sponsor should proceed.

C. The Government and the Non-Federal Sponsor shall determine whether to initiate construction of the Project, or, if already in construction, whether to continue with work on the Project, suspend future performance under this Agreement, or terminate this Agreement for the convenience of the Government, in any case where hazardous substances regulated under CERCLA are found to exist in, on, or under any lands, easements, or rights-of-way that the Government determines, pursuant to Article III of this Agreement, to be required for the construction, operation, and maintenance of the Project. Should the Government and the Non-Federal Sponsor determine to initiate or continue with construction after considering any liability that may arise under CERCLA, the Non-Federal Sponsor shall be responsible, as between the

Government and the Non-Federal Sponsor, for the costs of clean-up and response, to include the costs of any studies and investigations necessary to determine an appropriate response to the contamination. Such costs shall not be considered a part of total project costs. In the event the Non-Federal Sponsor fails to provide any funds necessary to pay for clean up and response costs or to otherwise discharge the Non-Federal Sponsor's responsibilities under this paragraph upon direction by the Government, the Government may, in its sole discretion, either terminate this Agreement for the convenience of the Government, suspend future performance under this Agreement, or continue work on the Project.

D. The Non-Federal Sponsor and the Government shall consult with each other in accordance with Article V of this Agreement in an effort to ensure that responsible parties bear any necessary clean up and response costs as defined in CERCLA. Any decision made pursuant to paragraph C. of this Article shall not relieve any third party from any liability that may arise under CERCLA.

E. As between the Government and the Non-Federal Sponsor, the Non-Federal Sponsor shall be considered the operator of the Project for purposes of CERCLA liability. To the maximum extent practicable, the Non-Federal Sponsor shall operate and maintain the Project in a manner that will not cause liability to arise under CERCLA.

ARTICLE XVI - NOTICES

A. Any notice, request, demand, or other communication required or permitted to be given under this Agreement shall be deemed to have been duly given if in writing and either delivered personally or by telegram or mailed by first-class, registered, or certified mail, as follows:

If to the Non-Federal Sponsor:

Secretary
Wisconsin Department of Natural Resources
Box 7921
Madison, Wisconsin 53707

If to the Government:

District Engineer
U.S. Army Engineer District, St. Paul
190 Fifth Street East
St. Paul, Minnesota 55101-1638

B. A party may change the address to which such communications are to be directed by giving written notice to the other party in the manner provided in this Article.

C. Any notice, request, demand, or other communication made pursuant to this Article shall be deemed to have been received by the addressee at the earlier of such time as it is actually received or seven calendar days after it is mailed.

ARTICLE XVII - CONFIDENTIALITY

To the extent permitted by the laws governing each party, the parties agree to maintain the confidentiality of exchanged information when requested to do so by the providing party.

ARTICLE XVIII - HISTORIC PRESERVATION

A. The costs of identification, survey and evaluation of historic properties shall be included in total project costs and cost shared in accordance with the provisions of this Agreement.

B. As specified in Section 7(a) of Public Law 93-291 (16 U.S.C. Section 469c(a)), the costs of mitigation and data recovery activities associated with historic preservation shall be borne entirely by the Government and shall not be included in total project costs, up to the statutory limit of one percent of the total amount authorized to be appropriated for the Project.

C. The Government shall not incur costs for mitigation and data recovery that exceed the statutory one percent limit specified in paragraph B. of this Article unless and until the Assistant Secretary of the Army (Civil Works) has waived that limit in accordance with Section 208(3) of Public Law 96-515 (16 U.S.C. Section 469c-2(3)). Any costs of mitigation and data recovery that exceed the one percent limit shall be included in total project costs and cost-shared in accordance with the provisions of this Agreement.

ARTICLE XIX - SECTION 1103 PROJECT COST LIMITS

The Non-Federal Sponsor has reviewed the provisions set forth in Section 1103 of Public Law 99-662, as amended, and understands that Section 1103 establishes the maximum amount of costs for the habitat rehabilitation and enhancement project component of the Upper Mississippi River System Environmental Management Program. Notwithstanding any other provisions of this Agreement, the Government shall not make a new Project financial obligation, make a Project expenditure, or afford credit toward total project costs for the value of any contribution provided by the Non-Federal Sponsor, if such obligation, expenditure, or credit would result in total project costs, plus the value of any obligations already made under the habitat rehabilitation and enhancement component of the Upper Mississippi River System Environmental Management Program, exceeding the maximum amount, unless otherwise authorized by law.

ARTICLE XX - OBLIGATIONS OF FUTURE APPROPRIATIONS

Nothing herein shall constitute, nor be deemed to constitute, an obligation of future appropriations by the Legislature of the State of Wisconsin.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement, which shall become effective upon the date it is signed by the District Engineer.

THE DEPARTMENT OF THE ARMY

BY: ____________________________

Kenneth S. Kasprisin
Colonel
Corps of Engineers
District Engineer

DATE: ____________________________

THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES

BY: ____________________________

George Meyers
Secretary, Wisconsin Department of Natural Resources

DATE: ____________________________

CERTIFICATE OF AUTHORITY

I, ______________________________________, do hereby certify that I am the ________ __________ of the Wisconsin Department of Natural Resources, that the Wisconsin Department of Natural Resources is a legally constituted public body with full authority and legal capability to perform the terms of the Agreement between the Department of the Army and the Wisconsin Department of Natural Resources in connection with the Ambrough Slough Habitat Rehabilitation and Enhancement Project, Crawford County, Wisconsin, and to pay damages in accordance with the terms of this Agreement, if necessary, in the event of the failure to perform, as required by Section 221 of Public Law 91-611 (42 U.S.C. Section 1962d-5b), and that the persons who have executed this Agreement on behalf of the Wisconsin Department of Natural Resources have acted within their statutory authority.

IN WITNESS WHEREOF, I have made and executed this Certificate this _______ day of _____________ 2000.

____

____
State of Wisconsin

CERTIFICATION REGARDING LOBBYING

The undersigned certifies, to the best of his or her knowledge and belief that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

____

George Meyers, Secretary
Wisconsin Department of
Natural Resources

DATE: ____________________

(STATE OF WISCONSIN)
COUNTY OF DANE)

On this ____ day of_______, 20__, before me, a Notary Public in and for said County, personally appeared ________________, who stated that he is the duly appointed and Secretary of the Wisconsin Department of Natural Resources, that he was authorized to execute the foregoing Agreement on behalf of the Wisconsin Department of Natural Resources, and that he executed the foregoing Agreement as his voluntary act and deed, and as the voluntary act and deed of the Wisconsin Department of Natural Resources.

____
Notary Public
in and for the State of Wisconsin

CERTIFICATION OF LEGAL REVIEW

The draft Project Cooperation Agreement for construction of the Ambrough Slough Habitat Rehabilitation and Enhancement Project, Crawford County, Wisconsin, has been fully reviewed by the Office of Counsel, St. Paul District, U.S. Army Corps of Engineers.

EDWIN C. BANKSTON
District Counsel

Date 18 Dec 2000

Attachment 9

Coordination/Correspondence

The draft Definite Project Report/Environmental Assessment or Executive Summary/Notice of Availability (*) was sent to the following agencies, interests, media, and libraries

Congressional
Sen. Russell Feingold (Middleton Office)
Sen. Charles Grassley (Davenport Office)
Sen. Tom Harkin (Des Moines Office)
Sen. Herbert Kohl (Madison Office)
Rep. Ron Kind (La Crosse Office)
Rep. Jim Nussle (Dubuque Office)

Federal
Environmental Protection Agency (William Franz, Al Fenedick)
Department of Transportation (Region V Administrator)
U.S. Geological Survey (UMESC)
National Park Service (Midwest Region Director)
National Resource Conservation Service (Madison)
Advisory Council on Historic Preservation (Wash DC)
U.S. Fish and Wildlife Service (William Hartwig, Russel Peterson, James Fisher, Keith Beseke, John Lindell, Clyde Male, Pam Thiel)

State of Wisconsin

Department of Natural Resources (George Meyers, Terry Moe, Jeff Janvrin, Kurt Welke, John Wetzel)
Department of Transportation (Madison)
State Historic Preservation Office

State of Minnesota

Department of Natural Resources (Mike Davis)

State of Iowa

Department of Natural Resources (Al Farris, Mike Griffin, Kevin Szcodronski, Scott Gritters, Karen Aulwes)

Local Government

Prairie du Chien, Wisconsin
Crawford County, Wisconsin

Interest Groups

American Rivers (Scott Faber)
Ducks Unlimited (Tim Kapellas, Tom Lewis, Tim Morgan)
Izaak Walton League (Paul Hansen, William Grant)
Minnesota-Wisconsin Boundary Area Commission (Buck Malik, Jim Harrison)
Mississippi River Revival (Sol Simon)
Sierra Club (Jane Elder, Jonathon Ela)
Upper Mississippi River Basin Association (Holly Stoerker)
Upper Mississippi River Conservation Committee (Jon Duyvejonck)
Upper Mississippi Waterways Association (Russel Eichman)
Prairie Rod and Gun Club (Chris Mara)
Falling Rock Walleye Club (Ron Schmitz)

Media/Libraries

Allamekee Journal and Lansing Mirror*
Courier Press*
Guttenberg Press*
La Crosse Tribune*
North Iowa Times*
Rochester Post Bulletin*
Vernon County Broadcaster-Censor*
Waukon Newspapers*

KNEI Radio (Waukon)*
WIZM Radio (La Crosse)*
WKBH Radio (La Crosse)*
WKBT TV (La Crosse)*
WKTY Radio (La Crosse)*
WLAX-TV (La Crosse)*
WLSU Radio (La Crosse)*
WPRE Radio (Prairie du Chien)*
WXOW TV (La Crosse)*

Gunderson Lutheran-Health Library
La Crescent Public Library
La Crosse Public Library
McGregor Public Library
New Albin Public Library

Guttenberg Public Library
La Crosse County Library
Lansing Public Library
Prairie du Chien Public Library

CENCS-PE-M 6 February 1996

MEMO FOR: See Distribution

SUBJECT: Ambrough Slough Habitat Rehabilitation and Enhancement Project

1. We have received approval to begin the study phase of the Ambrough Slough HREP. The project kick-off meeting is scheduled for February 27 at 10:00 a.m. at the U.S. Fish and Wildlife Service refuge office in Onalaska, Wisconsin.

2. The fact sheets for the Ambrough Slough and Gremore Lake projects are enclosed. As part of the Ambrough Slough study we will also be evaluating whether or not we can benefit Gremore Lake, possibly by introducing Ambrough Slough flows to alleviate dissolved oxygen or other water quality problems. It should be noted that most of Gremore Lake and the land surrounding the lake is not within the Upper Mississippi River National Wildlife and Fish Refuge. Therefore, any proposed action at Gremore Lake may require a non-Federal cost share sponsor.

3. We have summarized the historical mapping and air photo information we have within the St. Paul District, and have made an initial evaluation of the changes to the area evident from the maps and photos (enclosure 3). We request that the agencies bring whatever other maps, photos, etc., they may have available for this area.

4. It is critical that before we begin this study that the management agencies (USFWS and WDNR) decide what the broad goals and objectives are for this area. The Ambrough Slough and Gremore Lake projects were proposed a number of years ago when the focus of the UMRS-EMP habitat projects program was more oriented towards addressing site specific habitat problems. It has been expressed in a number of forums that the habitat projects should be more ecosystem based and oriented towards maintaining or restoring natural river processes. We request that the management agencies come to this meeting in a position to discuss their goals and objectives for the Ambrough Slough/Gremore Lake area.

5. A tentative agenda is attached (enclosure 4). If you have any questions, or have other topics you want added to the agenda, please call me at (612) 290-5282.

Encl

Gary Palesh
Technical Manager

Distribution:
COE (Hendrickson, Schneider, Face, Yager)
USFWS (Beseke, Mullen)
NBS (Barko)
WDNR (Janvrin, Welke)
IDNR (Szcodronski, Griffin, Ackerman)

RECORD OF ATTENDANCE

Meeting Ambrough Slough

Date 2/27/96

NAME (please print)	TELEPHONE #	REPRESENTING
Gary Palesh		COE
Joel Face	5656	COE
JEFF JANVRIN	608-785-9005	WDNR
KEITH BESEKE	507-452-4232	U.S.FWS
Mike Griffin	319-872-5700	IA DNR
Douglas M. Mullen	319-873-3423	USFWS
Gary Ackerman	319-252-1156	IADNR
Michelle Schneider	612-290-5576	COE

CENCS-PE-M 06 November 1996

MEMO FOR: See Distribution

SUBJECT: Ambrough Slough Habitat Rehabilitation and Enhancement Project

1. Enclosed are the draft habitat goals and objectives provided by Jeff Janvrin for the Ambrough Slough HREP. I have done some minor editing, but they are pretty much as provided.

2. Please review these goals and objectives and provide me with any comments, suggested modifications, etc., by November 29th. For the present, I am looking for major changes. There undoubtedly will be some continual tweaking of the goals and objectives as we proceed with the study.

3. A coordination meeting is scheduled for December 12 at 10:00 a.m. in room B-19 of the Wisconsin DNR offices in La Crosse, Wisconsin. The purpose of the meeting will be to discuss the goals and objectives, to start identifying potential alternatives, and to identify data needs, especially any data that will have to be collected during the winter of 1996-97. I will send out revised goals and objectives and other meeting info during the first week of December.

4. If there are any questions, please call me at (612) 290-5282.

Encl

Gary Palesh
Technical Manager

Distribution:
Keith Beseke, USFWS
Doug Mullen, USFWS
Jeff Janvrin, WDNR
Mike Griffin, IDNR
John Barko, EMTC

Ambrough Slough HREP Coordination Meeting
December 12, 1996

Agenda

1. Introductions
2. Goals and Objectives
3. Waterbody Screening
4. Data Requirements
5. Other

Ambrough Slough
12/12/96

Name	Org
Gary Palesh	COE
Tim Yager	COE
John [illegible]	WDNR
JOHN SULLIVAN	WDNR
Doug Muller	USFWS- McGREGOR
JEFF JANVRIN	WDNR
Michelle Schneider	COE
Kurt Welke	WDNR @ PdC
Ron Benjamin	WDNR
KEITH BESEKE	USFWS

[38] From: Robert J Whiting 1/16/97 11:59AM (3191 bytes: 1 ln)
To: Dennis D Anderson, Gary D Palesh
S- ct: Field trip to Ambro Slough
- ---------------------------- Forwarded ------------------------------
From: Timothy K Yager 1/16/97 9:59AM (2969 bytes: 1 ln)
To: Robert J Whiting
Subject: Field trip to Ambro Slough
------------------------------ Message Contents ------------------------------

CENCS-PE-M 01/16/97

MEMO FOR: Record

SUBJECT: Field trip to Ambro Slough

1. Subject trip was completed on January 15, 1997. Attendees included myself, Jeff Janvrin (WDNR), John Sullivan (WDNR), Ken Von Ruden (WDNR), Kurt Welke (WDNR), and Lisa ? (WDNR). The purpose of the trip was to collect winter habitat information (dissolved oxygen, depth, snow cover, ice cover, current velocity) to establish existing conditions. This information will be used in preparation of a Problem Appraisal Report (PAR) for the Ambro Slough HREP project and for future documentation.

2. The Ambro Slough backwater complex is located in pool 10, adjacent to the Wisconsin shoreline between river miles 638 and 642 (approx.). The area includes a complex of backwater lakes, running sloughs and floodplain forest wetlands.

3. Upon arrival at the WDNR landing, we separated into three teams. Each team proceeded to a different part of the Ambro Slough complex and completed spot sampling of dissolved oxygen (top, mid and bottom samples), temperature (top, mid and bottom), depth, snow cover, ice cover and current velocity information.

4. Observations: a) dissolved oxygen concentrations exceeded 5 ppm in all locations except Gremore Lake where concentrations generally fell below 3 ppm. Ice cover ranged between 0.7 ft and 1.5 ft. Snow cover was about 0.2 ft. Depths varied with location as did current velocities. Water temperatures were at or near 0 C at all locations.

b) A heron rookery is located on the western shore of Voth's Lake on an island between the east and west lobes of the lake.

c) Ambro Slough was completely frozen over. A flowing, open water area was located between Upper and Lower Doubles Lake.

d) An un-named slough located south of the western lobe of Voth's Lake carried very little flow and was shallow (nearly frozen to the bottom). This slough should be investigated if introduction of additional flows is deemed desireable for Voth's Lake or Big Missouri Lake. The slough would be easy to access via dredge or barge from the main channel and has hydraulic connection with several of the backwater lakes in the complex.

Tim Yager, PE-M

[redacted]
gary's disk:fn:pardist

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

REPLY TO
ATTENTION OF

July 16, 1997

Management and Evaluation Branch
Engineering and Planning Division

Mr. Robert Delaney
Environmental Management Technical Center
575 Lester Drive
Onalaska, Wisconsin 54650

Dear Mr. Delaney:

Enclosed for your review is the draft Problem Appraisal Report for the Ambrough Slough Habitat Rehabilitation and Enhancement Project. Please provide any comments you may have by August 22, 1997.

If you have any questions, please contact Mr. Gary Palesh at (612) 290-5282.

Sincerely,

Enclosure

Charles P. Spitzack
Chief, Management and Evaluation Branch
Engineering and Planning Division

Printed on Recycled Paper

9-9

[redacted]
gary's disk:fn:pardist

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

REPLY TO
ATTENTION OF

July 16, 1997

Management and Evaluation Branch
Engineering and Planning Division

Mr. Jeff Janvrin
Habitat Projects Coordinator
Wisconsin Department of Natural Resources
State Office Building
3550 Mormon Coulee Road
La Crosse, Wisconsin 54601

Dear Mr. Janvrin:

Enclosed for your review is the draft Problem Appraisal Report for the Ambrough Slough Habitat Rehabilitation and Enhancement Project. Please provide any comments you may have by August 22, 1997.

If you have any questions, please contact Mr. Gary Palesh at (612) 290-5282.

Sincerely,

Charles P. Spitzack
Chief, Management and Evaluation Branch
Engineering and Planning Division

Enclosure
(3 cys)

PE-M/Palesh
gary's disk:fn:pardist

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

REPLY TO
ATTENTION OF

July 16, 1997

Management and Evaluation Branch
Engineering and Planning Division

Mr. Mike Griffin
Habitat Projects Coordinator
Iowa Department of Natural Resources
206 Rose Street
Bellevue, Iowa 52031

Dear Mr. Griffin:

Enclosed for your review is the draft Problem Appraisal Report for the Ambrough Slough Habitat Rehabilitation and Enhancement Project. Please provide any comments you may have by August 22, 1997.

If you have any questions, please contact Mr. Gary Palesh at (612) 290-5282.

Sincerely,

Charles P. Spitzack
Chief, Management and Evaluation Branch
Engineering and Planning Division

Enclosure
(2 cys)

9-11

PE-M/Palesh
garys disk:fn:pardist

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

REPLY TO
ATTENTION OF

July 16, 1997

Management and Evaluation Branch
Engineering and Planning Division

Mr. Keith Beseke
Habitat Projects Coordinator
U.S. Fish and Wildlife Service
51 East Fourth Street
Winona, Minnesota 55987

Dear Mr. Beseke:

Enclosed for your review is the draft Problem Appraisal Report for the Ambrough Slough Habitat Rehabilitation and Enhancement Project. Please provide any comments you may have by August 22, 1997.

If you have any questions, please contact Mr. Gary Palesh at (612) 290-5282.

Sincerely,

/S/

Charles P. Spitzack
Chief, Management and Evaluation Branch
Engineering and Planning Division

Enclosure
(2 cys)

PUBLIC MEETING

for the

AMBROUGH SLOUGH
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM

at the
BARN RESTAURANT
PRAIRIE DU CHIEN, WISCONSIN

THURSDAY, AUGUST 7, 1997
7:00 P.M.

A public information meeting to discuss the Ambrough Slough Habitat Rehabilitation and Enhancement Project is scheduled to be held at the Barn Restaurant near Prairie du Chien, Wisconsin on Thursday, August 7, 1997 at 7:00 p.m. The Barn Restaurant is located on Cty Highway K on the east side of Gremore Lake, approximately 3 miles north of Prairie du Chien. The meeting is being held by the St. Paul District, Corps of Engineers, in cooperation with the U.S. Fish and Wildlife Service and the Wisconsin and Iowa Departments of Natural Resources.

The Ambrough Slough Habitat Rehabilitation and Enhancement Project is being studied under the Upper Mississippi River System Environmental Management Program. The study area encompasses the entire Ambrough Slough complex from the head of the Ambrough Slough to Gremore Lake. The purpose of the meeting is to discuss fish and wildlife habitat problems and habitat goals and objectives for the study area. We are soliciting the views and other information the public may be able to provide concerning habitat problems in the area. The input received at the meeting will assist us in focusing future study efforts for the Ambrough Slough project.

The meeting will be conducted as informally as practical to facilitate the exchange of information and ideas between the Federal and State agencies involved in the study and the public.

If you are unable to attend the meeting, feel free to contact Gary Palesh, St. Paul District technical manager, at (612) 290-5282 if you wish to receive information concerning any aspects of the Ambrough Slough habitat project.

RECORD OF ATTENDANCE

Meeting Ambrough Slough Date Aug 7, 1997

NAME (please print)	TELEPHONE #	REPRESENTING
Gordon Stephens	608-326-6235	Ambrough Slough
R Smith	608-326-8629	Rt 1 Box 382D PDC
Don & Celia Rose	608-875-5900	" "
Dick & Marge Mattie	608-375-4519	" "
Frank & Irene Mezera	608 326-2911	" "
Donald N. Higgins	608-326 4128	Ambro & Self
J. D. Walker	608-723-2562	Ambro Slough
Loren Holzinger	608 723-6789	Ambro Slough
Michael Donahue	608 744 2451	Ambro Slough
Alberta M Donahue	608-744-2451	Ambro Slough
Shirley Holzinger	(608) 723-6789	Ambro Slough
Jerry Jennings	319 534 2829	ambro Slough
James & Marie Kruckman	608-244-1999	Ambro Slough
James Stoffel	319 783 2441	Ambro Slough
Paul + Bea Sebastian	941-642-3348	Ambro Slough
Tom + Delores Wagner	319-539-2392	Greenmore
Ivan L. Purkapile	608 752084[illegible]	Locust Resort - Ambro
Carole Goarck	608-326-6786	Gremore Lake District
Carol Friedland	608-244-2683	Greymore
Jim Wilson	319-233-8850	Vice President Greymore Lake District
Merl Doland	608 326 4868	
Gary Donaldson	319-234-1363	
Thomas G Thomas	(515) 292-7534	823 Arizona, Ames, IA 50014

9-14

RECORD OF ATTENDANCE

Meeting Ambrough Slough

Date Aug 7, 1997

NAME (please print)	TELEPHONE #	REPRESENTING
Henry + Gert McMillan	319-426-5375	Elgin Ia 52141
William Howe	608 326-7441	Ode
Ted D Sheckler	608-326-6397	PPC W.

9-15

I

Donald N. Higgins
R4, Box 220
Cliffwood Drive
Prairie du Chien, WI 53821

Tel: 608-326-4128

August 7, 1997

Mr. Gary Palesh
St. Paul District Tech. Mgr.
Upper Mississippi River Sys.
Environmental Management Program

Dear Mr. Palesh,

I have several questions and comments regarding the Ambro Slough Habitat Rehabilitation & enhancement project.

① When was the Ambro Slough project authorized, and by whom?

② What is the not to exceed cost of the project?

③ What percentage of the project is scheduled for study vs. actual work?

④ If an actual improvement project is authorized, what are the proposed start & completion dates?

⑤ How much co-ordination is there between the St Paul, & Rock Island District Corps of Engineers, and the United States Weather Bureau, in forecasting river stages?

The reason for asking this question is that our family has owned a summer cottage on Ambro Island, adjacent to the Ambro Slough since 1938, and I find the Ambro Slough

II

One of the best places to observe an obstruction in the flow of the river at high water levels. (10ft & above). Should there be a strong current, it usually takes one to one and a half days to slow or stop it by closing Dam 10 gates. At times during a high water level the gates at Dam 10, Guttenberg are open, and the gates at Dam 11, Dubuque are closed. This condition usually takes two, to two & one half days to slow, or stop the current on the Ambro.

When inquiring about flood, or high water forecasts from the U.S. Weather Bureau in La Crosse, Wi, they have no idea what the gate positions on the damms are, or what they will be, thus it is a hit or miss situation for me to protect my property against high water. Without gate position information, as I see it, the Weather Bureau would have great difficulty forecasting water levels. More <u>co-ordination</u> is needed between the <u>Districts</u>, and the <u>Weather Bureau</u>.

⑥ On July 31, 1997, I had the opportunity to tour, VIA personal boat, the upper Ambro Slough area in the area of Roulette Lake, & Voth's & Cornford's Sloughs. The water level had been at the 10ft to 11ft for approximately three weeks, to a month prior to my tour, and has had about 90% of the backwater islands covered for that period of time. Being covered for this length of time has the ground saturated, and softened, and does not allow the trees to have a roothold. In fact I noticed six mature trees uprooted, I would imagine from the strong currents flowing over the islands.

⑦ Another item that should be noted is the Blue Heron nesting grounds on the east shore of Cornfords Slough, for approximately the past 35 years. It is not being used by the Herons this year. In the same area, there is one species of tree that is completely dead. For what reason the species is dead or what the species is, I do not know.

⑧ In my opinion, the Ambro Slough is deep enough, if the Beaver damms and fallen trees would be cleaned out each year. The problem, as I see it are the lakes, and ponds adjacent to the Ambro Slough, being so full of silt from their island boundries being washed away due to strong currents in high water stages, for long periods of time, plus the dramatic increase in boat traffic in the past two decades, both commercial, and recreational boats.

I would suggest that if the river stage cannot be controlled at the 9 foot stage or lower that all traffic, commercial, and recreational boats, be subjected to a "Slow No Wake" mode until the level drops below 9 feet. The "Slow No Wake" item could be controllable, where the high water problem apparently can not.

Should the Ambro project go ahead, I would suggest that the lakes, and ponds adjacent to the Ambro Slough be dredged. and the material be used to build the islands adjacent to the Ambro Slough back to where they were forty or fifty years ago. After dredging, quick growing willows should be planted on the dredged material to stabalize, and perhaps several years later maple and swamp birch, trees that are compatable with a swamp.

⑨ I have one objection (too late) to a project started several years ago on the east side of the Ambro Road. An attempt was made to manage the forest in this area by cutting many mature trees. With the water level sporadically above 10 feet the ground in this area remains very soft. The trees that were cut were probably very old and some hollow, but the forest, before cutting, was self sustaining, providing its own wind break. Now, most of the time, when there is a

V

strong wind, more trees are up-rooted, due to the soft ground, and no self-sustaining windbreak. One rule that should be followed is "You cannot manage a forest in a swamp".

The only things that this project has accomplished is make the area look like a battle ground, and allow louder train noises on the island, plus eliminate many nesting areas for birds, and animals.

(10) An example of the dangerous water levels of 10 to 11 feet; I have kept a record last autum.

On November 6, 1996, the water level was 7ft. Most of the moss, and weeds had already been washed out of the backwater ponds, and sloughs due to previous high water.

On November 25, 1996 the water stage was 11 ft, and the backwaters, and ponds, and Ambro Slough were frozen with about 1½" of ice due to zero° temps F.

On November 30, 1996 the water level was at 8½ feet, and the hollow under the ice began breaking away and girdling many small trees.

During this period, the Wisconsin River flow remained low. Therefore, I can only assume that there was too much gate lowering, and raising at the Dam's downstream. This example is in my opinion, a good reason that a forest should not be managed, or try to be managed in a swamp; because a managed forest in a swamp has great difficuty re-establishing itself.

(11) I have another all important question to be answered. Will this study, and project lead to the eliminatin of homes, and summer cottages on the inhabited section of the Ambro Slough? I am primarily interested in the Oak Ridge Subdivision area. Should it lead to elimination, will the property owners and residents be paid fair market value for their property?

(12.) It is also very difficult to determine which governing body has control, and final approval authority over this area; i.e. (A) Township of Prairie du Chien - Pay Taxes - Various permits for in water work "Slow No Wake Buoys", etc.

(B) Crawford County - Obtain building permits, abide by restrictions.

(C) DNR - Abide by restrictions

(D) Fish, & Wild life Service - ?

(E) Corps of Engineers - Control Water levels - Now Habitat Study? 9-21

VII

I would be very happy to support, and assist in improving the river bottoms, particularly Ambro Slough area, that I have fished and hunted for the past sixty years, But only if my property that I have been paying taxes on is left alone.

Thank you for allowing the citizens to express their opinions at this meeting 8/7/97.

Very truly yours
Donald W. Higgins

CC:4

CEMVP-PE-M 11 August 1997

MEMO FOR: Record

SUBJECT: Public Meeting on Ambrough Slough EMP project

1. The subject public meeting was conducted at the Barn restaurant in Prairie du Chien, Wisconsin on August 7, 1997. The meeting was conducted to allow local interests an opportunity to provide information on habitat conditions in the Ambrough Slough complex. The following is a synopsis of the comments provided by participants of the meeting.

2. Agency representatives present at the meeting included Gary Palesh (project manager, Corps of Engineers), Jeff Janvrin (Wisconsin Department of Natural Resources), Keith Beseke (U.S. Fish and Wildlife Service), Gary Ackerman (Iowa Department of Natural Resources) and myself. A roster of meeting attendees is attached.

3. Mr. Palesh opened the meeting with introductions and a brief overview of the Ambrough Slough EMP project planning procedures. A general discussion of the project area, project funding and study details followed. To solicit comments on specific project habitat features, Mr. Palesh presented aerial photographs of various project areas and requested comments on what the habitat conditions were in the identified areas. The comments received are provided below.

4. Upper Ambrough Slough

a. The head end of Ambrough Slough near Roulette Lake is shallow and has been filled with silt over the years.

b. Fishing in Ambrough Slough is good and has been for 30 years. There is no problem with Ambrough Slough and nothing needs to be done.

c. Sedimentation is filling in most of the lakes in the Ambrough Slough complex. This filling is elevating the lake bottoms and causing flooding. Island erosion is the primary source of sediment and needs to be prevented.

d. High water is the reason for island erosion.

e. Spring Lake is shallow, Tilmont Lake is shallow and Gremore Lake is shallow and weedy.

f. A dam on Ambrough Slough to direct flows to Spring Lake would be a good idea.

g. The inlet to Ambrough Slough off the main channel should be riprapped to prevent erosion and enlargement of Ambrough Slough. Too much water is coming down Ambrough Slough.

h. High water every fall and spring causes many problems, including ice damage to trees. Water control and pool levels are of great concern and definitely affect habitat conditions. Loss of trees is a major problem.

5. Voth's Lake

a. Voth's Lake is full of duckweed, but is shallow.

b. Duck hunting and bluegill fishing is good when the lake can be accessed. Can normally only get into lake when pool is high. A beaver dam across the lake inlet prevents access to Voth's Lake.

c. A blue heron rookery use to exist in Voth's Lake, however, no blue herons nested there this year (Jeff Janvrin confirmed the rookery no longer existed).

d. The channels into Roulette need to be improved by notching and riprapping inlets from main channel. The slough into Roulette Lake needs to opened up.

e. A stand of swamp white oak and swamp walnut exists in the Voth's Lake area. These stands need to be protected.

f. Springs exist in the north end of Voth's Lake.

6. Roulette Lake

a. A good duck hunting area, especially along the shorelines. Excellent vegetation. Fishing used to be good in the area, but sedimentation has filled in the lake. Only about 2 feet deep now.

7. Big Missouri Lake

a. Channels between Big Missouri and Upper Doubles should be filled in.

b. Beavers have enlarged/created these channels which now carry to much flow into area.

c. Good winter fishery exists in Big Missouri, south shore is good for bass.

d. Fishing is better when water levels are higher.

8. Spring Lake

a. Flows out of Spring Lake are restricted by an old road bed. Removing old road bed would help Spring Lake to flush out sediments.

b. Many springs exist in Spring Lake.

c. More flow should be introduced into the lake from the main channel to flush out sediments.

d. Do these backwater lakes turnover? Jeff Janvrin explained that these lakes do stratify, but do not turnover in the same sense that more northern lakes do.

9. Upper Doubles Lake

a. Vegetation is good in Upper Doubles, but the lake is to shallow for fishing.

b. The channel between Upper Doubles and Lower Doubles should be dredged (deepened). Also the channel between Lower Doubles and Fish Lake should be deepened.

c. Deeper water is needed to hold fish.

10. Lower Doubles

a. The lake is filled in with sediment and is too shallow to hold fish.

11. Black Slough

a. The oxbow loop in Black Slough is good for both fishing and hunting.

b. The inlet from the main channel into Black Slough needs to be riprapped to prevent erosion and channel enlargement. However, there is a good hole right below the inlet which should not be filled in.

c. Flukes Lake is all plugged up with sediment. There is a channel between Tilmont and Flukes Lake.

12. Fish Lake

a. South end should be dredged and spoil used to close off Black Slough.

b. Willows have disappeared from Fish Lake. The area used to have good willow growth.

c. Both Little Missouri and Fish Lake have pretty good winter fishing.

13. Tilmont Lake

a. The loss of the barrier island which separated Tilmont Lake from Ambrough Slough has resulted in degredation of habitat in Tilmont lake.

b. The area used to be good for duck hunting and bass fishing.

c. The barrier island needs to be rebuilt.

14. Gremore Lake

a. Sediment samples need to be taken to determine if material is contaminated. Some sediment samples were taken in the past but probably need to be redone.

b. There are springs in Gremore Lake, some are oxygenated, some are not. Spring alone would probably not solve dissolved oxygen problems.

c. A variety of problems are responsible for low dissolved oxygen levels in Gremore Lake, excess vegetation, shallow depths. Springs could be a source of oxygen, but probably would not solve the problem.

d. Gremore lake does stratify, but does not turnover.

e. Could material dredged from Gremore be disposed of on DNR land. Where would material be placed?

15. The meeting was concluded with a discussion of the timeline for project completion. Several other comments were made concerning issues not related to the project.

Timothy K. Yager
Fisheries Biologist
St. Paul District, Corps of Engineers

[redacted]
gary's disk:fn:higgins

September 5, 1997

Management and Evaluation Branch
Engineering and Planning Division

Mr. Donald N. Higgins
R4, Box 220
Cliffwood Drive
Prairie du Chien, Wisconsin 53821

Dear Mr. Higgins:

This is in response to the letter of comment you provided at the recent public meeting for the Ambrough Slough Habitat Rehabilitation and Enhancement Project. Responses to the specific concerns expressed in your letter are contained in the enclosure.

We hope the information presented at the public meeting and in this letter addresses your concerns. If you have any further questions, please contact Mr. Gary Palesh at (612) 290-5282.

Sincerely,

Enclosure

Charles P. Spitzack
Chief, Management and Evaluation Branch
Engineering and Planning Division

Ambrough Slough Rehabilitation and Enhancement Project

Responses to Concerns Expressed by Mr. Donald Higgins
in a letter dated August 7, 1997

Concern #1 - The Ambrough Slough project is being studied under the authority of the Upper Mississippi River System Environmental Management Program which was authorized by the Water Resources Development Act of 1986. Under this program, habitat projects are identified for study by Federal and/or State natural resource management agencies. In the case of the Ambrough Slough project, the Wisconsin Department of Natural Resources identified this area for study. Under the habitat projects program, individual projects are prioritized by Federal and State natural resource management agencies and are generally selected for study in priority order. The Ambrough Slough project has risen to the top of the priority list and has been selected for study.

Concern #2 - There is no cost ceiling for the project. Habitat projects are designed to solve specific problems, and are approved if the expected habitat benefits exceed the expected costs. A preliminary estimate for the Ambrough Slough project is that total project costs (study, design, and construction) would be around $2 million. However, the final cost may be more or less than this amount, depending upon what is recommended for implementation.

Concern #3 - It is difficult to estimate how much study costs will be versus actual construction costs. Historically, our experience with habitat projects has been that study and design costs fall within a range of 10 to 25 percent of construction costs. Usually the percentage is lower with large projects and higher with small projects. A $2 million habitat project would be considered large, so study and design costs are likely to be in the 10 to 15 percent range.

Concern #4 - If a habitat project for the Ambrough Slough area is recommended for implementation, our current schedule calls for initiation of construction in 2001 and completion in 2002. This construction schedule is dictated by the availability of funds.

Concern #5 - The National Weather Service (NWS) has the responsibility for forecasting river stages during flood events. The NWS coordinates with the St. Paul and Rock Island Districts in forecasting river stages. During a flood event, the Districts provide river discharges to the NWS. The NWS then uses these discharges and converts the results of their models to stages for providing river stages to the public. The NWS does not need dam gate settings to forecast river stages, because the discharges at each lock and dam are provided to them.

An individual wanting to know the gate settings at a lock and dam should call the appropriate lock and dam, and not the NWS. The St. Paul and Rock Island Districts coordinate with each other by providing discharges from Dam 10 to the operators at Dam 11. Dam 11 is then operated according to an approved operation manual. If the gates at Dam 10 are out of the water, that does not mean that the gates at Dam 11 should be out of the water. There could never be an occurrence when the gates at Dam 10 are out of the water and the gates at Dam 11 are closed. The gates at any lock and dam can be open without being out of the water. For example, the gates at Dam 10 have to be open 20 feet before reaching project pool of elevation 611.0. In other words, to someone observing from shore, gates that are partially in the water may appear to be closed. This is rarely the case. Also, gates may only appear to be "open" when the observer can "see daylight" under them. This may lead one to believe (erroneously) that gates are only either "open" or "closed."

Concern #6 - Floodplain forest species are typically shallow-rooted and susceptible to "wind throw" under the conditions described in your letter (i.e., saturated soils). The mature trees you observed were likely downed by wind rather than river currents; however, the tolerance of floodplain forest species to wind is lessened when soils are saturated. Your observations of downed mature trees are not unusual for the Mississippi River floodplain. The loss of mature trees opens up the forest canopy, permitting seeds and seedlings present on the forest floor to germinate, grow and flourish. A mixed-age forest provides both horizontal and vertical habitat structure which increases diversity and interspersion. Under natural conditions, we would expect to see a similar "turnover" of mature trees. It would be very difficult to identify if the uprooting of mature trees was directly caused by pool level operations or resulted from natural river processes.

Concern #7 - With respect to the heron rookery near Cornfords Slough, we do not know why the herons are not using the area this year. This is something that can be looked into as part of this study.

Concern #8 - The shallowing of the backwater lakes and ponds in the Ambrough Slough area due to siltation has been identified as a habitat problem. It is unlikely that bank erosion has contributed much to this problem. The general deposition of silt by river waters as they overflow this area during high water periods is likely the predominant factor in backwater sedimentation.

The Corps of Engineers does not have the authority to implement a "no wake" zone in an area such as Ambrough Slough. We can consider the effect of boat traffic on shoreline erosion as part of this study, but it is highly unlikely that, when compared to natural processes, boat traffic has any appreciable effect in this area.

Dredging is one of the alternatives we will evaluate as part of this study. It is doubtful that we would be able to place dredged material on the islands in the Ambrough Slough area. Because the dredged material would primarily be fine sediments, it would be difficult, if not impossible, to place this material without adversely affecting large areas of habitat in the process.

Concern #9 - We are not certain which area you are speaking of, but from your description we can only assume that the tree cutting was located on private property. Tree harvesting on private property is outside the purview of the Corps of Engineers and this study. We are not aware of any local or State restrictions on this activity.

Concern #10 - On November 6, 1996, the discharge at Lock and Dam 9 was approximately 43,200 cubic feet per second (cfs) with a water surface elevation at the McGregor gage of 613.79 feet (stage of 8.49 feet). On November 25, 1996, the discharge at Lock and Dam 9 was a peak of 71,200 cfs with a water surface elevation at the McGregor gage of 616.29 feet (stage of 11.01 feet). On November 30, 1996, the flow from Lock and Dam 9 was down to 41,000 cfs with a water surface elevation at the McGregor gage of 613.64 feet (stage of 8.34 feet).

During this same period, the discharge on the Wisconsin River increased from about 7,000 cfs to 15,000 cfs at Muscoda, Wisconsin. This discharge routed downstream probably contributed to the peak flow on November 25, 1996, at Lock and Dam 10.

The increase in water surface elevation peaking on November 25, 1996, in Pool 10 occurred due to an increase of approximately 30,000 cfs in discharge on the Mississippi River and an increase in approximately 8,000 cfs in discharge (a near doubling) on the Wisconsin River from upstream inflow. The rise in water surface elevation experienced was what would be expected at those discharge conditions. An increase in discharge from 41,000 cfs to 71,200 cfs would result in dam gate operation, but the peak water surface elevation was due to the increase in discharge, not to the dam gate operation.

Concern #11 - The habitat project will not affect developed areas. The only need for private property that we envision may develop with this project would be the need for dredged material placement sites such as agricultural fields, gravel pits, and/or pasture land. We would only use these sites if the property owner was willing to allow the use of the land for this purpose or was willing to sell the property. If private property were to be acquired for this project, Federal law requires that the landowner be paid fair market value.

Concern #12 - A number of agencies have regulatory interest in this area. The U.S. Fish and Wildlife Service manages the area lying within the National Wildlife Refuge, and their approval must be obtained for most activities on the refuge, other than recreational activities such as hunting, fishing, birdwatching, etc. Construction or fill activities within the water generally require permits from both the Corps of Engineers and the Wisconsin Department of Natural Resources. Generally, local townships and the county government regulate building and land use through zoning and building permits.

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary
Scott A. Humrickhouse, Regional Director

State Office Building, Room 104
3550 Mormon Coulee Road
La Crosse, WI 54601
TELEPHONE 608-785-9000
FAX 608-785-9990

September 15, 1997

Mr. Gary Palesh
St. Paul District, Corps of Engineers
Army Corps of Engineers Centre
Floodplain Management and Small Projects
190 Fifth Street
St. Paul, MN 55101-1638

Dear Mr. Palesh:

We have completed review of the Ambrough Slough Habitat Rehabilitation and Enhancement Project draft Problem Appraisal Report, dated July 1997. Following are our comments.

3-2: The discussion for Ambro Slough regarding how conditions have changed over the last 5-10 years. Black Slough has increased in size and discharge over the last few years. This has resulted in a significant change to the habitat in Black and Ambro Sloughs.

Table 3-2: Please identify source of information. This table includes data collected by the COE and Wisconsin DNR.

3-6: We recommend providing an estimate of how much flow Black Slough contributes to Ambro, expressed in percentage, particularly for winter.

4-2: The low DO measured in Ambro Slough during the summer may be less of a problem now since the flows have increased over time as a result of the Black Slough discharge increase.

4-6: The summer of 1989 was also a relatively "dry" period. Low summer flows occurred in 1987-1989.

5-4: We may want to be a bit more specific regarding some of these objectives by including a water depth criteria. Based on monitoring conducted at other sites, we have found that the criteria may not be met throughout the water column but can be met within certain portions of the water column. Meeting of the some of the criteria within the water column are highly dependent on depth. We recommend the following changes if partner agencies concur:

> Objective A1.a. To be met at mid-depth.
> Objective A1.b. To be met at mid-depth.
> Objective A1.c. The most likely depths these criteria will be met is closer to the bottom. These would be ideal temperatures to reach through the water column. However, we may need to think about this criteria in a 3 dimensional perspective.
>
> The narrative following these criteria will need to be edited to include discussion regarding depth.

5-4: Water depths - Increased water depth may improve surface DO but at the expense of low bottom DO due to stratification problems. The relationship between temperature, DO, current velocity and depth are strongly interrelated.

6-4: A check of the heron rookery this summer revealed that it no longer exists. Please verify this observation with the USFWS, and eliminate the rookery as a constraint if it is gone.

Table 6-2: Upper Doubles; Periodic stops at this lake indicate that current velocities may be a limiting factor. Water does flow through the lower end of Upper Double year round and recent monitoring indicates a detectable flow in the winter and summer. We recommend including reduction of flow as one measure under consideration for this lake.

6-6: Do we need to develop more explicit goals and objectives for Ambro and Black Sloughs since these inflows are likely very important in controlling the hydraulics and habitat conditions of the downstream lakes?

Please contact me at 608-785-9005 if you have any questions regarding these comments.

Sincerely,

Jeffrey A. Janvrin
Mississippi River Habitat Specialist

c: Keith Beseke, USFWS
Doug Mullen, USFWS
Gary Ackerman, Iowa DNR
Mike Griffin, Iowa DNR
Kurt Welke, Wisconsin DNR

Donald N. Higgins
Rt. 4 Box 220
Cliffwood Drive
Prairie du Chien, WI 53821
608-326-4128
September 22, 1997

Mr. Gary Palesh
Department of the Army
St. Paul Dist. Corps of Engineers Centre
190 5th Street East
St. Paul, MN 55101-1638

Dear Mr. Palesh:

I recently received a reply to my letter presented to you at the meeting for the Ambro Slough Habitat Rehabilitation Project on August 7, 1997, at the Barn Restaurant in Prairie du Chien.

The reply was from Mr. Charles P. Spitzack, Chief, Management and Evaluation Branch, Engineering, and Planning Division.

Mr. Spitzack advised in his letter that if I have any further questions, I should contact you.

I appreciate his reply, but do have several questions on his answers. I will number my questions as Mr. Spitzack numbered his replies.

Concern #5: I still maintain that the National Weather Service needs the proposed dam gate settings to forecast river stages. The discharges at each lock and dam are already at the dam when they are provided with them, and cannot be considered a forecast, but do give the present situation, at the time.

Another concern that I have with Mr. Spitzack's reply, is that I have not (erroneously) looked for daylight under the roller gates to determine if the gates are open, or closed.

My concern is that when there is only one, or two feet of the top of the roller gate exposed above the water on the headwater side of the gate, and eight or ten feet, or more of the top of the gate exposed on the tailwater side of the gate. To me, this is a potentially dangerous flood making problem, especially during certain snow run-off times, and during the heavy thunderstorm season. It would be difficult to release the water on the headwater side, along with the excessive run-off, without causing a flood-(Major or Minor).

Concern #6: I disagree with your exaluation of Flood plain forest species. I also believe that the trees were downed by wind, but only after the roots were exposed by river currents. Proof of this situation can be observed by the exposed roots, and adjacent downed trees on the shores of many backwater sloughs, and ponds.

I will agree that the loss of mature trees opens up the forest canopy permitting seeds, and seedlings to germinate, grow, and flourish on an area out of the flood plain. However, in a season such as 1996, the backwater islands were flooded twice, at local levels of 11 feet or more, and then again in April, 1997. (Three times in a twelve month period, washing away most of the seeds). The 11 foot stage on November 25, 1996 was frozen around the trunks of trees of all sizes, and when the level dropped to 8.34 on November 30, 1996, it created a hollow under 1½ "-2" of ice. Eventually the ice broke away, damaging all but the mature trees. I would venture to say that we have had more local level 10-11 ft floods in the past ten years than in the previous 50 years.

Concern #8: It may be highly unlikely that the effect of boat traffic on shoreline erosion may be part of the study, however a group of landowners, several years ago, petitioned the Town of Prairie du Chien to allow us to install "Slow No Wake" buoys in front of the occupied area of the Ambro Slough, from May 15 through September 15, each year. Prior to the installation of the "Slow No Wake" buoys, some areas were losing from one to three inches of shoreline per summer. I feel that the buoys have protected the inhabited shoreline, plus enhanced the fishing in this area of the Ambro Slough.

Concern #9: As I mentioned at the meeting of August 8, the area that I am referring to is on the east side of the Ambro Road, adjacent to the Oak Ridge Subdivision. I would not consider it "Private Property," as I understand it is owned by the Wisconsin DNR. As I also understand, it was the DNR that tried to "manage the forest." This area also floods at the 10½-11 ft. local water stage. The up-rooted trees have increased dramatically since their cutting of mature trees. The area is sandwiched between "National Wildlife Refuge" signs on the North and South.

Thank you once again for allowing me to express my opinions on an area that I am sincerely interested in.

Very truly yours,

Donald N. Higgins

Donald N. Higgins

cc: Mr. Charles P. Spitzack
Chief Management & Evaluation Branch
Engineering and Planning Division
Corps of Engineers

Ambrough Slough Field Trip Itinerary
October 6, 1997

The following is a proposed tour route along with notations on what we would like to look at. A photomap of the study area is attached.

a. Tilmont Lake - One of the alternatives we will be considering is reducing flow into Tilmont Lake. We want get a general feel for the topography surrounding the lake. We likely will need to survey the perimeter of the lake to determine the general elevation and identify low spots.

b. Black Slough - We will exit out to the river via Black Slough. We will take a look at the abandoned Black Slough oxbow to evaluate whether or not we want to try to get flow back through this area. We will also be looking at possible locations for a partial closure at the mouth of Black Slough to reduce flow and/or keep the slough from enlarging.

c. Roulette Lake Channel - We will stop at the mouth of this channel to evaluate current conditions. We will probably not attempt to go down this channel because of time constraints.

d. Ambrough Slough - We will come down Ambrough Slough from the upstream end. We want to look at the closure (possibly old bank revetment) across the mouth of Ambrough Slough in case this structure needs to be modified to increase or decrease flow. As we pass down Ambrough Slough we can look for opportunities for fish habitat improvement. The channel that runs from Ambrough Slough to Spring Lake will be identified, but we won't attempt to navigate it.

e. Big Missouri - We primarily want to look at the breach in the spit of land separating Big Missouri from Upper Double Lake. An option we will be evaluating is whether or not to close this breach. Depending upon time and interest, we can take a run up to look at Voth's Lake.

f. Upper and Lower Doubles Lakes - We will come down through these lakes. An option that we will be evaluating will be whether or not to close off the channel between Upper and Lower Doubles Lakes.

g. Fish Lake - We will pass through Fish Lake and take a look at the embayment off the north end of Fish Lake lying east of Lower Doubles Lake.

h. Spring Lake - We will run up the Spring Lake outlet to look at Spring Lake.

i. Gremore Lake - We will not tour Gremore Lake by boat unless time permits. One of the alternatives under consideration is introducing flow to Gremore Lake. We will look at the two potential routes for a channel and structure to introduce flow to the lake.

k. Dredging/Disposal - We will be evaluating the alternative of dredging for many of these lakes. We will need to be looking at access and possible disposal sites. Rough quantity information is attached showing how much would need to be dredged to meet the depth criteria in the objectives.

Ambrough Slough
October 6, 1997 Site Visit Attendees

Corps of Engineers
Gary Palesh
Michelle Schneider
Terry Williams
Rick Femrite
Joel Face

U.S. Fish and Wildlife Service
Keith Beseke
Doug Mullen
Clyde Male

Wisconsin DNR
Jeff Janvrin
Kurt Welke

Iowa DNR
Scott Gritters
Karen Aulwes

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary
Scott A. Humrickhouse, Regional Director

State Office Building, Room 104
3550 Mormon Coulee Road
La Crosse, WI 54601
TELEPHONE 608-785-9000
FAX 608-785-9990

December 12, 1997

Gary Palesh
St. Paul District, Corps of Engineers
Army Corps of Engineers Centre
Floodplain Management and Small Projects
190 Fifth Street
St. Paul, MN 55101-1638

Dear Mr. Palesh:

In lieu of tying you up on the phone, I decided to send you the following comments regarding the brainstorming of project features for the Ambrough Slough HREP.

Upper Ambrough Slough: We still believe a habitat channel here would increase habitat diversity in this area. However, as you stated, there appears to adequate woody cover throughout the slough and the structures would increase diversity for some species, but cost may be prohibitive due to access. Therefore, since there are other areas in the Ambrough complex with greater habitat deficiencies, we concur with deferring this project component at this time, with one exception. We will want to look at the channels which branch off Ambrough towards Spring Lake to document present conditions (a baseline for future comparison) and determine if there is reason to believe these side channels may impact Spring Lake in the future.

Fish Lake: A feature we presented in the past was the reconstruction of the historic islands which may have reduced the impact of flows from Ambrough and Black Sloughs. The construction technique would be similar to what is being proposed for Tilmont Lake.

Spring Lake: See discussion regarding impacts of flows from Ambrough channels.

Black Slough: If flow reduction, or channel stabilization, is done in this area, we would like to investigate the feasibility of a habitat channel for fish and mussels in this area.

Dredged Material Disposal Sites: The map you sent indicates locations for the disposal sites as being in the floodway. Since an easement will be the most likely alternative used, rather than acquisition, we are recommending that the disposal sites be located on lands outside of the floodway.

General: We are not providing any flow recommendation at this time since the planning team has not made any final decisions on which features will be pursued. Several factors (average depth, flow route/distribution, acres impacted, etc.) will need to be determined before a target flow can be identified for each area. However, one area where we believe a flow reduction will be necessary is at the entrance of Black Slough.

Give me a call if you have any questions on these comments.

Sincerely,

Jeffrey A. Janvrin
Mississippi River Habitat Specialist

5 February 1998

Mr. Timothy Yager
Corps of Engineers, St. Paul District
190 E. Fifth Street
St. Paul, MN 55101-1638

Re: **Ambrough Slough Habitat Project**

I am enthusiastic about the general concepts of this project. It is a most important fishery project which will benefit Iowans as well as Wisconsin fishers for many, many years providing the it is completed to its maximum potentials. The habitat suitability index does not provide the data necessary to accomplish these goals - only generalities as based upon averages and means rather than specific items.

Enhancing winter habitat for centrarchids cannot be maximized without getting upstream control of water flow and velocities. This can easily be attained by installing a gated culvert in Ambrough Slough (I would suggest a 6-foot diameter culvert be installed, much like the one in Bussey Lake). Initial costs are not prohibitive. The project sponsor (Wisconsin DNR) definitely should take total responsibility for water flow and velocity management as they have a competent fishery biologist located in Prairie du Chien. Water flow into the system from the West should also be totally controlled with a closure and installation of a gated valve (I would suggest a 2-foot diameter culvert be installed). Small boat access would be negatively affected , however, navigation would not be eliminated as the public can use canoes and portages to access the Amborough Slough complex from upstream and westerly.

Enhancing backwater habitats for fishes as well as wildlife needs be maximized by increasing the acreage of shallow water dredging. Water depths need be variable but not extreme. Channels connecting to deeper water (usually Ambrough Slough) need not exceed 8-feet deep with the magnitude of backwater dredging ranging between 5 and 6 feet deep. Spring Lake habitat is especially appealing as it has maximum protection and it is easily and safely accessible by foot and by vehicle from nearby highway 35. Private end holdings need be purchased (by condemnation if necessary) before the project begins. Depth variability along the banks can be enhanced by making multiple dredge cuts to "step" the sides rather than having vertical sides.

Spawning habitat for centrarchids has been left out of our project considerations. Perhaps it is time to do something about it. Perhaps selective dredging might be accomplished along banks which have bottom substrates of sand and gravel , or perhaps spawning beds might be constructed of suitable materials after dredging. There is much opportunity for this, especially along the banks in Greymore Lake. This parameter should be investigated more carefully rather than just assuming successfully reproduction of centrarchids is a given.

Enhancing in-river fish habitat should be included in the developmental phases of project development. Wisconsin started these concepts in the McCartney Lake project. Iowa's habitat installations post Bussey Lake have been successful. I think more attention and detail should an intricate part of this important fishery project. Especially the installation of submerged bank trees which might be affixed by pilings to stand the riggers of floods on the Mississippi River. Anglers would take bass, bluegill and crappies for years from them if they were built and placed with care . We used "Crappie Clusters" and "Bankline Brush Piles" of cedar trees successfully, and there are a multitude of other types habitats.

Nothing more. In summation, it would be a whole lot more beneficial to the project, users and critters if more emphasis was placed upon the idiosyncrasies of a project rather than on paper generalities such as an HIS.

Gary Ackerman
Iowa DNR
Guttenberg,

cc: WIDNR @ PDC

CEMVP-PM-A 9 April 1999

MEMO FOR: See Distribution

SUBJECT: Ambrough Slough HREP

1. The purpose of this memo is to confirm that we will be holding a coordination meeting for the subject project on April 16, 1999, at 10:00 a.m. in the La Crosse offices of the Wisconsin DNR. The primary purpose of the meeting is to identify which project features we will recommend for construction for the Ambrough Slough HREP. If we can make these decisions, I would then like to set a date for another public meeting at which we would present our recommendations to the public.

2. The attachment provides the current status of the various project features we need to discuss at the meeting.

3. If you have any questions, please contact me at (651) 290-5282 or E-mail me at gary.d.palesh@mvp02.usace.army.mil.

Encl

Gary Palesh
Project Manager

Distribution:
Keith Beseke, USFWS
Clyde Male, USFWS
Jeff Janvrin, WDNR
Kurt Welke, WDNR
Mike Griffin, IDNR
Karen Aulwes, IDNR
Michelle Schneider, COE
Joel Face,COE
Tim Yager, COE
Rick Femrite, COE
Terry Williams, COE

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Twin Cities Field Office
4101 East 80th Street
Bloomington, Minnesota 55425-1665

SEP 28 1999

Mr. Robert J. Whiting
Chief, Environmental and
Economic Analysis Branch
St. Paul District, U.S. Army Corps of Engineers
Army Corps of Engineers Centre
190 Fifth Street East
St. Paul, Minnesota 55101-1638

Dear Mr. Whiting:

This concerns your September 9, 1999, letter requesting U.S. Fish and Wildlife Service comments on potential impacts to federally endangered or threatened species from the proposed Ambrough Slough Habitat Rehabilitation and Enhancement Project in Pool 10 of the Upper Mississippi River.

Based on information contained in your above referenced letter and the nature of the proposed project, its location, and the habitat requirements of the federally threatened bald eagle (*Haliaeetus leucocephalus*), and endangered Higgins' eye pearly mussel (*Lampsilis higginsi*), we concur with your determination that the proposed project is not likely to adversely affect federally listed threatened or endangered species. We note that mussel surveys conducted for the proposed project did not find any live *L. higginsi*. Should this project be modified or new information indicates that listed species may be affected, consultation with this office should be reinitiated.

We appreciate the opportunity to offer our comments on this project. Please contact Mr. Gary Wege at 612/725 3548, extension 207, if you have any questions on the above or require additional information. These comments have been prepared under the authority of and in accordance with provisions of the Endangered Species Act of 1973, as amended. Comments with respect to the Fish and Wildlife Coordination Act will be provided at the appropriate stage of planning.

Sincerely,

Charles G. Kjos
for Russell D. Peterson
Field Supervisor

cc: Wisconsin Department of Natural Resources, LaCrosse, Wisconsin
Iowa Department of Natural Resources, Des Moines, Iowa

Ambrough Slough
October 25, 1999 Site Visit Attendees

Corps of Engineers
Gary Palesh
Jon Hendrickson

U.S. Fish and Wildlife Service
Keith Beseke
John Lindell
Clyde Male
Kathy Henry

Wisconsin DNR
Jeff Janvrin

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

REPLY TO
ATTENTION OF

12/28/99

Project Management Branch
Planning, Programs, and Project Management Division

Mr. Keith Beseke
Habitat Projects Coordinator
U.S. Fish and Wildlife Service
51 East Fourth Street
Winona, Minnesota 55987

Dear ~~Mr. Beseke~~ Keith:

Enclosed for review and comment is the preliminary draft Definite Project Report and Environmental Assessment for the Ambrough Slough Habitat Rehabilitation and Enhancement Project. This report is being reviewed concurrently by the Wisconsin and Iowa Departments of Natural Resources.

Please provide any comments you may have by January 31, 2000. If you concur with the recommended plan, we would appreciate a letter indicating your support of the project. We would include your letter in the public review draft of the report.

If you have any questions or need additional information, please contact me at 651-290-5282, or at gary.d.palesh@mvp.usace.army.mil.

Sincerely,

Gary Palesh
Project Manager

Encl (5 copies)

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

12/28/99

REPLY TO
ATTENTION OF

Project Management Branch
Planning, Programs, and Project Management Division

Mr. Jeff Janvrin
Habitat Projects Coordinator
Wisconsin Department of Natural Resources
State Office Building
3550 Mormon Coulee Road
La Crosse, Wisconsin 54601

Dear Mr. Janvrin: Jeff

Enclosed for review and comment is the preliminary draft Definite Project Report and Environmental Assessment for the Ambrough Slough Habitat Rehabilitation and Enhancement Project. This report is being reviewed concurrently by the U.S. Fish and Wildlife Service and the Iowa Department of Natural Resources.

Please provide any comments you may have by January 31, 2000. If you concur with the recommended plan, we would appreciate a letter indicating your support of the project. We would include your letter in the public review draft of the report.

If you have any questions or need additional information, please contact me at 651-290-5282, or at gary.d.palesh@mvp.usace.army.mil.

Sincerely,

Gary Palesh
Project Manager

Encl 6 (copies)

9-45

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

REPLY TO
ATTENTION OF

12/28/99

Project Management Branch
Planning, Programs, and Project Management Division

Mr. Mike Griffin
Habitat Projects Coordinator
Iowa Department of Natural Resources
206 Rose Street
Bellevue, Iowa 52031

Dear ~~Mr. Griffin~~ Mike:

Enclosed for review and comment is the preliminary draft Definite Project Report and Environmental Assessment for the Ambrough Slough Habitat Rehabilitation and Enhancement Project. This report is being reviewed concurrently by the U.S. Fish and Wildlife Service and the Wisconsin Department of Natural Resources.

Please provide any comments you may have by January 31, 2000. If you concur with the recommended plan, we would appreciate a letter indicating your support of the project. We would include your letter in the public review draft of the report.

If you have any questions or need additional information, please contact me at 651-290-5282, or at gary.d.palesh@mvp.usace.army.mil.

Sincerely,

Gary Palesh
Project Manager

Encl (2 copies)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Upper Mississippi River National Wildlife and Fish Refuge
51 E. Fourth Street - Room 101
Winona, Minnesota 55987

IN REPLY REFER TO:

February 9, 2000

Mr. Gary Palesh
St. Paul District, Corps of Engineers
NCS-PE-M
190 Fifth Street East
St. Paul. Minnesota 55101

Dear Mr. Palesh:

This provides U.S. Fish and Wildlife Service (Service) comments on the preliminary draft Definite Project Report and Environmental Documentation (SP-23) for the Ambrough Slough Habitat Rehabilitation and Enhancement Project. This project will benefit the biological resources of the Upper Mississippi River National Wildlife and Fish Refuge (Refuge) and adjacent state lands.

A portion of this project is being built on federal lands managed as part of the Refuge, therefore,
a Refuge compatibility determination and Refuge approval is required before this part of the
project can be constructed. A signed compatibility determination for the alternative discussed in
1 this draft report will be completed at a later date when the final selected alternative for the
Gremore Lake structure is made. This compatibility statement must appear in the final project
report. Approval of the project will be formally provided by the Regional Director after
completion of the final project report.

A final draft definite project report must include a copy of the draft Memorandum of Agreement
for the operation, maintenance, and rehabilitation. The Service will cover operation and
2 maintenance costs as discussed in this report for the portion of the project enhancing Refuge
lands. The Regional Director's letter on the final draft definite project report will include the
certification of support for operation and maintenance.

Both of the Gremore Lake channel routes described in the draft document enhances lands that are
3 not managed as part of the Upper Mississippi River National Wildlife and Fish Refuge.
Therefore, the Service would not be able to spend Refuge funds for operation and maintenance of
either alternative.

4 As stated all mussel surveys must be completed before we can move into the development of the
plans and specification for the project.

5 The peregrine falcon should be deleted from the federally threatened/endangered species text in the report, since it has been delisted.

6 Make sure that your agency coordinates as per our guidelines all cultural resource work.

7 The Service and the Wisconsin Department of Natural Resources are not responsible for rehabilitation. The Corps is the responsible agency. Please correct page 16-1.

These comments have been prepared under the authority of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.), the National Environmental Policy Act of 1969 (42 U.S.C. 4321-4327), the Endangered Species Act of 1973, (16 U.S.C. 1531-1543), as amended, and the U.S. Fish and Wildlife Service's Mitigation Policy.

This report illustrates the cooperation evident between the Corps and the Service. The cooperative efforts on this project and the Environmental Management Program as a whole ensure that progress in restoring habitat will continue on the Upper Mississippi River System.

Sincerely,

James R. Fisher

James R. Fisher
Complex Manager

Enclosures

cc: TCFO (Wege)
La Crosse FRO
WI DNR
IA DNR
McGregor District
RO – SS

Responses to U.S. Fish and Wildlife Service Comments dtd February 9, 2000

1. No response required.

2. A draft Memorandum of Agreement was included in attachment 7 to the preliminary draft report and will be included in the draft and final versions of the report.

3. No response required.

4. All mussel surveys for the project have been completed.

5. The recommended change has been made.

6. No response required.

7. The statement has been corrected.

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

WISCONSIN DEPT. OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary
Scott A. Humrickhouse, Regional Director

La Crosse Service Center
State Office Building, Room 104
3550 Mormon Coulee Road
La Crosse, Wisconsin 54601
Telephone 608-785-9000
FAX 608-785-9990

February 11, 2000

Palesh, Gary
St. Paul District, Corps of Engineers
Army Corps of Engineers Centre
Floodplain Management and Small Projects
190 Fifth Street
St. Paul, MN 55101-1638

Dear Mr. Palesh:

We have completed review of the Preliminary Draft Definite Project Report/Environmental Assessment for the Ambrough Slough Habitat Rehabilitation and Enhancement Project dated December 1999. Following are our comments.

1 General Comment: Many of the evaluations include consideration of over-topping during the winter 50% of the time (Tilmont, Upper and Lower Doubles, Fish). Our observations of the Ambrough Slough complex indicate that this event occurs much less frequently than your analysis showed. Several factors influence the over-topping frequency and we saw evidence in the hydraulics analysis that interpretation of the data may have been incorrect. These items are discussed below as they relate to the different alternatives considered.

2 Page 1-1; 1-1: Update summary of the authority for doing the project.

3 Page 3-4; 3.2.5: The outlet of Spring Lake also joins a small channel which branches off of Ambrough Slough approximately 200 yards upstream of Ambrough's connection with Roulette Lake. This channel is navigable during higher flows and has enlarged over the past 10 years. At this point, we believe it will be stable and not interfere with any habitat restoration measures in Spring Lake, however, it may be good to document its presence and anticipated future.

4 Page 3-5; 3.2.9: Fish lake is greatly influenced by eddy flows from Black and Ambrough Sloughs as well as flows from the small channel which runs from Ambrough Slough through the lower end of Upper Doubles and the middle of Lower Doubles before entering the northwest corner of fish lake. Add to this section.

5 Page 3-7& 8; 3.4.2 and 3: The Wisconsin DNR has water quality data for Gremore Lake and other water bodies in the Ambrough complex dating back to the mid 1960's. This information has been provided to your agency numerous times. While data summaries from the 60's, 70's and 80's may not be necessary to justify the project, acknowledgment of it existing shows that this area has a long history of DO problems. Add to this section.

6 Page 4-3; Table 4-2: Lower Doubles has sub-optimal current velocity. Please make correction.

7 Page 4-8; 4.3.1: Add discussion regarding how the 1972 change in pool management may have affected the area and possible ecological impacts of this change (i.e. tree mortality).

8 Page 5-3; Objective A-1: Add that velocity and temperature are related during winter periods. We cannot expect high temperatures without low velocity.

9 Page 5-4: "As in winter, water depths provide cover," needs clarification.

10 Page 7-1; 7.1.1.3: Another reason for eliminating dredging in Roulette Lake was lack of adequate water access to economically implement any restoration measures.

11 Page 7-3; Table 7-1: Lower Doubles and Fish probably do not meet velocity criteria in the winter based on our monitoring. Please change.

12 Page 7-6; 7.1.3.1: Another feature which was proposed for Ambrough Slough was a "habitat channel" similar to the one constructed as part of the Bertom and McCartney Lake HREP in Pool 11. This channel has shown a marked increase in target riverine fish species over a control channel which was not altered by the project. Add to this section that this structure was a proposed feature.

13 Page 7-8; 7.2.1.3: We are concerned that the proposed reduction is not sufficient to meet habitat objectives for the lower end of the Ambrough Slough complex. We recommend that the bottom elevation of the structure be raised to provide a 3 foot (0.92 m) clearance at summer low control pool conditions. The width of the structure should be sized to result in maximum surface velocities during this condition of approximately 5 feet per second. This will be sufficient for boat passage as the channels leading to this structure from the Ambrough Slough complex will most likely have long sections where the maximum depth will be one foot or less. Please make changes to plans and write-up.

14 Page 7-11; 7.2.1.4 Habitat Benefits: The structures for Upper and Lower Doubles each mention that the structures would only be effective 50 percent of the winters. The hydraulics appendix states that it would be overtopped 63% of the time during the winter. However, when we looked at the Table 2 on page 5-2 of the hydraulics appendix, we could not see how this was calculated. We believe an error was made in the calculations made. Table 2 would indicate that the structures would only be overtopped 30+% of the time.

15 Another observation we have made is that a high natural river berm "protects" the Ambrough complex from main channel flows and may also greatly influence the water surface elevations resulting in lower elevations in the Ambrough complex than those observed on the main channel. Furthermore, our observations in the area during winter do not include frequent "flooding" or water on top of the ice as this analysis would imply. We believe these structures would be more beneficial than stated and also request that you have your staff reevaluate their calculations and findings.

16 An additional factor which must be considered is the duration of over-topping. These structures can be over-topped and still meet the velocity and temperature criteria for over-wintering centrarchids. For example, if the structures were over-topped resulting in flows of 2-5 cfs the velocities within the lakes would not be detrimental to the fish utilizing the area. Even brief periods of over-topping which would result in flows above the this level would be acceptable. Also, it appears the analysis assumes that the structures would be over-topped the entire winter, which is not correct.

17 Page 7-13; 7.2.1.5: (also see comment for 7.2.1.4) The Lower Doubles Closure will also benefit portions of Fish Lake. The habitat improved in Fish Lake must also be included in the analysis of the partial closing structure.

18 Pages 7-15 to 7-19; 7.2.1.6 and 7.2.1.7: Once again, over-topping is cited as a reason to reduce the amount of time the islands would function. In the case of these structures, the over-topping would occur even less frequently than the rock closures since the islands would be built to a higher elevation. However, the analysis still states that they would be over-topped for the same duration. Table 2 of the hydraulics appendix indicates these structures would be over-topped <25% of the time. Table 3 provides further evidence that the islands and closing structures would most likely be over-topped less than 5% of the time (L & D 9 discharge of 1274 cms) during the months of December, January, and February, which are the most critical months. The chance of over-topping increases in October and November to 20% for the same flow condition and cross referencing to Table 1 indicates they may only be over-topped <10% of the time. Also, the duration of over-topping has to be factored into the analysis.

19 Page 7-30; 7.2.5: Gremore Lake. We have reservations about the ability of the selected plan, west route open channel, to meet project goals. Our concerns are related to the lack of head at this location and the fact the channel will enter a shallow bay of the lake then flow to the northeast before entering the main body of the lake. All measurements to date have shown a very small head between Ambrough Slough and Gremore Lake. This head difference may be reduced further, although slight, due to a decrease in water surface elevation of Ambrough Slough resulting from construction of the Black Slough partial closure. Vegetation and ice conditions within the Gremore Lake bay where the channel will enter may cause further "resistance" to the small amount of flow which will be entering the lake at this location during the winter. Also, the shallow nature of the bay may also result in ice formation to the bottom near where the channel terminates in Gremore if flow and head conditions do not provide enough velocities to maintain an open route for the water to enter the main body of the lake.

20 We strongly believe the northern route would meet the project goals and objectives consistently for a relatively small increase in project cost. A greater head would exist between Ambrough Slough and Gremore Lake which should allow for the construction of a smaller culvert and reduce the chance of ice interfering with the delivery of oxygenated water to the lake. We request that this option be reconsidered based on our concerns with the west route. Another thought is that we may need both culverts to provide adequate flows to alleviate winter DO sags.

21 Page 7-31 to 32; 7.2.5.3: Typo. The range of flow should be 0.08 to .11 cms. The bottom elevation of the dredge channel to Gremore (185.32m) does not match Plate 7 (185.70m). More verification of the water surface elevation during winter conditions is needed to verify the assumed slope for culvert flow calculations. Please add more narrative after the "channel was initially designed with a 1.2m culvert" (i.e. what is the final or proposed design).

22 We believe the Gremore Lake channels need to be excavated to a point where they meet the 4 foot contour of Gremore Lake to assure adequate mixing takes place. Otherwise, we believe that stratification will result, limiting the volume of the water column which will be oxygenated.

23 Page 8-1: Make appropriate changes based on incorporation of our comments.

24 Page 8-3: The access dredging material could also be used as part of the peninsula restoration or maybe to construct a small island in another portion of Tilmont Lake.

25 Page 11-2; 11.3: This section may need to be revised if our recommendation to use the north channel route is incorporated.

26 Page 12-3: Post construction monitoring should also include flow monitoring of closures and culverts. Please add the Wisconsin DNR will also conduct periodic fishery surveys of the complex as time and funding permit.

27 The 404(b)(1) should also include bulk chemical analysis results of sediments.

28 404(b)(1) 3-15; 8: There is no closed area in the Ambrough Slough complex. Remove last sentence.

29 404(b)(1) 3-16; 3: There may be short-term disturbance during construction of the Gremore Lake structures. Also, these structures will not be constructed to provide for navigation, however this should not be a problem since currently no navigation takes place since it is land.

30 Hydraulics Section 5-11: When and where was the head measurement made across the Gremore peninsula (i.e. 0.003m or 0.01 ft)? Winter measurements should be made if not available.

31 Closing comments: Permits will be required for the partial closing structures, Gremore Lake Channel and the disposal site. The Wisconsin DNR will process the water quality permit during plans and specifications.

We are pleased with the majority of project features proposed and anticipate quickly reaching a resolution on the comments we have made. Please contact me at the above address, or phone (608) 785-9005, if you have any questions regarding these comments.

Sincerely,

Jeffrey A. Janvrin
Mississippi River Habitat Specialist

c: Keith Beseke, USFWS
John Lindell, USFWS
Mike Griffin, Iowa DNR
Scott Gritters, Iowa DNR

Responses to Wisconsin DNR Comments dtd February 11, 2000

1. See responses to individual comments 14-16 and 18.

2. The referenced discussion has been updated.

3. This information is more appropriate to the discussion of alternatives and has been added to section 7.1.2.1 pertaining to Spring Lake.

4. This information is more appropriate to the discussion of alternatives and has been added to section 7.1.2.5 pertaining to Fish Lake.

5. It has been noted in this section that water quality monitoring extends back as far as the 1960's.

6. The noted correction has been made.

7. A discussion has been added as suggested.

8. A discussion noting this has been added to the referenced section.

9. This statement has been reworded.

10. This has been noted in the referenced discussion.

11. The noted corrections have been made.

12. A discussion of this feature has been added.

13. We have looked into this and do not plan to raise the bottom elevation of this structure at this time for the following reasons.

a) Even though, as you stated, water depths in the channels leading to this structure from the Ambrough Slough complex will be shallow during low river discharges, recreational boats will still be crossing this structure from the river side. In fact, we are likely to stimulate increased recreational boat traffic from the river side because this structure (and the scour hole that will form below it) is probably going to become a fishing hotspot, somewhat akin to what we are seeing with similar structures elsewhere on the river.

b) The sill elevation as proposed is 185.50. The 95% excedence elevation at this site during August and September is 186.45. Thus, during low flow conditions, we are only providing 0.95 meters of water over this structure, which is generally considered the minimum needed for safe recreational boat passage over a fixed structure. This does not take into account that with rock construction, some rocks will be sticking above the design elevation. We usually try to provide 1.20 meters of depth over rock structures to account for the fact that there will be some rocks sticking up above the design elevation. The structure as designed will provide 1.20 meters of clearance about 88 percent of the time in May, 81 percent in June, 70 percent in July, 59 percent in August, 62 percent in September, and 65 percent in October. Thus, we already are pushing the envelop in terms of meeting the 1.20-meter criteria.

14. The overtopping data in the hydraulics appendix was not used in the analysis to determine the potential effectiveness of the Upper Doubles Lake and Lower Doubles Lake structures. The data in the hydraulics appendix only looks at the frequency of overtopping of the structures which does not take into account, as you note in your comments, other factors such as timing, duration, etc. The discussion of how the potential effectiveness of these structures was estimated has been expanded in the draft DPR.

15. We looked at the surrounding topography for Upper and Lower Doubles Lakes to determine at what elevation they would likely be inundated. The natural river berm would be not be a barrier against higher river stages as water would still enter the complex via Black Slough, Ambrough Slough, and other small openings. The historic data for the McGregor gage indicates that in general, winter high water seems to be a persistent condition throughout the winters in which it occurs. It is generally not a single "spike" event In addition, the higher water levels usually are already present at the onset of winter. Thus, water running on top of the ice would not be expected as the ice would have formed at the higher water levels.

16. We took into account the duration and time of occurrence of high water in making our assessment. The most critical time of the winter to have high flows would be in December, which usually has been the case for those winters where high flows have occurred. The influx of colder water will "cool" off a lake, making water temperature conditions suboptimal for the rest of the winter, even if water levels recede and current velocities are not a problem. An example would be the winter of 1991-92 which had very high river stages throughout December into the first week of January. This likely cooled Upper and Lower Doubles Lake such that water temperatures were suboptimal for the remainder of the winter, even though river stages during the remainder of January and all of February were low.

17. There is apparently some confusion as to what the "percentages" in the report mean. On pages 7-16 and 7-18, it is stated that the structures will be overtopped "50-percent of the winters" which is frequency. Tables 2 and 3 in the hydraulics appendix give the percent of time (duration) that some river level is exceeded. Frequency does not equal duration. For example, say our winter period is 150 days long, and that over a 2-winter period, overtopping only occurred for 5 days during the first winter. The frequency of overtopping would be ½ or 50%, and the duration of overtopping would be 5/300 or 1.7%.

Cross referencing between table 1, 2, and 3 in the hydraulics appendix is not recommended. Table 1 is a discharge-frequency table only. The stages correspond to the discharge and were not based on a frequency analysis. Tables 2 and 3 are duration tables, however stages for a given duration in table 2 will not necessarily match (based on a rating curve) the discharge for a given duration in table 3. This is because state is a function of not only discharge at lock 9, but also discharge on the Wisconsin River and water levels in lower pool 10.

18. The same analysis was conducted for Fish Lake as for Upper and Lower Doubles Lakes as described in responses to comments 14-16 above. The discussion of this analysis in the draft DPR has been expanded. It is not the overtopping of the closure structures that is the concern at Fish Lake. The limiting factor re: inundation of Fish Lake is the broad expanse of low lying ground along the south side of the lake.

19. The original culvert design was based on a head differential of .003 feet. A 1.3 meter diameter culvert was determined to be necessary to convey the needed flow. Based on Wisconsin DNR input the culvert diameter was increased to 2.13 meters for maintenance purposes. In retrospect, over sizing the culvert for maintenance purposes and using stoplogs to reduce flow if necessary is a good idea since there are uncertainties regarding the head differential. The channel into Gremore Lake has been designed to accommodate shallow water and ice conditions.

20. We have reevaluated both routes. The west route is designed to provided the desired flow taking into account the low head differential and we believe it will function as designed.

21. This discussion was deleted from this section of the report. Design details are discussed in section 8.5.

22. This was assumed in the project design and included in the cost estimate for this feature. See section 8.5 for a discussion.

23. Changes have been made where necessary.

24. We can leave use of the access dredged material for part of the peninsula restoration as an option for the construction contractor if the contractor can demonstrate that the dredging operation will not disturb the soil. Our analysis of the soils in this area indicate that if access dredged material is handled twice (dredged and put on a barge and then taken from the barge and placed on the peninsula), it will no longer retain its basic soil structure and will be unsuitable for use in the peninsula, i.e., it will not be stable material. Therefore, it is likely that the access dredged material will have to be taken to an upland disposal site and our cost estimate reflects this.

For the same reasons stated above, we believe this material would be unsuitable for island construction as it would not have the structural stability to form an island. It would in all likelihood "ooze" away.

25. No response required.

26. This has been added to the referenced section.

27. This information has been added to the Section 404(b)(1) evaluation.

28. This correction has been made.

29. The referenced narrative has been modified to reflect this.

30. Our design notes indicate that the head difference measured by the Wisconsin DNR was .01' on 11/18/98 and that a measurement by USACE surveyors indicated a difference of .06' on 1/20/99. John Sullivan of your staff indicated he had made at least one more measurement that indicated a low, perhaps even negative head differential. From a design standpoint, the bottom line is that we are dealing with a low head system. As noted in the response to comment 19 above, the decision to go with a larger culvert for maintenance purposes should also provide some additional flow capacity should it be needed.

31. No response required.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

REPLY TO
ATTENTION OF

Dr. Leslie Eisenberg
State Compliance Coordinator
Division of Historic Preservation
State Historical Society of Wisconsin
816 State Street
Madison, Wisconsin 53706

28 March 2000

Dear Dr. Eisenberg,

Pursuant to our letter of 2 February 2000, concerning the Ambrough Slough Habitat Rehabilitation Project in Pool 10 of the Mississippi River, we are forwarding a copy of the survey report completed under contract with the St. Paul District (Frank Florin and Thomas Madigan, 2000. *Phase I Cultural Resources Investigation of Ambrough Slough Environmental Management Program Project: Mississippi River Pool 10, Crawford County, Wisconsin.* Report prepared by Hemisphere Field Services for the St. Paul District Corps of Engineers (Contract No. DACW37-99-Q-0081). Hemisphere Field Services Reports of Investigations No. 608, Minneapolis.)

The investigators surveyed the area of potential effect defined for the project, defined as the Dillman field (dredged material disposal), three river peninsulas (to be re-built), and the shallows of four floodplain lakes (to be dredged to improve habitat). The lake shallows were cored in 9 areas, but no buried intact former surfaces were encountered. The peninsulas contained no archaeological deposits. Three prehistoric archaeological sites (47 CR 616, 47 CR 617, and 47 CR 618) were identified in the Dillman field. These sites are small lithic scatters, potentially eligible for the National Register.

The St. Paul District can contour the dredged material to be placed in the Dillman field around these three sites. The dredged material disposal plans and specifications will be written to avoid these sites either for dredged material or heavy equipment. We will flag the site boundaries, with a buffer of 25 feet, before the dredged material disposal is begun, and allow no heavy equipment within these boundaries.

With these measures to avoid the three identified sites in the project area, the St. Paul District determines that the Ambrough Slough project will not affect any historic properties (36 CFR Part 800.4(d)(1).

We would be grateful for your review of this project and a response by 1 May 2000. Please call staff archaeologist Sissel Johannessen (651 290 5263) with any questions.

Sincerely,

/s/

Robert J. Whiting
Chief,
Environmental and Economics Branch

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

April 11, 2000

REPLY TO
ATTENTION OF

Project Management Branch
Planning, Programs, and Project Management Division

Mr. Keith Beseke
Habitat Projects Coordinator
U.S. Fish and Wildlife Service
51 East Fourth Street
Winona, Minnesota 55987

Dear Mr. Beseke: Keith

Enclosed for your review and comment are two copies of the draft Definite Project Report/Environmental Assessment for the Ambrough Slough Habitat Rehabilitation and Enhancement Project. Besides you, copies of the report have been provided to the following individuals within the U.S. Fish and Wildlife Service: James Fisher, Russell Peterson, John Lindell, Clyde Male, and Pam Thiel. In addition, a copy was provided to the Regional Director with a letter requesting confirmation that the U.S. Fish and Wildlife Service would assume responsibility for the operation and maintenance of project features located on the Refuge (copy furnished to you).

Please furnish any comments you may have on the document by May 19, 2000. Also, please provide a Refuge compatibility determination for the project for inclusion in the final report.

If you have questions, please contact me at (651) 290-5282, or at gary.d.palesh@mvp.usace.army.mil.

Sincerely,

Gary Palesh
Project Manager

Enclosure

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

April 11, 2000

REPLY TO
ATTENTION OF

Project Management Branch
Planning, Programs, and Project Management Division

Mr. Jeff Janvrin
Habitat Projects Coordinator
Wisconsin Department of Natural Resources
State Office Building
3550 Mormon Coulee Road
La Crosse, Wisconsin 54601

Dear Mr. Janvrin:

Enclosed for your review and comment are two copies of the draft Definite Project Report/Environmental Assessment for the Ambrough Slough Habitat Rehabilitation and Enhancement Project. Besides you, copies of the report have been provided to the following individuals within the Wisconsin Department of Natural Resources: George Meyer, Terry Moe, Kurt Welke, and John Wetzel.

Please provide any comments you may have on the document by May 19, 2000. If you have any questions, please contact me at (651) 290-5282, or at gary.d.palesh@mvp.usace.army.mil.

Sincerely,

Gary Palesh
Project Manager

Enclosure

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

April 11, 2000

REPLY TO
ATTENTION OF

Project Management Branch
Planning, Programs, and Project Management Division

Mr. Mike Griffin
Habitat Projects Coordinator
Iowa Department of Natural Resources
206 Rose Street
Bellevue, Iowa 52031

Dear Mr. Griffin: Mike

Enclosed for your review and comment is the draft Definite Project Report/Environmental Assessment for the Ambrough Slough Habitat Rehabilitation and Enhancement Project. Besides you, copies of the report have been provided to the following individuals within the Iowa Department of Natural Resources: Al Farris, Kevin Szcodronski, Scott Gritters, and Karen Aulwes.

Please provide any comments you may have on the document by May 19, 2000. If you have any questions, please contact me at (651) 290-5282, or at gary.d.palesh@mvp.usace.army.mil.

Sincerely,

Gary Palesh
Project Manager

Enclosure

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

REPLY TO
ATTENTION OF

APR 12 2000

Project Management Branch
Planning, Programs, and Project Management Division

Mr. Terry Moe
Wisconsin Department of Natural Resources
State Office Building
3550 Mormon Coulee Road
La Crosse, Wisconsin 54601

Dear Mr. Moe:

Enclosed for your review is the draft Definite Project Report/Environmental Assessment for the Ambrough Slough Habitat Rehabilitation and Enhancement Project, Crawford County, Wisconsin. The report contains an integrated environmental assessment, draft Finding of No Significant Impact, and Section 404(b)(1) evaluation. Attachment 9 contains the distribution for this report and indicates others within your agency that received a copy of the report.

The Wisconsin Department of Natural Resources would serve as the non-Federal cost share sponsor for the Gremore Lake feature of the recommended project. The non-Federal cost share for this feature would be 35 percent, as required by Section 509 of the Water Resources Development Act of 1999. The current estimated cost of the Gremore Lake feature (including sunk planning costs) is $332,400, as shown on page 13-1 of the report. The non-Federal share would be $116,340. Attachment 8 to the report contains a draft Project Cooperation Agreement for the Gremore Lake feature.

We request that you review this document and provide a letter by May 19, 2000, containing the following:

a. Any comments you may have on the contents of the report;

b. An indication of your agency's support for the proposed project;

c. An indication of your agency's intent to serve as the non-Federal sponsor for the Gremore Lake feature, including assuming responsibility for the operation and maintenance of this feature; and

d. State water quality certification for the project under Section 401 of the Clean Water Act, as amended, or an indication that you expect to issue water quality certification at a later date.

If you have any questions concerning the proposed project or our request, please contact Gary Palesh, Project Manager, at (651) 290-5282 or at gary.d.palesh@mvp02.usace.army.mil.

Sincerely,

Judith L. DesHarnais
Chief, Project Management Branch

Enclosure

Copy furnished (w/o encl):

Jeff Janvrin, WDNR Habitat Projects Coordinator

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

REPLY TO
ATTENTION OF

APR 12 2000

Project Management Branch
Planning, Programs, and Project Management Division

Mr. Kevin Szcodronski
Iowa Department of Natural Resources
Wallace State Office Building
Des Moines, Iowa 50319

Dear Mr. Szcodronski:

Enclosed for your review is the draft Definite Project Report/Environmental Assessment for the Ambrough Slough Habitat Rehabilitation and Enhancement Project, Crawford County, Wisconsin. The report contains an integrated environmental assessment, draft Finding of No Significant Impact, and Section 404(b)(1) evaluation. Attachment 9 contains the distribution for this report and indicates others within your agency that received a copy of the report.

We request that you review this document and provide a letter by May 19, 2000, containing any comments you may have on the contents of the report and an indication of your agency's support for the proposed project.

If you have any questions concerning the proposed project, please contact Gary Palesh, Project Manager, at (651) 290-5282 or at gary.d.palesh@mvp02.usace.army.mil.

Sincerely,

Judith L. DesHarnais
Chief, Project Management Branch

Enclosure

Copy furnished (w/o encl):

Mike Griffin, IDNR Habitat Projects Coordinator

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

REPLY TO
ATTENTION OF

APR 12 2000

Project Management Branch
Planning, Programs, and Project Management Division

Mr. William F. Hartwig
Regional Director
U.S. Fish and Wildlife Service
Bishop Henry Whipple Federal Building
1 Federal Drive
Fort Snelling, Minnesota 55111-4056

Dear Mr. Hartwig:

Enclosed for your review is the draft Definite Project Report/Environmental Assessment for the Ambrough Slough Habitat Rehabilitation and Enhancement Project, Crawford County, Wisconsin. Most of the project is located on the Upper Mississippi River National Wildlife and Fish Refuge. The report contains an integrated environmental assessment, draft Finding of No Significant Impact, and Section 404(b)(1) evaluation.

We request that you review this document and provide any comments by May 19, 2000. We also request that you provide a statement assuring that the Fish and Wildlife Service will assume operation and maintenance responsibilities for the project in accordance with Section 906(e) of the Water Resources Development Act of 1986. General operation and maintenance responsibilities are outlined in the draft report and in a draft Memorandum of Agreement contained in attachment 7 of the report.

If you have any questions, please contact Gary Palesh, Project Manager, at (651) 290-5282.

Sincerely,

Enclosure

Kenneth S. Kasprisin
Colonel, Corps of Engineers
District Engineer

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

REPLY TO
ATTENTION OF

APR 12 2000

Project Management Branch
Planning, Programs, and Project Management Division

Dear Interested Parties:

Enclosed for your information, review, and comment is the draft Definite Project Report/Environmental Assessment for the Ambrough Slough Habitat Rehabilitation and Enhancement Project located in pool 10 of the Upper Mississippi River near Prairie du Chien, Wisconsin. The report contains an integrated environmental assessment, a draft Finding of No Significant Impact (FONSI), and a Section 404(b)(1) evaluation. We are distributing this report to concerned agencies, local units of government, interested groups, and individuals. If you have any comments on the report or environmental assessment, please provide them within 30 days of the date of this letter.

The Section 404(b)(1) evaluation is being distributed as part of this report in lieu of a separate Section 404 public notice. Anyone may request a public hearing on this project. The request must be submitted in writing within 15 working days of the date of this letter. Interested parties are also invited to submit to this office written facts, arguments, or objections to this project within 30 days of the date of this letter. These statements should clearly state the interest that the project would affect and how the project would affect that interest. All statements, oral or written, will become part of the official project file and will be available for public examination.

Questions concerning the Ambrough Slough project should be directed to Mr. Gary Palesh, Project Manager, at (651) 290-5282 or at gary.d.palesh@mvp02.usace.army.mil. Please address all correspondence to the St. Paul District, Corps of Engineers, ATTN: CEMVP-PM-A, 190 Fifth Street East, St. Paul, Minnesota 55101-1638.

Sincerely,

Charles E. Crist
Deputy for Programs and
Project Management

Enclosure

AMBROUGH SLOUGH
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

PUBLIC MEETING NOTICE

Peoples State Bank
301 E. Blackhawk Avenue
Prairie du Chien, Wisconsin
7:00 p.m. – 9:00 p.m.
May 8, 2000

Since 1996, the St. Paul District Corps of Engineers, in cooperation with the U.S. Fish and Wildlife Service and the Wisconsin and Iowa Departments of Natural Resources, has been investigating measures for fish and wildlife habitat restoration within the Ambrough Slough backwater complex. Ambrough Slough located in pool 10 of the Upper Mississippi River a short distance above Prairie du Chien, Wisconsin. The study has been conducted under the Upper Mississippi River System - Environmental Management Program (UMRS-EMP).

Studies have been essentially completed and a draft report has been prepared recommending a number of measures to restore and enhance fish and wildlife habitat within the study area. These include:

(1) a partial closure structure at the head of Black Slough to reduce flows entering the slough

(2) restoration of an eroded peninsula that used to separate Tilmont Lake from Ambrough Slough

(3) construction of small rock closures on Tilmont Lake and Upper Doubles Lake

(4) dredging in Spring Lake, Big Missouri Lake, and Upper Doubles Lake

(5) construction of a channel to introduce flow to Gremore Lake

The purpose of the public meeting is to discuss the recommended habitat restoration features and provide the public an opportunity to provide comment on the recommended plan.

If there are any questions concerning the public meeting, please contact Gary Palesh, Project Manager, at (651) 290-5282 or at gary.d.palesh@mvp02.usace.army.mil.

ATTENDANCE ROSTER

Meeting: Ambrough Slough HREP
Prairie du Chien, WI

Date: May 8, 2000

Name (please print)	Address (please print)
TOM MILLER	4906 LAUB LA. MADISON 53711
GORDON STEPHENS	RT 4 Box 184 PRAIRIE DU CHIEN 53821
J. D. WALKER	351 N. MADISON ST LANCASTER WI 53812
A+D Ackerson	R#1 384 A Prairie du Chien Wi 53821
Douglas A Reilly	790 Oakview Ct PdC 53821 WI
Donald D. Higgins	63706 Clifford Dr. PdC, 53821 -
Jerry Criffe	3646 S. Raymond R. Waterloo IA. 50701
Stan Hamann	817 N. Main Prairie du Chien
Rich Hamann	216 E Blackhawk Prairie du Chien
Ron Schmitz	R1 Box 275 Eastman Wi 54626
Frank E. Mezera	209 S. Ohio P.D.C. Wi 53821
BRUCE L. KLANG	304 S. DOUSMAN PRAIRIE DU CHIEN WI 53821

ATTENDANCE ROSTER

Meeting: Ambrough Slough HREP
Prairie du Chien, WI

Date: May 8, 2000

Name (please print)	Address (please print)
MICHAEL DONAHUE	407 SUNSET DR
	CUBA CITY, WI 53807
DAVID & PATRICIA FLOM	2547 HWY JG, MOUNT HOREB, WI 53572
Keith Henderson	Prairie DuChien W.
Gerald Jennings	305 E Adams Farmersburg, Ia 52047
Jim Wilson	1623 Plymouth Ave. Waterloo, IA 50702
DARREL LOVELESS	2137 N. ELK RUN RD " " 50703
Larry Knutson	Box 85 Pr. du Chien, Wi 53821
Frank Heisz	63920 Mill Coulee Rd P.D.C
Don Rose	31972 Hwy 131 Waukeka Wis 53826

Upper Mississippi River National
Wildlife and Fish Refuge
Established 1924
Compatibility Determination
Ambrough Slough Habitat
Rehabilitation and Enhancement Project

Established Authority:

Public Law No. 268, 68th Congress, The Upper Mississippi River Wild Life and Fish Refuge Act.

Purposes for Which the Refuge was Established:

".... (a) as a refuge and breeding place for migratory birds... (b) ... as a refuge and breeding place for other wild birds, game animals, fur-bearing animals, and for the conservation of wild flowers and aquatic plants, and (c)... as a refuge and breeding place for fish and other aquatic animal life." 43 Stat. 650, dated June 7, 1924.

".... shall be administered by him (Secretary of the Interior) directly or in accordance with cooperative agreements ....and in accordance with such rules and regulations for the conservation, maintenance, and management of wildlife resources thereof, and its habitat thereon, ..." 16 U.S.C. 664 (Fish and Wildlife Coordination Act)

".... suitable for– (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species..." 16 U.S.C. 460k-1 "... the Secretary ...may accept and use ...real ...property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors..." 16 U.S.C. 460k-2 [Refuge Recreation Act (16 U.S.C. 460k-460k-4), as amended]

"... particular value in carrying out the national migratory bird management program." 16 U.S.C. 667b (An act Authorizing the Transfer of Certain Real Property for Wildlife, or other purposes)

Description of Proposed Use:

The proposal is a Habitat Rehabilitation and Enhancement project authorized by the Water Resource Development Act of 1986 (Pub. L. 99-662). The proposed project includes partial closure structure at Black Slough, a closure structure at Upper Doubles Lake and peninsula restoration at Tilmont Lake. Dredging will occur in Spring Lake, Big Missouri Lake, and Upper Doubles Lake to restore fish habitat.

More details of the project, including maps and an engineering drawings, are contained in the draft report entitled, "Upper Mississippi River System Environmental Management Program Definite Project Report with Integrated Environmental Assessment (SP-23) Ambrough (Ambro) Slough, Habitat Rehabilitation and Enhancement, Upper Mississippi River, Wisconsin, and Minnesota," as prepared by the St. Paul District, Corps of Engineers.

Anticipated Impacts on Refuge Purposes:

As a result of the project fish and wildlife populations should increase which will be a direct benefit toward maintaining and accomplishing refuge purposes. A summary of impacts to the natural resources of the Refuge are as follows:

The project will substantially improve habitat conditions for the backwater fish community in the Ambro Slough complex through a combination of flow control and dredging. Habitat conditions will be improved in five backwater lakes - Spring Lake, Big Missouri Lake, Upper Doubles Lake, Tilmont Lake, and Gremore Lake - totaling approximately 220 hectares. The habitat quality in these lakes will be increased from 35 to 67 percent, depending upon the lake.

In addition to the direct quantifiable benefits noted above, the fishery in other lakes and sloughs in the Ambro Slough complex will benefit. Many of the other lakes and sloughs such as Fish Lake, Lower Doubles Lake, Dark Slough, and Ambro Slough proper provide average to good summer habitat for backwater fish species. Improvements of habitat conditions in the above five lakes will provide overwintering habitat for fish using these other water bodies. Thus, in addition to directly benefitting about 220 hectares of aquatic habitat, the area of aquatic that will be secondarily benefitted is likely at least as large, if not larger, than the area directly affected.

Justification

The proposed project works toward the accomplishment of the above stated objectives of the refuge by improving habitat conditions over the entire Ambro Slough Complex. The closures and dredging will significantly improve winter and summer habitat conditions for the backwater fish community.

Determination: The proposed use is X is not ____ compatible with the purposes for which the refuge was established.

Determined by : James R. Fisher Date 5/11/00
Complex Manager

Concurred by : Richard A. Frietsche Date 5/10/00

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

WISCONSIN DEPT. OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary
Scott A. Humrickhouse, Regional Director

La Crosse Service Center
State Office Building, Room 104
3550 Mormon Coulee Road
La Crosse, Wisconsin 54601
Telephone 608-785-9000
FAX 608-785-9990

May 30, 2000

Ms. Judith L. DesHarnais
Chief, Project Management Section
Dept. of the Army, St. Paul District, Corps of Engineers
Army Corps of Engineers Centre
190 Fifth Street East
St. Paul, MN 55101-1638

Subject: Ambrough Slough Habitat Rehabilitation and Enhancement Project

Dear Ms. DesHarnais:

We have completed review of the Ambrough Slough Habitat Rehabilitation and Enhancement Project (HREP) Definite Project Report/Environmental Assessment (SP-23), dated March 2000. We concur with the recommended project features contained in the report. Our official letter of support is being processed and will include acknowledgment of our intent to serve as the non-Federal sponsor for the Gremore Lake features including operation and maintenance of these features. According to the report, our share of the planning and construction costs for the Gremore Lake features will be $116,340 with projected annualized operation and maintenance costs of $3,881.

Some features of the Ambrough Slough HREP will require permits from our agency once the project has been approved by the River Resources Forum and the MOU between our agencies has been updated. The features for which permits will be required are: the upland disposal site, closures at Black Slough and Upper Doubles, and the Gremore Lake channel and associated structures. These features may also need permits from Crawford County. Water quality certification will be provided after our review of plans and specifications for the project.

Following are specific comments we have regarding the March 2000 DPR:

Main Report

Table 7-5, Page 7-14 as it pertains to Lower Doubles Closure, Fish Lake Islands/Closures, Tilmont Lake Peninsula, and Upper Doubles Closure habitat benefit analysis: We still do not concur with the conclusions made in the report regarding the frequency of winter over-topping events for the various features. While we concur with the selected features for the project, we cannot agree with this analysis being used as the primary rationale for not selecting some of these features. Our observations in the area during winter do not include frequent "flooding" of low land in the backwater nor water on top of the ice as this analysis would imply. We believe these structures would be more beneficial than stated and will be over-topped less frequently than stated. This difference in opinion points out a data need which we as a planning team must address. We will work with your staff to develop an approach to better document such over-topping events for this project area and any future projects in other areas.

Section 404(b)(1)

Page 3-3: Dredged Material Placement: Statements regarding hydraulic retention time and out-fall locations must be included in this section.

Page 3-4: Gremore Lake was tested by the Wisconsin DNR for contaminants. Please contact Jeff Janvrin, 608-785-9005, if you would like a copy of these results.

Page 3-6: The method for excavation of each site should be included and disposal sites for any material dredged in conjunction with the closures and Gremore Lake channel must be identified.

If you have any questions regarding our comments, please contact Jeff Janvrin at the above address, or phone 608-785-9005.

Sincerely,

Terry A. Moe

Terry A. Moe
Mississippi-Lower St. Croix Team Leader

c: Jeff Janvrin, WDNR
Mike Davis, MN DNR
John Lindell, USFWS McGregor
Keith Beseke, USFWS Winona
Gary Palesh, COE St. Paul District

Responses to Wisconsin DNR Comments dtd. May 30, 2000

Main Report

Table 7-5, page 7-14 – We recognize the subjectivity inherent in the analysis. However, we believe the analysis is sufficient to make a reasoned judgement concerning whether or not to construct the closures in question. To appreciably increase our level of confidence in the analysis would require a significant amount of additional study to include collecting additional survey data, hydraulic analyses (possibly including modeling), and habitat analyses. Even with the additional study, judgement would still be required because of the natural variances that occur in ice formation, the unpredictability of increased river stages during the winter, and fish responses to these temporal and spatial changes. We believe there is sufficient evidence to show that it is unlikely that the Lower Doubles Lake partial closure and the Fish Lake peninsula restoration would provide sufficient habitat benefits to justify their costs.

Because the UMRS-EMP habitat project program is a relatively permanent authority the opportunity will exist to go back and reevaluate these features at a later date when post-project monitoring data for the recommended features becomes available. Post-project monitoring for the Tilmont Lake peninsula restoration should provide insight into the potential benefits of a similar structure at Fish Lake. Likewise, information concerning the effectiveness of the Upper Doubles Lake closure should provide insight into the potential benefits of a closure at Lower Doubles Lake.

Section 404(b)(1) Evaluation

Page 3-3 – Information concerning potential hydraulic effluent discharge points is contained in the evaluation. We do not believe estimating hydraulic retention times is of any value given that we will allow the contractor to use any combination of placement sites considered acceptable to the Government. We believe a better approach to insuring water quality protection is to provide an effluent limitation in the construction specifications that the contractor must meet. This would allow the contractor to design the containment facilities and his operation in manner suited to his dredging equipment. We will ask the Wisconsin DNR to provide input concerning acceptable effluent limitations depending on the nature of the discharge, e.g., directly into the receiving water or via overland flow through wetlands.

Page 3-4 – No response required.

Page 3-6 – This information is contained in the evaluation. The contractor will be required to dispose of the Gremore Lake channel material and the Tilmont Lake access dredging material in an upland site, most likely the same site used for the lake dredged material. Miscellaneous stripping material at the Black Slough, Upper Doubles Lake, and Tilmont Lake rock closures would be spread on the ground adjacent to the construction sites and seeded.

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary

101 S. Webster St.
Box 7921
Madison, Wisconsin 53707-7921
Telephone 608-266-2621
FAX 608-267-3579
TDD 608-267-6897

September 14, 2000

Colonel Kenneth Kasprisin
Dept. of the Army, St. Paul District, Corps of Engineers
Army Corps of Engineers Centre
190 Fifth Street East
St. Paul, MN 55101-1638

Colonel

Dear Colonel Kasprisin:

The Wisconsin Department of Natural Resources supports construction of the Ambrough Slough Habitat Rehabilitation and Enhancement Project, Pool 10, Upper Mississippi River. This project will be constructed under authority of the Environmental Management Plan as described by Section 509 of the Water Resources Development Act of 1999.

It is the Departments intent to serve as the non-Federal sponsor for the Gremore Lake features including operation and maintenance of these features. According to the Ambrough Slough Definite Project Report, dated March 2000, our share of the planning and construction costs for the Gremore Lake features will be $116,340 with projected annualized operation and maintenance costs of $3,881. The details of our responsibilities will be mutually agreed upon and documented in the Project Cooperators Agreement.

This project will greatly benefit a variety of Mississippi River fish and wildlife. I look forward to completion of the Ambrough Slough Habitat Rehabilitation and Enhancement Project and the benefits it will provide to the Upper Mississippi River System.

Sincerely,

George

Thank you for your consideration.

George E. Meyer
Secretary

c: William Hartwig, Regional Director, USFWS
Terry Moe, Wisconsin DNR, La Crosse
Gary Palesh, Corps of Engineers, St. Paul District.