UPPER MISSISSIPPI RIVER RESTORATION

ENVIRONMENTAL MANAGEMENT PROGRAM

POST-CONSTRUCTION

INITIAL PERFORMANCE EVALUATION REPORT

2012

FOR

SPRING LAKE

HABITAT REHABILITATION AND ENHANCEMENT PROJECT

US Army Corps
of Engineers ®
Rock Island District

POOL 13

RIVER MILES: 532-536

CARROLL COUNTY, ILLINOIS

ACKNOWLEDGEMENTS

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POINTS OF CONTACT

Many individuals of the Rock Island District, U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service contributed to the development of this Post-Construction Performance Evaluation for the Spring Lake Rehabilitation and Enhancement Project. These individuals are listed below:

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EXECUTIVE SUMMARY

General. The design of the Spring Lake Habitat and Restoration Project (HREP) was to provide the physical conditions necessary to improve and enhance wetland habitat quality. As stated in the Definite Project Report, the Spring Lake HREP was undertaken to address the following primary problems: increased sedimentation. These problems were contributing to the direct loss of vegetative habitat quality, leading to a decrease in migratory waterfowl use.

Purpose. The purposes of this Performance Evaluation Report (PER) are as follows:

1. Document the pre- and post-construction monitoring activities for the Spring Lake HREP.
2. Summarize and evaluate project performance on the basis of project goals and objectives as stated in the Definite Project Report (DPR).
3. Summarize project operation and maintenance efforts, to date.
4. Provide recommendations concerning future project performance evaluation.
5. Share lessons learned and provide recommendations concerning the planning and design of future HREP projects.

Project Goals and Objectives. The specific goals and objectives as stated in the DPR were to:

1. Enhance Aquatic Habitat
    a. Improve water quality for fish.
    b. Maintain backwater lake.
2. Enhance Wetland Habitat
    a. Provide reliable wetland vegetation/food source in Upper Lake for migratory birds.
    b. Provide reliable food source in Lower Lake for migratory birds and other wetland species.

Project Performance Monitoring. Pre- and post-project monitoring, both qualitative and quantitative, was performed in accordance with the Monitoring and Performance Evaluation Matrix from the original DPR. Monitoring and performance evaluation was conducted by the U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service. The period of data collection covered in this report includes the pre-project monitoring in 1987 and 1991, quantitative and qualitative post-project monitoring through 2012, and anecdotal information through 2012.

Evaluation of Project Objectives. For the evaluation period of 2002 to 2012, observations were made with regard to the efficacy of the objectives in meeting project goals. In addition, general conclusions were drawn regarding project measures that may affect future project design.

1. Enhance Aquatic Habitat
    a. Improve Water Quality for fish
        i. Evaluation Criteria: Dissolved Oxygen >5 mg/L at all times
        ii. General Observation: Dissolved oxygen (DO) concentrations often fell below 5 mg/L for short durations throughout summer months.

iii. Results: Average DO concentrations have not changed since pre-project, the number of samples below 5 mg/L has increased since pre-project conditions.
iv. Success: Project has not met target for DO concentrations (at or greater than 5 mg/L).
v. Conclusion: Project is unsuccessful at maintaining adequate DO concentrations.
vi. Lessons Learned & Recommendations: Future project management may require a change in inlet gate operation practices.

b. Maintain Backwater Lake
   i. Evaluation Criteria: Target of 0 linear feet of eroded levee
   ii. General Observation: No information could be obtained for the specified time period. However USFWS has completed significant rehab of levees in past few years.
   iii. Conclusion: Assume moderately successful in maintaining the backwater lake, based on repair work done by USFWS.
   iv. Lessons Learned & Recommendations: Levee profile data is needed to determine if evaluation criteria is being met.

2. Enhance Wetland Habitat
   a. Provide reliable food source in Upper Lake for migratory birds
      i. Evaluation Criteria: Target 500 acres of vegetation
      ii. General Observation: No information could be obtained for the specified time period.
      iii. Conclusion: Ancillary waterfowl data and site visits indicated moderate success.
      iv. Lessons Learned & Recommendations: Vegetation surveys are required to determine if evaluation criteria is being met.
   b. Provide reliable food source in Lower Lake for migratory birds
      i. Evaluation Criteria: Target of 108 acres of vegetation
      ii. General Observation: No information could be obtained for the specified time period.
      iii. Conclusion: Ancillary waterfowl data and site visits indicated moderate success.
      iv. Lessons Learned & Recommendations: Vegetation surveys are required to determine if evaluation criteria is being met.

Evaluation of Project Operation and Maintenance. The O&M manual was completed in July 2003. Periodic Maintenance is required on the levees, water control structures, pump house gated inlet structure, water well and shoreline protection. O&M cost through 2010 are approximately $703,000. Regular site inspections by the HREP Manager have resulted in proper coordination and corrective maintenance actions.

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POST-CONSTRUCTION
PERFORMANCE EVALUATION REPORT

2012

SPRING LAKE

HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 13
MISSISSIPPI RIVER MILES 532-563
CARROLL COUNTY, ILLINOIS

TABLE OF CONTENTS

FIGURES

TABLES

APPENDECIES

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POST-CONSTRUCTION
PERFORMANCE EVALUATION REPORT

2012

SPRING LAKE

HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13

MISSISSIPPI RIVER MILES 532-536

CARROLL COUNTY, ILLINOIS

INTRODUCTION

The Upper Mississippi River Restoration Environmental Management Program (UMRR-EMP) is a Federal-State partnership to manage, restore and monitor the UMR ecosystem. The UMRR-EMP was authorized by Congress in Section 1103 of the Water Resources Development Act of 1986 (Public Law 99-662) and reauthorized in 1999. Subsequent amendments have helped shape the two major components of EMP – the Habitat Rehabilitation and Enhancement Projects (HREPs) and Long Term Resource Monitoring (LTRM). Together, HREPs and LTRM are designed to improve the environmental health of the UMR and increase our understanding of its natural resources.

Habitat Rehabilitation and Enhancement Project (HREP) construction is one element of the UMRR-EMP. In general, the projects provide site-specific ecosystem restoration, and are intended and designed to counteract the adverse ecological effects of impoundment and river regulation through a variety of modifications, including flow introductions, modification of channel training structures, dredging, island construction, and water level management. Interagency, multi-disciplinary teams work together to plan and design these projects.

The Spring lake HREP is part of the UMRR-EMP. This project consisted of levee and dike restorations, installation of water control structures, a gated inlet structure, channel excavation, mechanical aerators and a hemi-marsh that were designed to enhance aquatic and wetland habitat.

1. Purpose of Project Evaluation Reports

The purposes of this Project Evaluation Report for the Spring Lake are to:

1. Document the pre- and post-construction monitoring activities for the Spring Lake HREP.
2. Summarize and evaluate project performance on the basis of project goals and objectives as stated in the Definite Project Report (DPR).
3. Summarize project operation and maintenance efforts, to date.
4. Provide recommendations concerning future project performance evaluation.
5. Share lessons learned and provide recommendations concerning the planning and design of future HREP projects.

2. Scope

This report summarizes available monitoring data, operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) information, and project observations made by the U.S. Army Corps of Engineers (USACE), U.S Fish and Wildlife Service (USFWS). The period of data collection covered in this report includes post-construction monitoring as of 2012.

3. Project References

Published reports which relate to the Spring Lake HREP are presented below.

1. Definite Project Report with Integrated Environmental Assessment, Spring Lake Habitat Rehabilitation and Enhancement Project, Rock Island District Corps of Engineers, May 1993.
2. Spring Lake HREP Operation and Maintenance Manual, Rock Island District Corps of Engineers, July 2003.
3. Spring Lake (Pool 13) HREP Annual Inspection Report, USFWS, November 2007.
4. Spring Lake (Pool 13) HREP Annual Inspection Report, USFWS, May 2008.
5. Spring Lake (Pool 13) HREP Annual Inspection Report, USFWS, May 2009.
6. Spring Lake (Pool 13) HREP Annual Inspection Report, USFWS, August 2010.

4. Project Location

The Spring Lake project is located in Carroll County, Illinois, on the left descending bank of the Mississippi River, between river miles 532 and 536 (Figure 1 – Spring Creek HREP project area). The project is operated by the Upper Mississippi River National Wildlife and Fish Refuge, U.S. Fish and Wildlife Service. Spring Lake, a 3,300-acre lake and backwater complex delineated by the natural riverbank and perimeter levee, is located approximately two miles south of Savanna, Illinois.

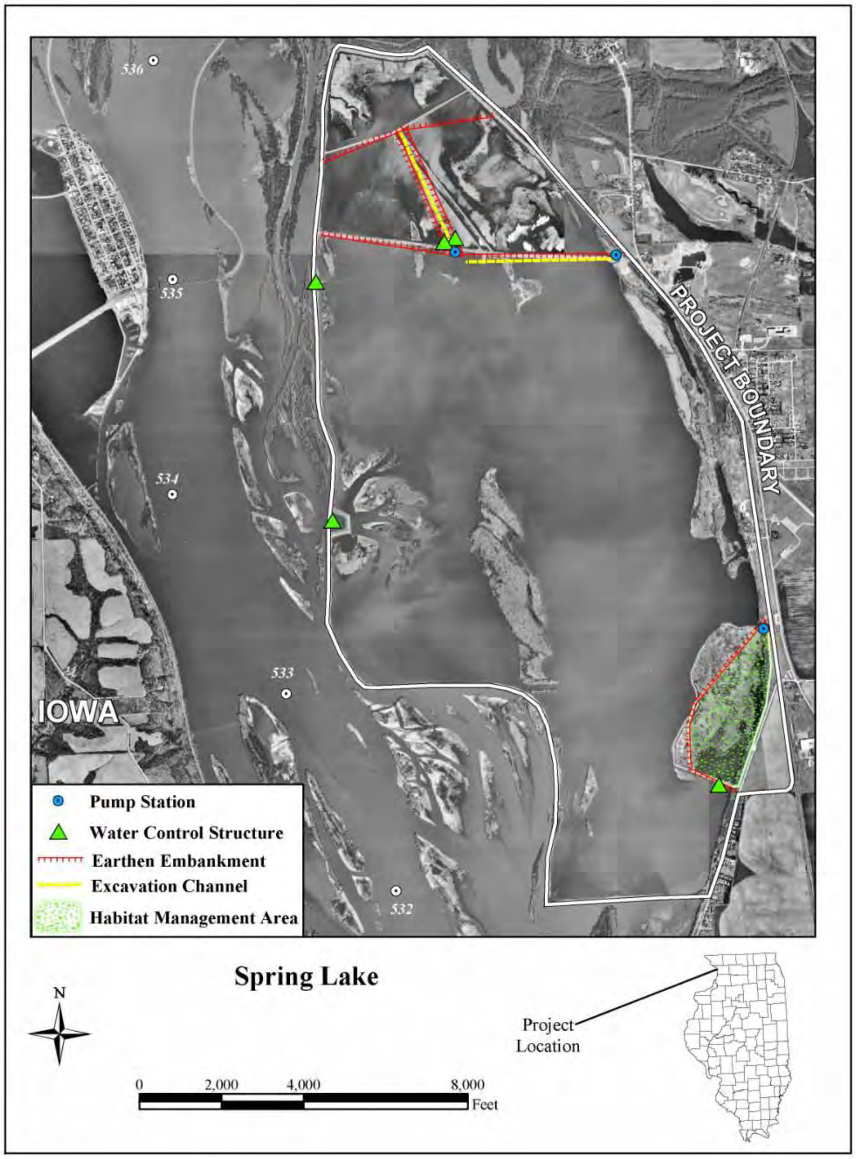

Figure 1. Spring Lake HREP project area

PROJECT PURPOSE

1. Overview

The design of the Spring Lake HREP was to provide the physical conditions necessary to improve and enhance wetland habitat quality. The specific goals as stated in the Definite Project Report (DPR) were to enhance aquatic and wetland habitats. In order to achieve these goals, the rate of sedimentation at the site needed to be addressed. This problem was contributing to the direct loss of direct loss of vegetative habitat quality, leading to a decrease in migratory waterfowl use. The problems, opportunities, goal, objectives and measures implemented to address the goals and objectives are listed in Table 1.

Table 1. Problems, opportunities, goals, objectives, and measures

PROBLEMS	GOALS	OBJECTIVES	RESTORATION MEASURES
Sedimentation	Enhance Wetland Habitat	Provide reliable food source in Upper Lake for migratory birds	Levee Restoration Upper Lake water control
		Provide reliable food source in Lower Lake for migratory birds	Hemi-marsh Lower Lake water control
	Enhance Aquatic Habitat	Improve water quality for fish	Levee & dike restoration Water control structures
		Maintain backwater lake	Gated inlet structure Excavated channel Upper/Lower Lake water control

2. Management Plan

No formalized management plan has been developed for this project.

PROJECT DESCRIPTION

1. Project Measures

The Spring Lake HREP included a combination of water control improvements; levee/dike restoration and construction of a hemi-marsh (see Figure 1 for locations of measures). A detailed description of each of these measures is provided below.

1. Perimeter Levee. The existing perimeter levee built after WWI was raised and strengthened by excavating and placing adjacent borrow soil along the existing levee embankment. The levee top was restored to the 50-year flood design elevation of 595.0 feet MSL at the upper end of the project and sloping to 593.0 feet MSL at the lower end. A 12-foot top width and 1V:4H side slopes ensure adequate levee stability. Along portions of the levee, where a higher percentage of sand was found in the borrow materials, the levee cross section was modified from a 1V:4H to a 1V:5H.

2. Cross Dike. The existing cross dike built after WWI was raised and strengthened by excavating and placing adjacent soil along the levee embankment. The levee top

was raised to the elevation of 590.0 feet MSL to increase protection against floodwater damage to the Upper Lake. Two overflow sections along the cross dike, depressed to an elevation of 588.75 feet MSL, will help minimize overtopping damage to the cross dike and help equalize pressure effects along the dike and levees prior to flooding, while allowing vehicular access to the pump station and the lower perimeter levee.

3. <u>Pump Station.</u> A new, two-way pump station was installed in the cross dike to fill and empty the Upper Lake. The pumps, manufactured by Flygt Corp.®, are sized to fill the Upper Lake in approximately 30 days and empty it in 25 days. The pump station has two identical pumps that pump in opposite directions. This provides the capability to de-water the Upper Lake during draw-down periods and to pump water from the Lower Lake into the Upper Lake during desired inundation periods. An electrical lock-out prevents the pumps from being operated simultaneously. The rated capacity of each pump is 5200 gallon per minute at 8.5 feet of TDH. The pump station is turned on manually and will operate automatically until turned off. An underground electric cable in the cross dike supplies 480 volt, three phase power.

   The pump station is furnished with a trash rack on both the Upper Lake side and the Lower Lake side due to the dual pumping capacity as described. A mechanically excavated inlet channel on the Lower Lake side reduces sediment flow into the pump station forebay. Additionally, a radius section directly in front of the pump station inlet was over-excavated to inhibit vegetative growth in this area.

   The pump station includes a 3-foot by 3-foot sluice gate to allow for gravity flows. The gate is operated with an electrically driven motor. The gate may be used any time the desired flow occurs by gravity, saving wear on the pumps and reducing operating costs. Both pumps and the gate are located within the durable concrete pump station building. A 7-foot chain-link perimeter fence with a barbed wire crown surrounds the building to discourage vandalism.

4. <u>Interior Levees.</u> Three independent cells of the Upper Lake are separated by low-level interior levees, built to the elevation of 587.0 feet MSL, with 1H:3V side slopes. Excavating and creating two separate levees between Cells B and C provide a water feeder channel from Cell A to the Lower Lake. Both Cell A and Cell B levees have a 10-foot top width. The Cell C levee has a 12-foot top width and a 10-foot wide granular roadway to allow access to the Cell A stoplog structure.

5. Stoplog Structures. Four stoplog structures are utilized throughout the project to control water levels. All structures are the same type, consisting of a concrete sill and abutments that incorporate stoplog channels. The structures are used to control water levels in Cells A, B, and C and the Hemi-marsh by inserting or removing the stoplogs. Heavy duty, removable grating is provided to allow removal of debris from the structure and vehicular access across the structures.

6. Gated Inlet Structure. A gated inlet structure allows river water to enter the Lower Lake to increase dissolved oxygen concentrations during periods of low flow. The structure consists of two 5-foot by 5-foot gated box culverts capable of passing 175 cubic feet per second, at typical low-flow river elevations.

   The 60-inch by 60-inch vertical sluice gates are raised and lowered by pedestal lifts located on the top of the structure. Each lift is equipped with an indicator to indicate the position of the gates. These lifts may be operated by a hand crank or by a portable engine operator. Each gatewell is furnished with an integral ladder and covered with removable grating to allow access to the gates and gate stems. The grating is equipped with a locking mechanism to prevent unauthorized entry into the gatewells. A 7-foot chain-link perimeter fence with barbed-wire crown surrounds the entire structure to discourage vandalism and unauthorized operation.

7. Gatewell Structure. A 24-inch concrete gatewell structure provides extra management capability to provide oxygenated water to the southwest region of the Lower Lake. The structure was sized to be small enough to operate easily and large enough to not pose a chronic maintenance problem. The structure has a single 24-inch diameter vertical sluice gate, invert elevation of 580.0 feet MSL, operated by a pedestal lift located on top of the structure. This lift may be operated by a hand crank or by a portable engine operator. Access to the gate and gate stem is provided through a manhole on top of the structure. A lockable manhole cover prevents unauthorized entry.

8. Hemi-Marsh. This project feature is approximately 130-acres of low water level marsh located on the eastern edge of the Lower Lake. A low-level perimeter levee separates the hemi-marsh from the rest of the Lower Lake. A levee top elevation of 586.0 feet MSL was chosen based on the need to pond 2 feet of water in the hemi-marsh for maintaining the created habitat. An 1170-gallon per minute well was installed at the northeast corner of the hemi-marsh to aid in filling the feature, particularly during periods of low precipitation and low river elevations. The well is

provided with a vandal-resistant cover and pipe bollards to prevent damage by vehicles. A riprap channel at the discharge end prevents erosion of the surrounding ground.

2. Project Construction

The Spring Lake HREP project was approved for construction in January 1995 at an estimated cost of $5,175,188 (equivalent to $6,706,605 in FY10). Stage 1 was the main contract, which included levee/dike restoration, structure and water control. Stage II consisted of construction of the Hemi-Marsh water well. Stage III work included modifications to various structures in the project. The perimeter levee cross section was adjusted from 1V:4H to 1V:5H due to a higher percentage of sand in borrow materials. Flooding in 1997 caused damage to 500 feet of Cell B levee. The original stoplogs were determined to be inadequate, and were modified by eliminated the wooden end seals and bottom seals and replacing them with rubber seals. Briefly describe any modifications to construction and cost of the modifications. A scour hole at the setback levee necessitated the realignment of the setback levee to minimize fill requirements. The revised setback levee was given a rock core.

3. Project Operation and Maintenance

General. In the original DPR it was estimated that the Spring Lake HREP would require little or no maintenance. Operation and maintenance responsibilities for the Spring Lake HREP were originally outlined in the DPR. The acceptance of these responsibilities was formally recognized by an agreement signed by the USFWS and the Rock Island District, USACE.

A detailed description of all operation and maintenance requirements can be found in the Project Operation, Maintenance, Repair, Replacement, and Rehabilitation Manual (OMRR&R Manual). The OMRR&R Manual for the project delegated responsibilities and procedures for post project activities. Project operation and maintenance generally consists of the following:

1. Inspection of levees and cross dike prior to and during inundation periods, immediately following high water periods, and annually.
2. Emergency filling prior to high-water events.
3. Addition or removal of stoplogs in Stoplog Structures as required to maintain desired water levels in impoundment areas.
4. Inspection of Stoplog Structures immediately following drainage of the impoundment areas and after high water event for damage and seepage. Conduct periodic inspections of Stoplog Structure. Conduct corrective action activities based on inspections.
5. Manipulating pumps at pumps station based on Mississippi River, Upper Lake and Lower Lake elevations.
6. Inspect pump station immediately after high-water event, conduct periodic inspections. Conduct corrective action activities based on inspections.

7. Manually open sluice gates to allow river water to enter Lower Lake. Close gates as river flow increases.
8. Inspection of Gated Inlet Stricture and Gatewell Structure immediately following drainage of the impoundment areas and after high water event for damage and seepage. Conduct periodic inspections of Gated Inlet Structure and Gatewell Structure. Conduct corrective action activities based on inspections.
9. Manually activate water well pump to inundate Hemi-Marsh.
10. Conduct well inspections and corrective action to correct adverse conditions.

Project Measures Requiring Operation and Maintenance. Maintenance of the project measures was to be completed on an as needed basis to maintain their structural integrity and continued function in the manner for which they were designed. One area of concern is erosion on the west leg of Perimeter Levee. The erosion is located at the base of the levee and is associated with a scour hole (20 to 25 feet deep) and high current velocities.

PROJECT PERFORMANCE MONITORING

1. General

Performance monitoring of the Spring Lake HREP has been conducted by USACE to help determine the extent to which the design meets the habitat improvement objectives. Information from this monitoring will also be used, if required, for adaptive management.

The monitoring and performance evaluation matrix is outlined in Table 2. Pre- and post-project monitoring, both qualitative and quantitative by each of the involved agencies is summarized below.

1. U.S. Army Corps of Engineers: The success of the project relative to original project objectives shall be measured utilizing data, field observations, and project inspections provided by USFWS, and USACE. The Corps of Engineers was responsible for post-project analyses of water quality, sedimentation, vegetation, and the levee system. The Corps of Engineers has overall responsibility to measure and document project performance.
2. U.S. Fish and Wildlife Service: The USFWS is responsible for operating and maintaining the Spring Lake HREP. USFWS was responsible for post-project annual field inspections.

Table 2. Monitoring and Performance Evaluation Matrix

Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source	Remarks
Sedimentation Problem Analysis	System-wide problem definition. Evaluates planning assumptions	USFWS	USFWS (EMTC)	LTRMP	Leads into pre-project monitoring; defines desired conditions for plan formulation
Pre-project monitoring	Identifies and defines problems at HREP site. Established need for proposed project feature	Sponsor	Sponsor	Sponsor	Attempts to begin defining baseline. See DPR.
Baseline monitoring	Establishes baselines for performance evaluation	USACE	Field station or sponsor thru Cooperative Agreements or Corps	LTRMP	See DPR for location and sites for data collection and baseline information. Actual data collection will be accomplished during Plans & Specification phase.
Data Collection for Design	Includes identification of project objectives, design of project, and development of performance evaluation plan	USACE	USACE	HREP	Comes after fact sheet. This data aids in defining the baseline
Construction Monitoring	Assesses construction impacts; assess permit conditions are met	USACE	USACE	HREP	Environmental protection specifications to be included in construction contract documents. Inter-agency field inspections will be accomplished during project construction phase
Performance Evaluation Monitoring	Determine success of project as related to objectives	USACE (quantitative), sponsor (field observations)	Field station or sponsor thru Cooperative Agreements or Corps	LTRMP Cooperative	Comes after construction phase of project
Analysis of Biological Responses to Project	Evaluates predictions and assumptions of habitat unit analysis. Determine critical impact levels, cause-effect relationships, and effect on long-term losses of significant habitat	USFWS	USFWS (EMTC)	LTRMP	Problem Analysis and Trend Analysis studies of habitat projects

2. Project-Induced Habitat Changes

Spring Lake habitat conditions have experienced some changes since the pre-project monitoring. Vegetation growth has been successful and waterfowl use has appeared to increase, although quantitative assessments have not been conducted. Average dissolved oxygen concentrations have not changed significantly from pre project concentrations. The number of samples with dissolved concentrations *less* than 5 mg/L has increased since pre-project conditions.

PROJECT EVALUATION

1. Construction and Engineering

Construction began in February 1999 and was initially completed in January 2002. Final construction was completed in August 2002.

Stage III, a structural modifications contract, was awarded on September 8, 2000 to Del-Jen under the Regional Job Order Contract. This contract consisted of minor modifications to the structures built during Stage I, to make them better adapted, for easy use by Refuge personnel.

2. Costs

In the original DPR, cost estimates for the entirety of the project were $5,243,000. Initial construction costs were $4,651,000. As of the 2003 Operation and Maintenance Manual, the total cost of the Spring Lake HREP was $6,645,775.17.

3. Operation and Maintenance

In the original DPR, over the 50-year project life the estimated cost was $1,654,700. From the estimate, an average annual operation and maintenance cost was calculated to be $33,094. This amount included inspections, mowing, burning, rock replacement, stoplog operation, pump station operation, well pump operation and maintenance, gated inlet structure and gatewell structure operation and maintenance and debris removal from the trash rack. As of 2009, the total OMRR&R cost has been $703,108, with the estimated average annual cost to be $100,500. Table 3 provides OMRR&R history and cost for the Spring Lake HREP.

<u>History of Major Disturbances.</u> Major disturbances include significant flooding in 1997, 2001, and 2008. Damage from the 2001 flood required rerouting of the entrance road and the addition of the west Cross Dike spillway. In 2004 lighting struck the Sloan Marsh pump, requiring approximately $22,500 in repairs. The 2008 flooding damages the Perimeter Levee at STA 230+00, STA 234 and the entrance road spillway. Repairs for the 2008 flood included repairing 120 feet of the Perimeter Levee and protecting 780 feet of it for a total of $434,200.

In 2012 Levee A was completely rebuilt and armored with riprap. Areas along the east perimeter levee and cross dike were repaired, and the Hemi-Marsh levee was repaired and armored with riprap.

Table 3. Operation and Maintenance History for the Spring Lake HREP through FY2009

Year	Years in O&M	Est. Annual Cost with Inflation	Actual USFWS Costs	Activities
FY2003	1	$43,416	$83,577	2001 Flood repairs
FY2004	2	$44,488	$8,733	Pump Repair
FY2005	3	$4,6104	$38,138	Pump Repair
FY2006	4	$47,579	$17,421	Normal operations
FY2007	5	$49,006	$227,267	Cells dewatered, Dike B regraded
FY2008	6	$50,917	$9,592	Riprap Dike B
FY2009	7	$50,616	$308,400	Spillway/levee repairs

4. Ecological Effectiveness

A. Improve Water Quality for Fish

General. The gated inlet structure was constructed in the Lower Lake to allow oxygenated water into the lake during periods when low dissolved oxygen (DO) concentrations are present, thereby improving water quality. The ability to distribute oxygenated water throughout the lake, especially during periods of ice cover, is essential for the prevention of fish kills. The target DO concentration is > 5 mg/L.

Pre- and Post-Project Conditions. Pre-project aquatic habitat was negatively affected as the shallow water conditions and low flows in the Upper and Lower Lakes generated poor dissolved oxygen levels.

Baseline DO and sediment monitoring was conducted in 1987 and 1991. The monitoring indicated that while DO concentrations are adequate most times of the year to support native fisheries, during the winter months the DO concentrations fall to undesirable levels (<4 mg/L).

Dissolved oxygen and related parameter data (water temperature, DO, pH, turbidity, total suspended solids (TSS), phosphorus, nitrogen, nitrate, chlorophyll and soluble reactive phosphorus) was collected from three sampling points (W-M532.6Q, W-M534.8R, and W-M534.6V). Samples were collected by the use of in-situ continuous monitors and grab sampling. Data from December 2002 through March 2012 was utilized for this report. In addition a dye tracer study was conducted in February 2005 to determine how oxygenated water disperses through the lake when ice cover is present. Further detail is included in Appendix A, Water Quality Assessment.

Conclusion. The project measures were unsuccessful in providing the ability to meet the target DO concentration of 5 mg/L. This was evident particularly during the summer months; however, extended periods of low DO concentrations were observed in both the summer and winter months. The DO concentration during the summer months often fell below 5 mg/l; however, most of these excursions were short-lived. Only occasionally would DO remain below 5 mg/l for more than two consecutive days. The gated inlet structure could be utilized during the summer months; however, close monitoring would be required in order to keep undesirable amounts of sediment from entering the lake.

The dye tracer study was conducted for the purpose of determining how oxygenated water entering Spring Lake via the gated inlet structure disperses throughout the lake when ice cover is present with a gate opening of 3 feet. A similar study was performed during February 2002 with a gate opening of 10 inches, and the results of that study suggested that a larger gate opening would allow for a more rapid dispersion of oxygenated water throughout the lake. With a larger gate opening in 2005, inflowing water dispersed throughout Spring Lake faster and more completely than was observed during the 2002 study. Dye was eventually detected on the west side of Silo Island in the 2005 study, but it was not detected at the sites at the south end of the lake in either 2002 or 2005. One purpose of the study was to determine if an increase in water velocity caused by a larger gate opening would adversely impact over-wintering centrarchids, which prefer areas with little or no velocity. Movement of radio-tagged centrarchids (black crappies and a bluegill) indicated the fish were not adversely impacted by the increased gate opening. The 0.29 cm/s increase in velocity in the vicinity where most of the fish were located throughout the study was apparently not sufficient to cause the fish to disperse from the area.

Comparisons of pre- and post-project DO data from surface samples collected at sites W-M532.6Q, W-M534.8R and W-M534.6V are summarized in Table D-5. The average DO concentration at sites M532.6Q and W-M534.6V during the post-project period was lower than that for the pre-project period. However, in the post-project period since December 2002, the average DO concentration was greater than the average for the post-project period prior to December 2002 at all three sites. In addition, the average DO concentration at site W-M534.8R for December 2002 – March 2012 was greater than pre-project conditions. Due to the short time frame of the two study periods, the value of making statistical comparisons is somewhat limited. One factor that probably resulted in the lower post-project average DO concentrations was closure of the breach in the perimeter levee. Pre-project data were gathered while the breach still existed. A significant volume of oxygenated water entered the lake through the breach, along with an undesirable sediment load; thus, it was essential that the breach be closed. The gated inlet structure was designed to allow oxygenated water into the lake during periods when the suspended sediment load of the river is relatively low (primarily winter months). Results from this performance evaluation indicate that a larger gate opening may be necessary in order to prevent fish kills during winters when particularly adverse conditions (early onset of snow-covered ice) occur. A 20-inch gate opening during the winter of 2010-2011 did not allow for adequate DO concentrations in the southern portion of the lake. The results from the 2005 dye tracer study suggest that if a 36-inch gate opening would have been utilized during this winter, the low DO concentrations measured at sites W-M 532.3T and W-M532.6Q would likely not have occurred. Opening the gate sooner may also help prevent fish kills, but this would increase the likelihood of undesirable sediment entering the lake.

Water quality monitoring at the current locations and schedules is recommended.

B. Maintain Backwater Lake

General. The perimeter and interior levees were constructed to provide a level of protection from floodwaters and subsequent sedimentation. The levee top was restored to the 50 year design elevation with a 12 foot top width. The 50 year target for linear feet of eroded levee is 0 feet.

Pre- and Post-Project Conditions. Pre-project eroded levee was 44,800 linear feet. Historically, Spring Lake was a highly productive and heavily used feeding and resting area for migratory waterfowl. The perimeter levee failed during a 1965 flooding event. Over time the breach of the levee remained open, causing deposition of sediments and a gradual decline in the quality and availability of aquatic vegetation. The breach in the levee prevented proper maintenance of the perimeter levee system and allowed sediment accumulation to occur during each subsequent flood event.

Since completion of levees, maintenance has been an issue due to muskrat burrowing. In addition, flooding in 2001 and 2008 caused significant damage. Severe animal burrowing and sinkholes were observed on the levees in 2002, 2007, 2008, 2009 and 2010. Site visits were conducted by USACE and USFWS personnel in 2011 and 2012. These visits observed persistent beaver dams by two of the gatewells, and an area on Perimeter Levee with erosion and a scour hole. A copy of the 2011/2012 Trip Report is included in Appendix B. Levee B was reshaped in 2007, Levee A was rebuilt in 2012, and Levee C rebuilding is proposed for 2013.

Sediment transects were completed by the USACE in April 2012. As no previous levee cross sections or sediment transects had been completed prior to 2012, no comparisons or assessment of levee erosion can be made. The transects and a copy of a set of as-constructed plans are included in Appendix C.

Conclusion. No quantitative assessment can be made regarding the success of reaching the project in meeting the objective. Levee cross sections will be needed to determine erosion of the Perimeter Levee and interior levees. However, based on the ongoing maintenance and major repairs, and replacement of flood and animal damaged segments of the levees, it can be assumed that the project has been moderately successful in keeping the levees at the design elevations and slopes.

Current management activities by the USFWS appear to be moderately successful at maintaining levee integrity and combating animal burrowing.

A survey of levee elevations should be completed prior to the next PER (2017) in order for profiles and cross sections to be generated. A qualitative assessment of levee erosion can then be conducted.

C. Provide reliable food source in Upper Lake for migratory birds

General. One of the specific project objectives for the Spring Lake HREP was to provide a reliable food source in the Upper Lake. The levees, cross dike, and water control structures were installed to increase the acres of vegetation from 0 to 500 by Year 50.

Pre- and Post-Project Conditions. Pre-project conditions consisted of deposition of sediments into Spring Lake and a gradual decline in the quality and availability of aquatic vegetation. The area also underwent an invasion of woody vegetation and undesirable aquatic plants that were not acceptable to waterfowl. Waterfowl use in the Upper Lake clearly diminished because of the reduction in the water quality and the quantity of preferred food plant species.

Vegetation is present but no information has been collected on the amount or quality of the vegetation.

Conclusion. The success of the biological response of Spring Lake is difficult to determine as collection of data from all prescribed monitoring has not been performed. The response of vegetation in Spring Lake has only been noted through general observations. No sampling of the vegetation transects within Upper Spring Lake, Lower Spring Lake, or the Hemi-marsh has been performed. Vegetation is present but no information has been collected on the amount or quality of the vegetation. Without vegetation monitoring it is difficult to fully evaluate the biological response of the project and determine if the project is in line with project goals.

Although project success is relation to amount vegetation and reliable food sources for migratory birds is difficult to determine. The amount of migratory bird use may indirectly indicate that potential food sources are available within the project. The US Fish and Wildlife Service has performed fall flight surveys, which can help estimate and describe general trends of waterfowl use on in the project area (Appendix D).

D. Provide reliable food source in Lower Lake for migratory birds

General. One of the specific project objectives for the Spring Lake HREP was to provide a reliable food source in the Upper Lake. The levees, cross dike, and water control structures were installed to increase the acres of vegetation from 0 to 108 by Year 50.

Pre- and Post-Project Conditions. Pre-project conditions consisted of deposition of sediments into Spring Lake and a gradual decline in the quality and availability of aquatic vegetation. The area also underwent an invasion of woody vegetation and undesirable aquatic plants that were not acceptable to waterfowl.

Vegetation is present but no information has been collected on the amount or quality of the vegetation.

Conclusion. The success of the biological response of Spring Lake is difficult to determine as collection of data from all prescribed monitoring has not been performed. The response of vegetation in Spring Lake has only been noted through general observations. No sampling of the vegetation transects within Upper Spring Lake, Lower Spring Lake, or the Hemi-marsh has been performed. Vegetation is present but no information has been collected on the amount or quality of the vegetation. Without vegetation monitoring it is difficult to fully evaluate the biological response of the project and determine if the project is in line with project goals.

Although project success is relation to amount vegetation and reliable food sources for migratory birds is difficult to determine. The amount of migratory bird use may indirectly indicate that potential food sources are available within the project. The US Fish and Wildlife Service has performed fall flight surveys, which can help estimate and describe general trends of waterfowl use on in the project area (Appendix D).

Table 4 summarizes the performance evaluation plan and schedule for Spring Lake HREP goals and objectives.

Table 4. Performance Evaluation and Monitoring Schedule

Goal	Objective	Enhancement Measure	Units	Monitoring Target Values			Monitoring Schedule
				Year 0 without project	Year 13 with project	Year 50 target with project	
Enhance Aquatic Habitat	Improve water quality for fish	Levee & Dike restoration Water control structures	Dissolved Oxygen (mg/L)	<5.0 during critical periods	>5.0 at all times	>5.0 at all times	April-September every 2 weeks, October-March every month
	Maintain backwater lake	Gated inlet structure Excavated channel Upper/Lower Lake water control	Lineal Feet of Eroded Levee	44,800	0	0	Every 5 years
Enhance Wetland Habitat	Provide reliable food source in Upper Lake for migratory birds	Levee restoration Upper Lake water control	Acres of Vegetation	0	500	500	Every 5 years
	Provide reliable food source in Lower Lake for migratory birds	Hemi-Marsh Lower Lake water control	Acres of Vegetation	0	108	108	Every 5 years

LESSONS LEARNED AND RECOMMENDATIONS FOR FUTURE SIMILAR PROJECTS

The goals and objectives set for in the DPR have been somewhat achieved. Water quality target levels have not been met. Dissolved oxygen continues to remain below the 5 mg/L target level in summer and winter months. A complete assessment on the remaining objectives (maintaining backwater lake, reliable food sources in Upper and Lower Lakes) cannot be conducted as field data has not been gathered since project completion. Ancillary data indicates that these objectives are being achieved for the most part.

Obstacles hindering success include determination of best management practices for the gated inlet structure that would allow for greater dissolved oxygen influx and dispersion; the persistent muskrat and beaver populations casing damage to the structures, and erosion/scour control. Efforts by the USFWS have made headway in dealing with the later two issues.

REFERENCES

U.S. Army Corps of Engineers: Upper Mississippi River System Environmental Management Program, Definite Project Report (R-12F) with Integrated Environmental Assessment, Spring Lake Rehabilitation and Enhancement; Rock Island District, Rock Island, IL., May 1993.

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U.S. Fish and Wildlife Service: Spring Lake HREP, 2010 Annual Inspection Report; Upper Mississippi River National Wildlife and Fish Refuge, Winona, MN., August 2010.

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U.S. Fish and Wildlife Service: Spring Lake HREP, 2008 Annual Inspection Report; Upper Mississippi River National Wildlife and Fish Refuge, Winona, MN., May 2008.

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APPENDIX A

Water Quality Assessment

Spring Lake Performance Evaluation Report, March 2012

Goal – Enhance Aquatic Habitat

Objective – Improve Water Quality for Fish

Enhancement Feature – Inlet Structure/Excavated Channel

(1) Overview. A gated inlet was constructed in Lower Spring Lake for the purpose of allowing oxygenated water into the lake during periods when low dissolved oxygen (DO) concentrations are present. The ability to distribute oxygenated water throughout the lake, especially during periods of ice cover, is essential for the prevention of fish kills. The water quality objective of the Spring Lake project is to improve water quality for fish by maintaining a minimum DO concentration. The Year 50 Target of the project is to maintain a DO concentration greater than 5 mg/l at all times. In order to determine the effectiveness of the project in attaining this goal, post-project water quality monitoring commenced on December 17, 1998 at three sites: W-M532.6Q, W-M534.8R and W-M534.6V (see Plate 3 in Appendix C for site locations). This monitoring was performed by COE personnel. Samples were also collected at site W-M532.3T by IDNR personnel as part of the LTRM program. This report discusses post-project data collected December 2002 through March 2012 by Corps personnel and 2002 through 2011 by IDNR personnel. The results from a special dye tracer study performed by COE personnel during February 2005 are also discussed. Previously collected data and studies were discussed in the March 2004 Initial PER.

(2) Monitoring. COE data were obtained through a combination of periodic grab samples and the use of *in-situ* continuous monitors. Grab samples were collected just below the surface on 66, 65 and 42 occasions, respectively, at sites W-M532.6Q, W-M534.8R and W-M534.6V. The three sites were usually visited about twice per month from June through September and two to four times from December through March. Samples were obtained from December 2002 to September 2006 and June 2010 to March 2012; however, site W-M534.6V was discontinued following September 2006 due to dense aquatic vegetation at the site. Samples were not collected during 2007 through 2009 due to the cyclical nature of the District's EMP monitoring program. Sampling was usually not performed during April, May, October and November. The following variables were typically measured: water depth, velocity, wave height, air and water temperature, cloud cover, wind speed and direction, DO, pH, total alkalinity, specific conductance, Secchi disk depth, turbidity, total suspended solids (TSS), chlorophyll (a, b and c) and pheophytin a. IDNR personnel collected grab samples on 130 occasions at site W-M532.3T. Sampling was performed approximately one to two times per month from 2002 to 2011; however, no data were collected from October 2002 – April 2003, and only limited data were collected from April 2003 – December 2003. The following variables were typically measured: water temperature, DO, pH, turbidity, total suspended solids (TSS), phosphorus, nitrogen, nitrate, chlorophyll and soluble reactive phosphorus.

In-situ water quality monitors (YSI model 6000, YSI model 6600, or Hach DS5X sondes) were deployed by COE personnel on 51 occasions at site W-M532.6Q. The sonde was positioned 2 to 4 feet above the bottom during each deployment. Deployments were typically for a period of two weeks during the summer months and four to eight weeks during the winter months. The sonde was normally equipped to measure DO, temperature, pH, specific conductance, depth and turbidity.

The results from water quality monitoring at all sites are found in Appendix D. Table D-1 gives the monitoring results from grab samples collected at site W-M532.6Q. This site is located in a channel, nearly two miles downstream from the gated inlet structure. DO concentrations here ranged from 1.25 mg/l – 23.05 mg/l. Fifteen DO measurements were less than or equal to 5 mg/l, with one of these occurring during the winter months (4.56 mg/l on February 7, 2011). The monitoring results from grab samples collected at site W-M534.8R are found in Table D-2. This site is located in the main basin of the lake, about one-half mile east of the gated inlet structure. DO concentrations here ranged from 2.51 mg/l – 23.34 mg/l. Twelve DO measurements were less than or equal to 5 mg/l, with none of these occurring during the winter months. Table D-3 shows the monitoring results from grab samples collected at site W-M534.6V. This site, located in a shallow area dominated by American lotus, is nearly 1.5 miles east of the gated inlet structure. DO concentrations here ranged from 1.33 mg/l – 23.20 mg/l. Seven DO measurements were less than or equal to 5 mg/l, with none of these occurring during the winter months. The monitoring results from grab samples collected by IADNR personnel at site W-M532.3T are found in Table D-4. This site is located in an open area of the lake, about three miles southeast of the gated inlet structure. DO concentrations here ranged from 1.7 mg/l – 20.0 mg/l. The DO concentration was less than or equal to 5 mg/l ten times at this location with one of these occurring during the winter months (4.0 mg/l on January 10, 2011).

The low DO readings typically occurred in late July and/or August, particularly during 2003, 2006, 2010, and 2011. These readings are likely due primarily to oxygen demand created by algal respiration and/or decomposition in the lake during the summer months. Of the 44 DO measurements which were less than or equal to 5 mg/l, 20 occurred during the summer of 2006. The activity log for the gated inlet structure shows that it remained closed throughout this period. An algal bloom was noted at sites W-M534.6V and W-M534.8R on the June 6, 2006 site visit. The grab sample DO concentration was 4.82 mg/l on June 20, 2006 at site W-M534.8R, and it was 4.05 mg/l on July 5, 2006 at site W-M534.6V. From mid-July through mid-September 2006, DO concentrations of less than 5 mg/l were measured in all of the grab samples taken at all four sampling locations.

Of the 44 DO measurements which were less than or equal to 5 mg/l, only two occurred during the winter months, both of which were measured during the winter of 2010-2011. On December 27, 2010, the gate to the inlet structure was opened 20 inches, but apparently this was not sufficient to prevent low DO concentrations at sites W-M532.3T and W-M532.6Q, which are located in the southern portion of the lake. A concentration of 4.0 mg/l was measured by

IADNR personnel on January 10, 2011 at site W-M532.3T. The results from a dye study performed in 2005 (to be discussed later) would suggest that at a gate opening of 20 inches (roughly half of the 3 feet of opening used for the dye study), inflowing oxygenated water probably did not reach site W-M532.3T by the January 10, 2011 sampling date, 14 days after gate opening. (Dye was not detected at the sites nearest site W-M532.3T during the dye study, which lasted 13 days.) COE personnel did not collect grab samples on this sampling date; however, an in-situ continuous monitor deployed on December 9, 2010 at site W-M532.6Q also measured DO concentrations below 5 mg/l on January 10, 2011. The results from this deployment and the following deployment on February 7, 2011 (to be discussed in detail later) showed an extended period of low DO concentrations.

Concentrations of 4.56 mg/l at the water surface and 0.73 mg/l at the depth of the in-situ continuous monitor were measured on February 7, 2011 at site W-M532.6Q. This site is located near vegetation beds at the southeast tip of Silo Island. The dye study results showed that dye was detected near this site in both 2002 and 2005 (see Figure D-9), but it is possible that vegetation or bathymetry inhibited flow from reaching site W-M532.6Q itself. When sufficient light is present, algal photosynthesis can contribute to increasing DO concentrations, but on the sampling date, the site was covered by an 11-inch thick ice layer topped by 15 inches of snow. According to the National Weather Service observation station at Moline, IL, the average high temperature during December 2010 was 29°F and 17 inches of snow fell that month. The below-normal cold and above-normal snowy conditions continued through early February; thus, the site remained covered for most of the winter. Algal photosynthesis was probably limited, along with DO production at site W-M532.6Q. The DO concentration at site W-M534.8R on the sampling date was 11.47 mg/l. Site W-M534.8R is located in an open area just east of the gated inlet structure that is relatively devoid of vegetation. It is near a deep hole where the 2005 dye study indicated overwintering fish congregate. According to Ed Britton, District Manager for the Savanna District of the Upper Mississippi River National Wildlife and Fish Refuge, no fish kills were observed during the winter of 2010-2011 despite the low dissolved oxygen measurements in the southern part of the lake. It seems that the gate opening provided enough oxygen for overwintering habitat, such as the deep hole, that the fish were able to avoid the oxygen-deprived areas.

In-situ continuous monitors were deployed at site W-M532.6Q on eleven occasions during the winter months. The monitors deployed on February 3, 2004 and December 13, 2005 did not contain any useable data; however, DO readings taken in the field at the time of deployment and retrieval indicated concentrations well above 5 mg/l. As discussed previously, an extended period of low DO concentrations were measured from late December 2010 through mid-February 2011 (see Figures D-1 and D-2). The DO concentration was below 5 mg/l for 39 consecutive days in December and January and again for 15 consecutive days in February. In fact, near anoxic conditions were observed for much of the low period. Although the beginning of the February 7, 2011 deployment erroneously indicates negative DO concentrations, these values were most likely very low, if pH values and the remainder of the deployment are taken into consideration. The DO concentrations of the remaining winter deployments were similar to those shown in Figure D-3, where concentrations always exceeded 5 mg/l and were often supersaturated.

In-situ continuous monitors were deployed at site W-M532.6Q on 40 occasions during the summer months. Data from monitors deployed on June 3, June 17, July 15, July 29, August 12, and August 26, 2003, August 9 and 23, 2005, August 29, 2006, and August 3 and 17, 2010 were not useable. Representative graphs of the range of DO concentrations observed during the remaining summer deployments are found in Figures D-4 through D-6. Every summer deployment had at least one concentration fall below the 5 mg/l target level except the June 1, 2005 and June 6, 2006 deployments. The results from most summer deployments were similar to the July 27 – August 10, 2004 deployment (see Figure D-4). The typical diel pattern of rising daytime DO concentrations followed by falling nighttime concentrations is evident in this figure. For most summer deployments, the diel DO pattern oscillated around the 4 to 6 mg/l range, with high DO concentrations commonly in the 6 to 8 mg/l range and low values typically in the 2 to 4 mg/l range. The most favorable DO conditions observed during a summer deployment occurred from June 14-28, 2005 (see Figure D-5). During this deployment, only four DO concentrations were below 5 mg/l and supersaturated concentrations were common during the daytime, with some concentrations exceeding 20 mg/l! The most adverse summer DO conditions were observed during the entire August 15-29, 2006 deployment, as shown in Figure D-6. The preceding and following deployments did not provide usable data; however, DO measurements taken at 3 feet below the water surface were below 5 mg/l on July 5, July 18, August 1, August 15, August 29, and September 12, 2006. Another long period of low DO concentrations was measured in the June 23 – July 7, 2010 deployment, when the DO was continuously below 5 mg/l for at least a week. The data from the following four deployments were not useable, but DO measurements taken at 5 feet below the water surface were 0.17 mg/l, 0.08 mg/l, 5.38 mg/l, 1.90 mg/l, and 2.82 mg/l on July 15, August 3, August 17, August 31, and September 14, 2010, respectively. In addition, senescence of nearby American lotus was noted on the August 3, 2010 site visit. Low DO concentrations also occurred in July 2011 but for shorter periods of 3-5 days.

(3) <u>Dye Tracer Study</u>. The 2006 report "Dye Dispersion and Fish Movement in Response to Increased Winter Inflow at Spring Lake, a Backwater of the Mississippi River near Savanna, Illinois" by David P. Bierl describes a dye tracer study performed during February 2005 in lower Spring Lake. This section presents a summary of the study and its results.

The 2005 dye tracer study was conducted for the purpose of determining how oxygenated water entering via the gated inlet structure disperses throughout the lake when ice cover is present for a gate opening of 3 feet. A similar study was performed during February 2002 with a gate opening of 10 inches, and the results of that study suggested that a larger gate opening would allow for a more rapid dispersion of oxygenated water throughout the lake. A single slug injection of Rhodamine WT dye was dispensed in the inlet structure and tracked over a period of thirteen days as it dispersed throughout the lake. An additional objective of the study was to track the movement of 20 radio-tagged centrarchids in response to the increased inflow. Fish movement was determined during three tracking events over an 11-day period.

The fluorescent dye used for the study was a 20 percent solution of Rhodamine WT. On the morning of February 1st, the dye was dispensed into the north gate well of the inlet structure and tracked over a period of thirteen days as it dispersed throughout the lake. Water samples were collected on ten occasions at up to 29 sampling points located throughout the lake.

The locations where dye was detected are shown on orthophotos of Spring Lake in Figures D-7 through D-9. The photos are positioned sequentially for the ten sampling events and include the time elapsed from initial addition of the dye to the beginning of each sampling event. The last photo is a cumulative map, showing all sites where dye was detected. Dye was detected at site 1 during the first six sampling events, was not found here during event seven, and then reappeared during events eight and nine. It is surmised that the reappearance of dye at site 1 may have been due to the rise in water level that occurred between events seven and eight, which may have flushed dye out of a small bay in the lake where site 31 is located. By sampling event two (elapsed time 3 hours), the dye was also detected at site 3. During sampling events three (elapsed time 5½ hours) and four (elapsed time 8½ hours), dye was present at sites 1, 3 and 4. After one day (sampling event five), the dye was detected at sites 1-5 and 31. At this point during the 2002 study the dye was present at only sites 3 and 4. During event six, at the 1¼ day mark, dye was detected at one additional site (7). By day 3 (sampling event seven), dye was not detected at site 1, but was additionally detected at sites 6, 8 and 11. The dye was no longer detected at sites 2, 3 and 4 during sampling event eight (elapsed time 6 days) but it reappeared at site 1 and was detected for the first time at sites 12 and 16. At this point during the 2002 study, site 7 was the farthest point from the injection site where dye was detected. During sampling event nine on day 9, the dye was detected at the most sampling points (sites 1, 5-17, 24-26, 28 and 31). On the final sampling event, day 13, dye was for the first time detected in the sub-basin of the lake west of Silo Island, appearing at sites 22 and 23. Dye was not detected in this area of the lake during the 2002 study. Other sites where dye was detected during event ten include 5, 13-15, 24-26, 28 and 31. The cumulative map indicates that over the course of the study, dye was detected at 23 of the 29 sites. During both the 2002 and present study, samples were collected on the sixth day following dye injection. Comparison of dye analysis results from these sampling events show that the dye traveled more than twice the distance during 2005 compared to that observed in 2002. The dye traveled 1,125 m (3,691 ft) in 2002, for an average velocity of .22 cm/sec while in 2005 it traveled 2,375 m (7,792 ft) for an average velocity of .46 cm/sec.

The middle portion of lower Spring Lake is bisected by Silo Island. As observed in 2002, the primary route of the dye in 2005 was to the east side of Silo Island. However, unlike in 2002, dye was detected in the sub-basin west of Silo Island in 2005, albeit not until the last sampling event. The area west of the upper part of Silo Island is relatively shallow. A significant amount of sediment deposition has occurred here due to previous levee failures. Much of this area is above the normal lake level and is covered with willow trees, thus, isolating it from the main basin of the lake. On the final sampling event, dye was detected adjacent to Silo Island at sites 22 and 23. Since dye was not detected at sites 19, 20 and 21, it is presumed that the dye traveled along the west side of Silo Island from site 10A to sites 22 and 23.

With a gate opening of 3 feet in 2005, inflowing water dispersed throughout Spring Lake faster and more completely than was observed during a similar study in 2002 when the inlet structure gate was open only 10 inches. With the larger gate opening in 2005, the inflow to the lake was measured at 1.06 m^3/s (37.39 cfs), which is comparable to the value predicted (1.33 m^3/s or 47 cfs) prior to construction utilizing a culvert rating program. The dispersal pattern still favored the deeper portions of the lake north and east of Silo Island; however, unlike in 2002, dye was eventually detected in samples collected from the sub-basin of the lake west of Silo Island. A comparison of dye analysis results from samples collected on the sixth day following injection during both studies show that the dye traveled more than twice the distance during 2005 compared to that observed in 2002. The dye traveled 1,125 m (3,691 ft) to site 7 in 2002, for an average velocity of .22 cm/sec while in 2005 it traveled 2,375 m (7,792 ft) to site 16 for an average velocity of .46 cm/sec. In both studies the velocity of the inflow dropped markedly once it exited the dredged channel near site 1 and entered the main basin of the lake. In 2002, the velocity measured at site 1 was 3.353 cm/s, while in 2005 it ranged from 15.18 to 20.97 cm/s. Velocities measured at other sites throughout the lake were nearly all below 1 cm/sec.

One objective of the study was to determine if an increase in water velocity caused by a larger gate opening would adversely impact over-wintering centrarchids, which prefer areas with little or no velocity. This objective was accomplished by tracking the movement of centrarchids fitted with radio transmitters to determine if they would leave the area where they were captured/released in response to the increased inflow. Twenty fish, including one bluegill and nineteen black crappie, were caught and released below the cross dike on January 25th and 26th (see Figure D-10). The fish were monitored during three tracking events: January 31st-February 2nd; February 4th; and February 10th-11th. The objective of the first tracking event was to determine initial fish location. The second and third tracking events were performed following the increase in gate opening. Figures D-10 through D-14 show the locations of the fish during each tracking event by date. During the first tracking event, sixteen fish were located on January 31st. The position of some fish on this date was estimated when late in the day the GPS unit lost battery power. Fish 084C and 631C were found on February 1st and fish 194C was found on February 2nd. Although some fish were located after the increase in gate opening, it is unlikely the area where they were found was yet impacted by the increased inflow, except for perhaps fish 194C. The fish remained relatively close to the area where they were captured/released. The farthest distance traveled during the first tracking event was approximately 1,200 m (3,937 ft) by fish 631C (see Figure D-12). The second tracking event occurred on the fourth day (February 4th) following the increase in gate opening. The fish still remained relatively close to the area of capture/release, except for fish 751C. This black crappie traveled over 1,800 m (5,906 ft) to the east side of the lake; however, by the third tracking event six days later, it had returned to the vicinity where it was originally captured/released (see Figure D-13). The third tracking event was performed on the tenth and eleventh days following the increase in gate opening. Again, the fish were located relatively close to the area of capture/release. The farthest distance traveled was approximately 900 m (2,953 ft) by fish 831C (see Figure D-14).

Based on the distance traveled from the capture/release site, the telemetry data indicate the fish were not adversely impacted by the increase in gate opening. Initial concerns that the fish may be "flushed" from the lake did not materialize. In fact, the fish that traveled the furthest distance from its capture/release site eventually returned to the area, suggesting that the increased inflow was not the reason for its initial departure from the area. The velocity at site 7, in the vicinity where most of the fish were located throughout the study, increased from 0.16 cm/sec on January 28th to 0.45 cm/s on February 14th. The 0.29 cm/s increase in velocity was apparently not sufficient to cause the fish to disperse from the area.

(4) Conclusions. The project has not been successful in attaining the target DO concentration (>5 mg/l), particularly during the summer months; however, extended periods of low DO concentrations have been observed in both the summer and winter months. The DO concentration during the summer months often fell below 5 mg/l; however, most of these excursions were short-lived. Only occasionally would the DO remain below 5 mg/l for more than two consecutive days. The gated inlet structure could be utilized during the summer months; however, close monitoring would be required in order to keep undesirable amounts of sediment from entering the lake.

A dye tracer study was conducted in February 2005 for the purpose of determining how oxygenated water entering Spring Lake via the gated inlet structure disperses throughout the lake when ice cover is present with a gate opening of 3 feet. A similar study was performed during February 2002 with a gate opening of 10 inches, and the results of that study suggested that a larger gate opening would allow for a more rapid dispersion of oxygenated water throughout the lake. With a larger gate opening in 2005, inflowing water dispersed throughout Spring Lake faster and more completely than was observed during the 2002 study. Dye was eventually detected on the west side of Silo Island in the 2005 study, but it was not detected at the sites at the south end of the lake in either 2002 or 2005. One purpose of the study was to determine if an increase in water velocity caused by a larger gate opening would adversely impact over-wintering centrarchids, which prefer areas with little or no velocity. Movement of radio-tagged centrarchids (black crappies and a bluegill) indicated the fish were not adversely impacted by the increased gate opening. The 0.29 cm/s increase in velocity in the vicinity where most of the fish were located throughout the study was apparently not sufficient to cause the fish to disperse from the area.

Comparisons of pre- and post-project DO data from surface samples collected at sites W-M532.6Q, W-M534.8R and W-M534.6V are summarized in Table D-5. The average DO concentration at sites M532.6Q and W-M534.6V during the post-project period was lower than that for the pre-project period. However, in the post-project period since December 2002, the average DO concentration was greater than the average for the post-project period prior to December 2002 at all three sites. In addition, the average DO concentration at site W-M534.8R for December 2002 – March 2012 was greater than pre-project conditions. Due to the short time frame of the two study periods, the value of making statistical comparisons is somewhat limited. One factor that probably resulted in the lower post-project average DO concentrations was closure of the breach in the perimeter levee. Pre-project data were gathered while the breach still existed. A significant volume of oxygenated water entered the lake through the breach, along with an undesirable sediment load; thus, it was essential that the breach be closed. The gated inlet structure was designed to allow oxygenated water into the lake during periods when the suspended sediment load of the river is relatively low (primarily winter months). Results from this performance evaluation indicate that a larger gate opening may be necessary in order to prevent fish kills during winters when particularly adverse conditions (early onset of snow-covered ice) occur. A 20-inch gate opening during the winter of 2010-2011 did not allow for adequate DO concentrations in the southern portion of the lake. The results from the 2005 dye tracer study suggest that if a 36-inch gate opening would have been utilized during this winter, the low DO concentrations measured at sites W-M 532.3T and W-M532.6Q would likely not have occurred. Opening the gate sooner may also help prevent fish kills, but this would increase the likelihood of undesirable sediment entering the lake.

(5) References.

Bierl, David P. *Dye Dispersion and Fish Movement in Response to Increased Winter Inflow at Spring Lake, a Backwater of the Mississippi River near Savanna, Illinois.* U.S. Army Corps of Engineers, Rock Island District, 2006.

Bierl, David P. *Dye Dispersion under Ice at Spring Lake, a Backwater of the Mississippi River.* U.S. Army Corps of Engineers, Rock Island District, 2002.

U.S. Army Corps of Engineers. *Upper Mississippi River System Environmental Management Program Post-Construction Initial Performance Evaluation Report Spring Lake Habitat Rehabilitation and Enhancement Project.* U.S. Army Corps of Engineers, Rock Island District, 2004.

Table D-1. Post-project water quality monitoring results from surface samples collected at site W-M532.6Q

DATE	WATER DEPTH (M)	VELOCITY (CM/SEC)	WATER TEMP. (°C)	DISSOLVED OXYGEN (MG/L)	pH (SU)	TOTAL SUSPENDED SOLIDS (MG/L)	CHLOROPHYLL a (MG/M^3)
12/12/2002	2.085	0.21	3.6	18.67	8.57	-	-
1/28/2003	2.000	0.38	2.3	18.18	8.02	-	-
4/1/2003	1.510	-	10.7	13.35	8.70	-	-
6/3/2003	2.140	-	17.6	7.77	8.20	9.0	44.0
6/17/2003	2.060	1.79	24.0	8.58	8.70	8.0	28.0
7/1/2003	2.200	4.52	27.9	11.21	8.70	2.0	4.5
7/15/2003	2.200	-	26.3	8.14	8.30	<1	8.5
7/29/2003	2.110	-	25.5	5.41	8.30	5.0	5.7
8/12/2003	2.070	1.61	24.2	1.25	-	3.0	6.0
8/26/2003	2.800	3.76	25.2	2.10	8.40	1.0	2.3
9/9/2003	1.910	1.69	21.7	3.22	7.70	1.0	8.5
12/18/2003	2.010	*	1.5	15.66	8.55	-	-
2/3/2004	2.110	0.47	10.3	14.93	8.70	-	-
3/25/2004	1.810	-	20.2	8.50	7.90	-	-
6/2/2004	2.650	1.57	26.8	11.42	8.40	13.0	16.0
6/15/2004	2.770	2.85	23.3	11.19	8.30	4.0	28.0
6/29/2004	2.470	6.96	26.1	11.50	8.90	13.0	23.0
7/13/2004	2.165	3.93	25.1	9.01	7.90	28.0	89.0
7/27/2004	1.920	2.89	23.0	5.18	7.60	15.0	55.0
8/10/2004	2.000	-	23.1	5.32	7.70	10.0	43.0
8/24/2004	2.050	0.43	21.5	6.10	8.00	9.0	26.0
9/8/2004	1.950	2.97	3.0	15.98	8.34	8.0	16.0
12/29/2004	2.060	0.75	1.2	23.05	8.40	6.0	32.0
2/16/2005	2.375	-	1.8	17.63	7.90	<1	<1
3/17/2005	1.710	-	6.0	17.24	9.20	140.0	105.0
6/1/2005	2.110	4.51	22.6	10.81	8.90	14.0	31.0
6/14/2005	2.120	-	24.9	7.85	8.50	9.0	40.0
6/28/2005	2.300	3.91	27.3	6.70	8.60	12.0	46.0
7/13/2005	2.050	-	25.4	3.67	7.40	6.0	56.0
7/26/2005	1.910	1.11	28.1	2.75	7.30	14.0	36.0
8/9/2005	1.980	0.24	28.4	8.47	7.90	6.0	22.0
8/23/2005	1.920	0.63	23.7	5.98	7.60	8.0	23.0
9/7/2005	1.860	0.57	23.7	6.72	7.90	4.0	4.0
12/13/2005	2.000	0.22	2.7	14.60	8.20	1.0	79.0
1/19/2006	1.900	0.79	1.3	19.33	8.40	4.0	4.2
3/2/2006	1.790	-	2.2	15.38	8.40	12.0	8.1
6/6/2006	1.900	-	23.3	6.13	8.30	15.0	46.0
6/20/2006	1.910	0.77	25.5	7.37	8.40	18.0	55.0
7/5/2006	2.020	4.05	25.7	5.80	7.80	17.0	46.0
7/18/2006	1.940	0.02	28.6	3.01	7.20	7.0	34.0
8/1/2006	1.820	3.12	30.2	3.84	7.40	14.0	54.0
8/15/2006	1.930	1.97	24.2	4.04	7.30	11.0	28.0
8/29/2006	1.950	0.16	23.2	2.98	7.20	9.0	11.0
9/12/2006	1.870	6.43	17.9	1.56	6.90	2.0	1.9
6/8/2010	1.820	***	21.9	6.55	8.90	6.0	22.0
6/23/2010	2.240	*	26.9	7.51	9.00	4.0	11.0
7/7/2010	2.420	*	27.0	6.60	9.50	4.0	3.0
7/15/2010	2.355	*	29.6	6.50	9.30	3.0	11.0
8/3/2010	2.430	*	27.0	4.30	7.40	9.0	66.0
8/17/2010	2.245	*	25.8	5.22	7.50	16.0	74.0
8/31/2010	2.040	*	24.8	2.65	7.40	10.0	33.0
9/14/2010	2.090	3.14	22.3	6.76	8.20	22.0	56.0
12/9/2010	2.000	0.10	2.7	12.22	8.10	-	-
2/7/2011	2.075	-	1.3	4.56	7.10	-	-
3/7/2011	2.080	1.60	3.4	13.42	7.70	-	-
6/1/2011	2.040	3.85	22.5	9.66	8.40	14.0	34.0
6/14/2011	2.000	*	22.0	8.30	7.90	34.0	91.0
6/28/2011	2.190	4.72	24.2	10.15	8.30	22.0	47.0
7/12/2011	2.310	2.74	28.7	6.33	8.00	12.0	53.0
7/26/2011	2.110	0.65	28.8	10.30	8.30	13.0	82.0
8/9/2011	1.990	4.99	26.3	3.96	7.50	10.0	27.0
8/23/2011	1.770	***	24.6	4.81	7.90	13.0	27.0
9/7/2011	1.930	-	19.9	6.58	8.00	-	-
12/13/2011	1.800	1.04	2.7	20.26	9.10	-	-
1/25/2012	1.740	-	1.5	15.97	8.30	-	-
3/8/2012	1.870	-	8.8	16.36	9.10	-	-
MIN.	1.510	0.02	1.2	1.25	6.90	1.0	1.9
MAX.	2.800	6.96	30.2	23.05	9.50	140.0	105.0
AVG.	2.060	2.20	19.0	9.04	-	12.7	34.7

* Meter malfunction
** Not applicable, ice cover
*** Too windy to take measurement

Table D-2. Post-project water quality monitoring results from surface samples collected at site W-M534.8R

DATE	WATER DEPTH (M)	VELOCITY (CM/SEC)	WATER TEMP. (°C)	DISSOLVED OXYGEN (MG/L)	pH (SU)	TOTAL SUSPENDED SOLIDS (MG/L)	CHLOROPHYLL a (MG/M^3)
12/12/2002	1.140	0.69	2.8	19.70	8.46	-	-
1/28/2003	1.260	0.18	1.7	23.34	8.77	-	-
4/1/2003	0.880	-	9.9	11.67	8.40	-	-
6/3/2003	1.310	-	16.7	9.07	7.90	20.0	47.0
6/17/2003	1.100	0.51	25.6	9.36	8.60	5.0	37.0
7/1/2003	1.300	-	27.3	11.88	8.60	12.0	18.0
7/15/2003	2.270	-	25.4	8.29	8.40	7.0	51.0
7/29/2003	1.180	1.73	25.8	6.88	8.00	15.0	33.0
8/12/2003	1.045	1.86	24.6	3.98	-	11.0	35.0
8/26/2003	1.040	1.26	26.5	6.06	7.80	20.0	51.0
9/9/2003	1.000	1.95	23.4	7.57	8.00	27.0	46.0
12/18/2003	1.000	*	1.5	18.47	8.63	-	-
2/3/2004	0.935	0.40	1.3	20.55	8.60	-	-
3/25/2004	1.000	-	10.6	13.42	8.60	-	-
6/2/2004	1.840	2.50	19.5	9.54	8.30	15.0	25.0
6/15/2004	2.110	-	27.2	11.46	8.60	17.0	64.0
6/29/2004	1.600	0.74	23.9	12.13	8.50	12.0	31.0
7/13/2004	1.200	0.44	26.0	7.57	8.10	11.0	42.0
7/27/2004	1.020	0.48	24.3	9.73	8.20	22.0	53.0
8/10/2004	1.150	-	22.6	7.20	7.90	25.0	61.0
8/24/2004	1.070	-	23.5	*	7.80	14.0	40.0
9/8/2004	1.000	-	21.3	7.67	8.00	22.0	56.0
12/29/2004	1.100	0.66	3.5	14.68	8.20	6.0	19.0
2/16/2005	1.450	0.35	1.4	12.02	7.70	32.0	<1
3/17/2005	0.900	-	6.1	16.03	9.20	42.0	68.0
6/1/2005	1.260	-	23.1	12.21	8.90	18.0	45.0
6/14/2005	1.320	-	25.3	7.54	9.10	23.0	71.0
6/28/2005	1.355	1.63	27.4	9.73	9.80	27.0	150.0
7/13/2005	1.010		24.8	5.75	8.90	24.0	195.0
7/26/2005	1.010		27.8	3.49	8.10	36.0	120.0
8/9/2005	1.100		29.2	8.50	8.20	28.0	92.0
8/23/2005	1.010		23.6	6.40	7.70	28.0	88.0
9/7/2005	1.200	0.25	26.0	11.62	8.50	-	-
12/13/2005	1.050	0..26	2.7	11.67	8.10	17.0	23.0
1/19/2006	1.040		0.9	18.11	8.20	4.0	<1
3/2/2006	1.270		1.6	19.35	8.80	5.0	13.0
6/6/2006	1.330		23.3	7.41	8.90	33.0	100.0
6/20/2006	1.010		25.0	4.82	8.40	43.0	75.0
7/5/2006	1.000	0.11	26.4	8.57	8.30	26.0	91.0
7/18/2006	1.000	0.06	28.4	3.59	7.40	31.0	85.0
8/1/2006	1.020	3.22	29.6	2.51	7.50	14.0	59.0
8/15/2006	1.020	1.19	23.7	4.42	7.40	18.0	71.0
8/29/2006	0.970		23.0	2.93	7.30	13.0	37.0
9/12/2006	1.020	4.27	18.4	2.89	7.20	10.0	28.0
6/8/2010	***	***	22.5	6.85	8.20	16.0	51.0
6/23/2010	1.280	*	27.4	6.66	8.40	3.0	14.0
7/7/2010	1.455	*	27.2	9.70	9.70	6.0	22.0
7/15/2010	1.355	*	28.8	8.10	9.20	7.0	34.0
8/3/2010	1.470	*	27.3	4.04	7.40	3.0	8.0
8/17/2010	1.405	*	25.0	6.51	7.80	7.0	37.0
8/31/2010	1.230	*	25.1	4.91	7.60	7.0	18.0
9/14/2010	1.010	1.96	22.1	8.58	8.60	24.0	12.0
12/9/2010	1.190	0.15	2.4	15.15	8.30	-	-
2/7/2011	1.305	0.85	-0.1	11.47	7.40	-	-
3/7/2011	1.315	0.22	0.5	16.34	8.20	-	-
6/1/2011	1.400	0.06	22.2	7.95	8.00	15.0	45.0
6/14/2011	1.600	*	21.6	8.01	7.80	33.0	99.0
6/28/2011	1.540	3.09	23.8	5.82	7.70	16.0	44.0
7/12/2011	1.430	2.23	28.9	6.92	8.10	17.0	61.0
7/26/2011	1.5	1.85	30.2	11.50	8.40	12.0	45.0
8/9/2011	1.640	-	26.3	4.47	7.60	23.0	75.0
8/23/2011	1.360	***	24.7	4.79	7.80	22.0	46.0
9/7/2011	1.055	-	19.9	8.20	8.10	-	-
1/25/2012	0.920	0.08	2.3	16.66	8.50	-	-
3/8/2012	1.045	-	8.1	13.74	8.90	-	-

MIN.	0.880	0.06	-0.1	2.51	7.20	3.0	8.0
MAX.	2.270	4.27	30.2	23.34	9.80	43.0	195.0
AVG.	1.225	1.17	19.2	9.63	-	18.2	54.6

* Meter malfunction
** Not applicable, ice cover
*** Too windy to take measurement

Table D-3. Post-project water quality monitoring results from surface samples collected at site W-M534.6V

DATE	WATER DEPTH (M)	VELOCITY (CM/SEC)	WATER TEMP. (°C)	DISSOLVED OXYGEN (MG/L)	pH (SU)	TOTAL SUSPENDED SOLIDS (MG/L)	CHLOROPHYLL a (MG/M^3)
1/28/2003	0.810	-	0.7	17.58	8.00	-	-
4/1/2003	0.790	-	11.2	8.39	7.90	-	-
6/3/2003	1.040	-	16.7	7.77	7.60	12.0	22.0
6/17/2003	0.850	1.79	25.5	10.71	8.90	28.0	15.0
7/1/2003	0.940	-	26.7	13.52	9.40	1.0	1.2
7/15/2003	0.980	-	26.3	11.20	9.20	14.0	102.0
7/29/2003	0.810	1.45	26.4	2.85	7.50	54.0	22.0
8/12/2003	0.800	-	24.3	6.02	-	9.0	13.0
8/26/2003	0.760	0.20	26.1	8.20	8.50	4.0	7.7
9/9/2003	0.600	0.60	23.4	5.31	7.80	23.0	6.8
12/18/2003	0.680	*	2.3	17.90	8.57	-	-
2/3/2004	0.770	-	1.0	23.20	8.60	-	-
3/25/2004	0.710	-	11.1	12.95	8.60	-	-
6/2/2004	1.450	3.42	19.1	9.04	8.30	13.0	24.0
6/15/2004	1.610	-	27.3	8.63	8.30	7.0	22.0
6/29/2004	1.305	1.77	23.5	14.94	8.80	4.0	34.0
7/27/2004	0.620	1.69	24.5	7.12	7.50	37.0	36.0
8/10/2004	0.740	-	20.9	8.16	8.00	20.0	42.0
8/24/2004	0.770	1.36	23.0	*	7.80	7.0	24.0
9/8/2004	0.730	-	20.7	8.11	7.90	23.0	57.0
12/29/2004	0.770	0.30	2.3	20.85	8.30	4.0	8.7
2/16/2005	1.100	0.60	1.9	12.45	7.90	4.0	2.5
3/17/2005	0.730	-	5.7	16.16	9.10	40.0	62.0
6/1/2005	0.860	-	23.6	12.16	9.00	15.0	26.0
6/14/2005	1.070	-	24.4	9.16	9.50	25.0	200.0
6/28/2005	1.080	0.80	26.3	8.12	9.90	32.0	200.0
7/13/2005	0.730	-	24.9	8.51	9.40	29.0	200.0
7/26/2005	0.740	1.05	26.6	5.93	8.80	77.0	130.0
8/9/2005	0.750	0.59	29.0	11.58	8.50	32.0	72.0
8/23/2005	0.660	-	22.9	6.06	7.40	23.0	58.0
9/7/2005	0.620	0.71	24.1	6.33	7.70	20.0	77.0
12/13/2005	0.790	0.18	3.4	9.42	7.60	2.0	21.0
1/19/2006	0.750	0.14	3.6	20.40	8.30	6.0	16.0
3/2/2006	0.720	-	3.1	14.18	8.20	75.0	41.0
6/6/2006	0.830	-	22.7	7.23	8.30	20.0	81.0
6/20/2006	0.570	-	24.3	5.03	8.10	33.0	49.0
7/5/2006	0.730	0.63	24.9	4.05	7.90	11.0	8.7
7/18/2006	0.660	0.04	26.8	4.15	7.20	16.0	43.0
8/1/2006	0.665	0.57	28.4	3.31	7.40	5.0	17.0
8/15/2006	0.680	0.43	22.6	2.00	6.90	5.0	36.0
8/29/2006	0.720	0.45	21.7	3.08	7.20	13.0	23.0
9/12/2006	0.720	0.37	17.8	1.33	6.90	1.0	8.9
MIN.	0.570	0.04	0.7	1.33	6.90	1.0	1.2
MAX.	1.610	3.42	29.0	23.20	9.90	77.0	200.0
AVG.	0.826	0.87	18.9	9.59	-	20.1	48.9

* Meter malfunction
** Not applicable, ice cover
*** Too windy to take measurement

Table D-4. Post-project water quality monitoring results from surface samples collected at site W-M532.3T by Bellevue, Iowa LTRM personnel

DATE	WATER TEMP. (°C)	DISSOLVED OXYGEN (MG/L)	pH (SU)	TOTAL SUSPENDED SOLIDS (MG/L)	CHLOROPHYLL a (MG/M^3)
1/8/2002	2.4	16.4	8.0	3.5	-
1/25/2002	4.2	14.9	7.7	3.3	-
2/4/2002	3.6	13.7	7.8	-	-
2/22/2002	1.9	14.1	8.2	18.4	-
3/7/2002	2.1	-	8.8	12.0	-
3/18/2002	5.3	15.1	8.8	17.4	45.36
4/4/2002	3.2	14.0	8.7	38.1	-
4/17/2002	21.3	9.3	8.7	-	-
4/30/2002	11.9	17.3	9.2	19.2	-
5/14/2002	13.1	10.7	8.3	19.8	-
5/28/2002	20.2	8.2	8.4	8.6	10.36
6/12/2002	25.1	8.3	8.4	18.1	40.33
6/25/2002	29.3	8.7	8.8	14.4	29.69
7/9/2002	27.3	6.5	9.2	1.6	-
7/23/2002	26.5	6.8	8.3	2.1	-
8/6/2002	24.4	4.2	8.9	1.9	-
8/20/2002	23.2	6.8	8.0	5.5	-
9/3/2002	23.6	8.9	8.4	3.3	-
9/16/2002	22.0	6.1	7.9	5.3	-
4/5/2004	9.8	10.9	8.0	25.5	-
4/21/2004	13.8	9.8	8.7	53.7	83.95
5/5/2004	15.4	10.6	8.9	22.4	19.86
5/18/2004	20.1	8.0	8.4	16.5	-
6/3/2004	21.0	9.3	8.3	11.3	-
6/15/2004	25.6	8.3	8.1	6.7	-
6/30/2004	25.3	19.5	9.3	22.5	-
7/15/2004	24.4	10.7	9.2	32.1	-
7/26/2004	21.7	11.4	8.7	25.4	-
8/11/2004	18.3	6.0	7.8	13.3	-
8/26/2004	22.5	3.1	7.5	-	-
9/9/2004	19.4	8.0	8.1	18.7	-
9/23/2004	20.1	8.2	8.1	10.8	-
10/6/2004	12.4	12.9	8.8	2.5	-
11/5/2004	8.1	11.1	8.2	8.9	-
1/13/2005	1.7	8.2	7.5	3.2	-
3/14/2005	2.7	16.2	8.6	15.8	22.21
4/4/2005	13.2	17.2	9.1	24.6	-
4/18/2005	19.1	8.6	8.3	10.6	-
5/4/2005	13.5	12.7	9.1	20.6	-
5/16/2005	13.8	11.7	8.7	23.2	-
5/31/2005	21.1	11.2	8.9	17.7	26.61
6/15/2005	22.4	7.9	8.0	11.8	-
6/27/2005	28.3	5.4	7.7	8.1	-
7/14/2005	24.8	5.1	7.7	13.5	-
8/8/2005	27.5	7.1	8.4	11.5	-
9/6/2005	21.8	4.6	7.4	2.3	-
10/4/2005	20.8	4.0	7.4	1.9	1.47
11/7/2005	9.8	7.8	7.7	17.4	-
3/7/2006	2.4	14.9	8.4	8.0	-
4/4/2006	8.9	12.3	8.4	36.4	98.85
4/19/2006	16.4	11.0	8.5	10.9	-
5/2/2006	15.3	9.4	8.1	11.7	-
5/18/2006	16.8	9.1	8.6	204.4	-
6/1/2006	24.9	6.4	8.2	15.7	44.70
6/15/2006	21.7	8.7	8.0	10.1	-
6/29/2006	24.1	9.1	8.5	14.6	-
7/12/2006	24.1	1.7	7.4	6.6	-
8/7/2006	26.7	3.5	7.6	6.1	-
9/6/2006	20.7	3.5	7.3	21.7	-
10/2/2006	16.1	7.2	7.6	3.2	10.89
11/7/2006	8.0	13.3	8.3	13.6	-
1/11/2007	0.5	13.7	8.2	7.0	11.13
4/6/2007	3.7	12.3	8.1	69.0	-
4/19/2007	11.6	12.2	8.9	22.7	-
5/3/2007	17.7	7.7	8.4	11.7	12.00
5/16/2007	16.4	8.0	9.2	15.5	-
5/30/2007	24.3	12.3	8.7	4.9	-

Table D-4 (cont.). Post-project water quality monitoring results from surface samples collected at site W-M532.3T by Bellevue, Iowa LTRM personnel

DATE	WATER TEMP. (°C)	DISSOLVED OXYGEN (MG/L)	pH (SU)	TOTAL SUSPENDED SOLIDS (MG/L)	CHLOROPHYLL a (MG/M^3)
6/11/2007	25.4	17.4	9.7	2.8	-
6/25/2007	21.9	5.5	7.5	11.7	-
7/12/2007	-	-	-	2.7	-
8/10/2007	26.6	7.6	8.0	7.1	10.99
9/5/2007	23.8	4.4	7.4	12.5	-
10/1/2007	18.4	7.4	7.9	0.3	-
11/7/2007	4.3	12.7	8.2	18.1	-
3/6/2008	0.0	20.0	7.3	1.4	-
4/2/2008	6.4	13.1	7.4	19.1	-
4/14/2008	8.9	11.6	8.0	26.9	-
5/1/2008	12.8	11.4	8.4	17.5	48.31
5/15/2008	16.4	13.5	8.5	29.5	-
5/28/2008	16.9	10.5	8.7	16.1	45.78
6/10/2008	21.1	5.5	7.5	113.5	13.73
6/23/2008	25.6	12.9	8.7	12.9	-
7/8/2008	25.8	6.3	7.9	21.1	-
8/5/2008	26.9	6.3	7.9	15.5	-
9/3/2008	23.3	6.3	7.8	21.0	-
10/8/2008	16.1	10.2	8.1	3.9	3.35
11/10/2008	2.2	12.0	8.3	18.1	-
1/13/2009	0.9	7.4	7.1	5.0	27.81
3/13/2009	3.4	15.6	8.5	17.7	33.48
4/9/2009	10.3	17.3	9.3	26.7	-
4/21/2009	9.6	10.1	8.4	43.8	-
5/4/2009	18.3	11.5	8.9	15.7	-
5/21/2009	20.7	9.6	8.8	18.5	-
6/4/2009	22.4	11.1	9.2	9.5	-
6/15/2009	23.1	7.4	7.9	21.5	-
7/2/2009	19.9	13.0	9.9	1.6	-
7/13/2009	25.4	13.8	9.4	6.5	-
8/11/2009	25.0	10.2	8.2	4.9	-
9/10/2009	23.1	11.1	9.1	3.7	-
10/5/2009	13.5	12.4	8.6	4.4	-
11/9/2009	13.3	11.8	8.6	16.5	-
1/14/2010	0.9	7.8	7.5	4.3	-
3/8/2010	1.4	19.0	7.6	6.9	-
4/9/2010	11.0	11.3	8.5	18.8	63.34
4/20/2010	16.9	9.5	8.5	11.0	-
5/3/2010	18.5	11.2	8.6	14.6	-
5/20/2010	19.2	10.5	8.5	19.2	-
6/1/2010	26.7	7.3	8.9	12.0	10.18
6/16/2010	23.0	6.1	7.7	12.1	2.94
6/29/2010	26.1	9.8	8.4	14.9	64.38
7/15/2010	28.9	7.0	8.1	17.7	-
8/12/2010	31.4	7.4	8.1	16.4	-
9/8/2010	19.1	9.9	8.3	24.9	70.32
10/5/2010	15.1	4.7	7.6	8.9	-
11/8/2010	6.8	15.8	8.7	32.4	-
1/10/2011	2.8	4.0	7.0	11.6	-
3/7/2011	5.8	-	8.6	5.7	-
4/7/2011	9.1	17.9	8.9	27.9	104.24
4/21/2011	7.8	13.9	8.8	16.8	-
5/2/2011	12.4	11.5	9.1	19.0	-
5/17/2011	14.8	14.0	8.8	19.7	-
6/1/2011	21.4	10.5	8.5	17.4	57.66
6/13/2011	21.4	7.7	8.0	27.4	-
6/29/2011	26.0	12.3	8.4	18.5	-
7/15/2011	26.6	8.0	8.2	15.9	-
8/9/2011	26.3	5.0	7.9	17.0	33.13
9/7/2011	19.8	8.2	8.4	6.3	-
9/7/2011	22.4	9.3	8.2	29.0	-
10/3/2011	14.8	9.4	8.3	12.3	-
11/7/2011	9.2	11.3	8.4	45.0	-

MIN.	0.0	1.7	7.0	0.3	1.47
MAX.	31.4	20.0	9.9	204.4	104.24
AVG.	16.6	10.1	-	17.4	36.11

FIGURE D-1. POST-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M532.6Q FROM 12/9/10-2/7/11

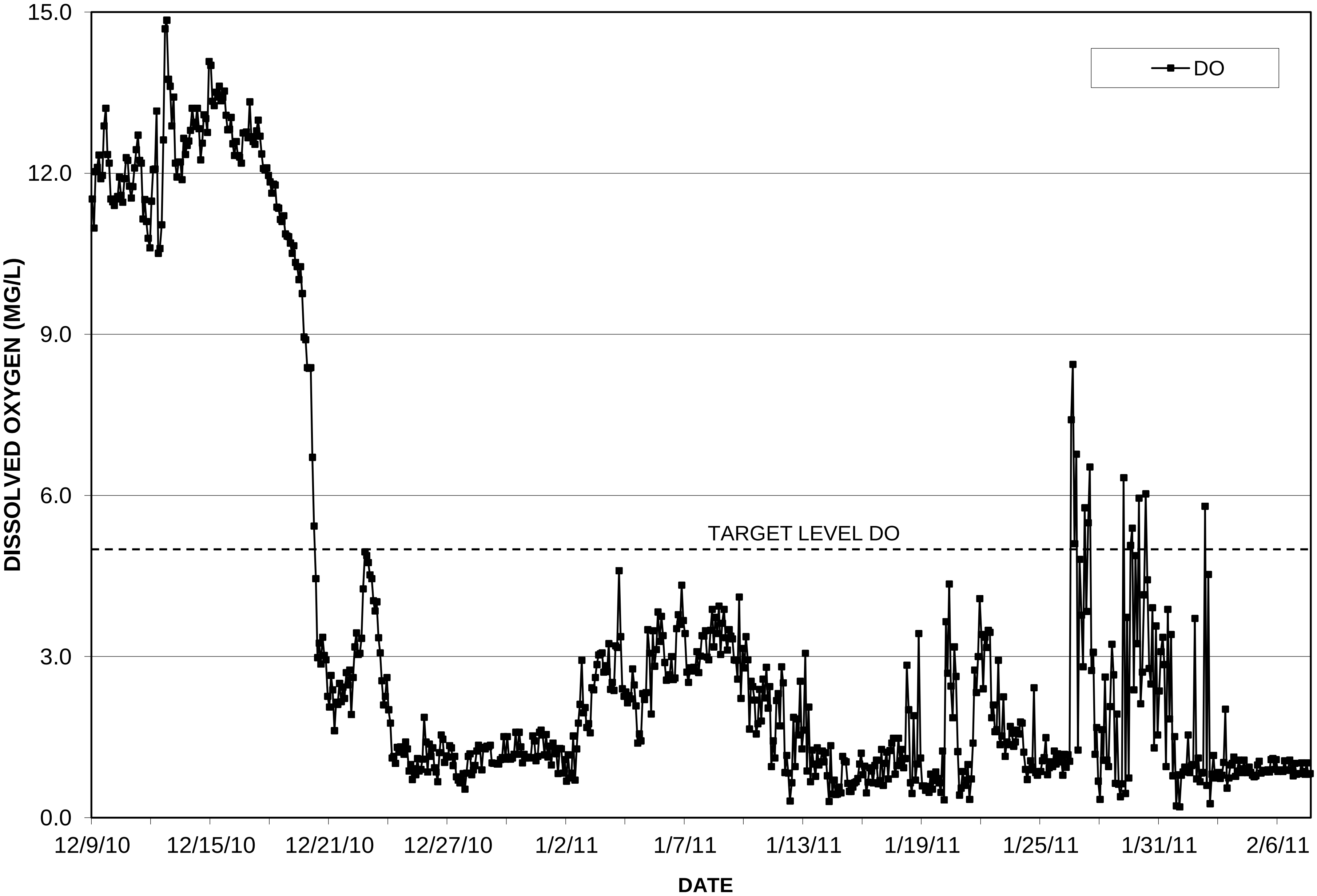


FIGURE D-2. POST-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M532.6Q FROM 2/7/11-3/7/11

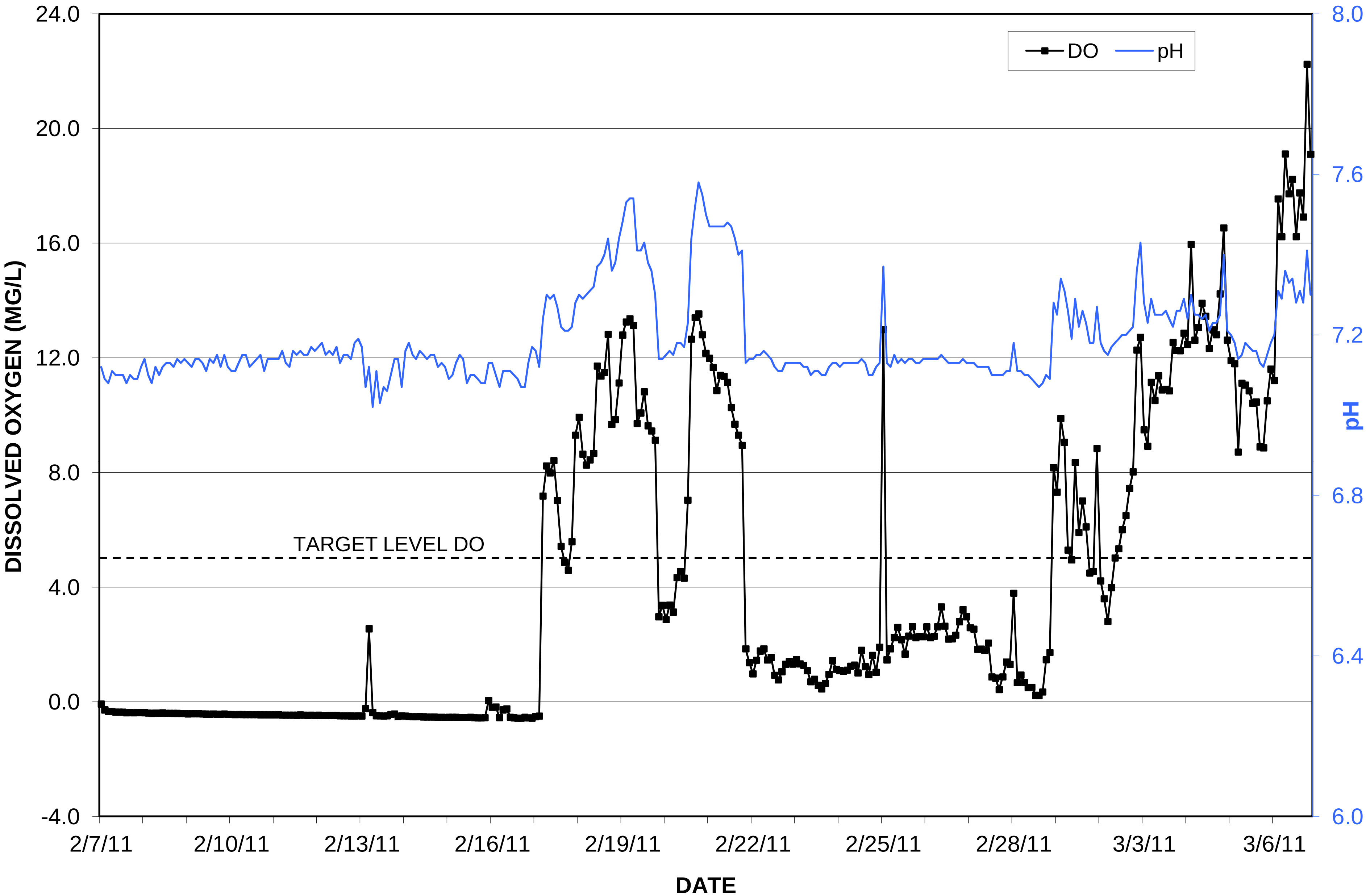


FIGURE D-3. POST-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M532.6Q FROM 12/14/11-1/25/12

FIGURE D-4. POST-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M532.6Q FROM 7/27/04-8/10/04

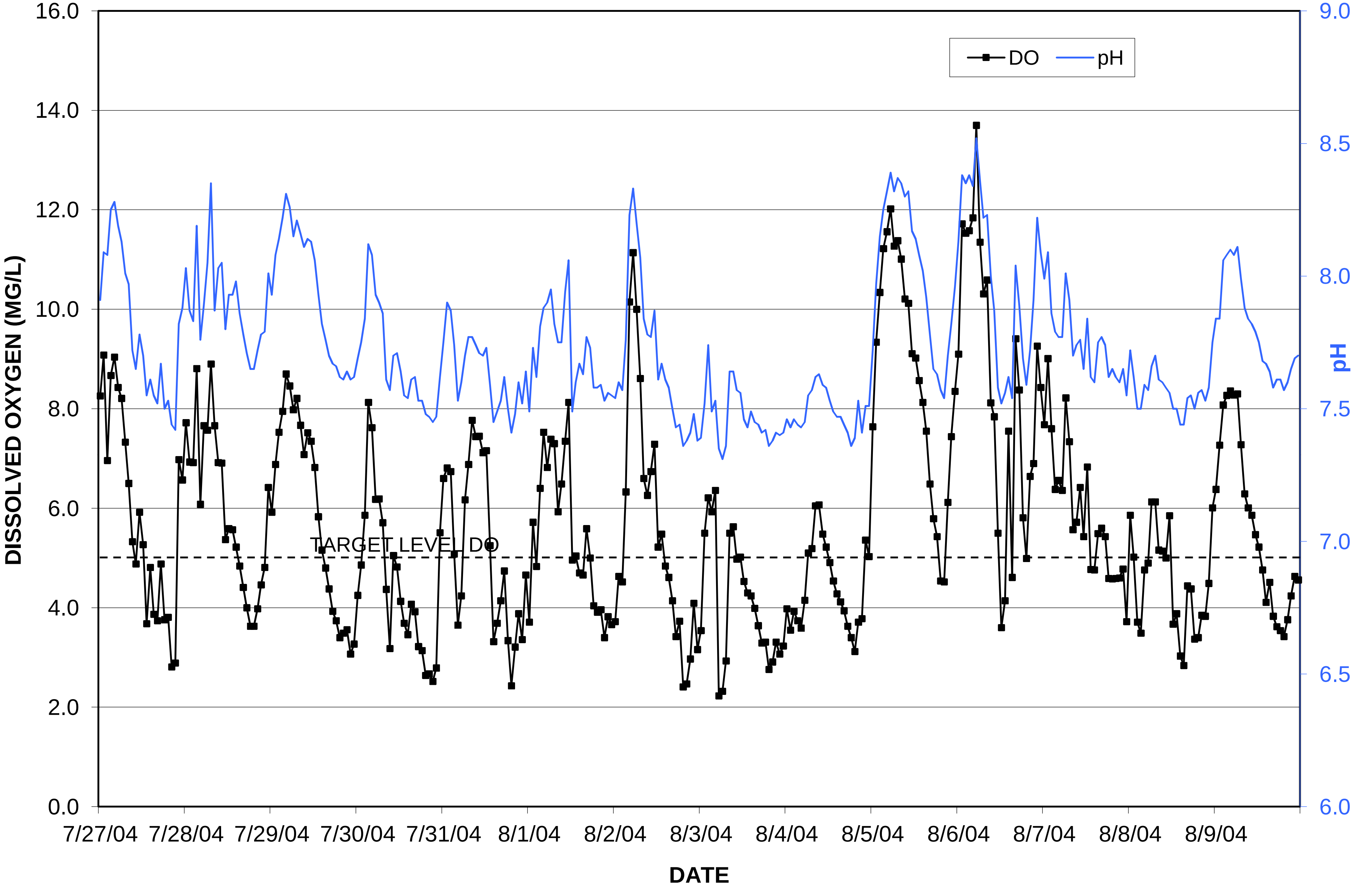


FIGURE D-5. POST-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M532.6Q FROM 6/14/05-6/28/05

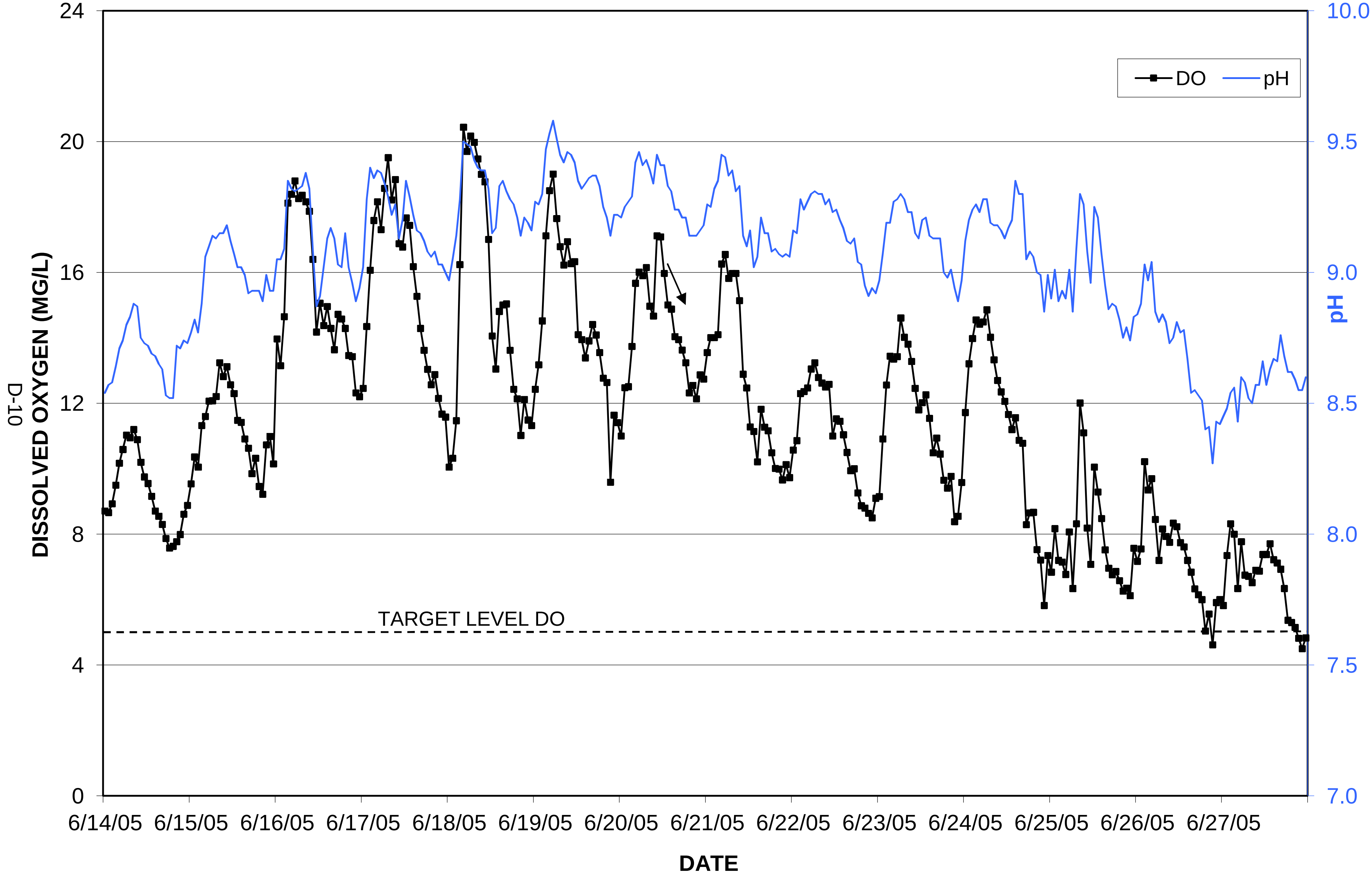


FIGURE D-6. POST-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M532.6Q FROM 8/15/06-8/29/06

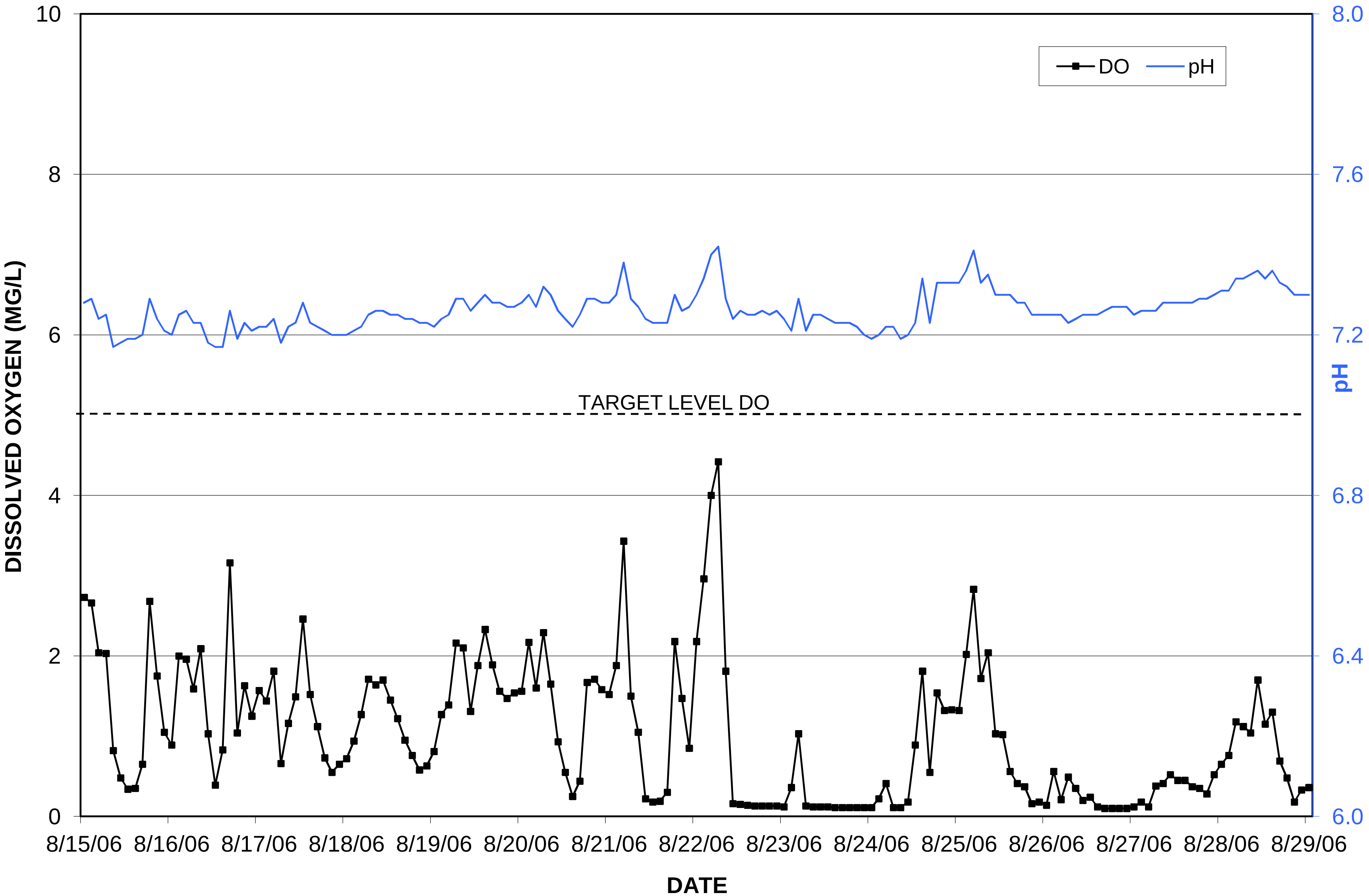
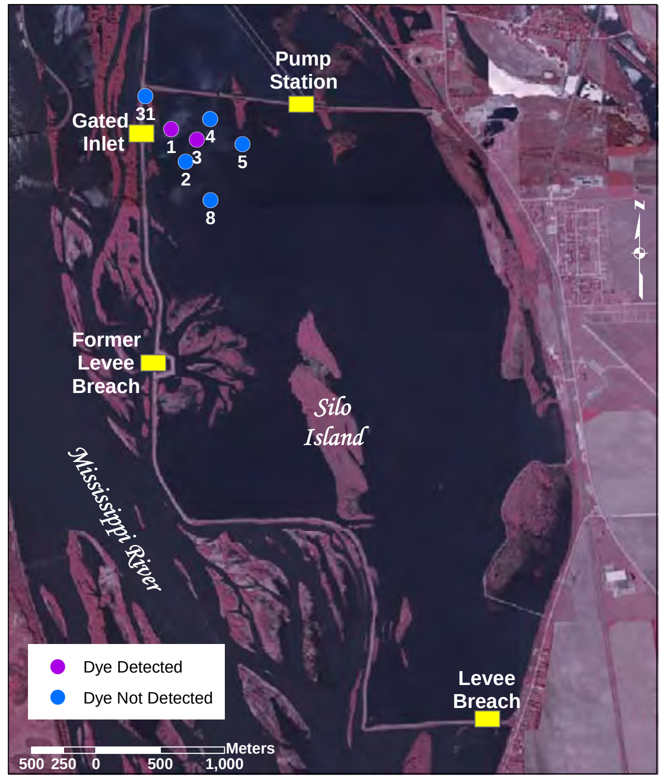


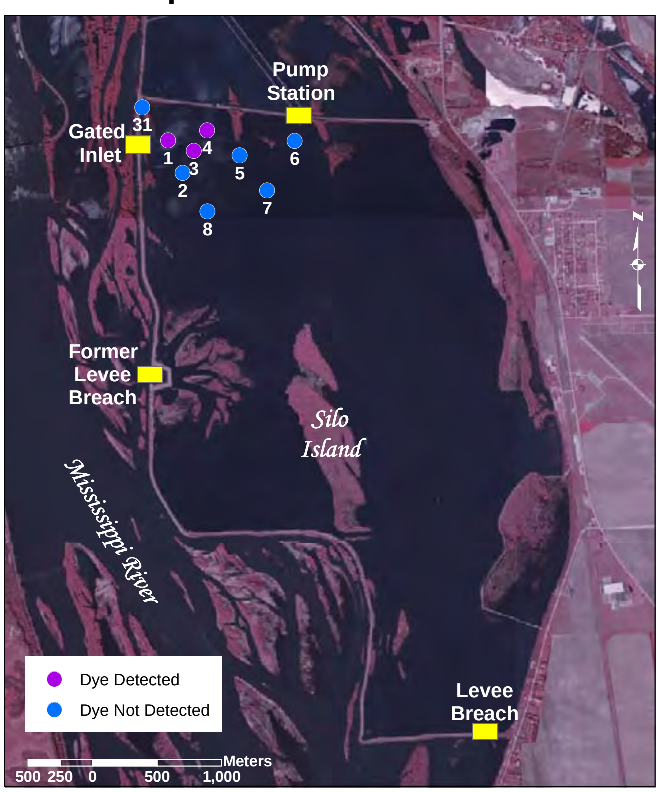
Figure D-7. Spring Lake Dye Dispersion, February 1, 2005.

**Spring Lake Dye Sampling Results
Elapsed Time - 1 Hour**

**Spring Lake Dye Sampling Results
Elapsed Time - 3 Hours**



**Spring Lake Dye Sampling Results
Elapsed Time - 5 1/2 Hours**



**Spring Lake Dye Sampling Results
Elapsed Time - 8 1/2 Hours**

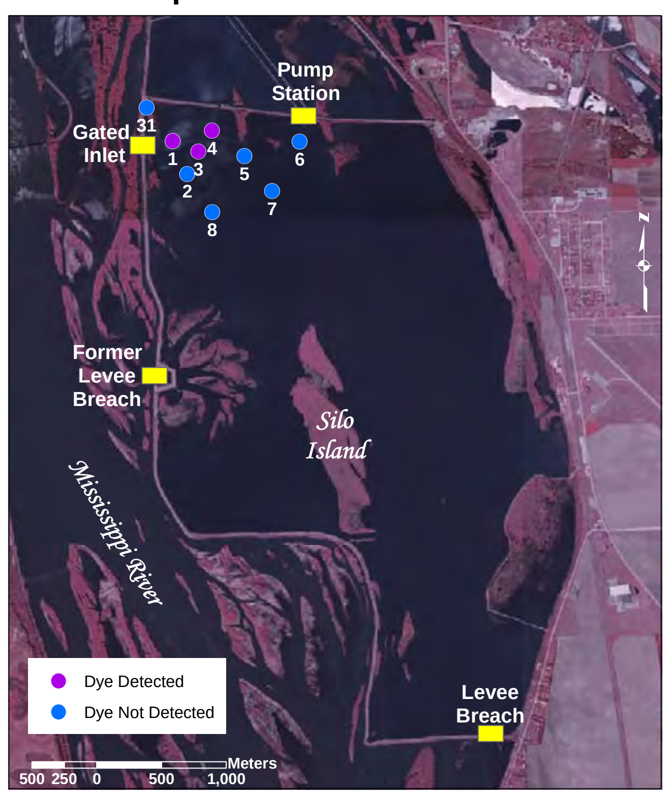
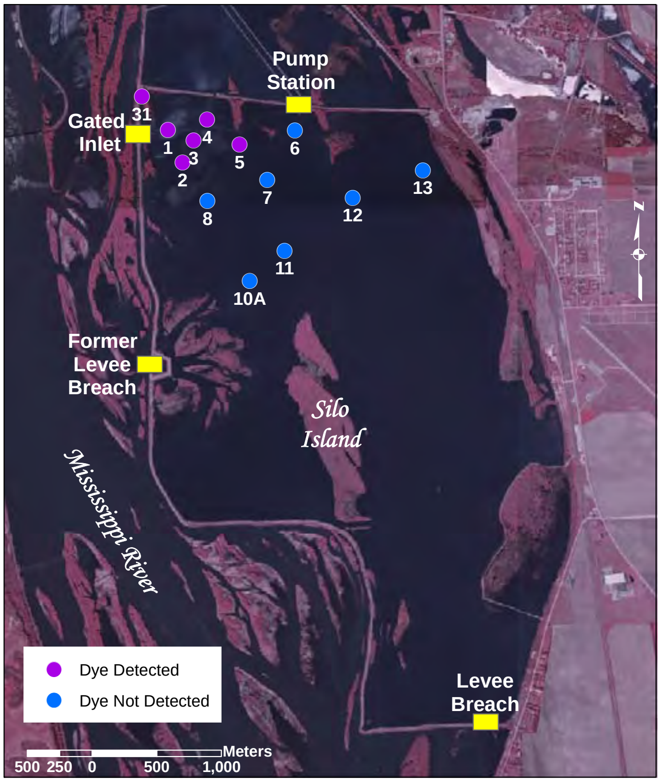
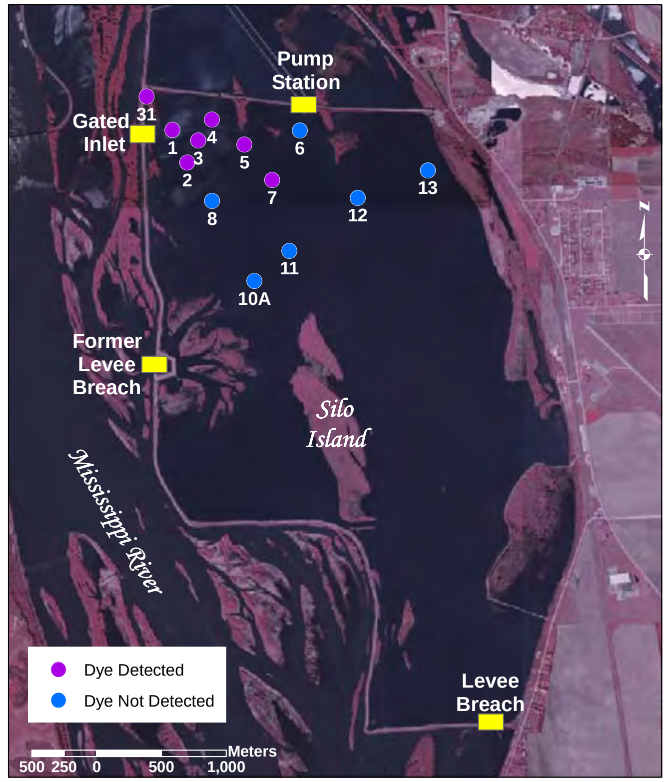


Figure D-8. Spring Lake Dye Dispersion, February 2, 4 and 7, 2005.

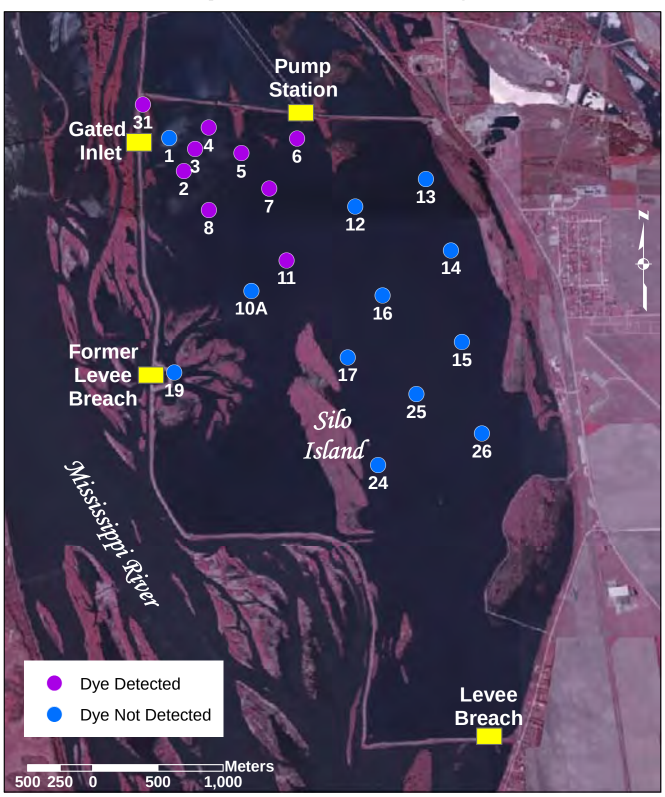
Spring Lake Dye Sampling Results
Elapsed Time - 1 Day



Spring Lake Dye Sampling Results
Elapsed Time - 1 1/4 Days



Spring Lake Dye Sampling Results
Elapsed Time - 3 Days



Spring Lake Dye Sampling Results
Elapsed Time - 6 Days

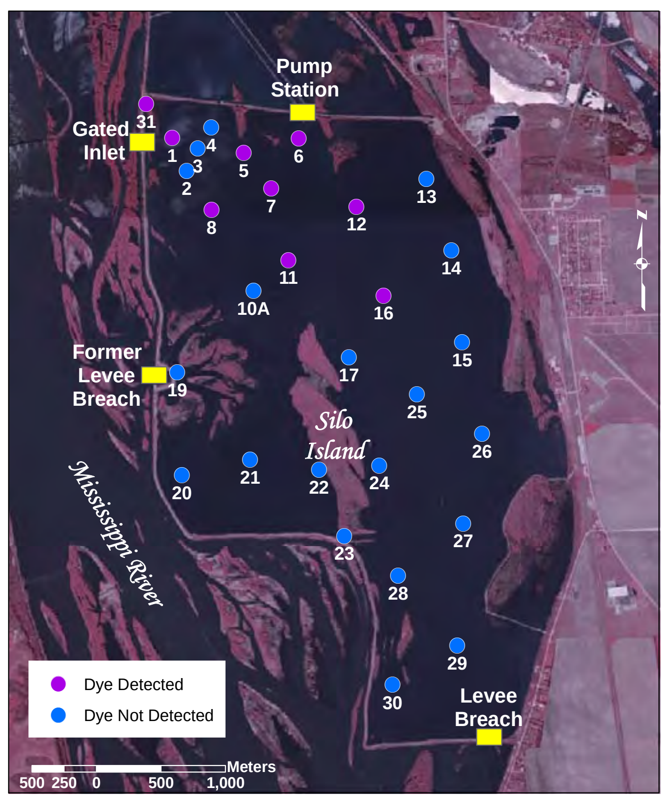
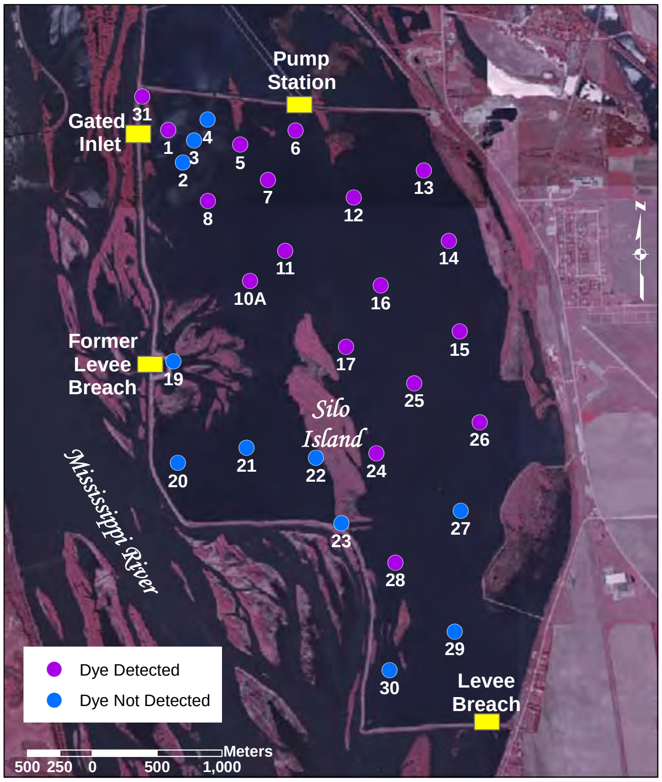
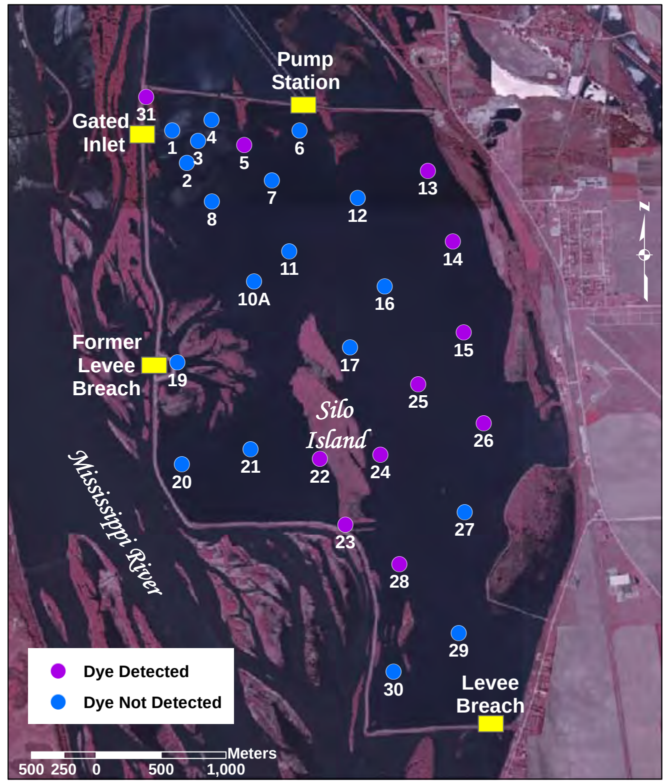


Figure D-9. Spring Lake Dye Dispersion, February 10 and 14, 2005 and a Cumulative Map of all Sites where Dye was Detected.

Spring Lake Dye Sampling Results
Elapsed Time - 9 Days



Spring Lake Dye Sampling Results
Elapsed Time - 13 Days



Spring Lake Dye Sampling Results
Cumulative Dye Detection

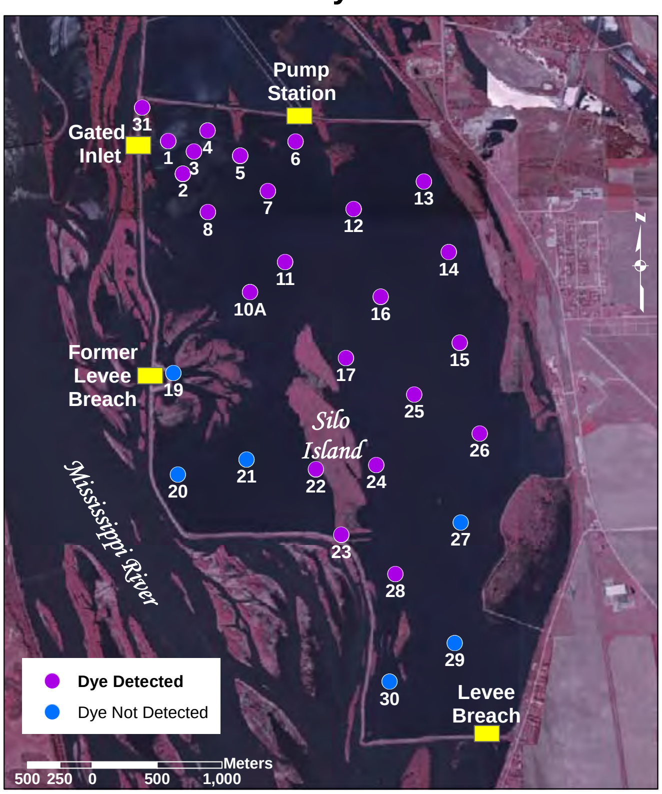


Figure D-10. Location of Fish Capture Sites and Movement of Fish 054C, 074C and 084C on Specified Dates in 2005.

Number of Fish Obtained from each of Six Capture Sites

Location of Fish 054C (Black Crappie) on Specified Dates in 2005

Location of Fish 074C (Black Crappie) on Specified Dates in 2005

Location of Fish 084C (Black Crappie) on Specified Dates in 2005

Figure D-11. Location of Fish 143C, 154C, 164B and 173C on Specified Dates in 2005.

Location of Fish 143C (Black Crappie) on Specified Dates in 2005

Location of Fish 154C (Black Crappie) on Specified Dates in 2005

Location of Fish 164B (Bluegill) on Specified Dates in 2005

Location of Fish 173C (Black Crappie) on Specified Dates in 2005

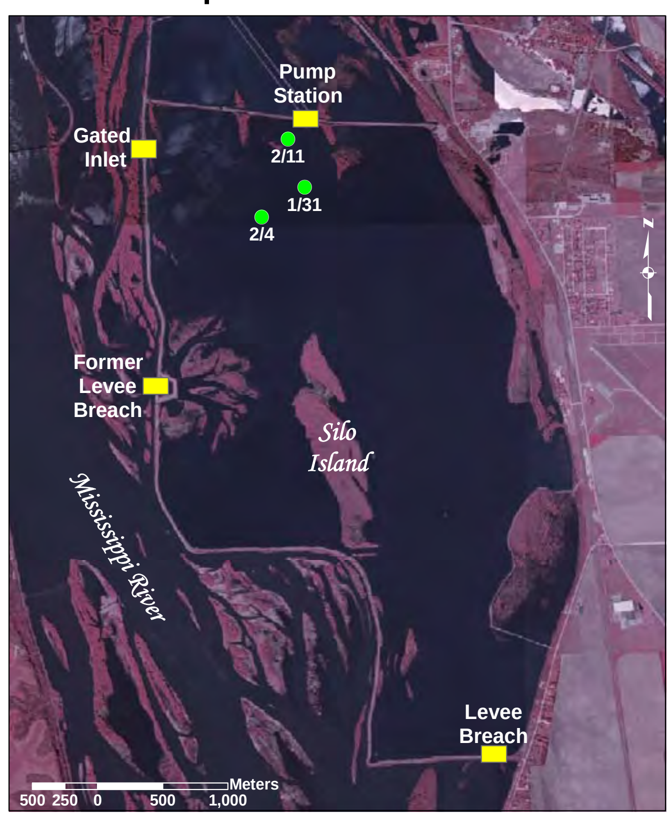
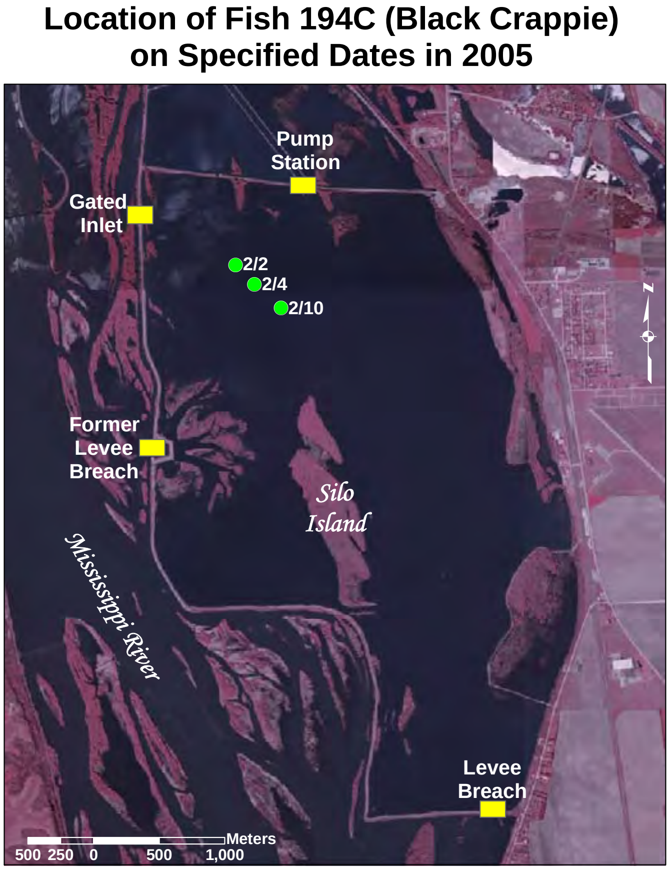
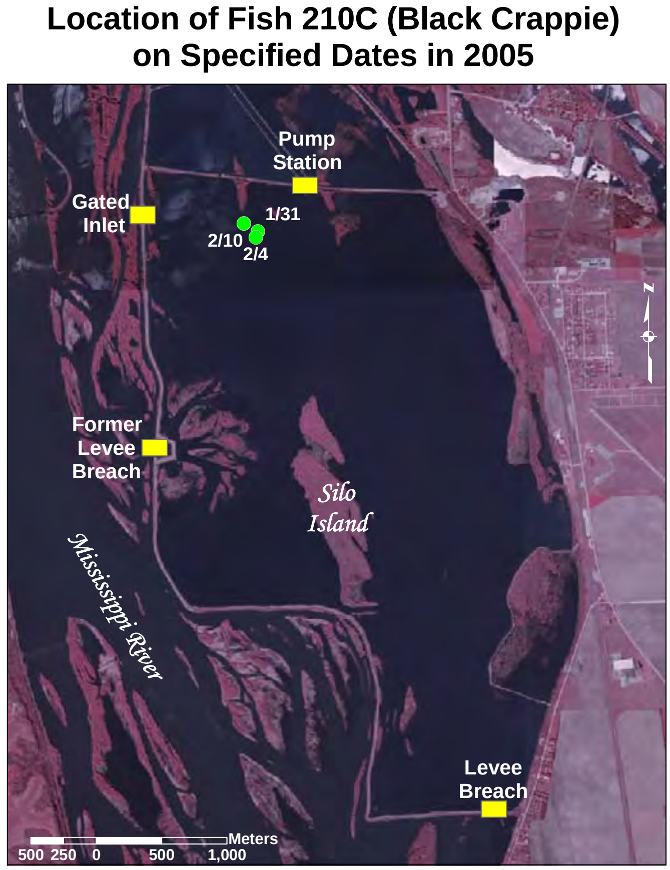
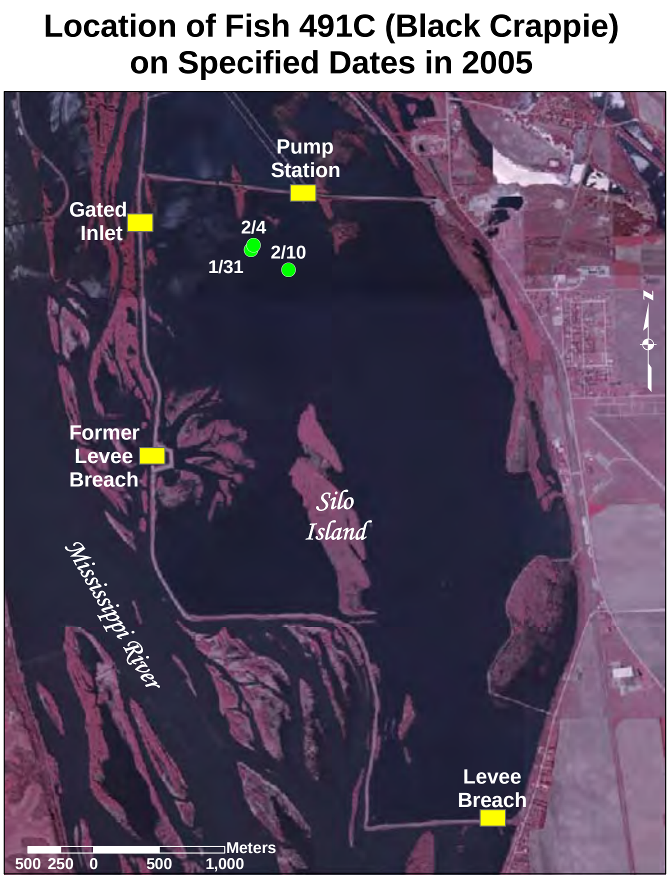


Figure D-12. Location of Fish 194C, 210C, 491C and 631C on Specified Dates in 2005.







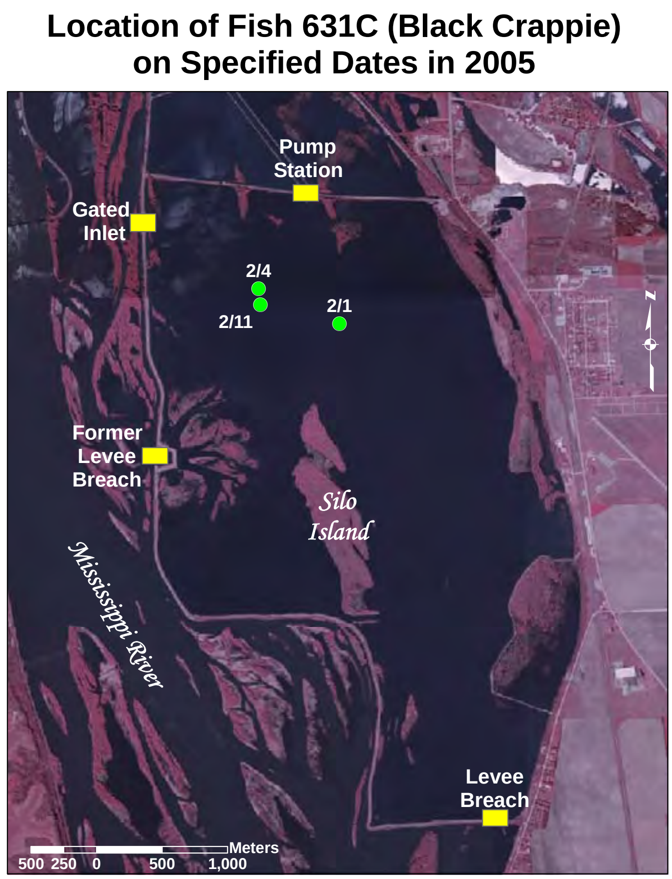
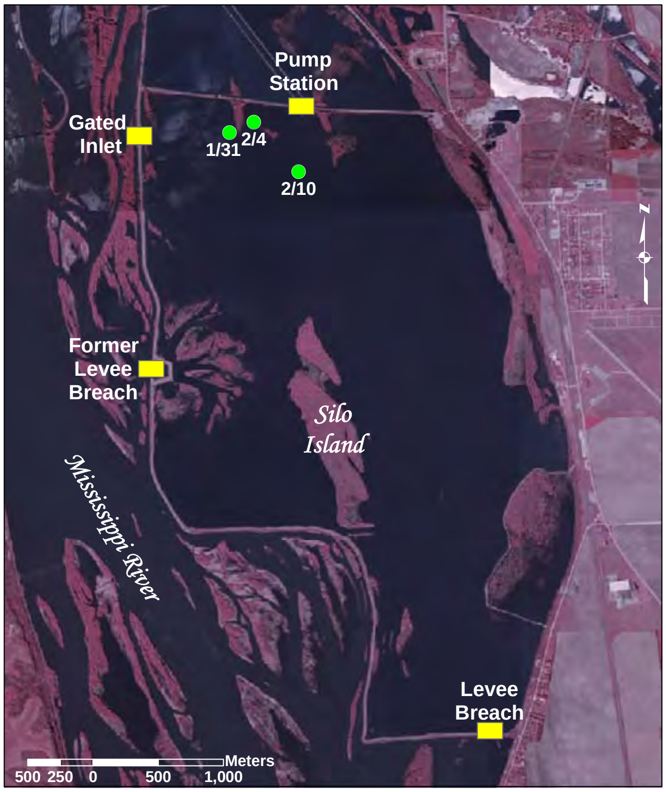
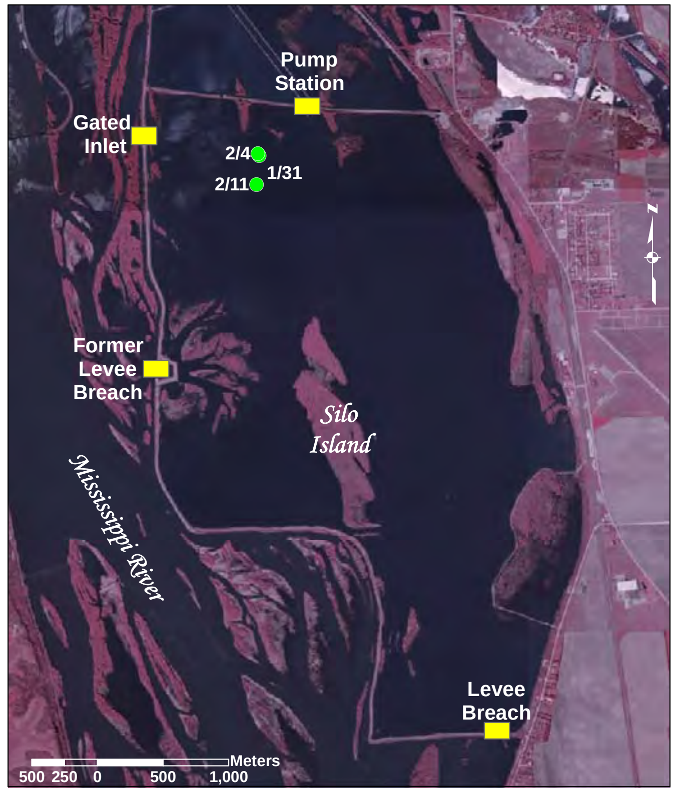


Figure D-13. Location of Fish 711C, 721C, 751C and 770C on Specified Dates in 2005.

Location of Fish 711C (Black Crappie) on Specified Dates in 2005



Location of Fish 721C (Black Crappie) on Specified Dates in 2005



Location of Fish 751C (Black Crappie) on Specified Dates in 2005

Location of Fish 770C (Black Crappie) on Specified Dates in 2005

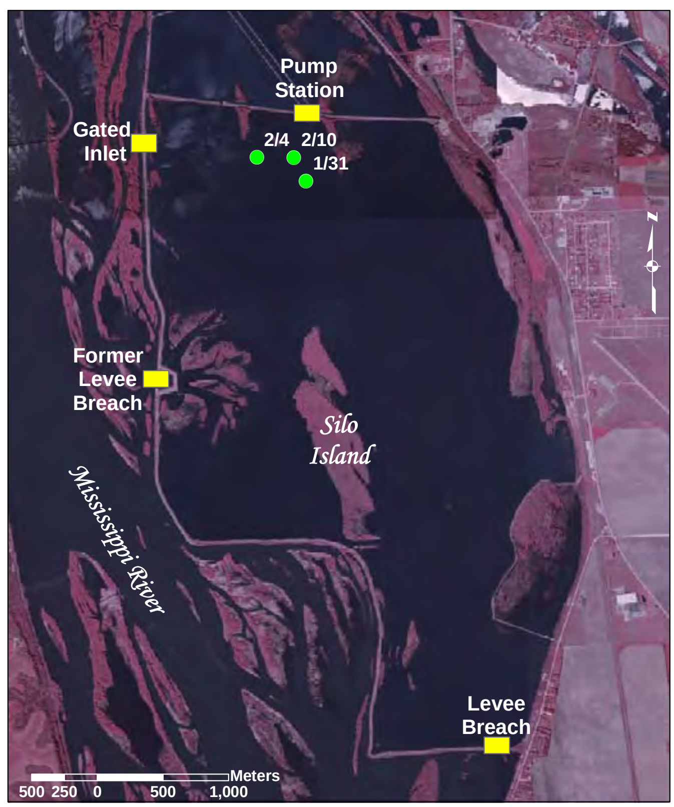
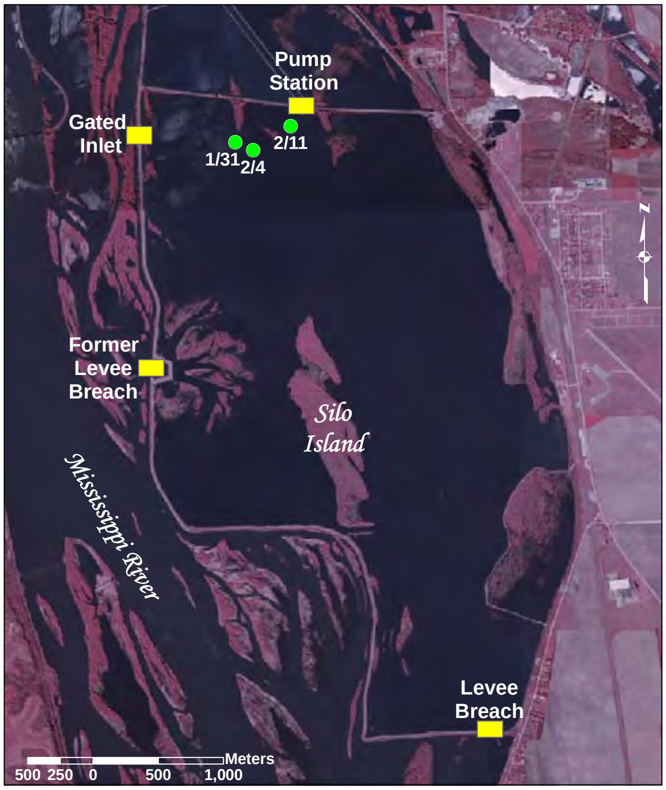
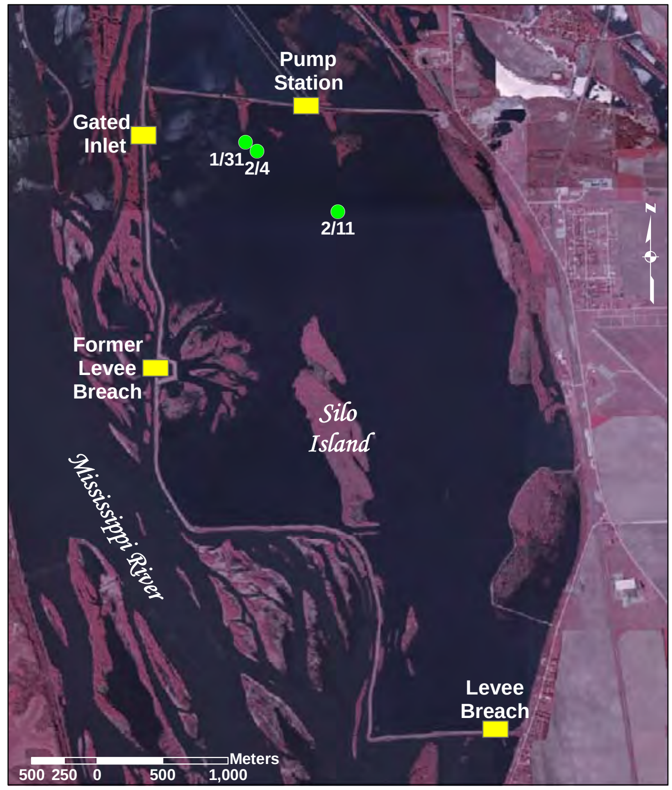


Figure D-14. Location of Fish 810C, 831C, 851C and 890C on Specified Dates in 2005.

Location of Fish 810C (Black Crappie) on Specified Dates in 2005



Location of Fish 831C (Black Crappie) on Specified Dates in 2005



Location of Fish 851C (Black Crappie) on Specified Dates in 2005

Location of Fish 890C (Black Crappie) on Specified Dates in 2005

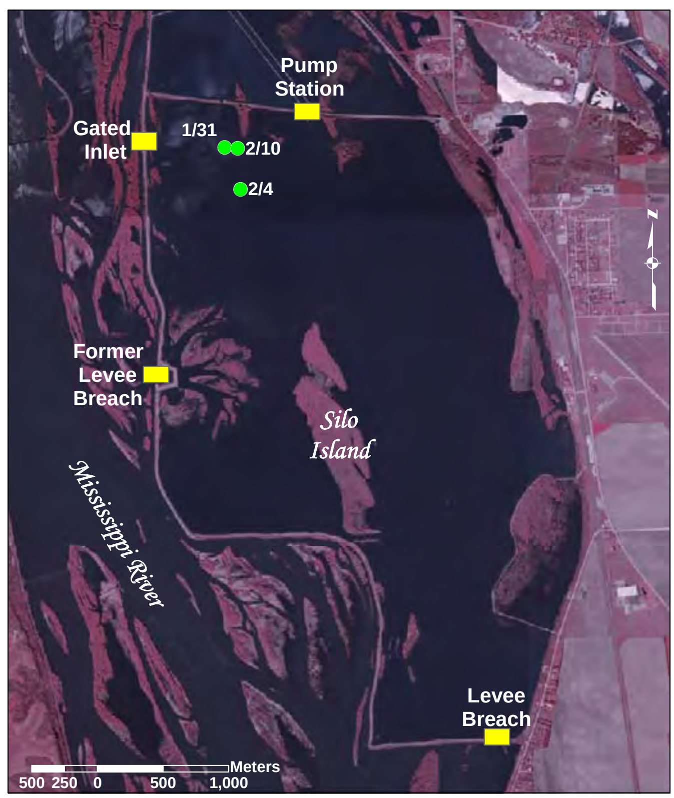


Table D-5. Comparisons of Pre- and Post-Project DO Data from Spring Lake

Site W-M532.6Q	**Pre-Project 5/13/91–5/11/95**	**Post-Project 12/17/98–12/12/02**	**Post-Project 12/12/02-3/8/2012**
Number of Samplings	42	47	66
October – March Samplings	12	14	17
April - September Samplings	30	33	49
DO Concentrations ≤ 5 mg/l	3 (7.1%)	10 (21.3%)	15 (22.7%)
DO Concentrations ≤ 5 mg/l (October – March Samplings)	0	0	1 (5.9%)
DO Concentrations ≤ 5 mg/l (April - September Samplings)	3 (10.0%)	10 (30.3%)	14 (28.6%)
Minimum DO Concentration (mg/l)	3.10	2.20	1.25
Maximum DO Concentration (mg/l)	22.70	22.98	23.05
Average DO Concentration (mg/l)	9.59	8.99	9.04

Site W-M534.8R	**Pre-Project 5/13/91–5/11/95**	**Post-Project 12/17/98–12/12/02**	**Post-Project 12/12/02-3/8/2012**
Number of Samplings	41	45	65
October – March Samplings	13	12	16
April - September Samplings	28	33	49
DO Concentrations ≤ 5 mg/l	4 (9.8%)	5 (11.1%)	12 (18.5%)
DO Concentrations ≤ 5 mg/l (October – March Samplings)	0	1 (8.3%)	0
DO Concentrations ≤ 5 mg/l (April - September Samplings)	4 (14.3%)	4 (12.1%)	12 (24.5%)
Minimum DO Concentration (mg/l)	3.55	3.45	2.51
Maximum DO Concentration (mg/l)	18.37	23.33	23.34
Average DO Concentration (mg/l)	9.62	9.19	9.63

Site W-M534.6V	**Pre-Project 9/29/93–5/11/95**	**Post-Project 12/17/98–9/17/02**	**Post-Project 12/12/02-9/12/2006**
Number of Samplings	18	44	42
October – March Samplings	8	11	10
April - September Samplings	10	33	32
DO Concentrations ≤ 5 mg/l	0	12 (27.3%)	7 (16.7%)
DO Concentrations ≤ 5 mg/l (October – March Samplings)	0	0	0
DO Concentrations ≤ 5 mg/l (April - September Samplings)	0	12 (36.4%)	7 (21.9%)
Minimum DO Concentration (mg/l)	5.38	1.94	1.33
Maximum DO Concentration (mg/l)	20.60	24.89	23.20
Average DO Concentration (mg/l)	11.14	8.43	9.59

APPENDIX B

Spring Lake HREP Inspection of Completed Works: Trip Report

EC-DN
LSL/ 5150
13 SEPT 2012

PROJECT: Spring Lake Habitat Rehabilitation and Enhancement Project (HREP)

LOCATION: Pool 13, Upper Mississippi River Miles 532.5 - 536.0
Carroll County, Illinois

DATE OF FIELD VISITS: 28 SEPT 2011 and 17 APR 2012

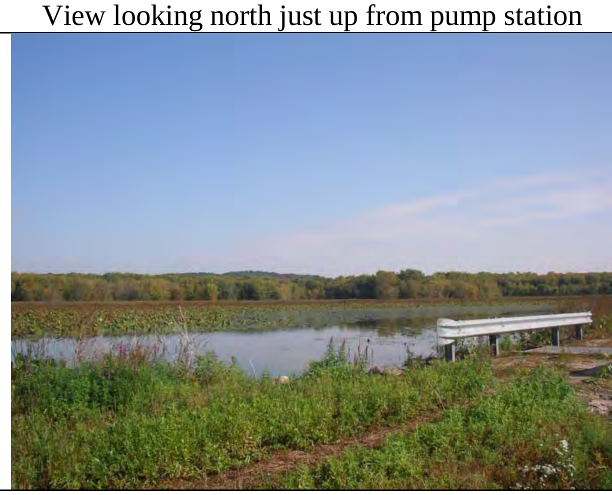
ATTENDEES: **28 SEPT 2011 Trip** USACE: Darron Niles, Randy Kraciun, Amanda Geddes; FWS: Ed Britton
17 APR 2012 Trip USACE: Elizabeth Bruns, Laura St. Louis, Matt Afflerbaugh; FWS: Bill Davison, John K.

OBSERVATIONS:

- There are persistent beaver dams issues near two of the gatewells. These are cleaned out approximately every two days by FWS personnel.
- There is an issue with the loss of rip rap and a scour area that was brought to the attention of the Corps by Ed Britton in an April 2012 email.
- The FWS added rock to Cell B's eastern interior berm to protect against wave induced erosion from wind fetch.
- Overall, the Spring Lake project is functioning well.

RECOMMENDATIONS: Information in this memo shall be incorporated into next Performance Evaluation Report (scheduled for FY12).

Enclosures:
Site Visit Photos
Site Plan

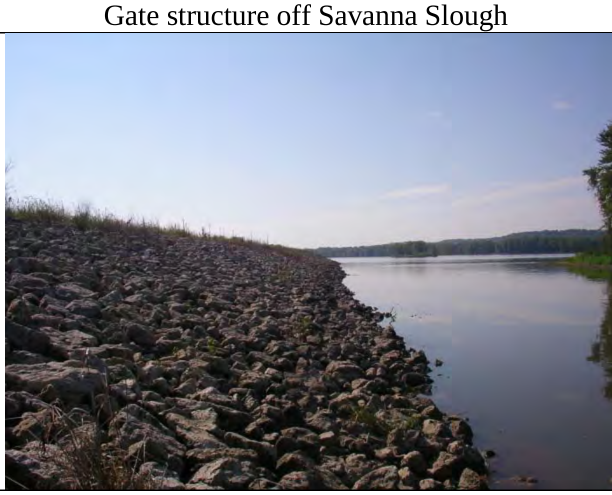
	
Spring Lake Site Visit 28-SEP-2011 Pump station near main entrance (looking SE)	Spring Lake Site Visit 28-SEP-2011 View looking north from pump station
	
Spring Lake Site Visit 28-SEP-2011 View looking SE (pump station to right off camera)	Spring Lake Site Visit 28-SEP-2011 View looking north just up from pump station
	
Spring Lake Site Visit 28-SEP-2011 View looking north just up from pump station	Spring Lake Site Visit 28-SEP-2011 View looking NE across from pump station


Spring Lake Site Visit 28-SEP-2011
Interior levee


Spring Lake Site Visit 28-SEP-2011


Spring Lake Site Visit 28-SEP-2011
Gate structure off Savanna Slough


Spring Lake Site Visit 28-SEP-2011
Interior view looking east from west side


Spring Lake Site Visit 28-SEP-2011
Looking southwest at Mississippi from exterior of containment levee. 2008 flood damage repair.


Spring Lake Site Visit 28-SEP-2011
Interior view looking east from west side

Spring Lake Site Visit 28-SEP-2011
Looking south from west side levee

Spring Lake Site Visit 28-SEP-2011
Great Egrets at rest in trees on west side

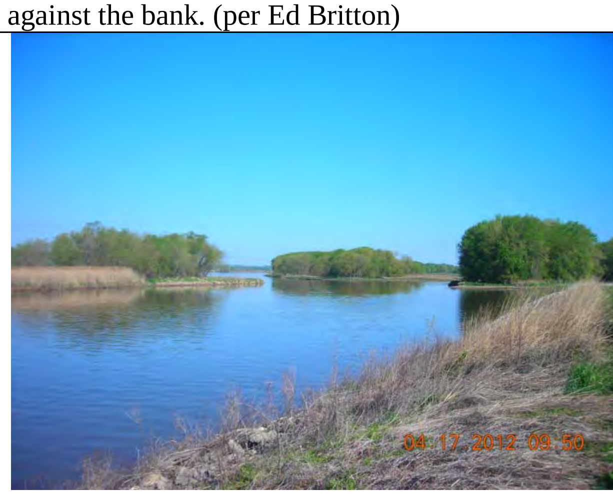
Spring Lake Site Visit 28-SEP-2011
Great Egrets at rest in trees

Spring Lake Site Visit 28-SEP-2011
Great Egrets at rest in trees

Spring Lake Site Visit 28-SEP-2011
Well water pump on at Hemi-Marsh

Spring Lake Site Visit 28-SEP-2011
East side looking west

	
Spring Lake Site Visit 28-SEP-2011 East side looking southwest.	Spring Lake Site Visit 28-SEP-2011 West view from visitor overlook, Hemi-Marsh.
	
Spring Lake Site Visit 28-SEP-2011 Northwest view from visitor overlook.	Spring Lake Site Visit 28-SEP-2011 Southwest view from visitor overlook.

	
Spring Lake Site Visit 17-APR-2012 West levee.	Spring Lake Site Visit 17-APR-2012 Erosion at base of west levee. The water depth is 20-25’ just a few feet offshore with strong currents against the bank. (per Ed Britton)
	
Spring Lake Site Visit 17-APR-2012 Erosion at base of west levee.	Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012


Spring Lake Site Visit 17-APR-2012


Spring Lake Site Visit 17-APR-2012


Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012


Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Toad
Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

	
Gate Well Spring Lake Site Visit 17-APR-2012	Spring Lake Site Visit 17-APR-2012
	
Pump Station Spring Lake Site Visit 17-APR-2012	Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Pump station near main entrance (looking SE)
Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012


Spring Lake Site Visit 17-APR-2012

Red-Winged Blackbird
Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

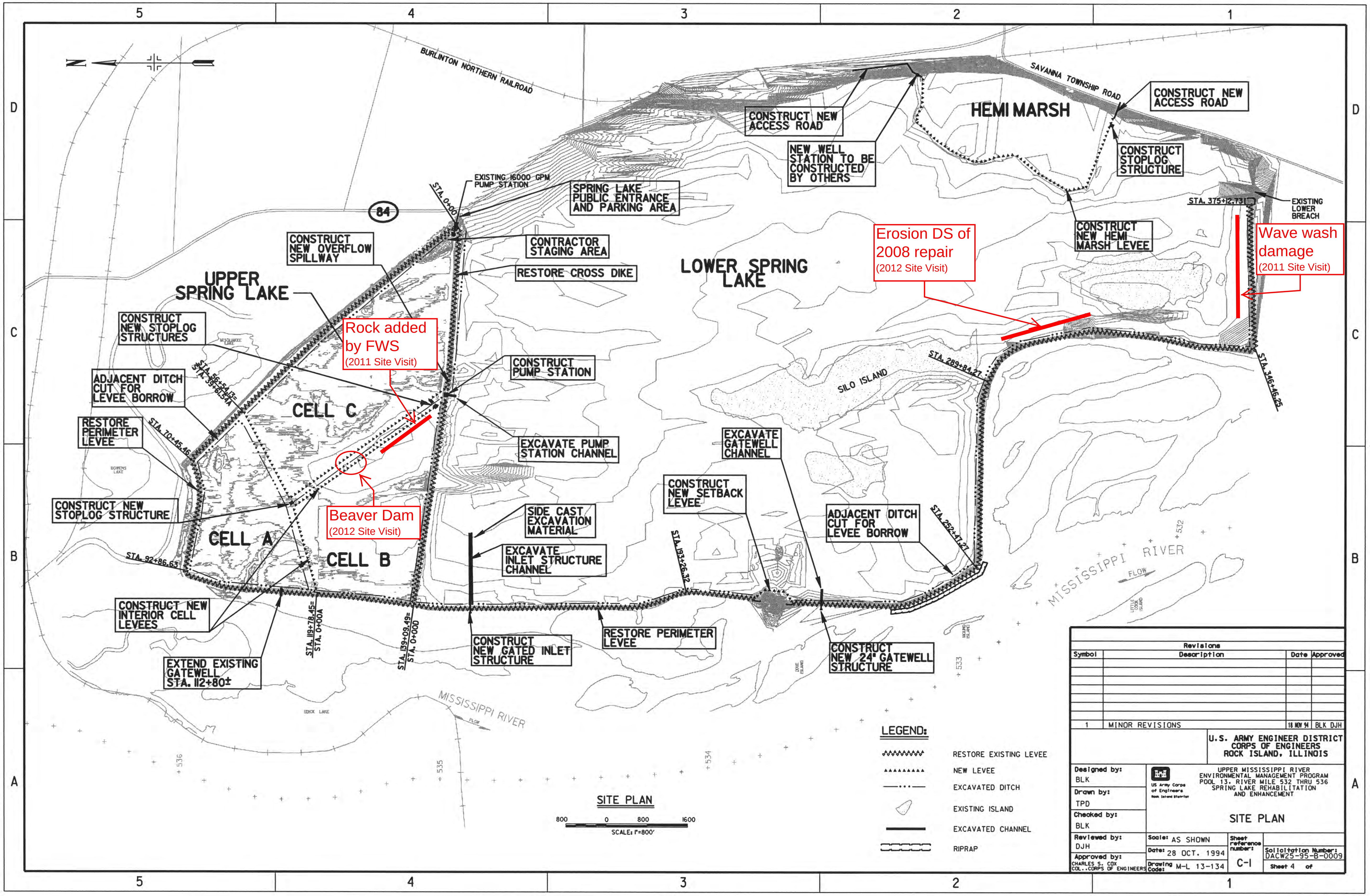
Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Spring Lake Site Visit 17-APR-2012

Persistent beaver dam between cells A and B
Spring Lake Site Visit 17-APR-2012

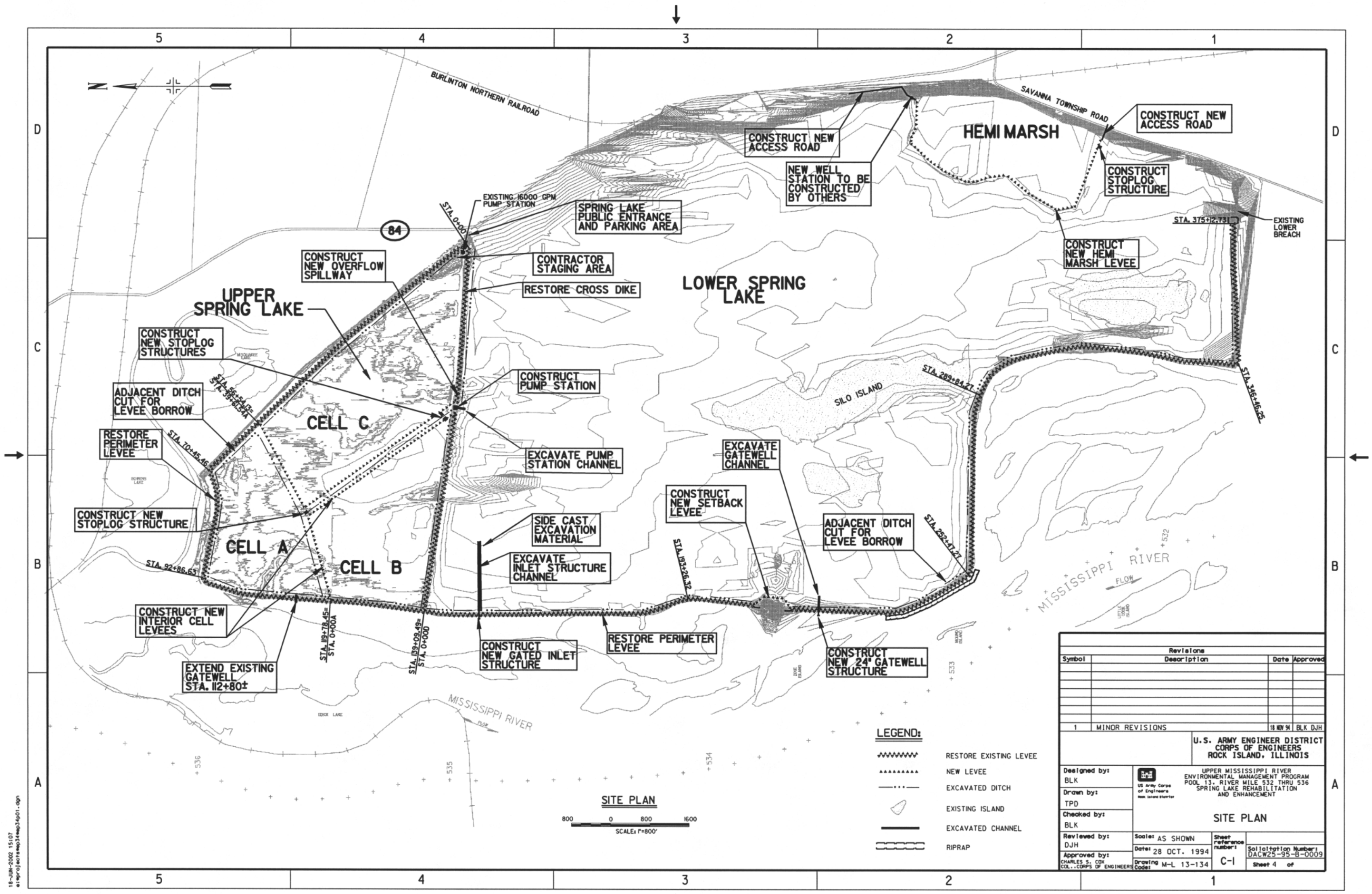
	
Persistent Beaver Dam Spring Lake Site Visit 17-APR-2012	


BURLINGTON NORTHERN RAILROAD
SAVANNA TOWNSHIP ROAD
HEMI MARSH
CONSTRUCT NEW ACCESS ROAD
NEW WELL STATION TO BE CONSTRUCTED BY OTHERS
CONSTRUCT STOPLOG STRUCTURE
EXISTING 16000 GPM PUMP STATION
SPRING LAKE PUBLIC ENTRANCE AND PARKING AREA
CONTRACTOR STAGING AREA
RESTORE CROSS DIKE
CONSTRUCT NEW OVERFLOW SPILLWAY
UPPER SPRING LAKE
LOWER SPRING LAKE
Erosion DS of 2008 repair (2012 Site Visit)
Wave wash damage (2011 Site Visit)
CONSTRUCT NEW HEMI MARSH LEVEE
EXISTING LOWER BREACH
CONSTRUCT NEW STOPLOG STRUCTURES
Rock added by FWS (2011 Site Visit)
ADJACENT DITCH CUT FOR LEVEE BORROW
RESTORE PERIMETER LEVEE
CELL C
CONSTRUCT PUMP STATION
EXCAVATE PUMP STATION CHANNEL
SILO ISLAND
EXCAVATE GATEWELL CHANNEL
Beaver Dam (2012 Site Visit)
CONSTRUCT NEW STOPLOG STRUCTURE
CELL A
CELL B
SIDE CAST EXCAVATION MATERIAL
EXCAVATE INLET STRUCTURE CHANNEL
CONSTRUCT NEW SETBACK LEVEE
ADJACENT DITCH CUT FOR LEVEE BORROW
MISSISSIPPI RIVER
CONSTRUCT NEW INTERIOR CELL LEVEES
EXTEND EXISTING GATEWELL STA. 112+80±
CONSTRUCT NEW GATED INLET STRUCTURE
RESTORE PERIMETER LEVEE
CONSTRUCT NEW 24" GATEWELL STRUCTURE
MISSISSIPPI RIVER
SITE PLAN
SCALE: 1"=800'
LEGEND:
RESTORE EXISTING LEVEE
NEW LEVEE
EXCAVATED DITCH
EXISTING ISLAND
EXCAVATED CHANNEL
RIPRAP
1 MINOR REVISIONS 18 NOV 94 BLK DJH
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM POOL 13, RIVER MILE 532 THRU 536 SPRING LAKE REHABILITATION AND ENHANCEMENT
SITE PLAN
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Scale: AS SHOWN
Date: 28 OCT. 1994
Drawing Code: M-L 13-134
C-1
Solicitation Number: DACW25-95-B-0009

APPENDIX C

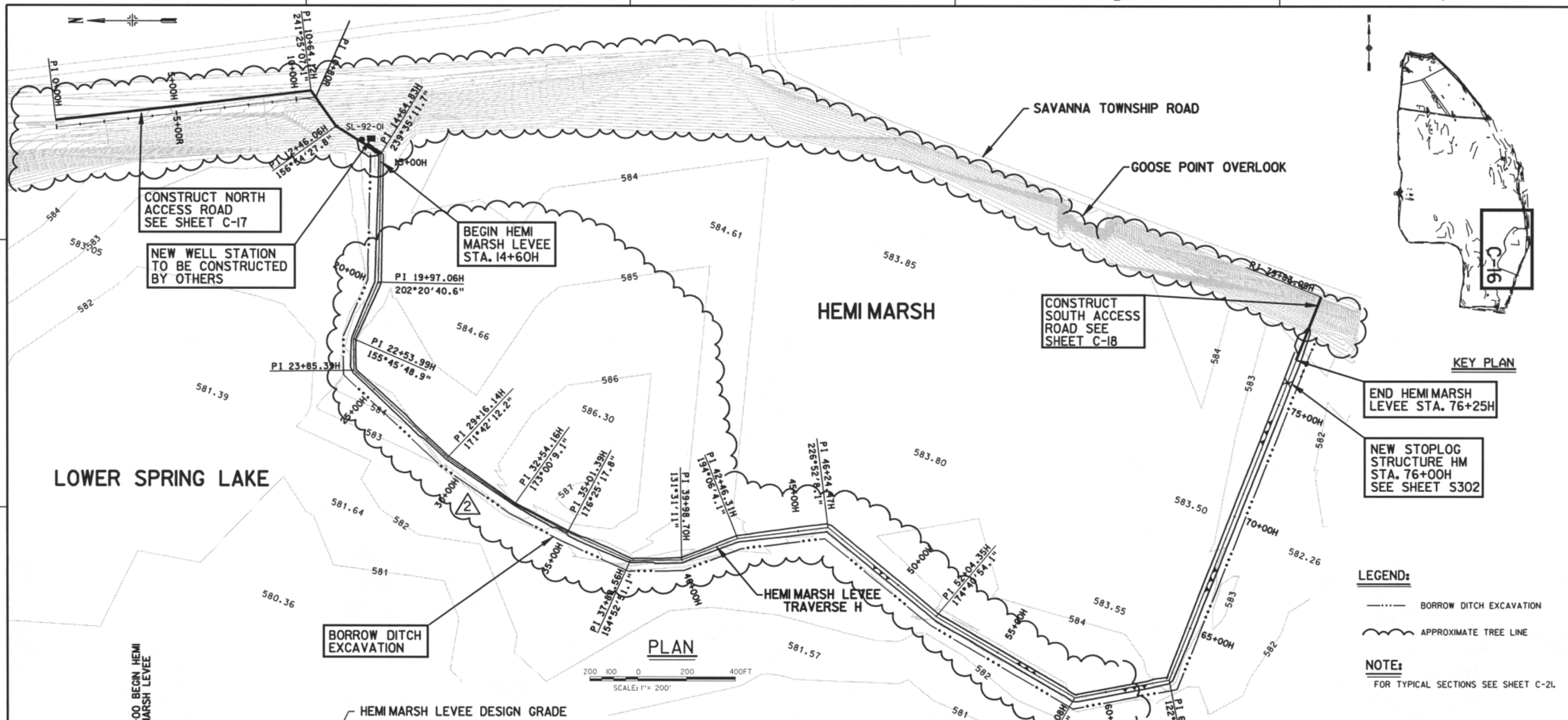
Project Plates

2012 Sediment Transects



BURLINTON NORTHERN RAILROAD
SAVANNA TOWNSHIP ROAD
HEMI MARSH
CONSTRUCT NEW ACCESS ROAD
CONSTRUCT NEW ACCESS ROAD
NEW WELL STATION TO BE CONSTRUCTED BY OTHERS
CONSTRUCT STOPLOG STRUCTURE
CONSTRUCT NEW HEMI MARSH LEVEE
STA. 375+12.73
EXISTING LOWER BREACH
EXISTING 16000 GPM PUMP STATION
STA. 0+00
84
SPRING LAKE PUBLIC ENTRANCE AND PARKING AREA
CONTRACTOR STAGING AREA
RESTORE CROSS DIKE
CONSTRUCT NEW OVERFLOW SPILLWAY
UPPER SPRING LAKE
LOWER SPRING LAKE
CONSTRUCT NEW STOPLOG STRUCTURES
CONSTRUCT PUMP STATION
ADJACENT DITCH CUT FOR LEVEE BORROW
RESTORE PERIMETER LEVEE
STA. 70+45.46
CELL C
EXCAVATE PUMP STATION CHANNEL
SILO ISLAND
STA. 289+84.27
STA. 346+46.25
EXCAVATE GATEWELL CHANNEL
CONSTRUCT NEW STOPLOG STRUCTURE
CONSTRUCT NEW SETBACK LEVEE
SIDE CAST EXCAVATION MATERIAL
EXCAVATE INLET STRUCTURE CHANNEL
ADJACENT DITCH CUT FOR LEVEE BORROW
STA. 252+47.27
MISSISSIPPI RIVER
FLOW
CELL A
CELL B
STA. 92+86.63
STA. 193+26.32
CONSTRUCT NEW INTERIOR CELL LEVEES
STA. 119+78.45= STA. 0+00A
STA. 139+09.49= STA. 0+000
CONSTRUCT NEW GATED INLET STRUCTURE
RESTORE PERIMETER LEVEE
CONSTRUCT NEW 24" GATEWELL STRUCTURE
EXTEND EXISTING GATEWELL STA. 112+80±
MISSISSIPPI RIVER
SITE PLAN
800 0 800 1600
SCALE: 1"=800'
LEGEND:
RESTORE EXISTING LEVEE
NEW LEVEE
EXCAVATED DITCH
EXISTING ISLAND
EXCAVATED CHANNEL
RIPRAP
Revisions
Symbol | Description | Date | Approved
1 MINOR REVISIONS 18 NOV 94 BLK DJH
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: CHARLES S. COX COL., CORPS OF ENGINEERS
UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM POOL 13, RIVER MILE 532 THRU 536 SPRING LAKE REHABILITATION AND ENHANCEMENT
SITE PLAN
Scale: AS SHOWN
Date: 28 OCT. 1994
Drawing Code: M-L 13-134
Sheet reference number: C-1
Solicitation Number: DACW25-95-B-0009
Sheet 4 of

PLATE 1



Symbol	Description	Date	Approved
2	AMD. #1 MOVE BORROW EXCAVATION DITCH TO EXTERIOR	15 DEC 94	BLK DJH
1	MINOR REVISIONS	18 NOV 94	BLK DJH

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

UPPER MISSISSIPPI RIVER
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13, RIVER MILE 532 THRU 536
SPRING LAKE REHABILITATION
AND ENHANCEMENT

HEMI MARSH LEVEE PLAN AND PROFILE

Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: CHARLES S. COX COL., CORPS OF ENGINEERS

Scale: AS SHOWN
Date: 28 OCT. 1994
Drawing Code: M-L 13-134
Sheet reference number: C-16
Solicitation Number: DACW25-95-B-0009
Sheet 19 of

PLATE 2

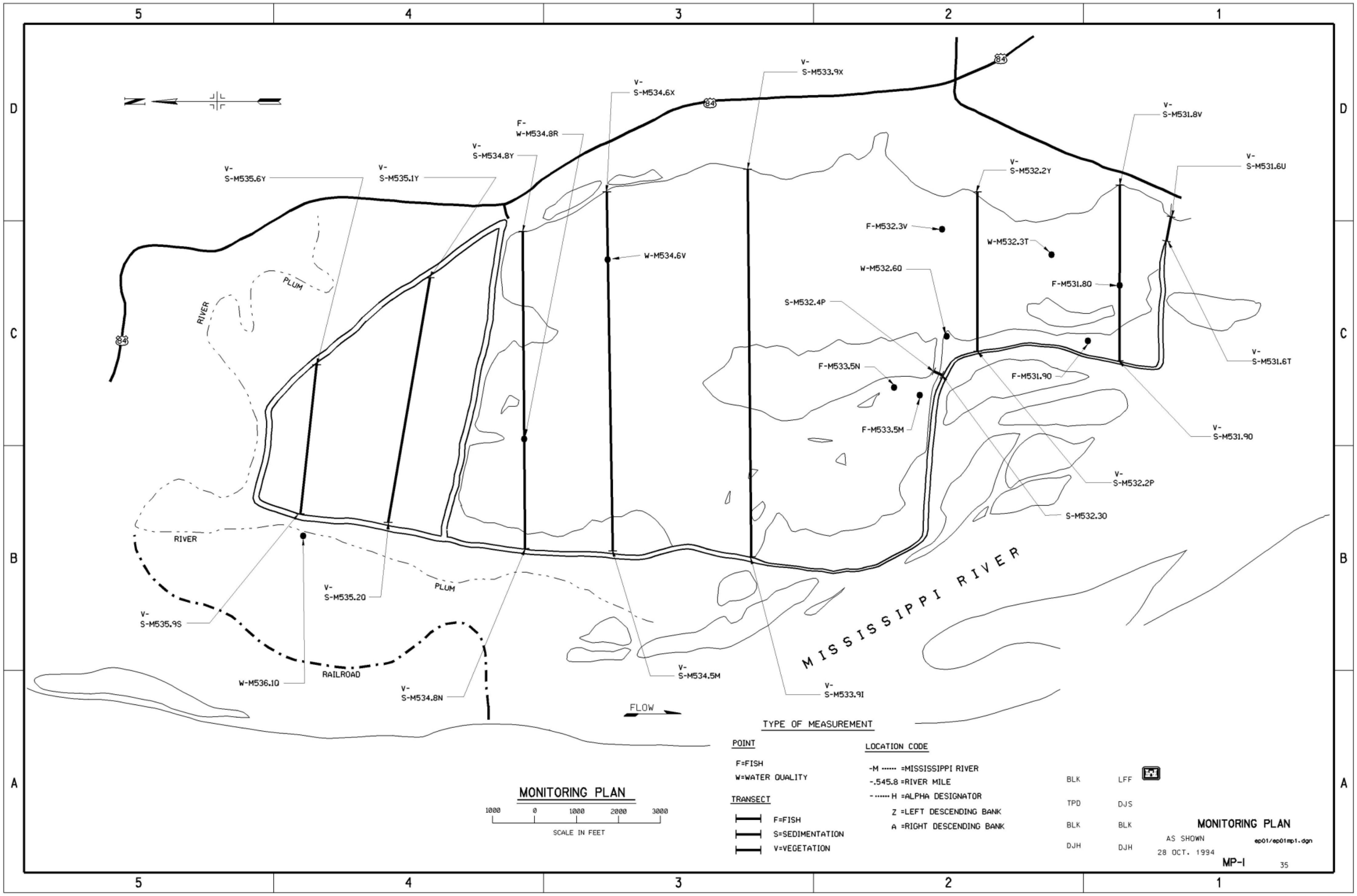


PLATE 3

10-MAR-2003 09:07
ei:projects:ep48:ep01mp1.dgn

APPENDIX D

2006-2011 Annual Fall Flight Survey

Spring Lake (Upper)	2011	2010	2009	2008	2007	2006
Swans	1025	195	90	1800	30	1100
Canada Geese	990	2840	1130	1865	1930	1695
Other Geese	0	0	0	0	0	0
Mallard	1140	1470	1635	4800	210	2845
Blackduck	0	50	0	0	0	0
Pintail	775	410	300	310	200	130
Gadwall	1250	5325	935	3350	100	395
Wigeon	0	1300	150	230	0	30
N. Sholveler	265	520	0	0	0	85
Blue-Winged Teal	50	0	0	0	0	20
Green-Winged Teal	250	260	725	300	0	35
Woodduck	0	0	0	0	0	115
Red Head	0	0	0	0	0	0
Canvasback	0	450	0	0	0	0
Ringneck	25	1600	30	0	0	25
Scaup	0	100	0	0	0	150
C. Goldeneye	0	0	50	0	0	0
Bufflehead	50	60	0	0	0	0
Merganser	0	0	0	0	0	0
Ruddy Duck	50	200	0	0	0	0
Great Blue Heron	0	0	0	0	25	1
Great Egret	0	0	0	0	20	0
Bald Eagle	3	7	1	3	0	1
Coot	1325	11300	1600	250	130	615
White Pelican	0	5	0	0	400	0
Cormorant	0	0	0	110	0	0

Spring Lake (Lower)	2011	2010	2009	2008	2007	2006
Swans	5100	2652	1520	1805	1415	1570
Canada Geese	12670	8845	8205	7400	8855	7415
Other Geese	0	25	0	0	6300	0
Mallard	48105	12275	16640	23070	10460	10750
Blackduck	250	260	0	0	2200	75
Pintail	26150	5030	4815	5600	9280	650
Gadwall	32250	10490	10180	9200	10580	5600
Wigeon	5280	3395	2090	2700	3230	1755
N. Sholveler	10130	1250	1925	0	300	380
Blue-Winged Teal	400	0	0	0	0	590
Green-Winged Teal	21860	2895	7830	1750	1500	640
Woodduck	0	0	0	0	0	490
Red Head	2915	0	0	0	0	20
Canvasback	59860	13960	29880	15700	10050	9150
Ringneck	36530	7135	11170	5500	3900	585
Scaup	20890	2550	4570	1500	0	995
C. Goldeneye	0	0	0	10	700	0
Bufflehead	4300	0	200	100	300	0
Merganser	2635	110	0	2000	0	30
Ruddy Duck	5990	3260	1000	100	0	30
Great Blue Heron	0	0	0	0	0	16
Great Egret	0	0	0	10	56	5
Bald Eagle	27	49	33	8	6	61
Coot	120040	77745	52110	38600	34760	4225
White Pelican	995	1040	240	585	1510	185
Cormorant	10	215	0	50	0	0

Spring Lake (Upper)	Sept 19, 2011	Oct 3, 2011	Oct 10, 2011	Oct 17, 2011	Oct 24, 2011	Oct 31,2011	Nov 7, 2011	Nov 14, 2011	Nov 21, 2011	Nov28, 2011	Dec 5, 2011	Total 2011
Swans					5	20	260	190	75	420	55	1025
Canada Geese				425	20	35	20	55	210	150	75	990
Other Geese												0
Mallard				300	50	175	200	50	100	200	65	1140
Blackduck												0
Pintail				200	100	275		50		50	100	775
Gadwall					50	300	100	300	200	300		1250
Wigeon												0
N. Sholveler							150		50	25	40	265
Blue-Winged Teal			50									50
Green-Winged Teal					100	100				50		250
Woodduck												0
Red Head												0
Canvasback												0
Ringneck										25		25
Scaup												0
C. Goldeneye												0
Bufflehead									50			50
Merganser												0
Ruddy Duck									50			50
Great Blue Heron												0
Great Egret												0
Bald Eagle					1					1	1	3
Coot				300	325	350	250	100				1325
White Pelican												0
Cormorant												0

Spring Lake (Upper)	Sept 27, 2010	Oct 4, 2010	Oct12, 2010	Oct18,2012	Oct25,2010	Nov1,2010	Nov 8, 2010	Nov 15,2010	Nov 23, 2010	Nov 29, 2010	Dec 8, 2010	**Total 2010**
Swans							30	150		15		195
Canada Geese			95	160	100	200	150	2050		85		2840
Other Geese												0
Mallard			60	100		400	150	350		410		1470
Blackduck										50		50
Pintail			10	50		200	50	100				410
Gadwall			25	500	50	1700	1000	1600		450		5325
Wigeon			100	500		500	200					1300
N. Sholveler			20			300		50		150		520
Blue-Winged Teal												0
Green-Winged Teal			10	50		200						260
Woodduck												0
Red Head												0
Canvasback								100		350		450
Ringneck			150	100	200	300	300	200		350		1600
Scaup										100		100
C. Goldeneye												0
Bufflehead								60				60
Merganser												0
Ruddy Duck								200				200
Great Blue Heron												0
Great Egret												0
Bald Eagle			1		1					5		7
Coot			300	1000	2000	5300	1000	1700				11300
White Pelican				5								5
Cormorant												0

Spring Lake (Upper)	Sept 30, 2009	Oct 5, 2009	Oct 13, 2009	Oct 19, 2009	Oct 26, 2009	Nov 2, 2009	Nov 9, 2009	Nov 16, 2009	Nov 23, 2009	Nov 30, 2009	Dec 7, 2009	Total 2009	Oct 13, 2008	Oct 28, 2008	Nov 3, 2008	Nov 10, 2008	Nov 18, 2008	Nov 25, 2008	Dec 2, 2008	Total 2008
Swans				10		15	10		55			90		210	100	170	410	650	260	1800
Canada Geese			350	560		190	20		10			1130	100	250	250	750	30	435	50	1865
Other Geese												0								0
Mallard			100	1000		50	300		185			1635		100	900	1100	1950	600	150	4800
Blackduck												0								0
Pintail			50	200		50						300				200	110			310
Gadwall			50	200		200	175		310			935	50	100	600	2500	100			3350
Wigeon							150					150			30	200				230
N. Sholveler												0								0
Blue-Winged Teal												0								0
Green-Winged Teal			100	300		200	125					725			200	100				300
Woodduck												0								0
Red Head												0								0
Canvasback												0								0
Ringneck									30			30								0
Scaup												0								0
C. Goldeneye									50			50								0
Bufflehead												0								0
Merganser												0								0
Ruddy Duck												0								0
Great Blue Heron												0								0
Great Egret												0								0
Bald Eagle						1						1	1						2	3
Coot			700	300		100	300		200			1600	150	100						250
White Pelican												0								0
Cormorant												0	110							110

Spring Lake (Upper)	Oct 9, 2007	Oct 22, 2007	Oct 29, 2007	Nov 13, 2007	Nov 21,2007	Nov 27, 2007	Dec 4, 2007	Total 2007	Oct 2, 2006	Oct 10, 2006	Oct 19, 2006	Oct 30, 2006	Nov 7, 2006	Nov 20, 2006	Nov 30, 2006	Total 2006
Swans						30		30			5	50	205	390	450	1100
Canada Geese	175	300	950	5		500		1930	30	95	195	160	310	270	635	1695
Other Geese								0								0
Mallard				110	100			210	105	80	370	300	485	670	835	2845
Blackduck								0								0
Pintail	150	50						200	15		80		35			130
Gadwall					100			100		35	110	105		145		395
Wigeon								0		5	25					30
N. Sholveler								0				25		15	45	85
Blue-Winged Teal								0	10	10						20
Green-Winged Teal								0			30	5				35
Woodduck								0	20	65	30					115
Red Head								0								0
Canvasback								0								0
Ringneck								0					25			25
Scaup								0						50	100	150
C. Goldeneye								0								0
Bufflehead								0								0
Merganser								0								0
Ruddy Duck								0								0
Great Blue Heron			25					25				1				1
Great Egret			20					20								0
Bald Eagle								0							1	1
Coot				130				130				380	235			615
White Pelican			200		150	50		400								0
Cormorant								0								0

Spring Lake (Lower)	Sept 19, 2011	Oct 3, 2011	Oct 10, 2011	Oct 17, 2011	Oct 24, 2011	Oct 31,2011	Nov 7, 2011	Nov 14, 2011	Nov 21, 2011	Nov28, 2011	Dec 5, 2011	**Total 2011**
Swans				30	50	235	155	635	1255	930	1810	5100
Canada Geese			1825	1200	1075	1330	550	1700	2300	1500	1190	12670
Other Geese												0
Mallard			300	4050	3450	8050	1700	7250	8000	10000	5305	48105
Blackduck										150	100	250
Pintail			1100	8500	6900	5500	2000	1000	700	300	150	26150
Gadwall			1000	5250	3450	6000	4500	4100	4200	2700	1050	32250
Wigeon			1100	1300	1380	1000	500					5280
N. Sholveler			500	2450	1380	1000	3100	300	200	700	500	10130
Blue-Winged Teal			400									400
Green-Winged Teal			700	5750	3450	6000	2000	1100	1450	1400	10	21860
Woodduck												0
Red Head				325	690	1000		500			400	2915
Canvasback					2070	7500	2500	500	30150	8140	9000	59860
Ringneck				650	1380	1000	10000	4000	9000	6500	4000	36530
Scaup				1300	690	2500	1500	7000	4500	1100	2300	20890
C. Goldeneye												0
Bufflehead						500			500	3300		4300
Merganser							100		200	2200	135	2635
Ruddy Duck					690	1000	1000		1700	1100	500	5990
Great Blue Heron												0
Great Egret												0
Bald Eagle				1	2	6	5	1	1	4	7	27
Coot			12500	45500	43470	12000	4510	200	200	1260	400	120040
White Pelican			80	750	110	50	5					995
Cormorant			10									10

Spring Lake (Lower)	Sept 27, 2010	Oct 4, 2010	Oct12, 2010	Oct18,2012	Oct25,2010	Nov1,2010	Nov 8, 2010	Nov 15,2010	Nov 23, 2010	Nov 29, 2010	Dec 8, 2010	Total 2010
Swans				2		530	905	870		345		2652
Canada Geese			270	1440	1210	1900	1555	1500		970		8845
Other Geese							25					25
Mallard			150	695	880	2800	350	3600		3800		12275
Blackduck					100					160		260
Pintail			100	465	1465	2000	400	600				5030
Gadwall			600	1160	2930	3200	800	1500		300		10490
Wigeon			750	1160	585	400	300	200				3395
N. Sholveler			200	465	585							1250
Blue-Winged Teal												0
Green-Winged Teal			50	465	880	1200	100	200				2895
Woodduck												0
Red Head												0
Canvasback					2930	1200	7830	2000				13960
Ringneck			500	2320	1465	2000	350	400		100		7135
Scaup					290	1200	260	800				2550
C. Goldeneye												0
Bufflehead												0
Merganser								10		100		110
Ruddy Duck							260	3000				3260
Great Blue Heron												0
Great Egret												0
Bald Eagle					2	1	2	5		39		49
Coot			17500	16240	16605	25600	700	1100				77745
White Pelican				10	185	695	150					1040
Cormorant			100		100	15						215

Spring Lake (Lower)	Sept 30, 2009	Oct 5, 2009	Oct 13, 2009	Oct 19, 2009	Oct 26, 2009	Nov 2, 2009	Nov 9, 2009	Nov 16, 2009	Nov 23, 2009	Nov 30, 2009	Dec 7, 2009	Total 2009	Oct 13, 2008	Oct 28, 2008	Nov 3, 2008	Nov 10, 2008	Nov 18, 2008	Nov 25, 2008	Dec 2, 2008	Total 2008
Swans			10			405	415		685		5	1520		190	150	350	315	160	640	1805
Canada Geese			1320	1660		1225	2085		1645		270	8205	385	1215	1350	1900	1365	585	600	7400
Other Geese												0								0
Mallard			300	3440		885	8540		3450		25	16640	110	9050	1400	6000	5900		610	23070
Blackduck												0								0
Pintail			500	3440		530			345			4815	300	900	1200	2500	700			5600
Gadwall			2000	1720		885	3140		2415		20	10180	600	3800	500	2500	1800			9200
Wigeon			1100	690			300					2090	1400	1000	100	200				2700
N. Sholveler			200	1035					690			1925								0
Blue-Winged Teal												0								0
Green-Winged Teal			1300	3440		1770	1220		100			7830	250	800	200	200	300			1750
Woodduck												0								0
Red Head												0								0
Canvasback						4780	14600		10500			29880			6000	9000	700			15700
Ringneck			100			1770	4200		5100			11170			1000	3000	1500			5500
Scaup						1770	1400		1400			4570			1000	500				1500
C. Goldeneye												0							10	10
Bufflehead									200			200				100				100
Merganser												0				2000				2000
Ruddy Duck									1000			1000					100			100
Great Blue Heron												0								0
Great Egret												0			10					10
Bald Eagle				1			2		22		8	33		1				1	6	8
Coot			16110	20640		7510	2850		5000			52110	8600	10900	8100	11000				38600
White Pelican			40	100		50			50			240	45	290	100	150				585
Cormorant												0	50							50

Spring Lake (Lower)	Oct 9, 2007	Oct 22, 2007	Oct 29, 2007	Nov 13, 2007	Nov 21,2007	Nov 27, 2007	Dec 4, 2007	Total 2007	Oct 2, 2006	Oct 10, 2006	Oct 19, 2006	Oct 30, 2006	Nov 7, 2006	Nov 20, 2006	Nov 30, 2006	Total 2006
Swans				195	605	540	75	1415		5		75	425	870	195	1570
Canada Geese	950	985	920	2600	2250	900	250	8855	80	445	1285	965	1270	1760	1610	7415
Other Geese						6300		6300								0
Mallard	100	1500		2100	6610		150	10460	215	990	1255	1270	1560	3070	2390	10750
Blackduck						2200		2200		5	5	5	10	50		75
Pintail	300	550		2800	1130	4500		9280	65	135	175	15	125	135		650
Gadwall	200	1500	500	5600	2780			10580	580	1705	1820	475	605	415		5600
Wigeon	200	1800		900	330			3230	255	860	385	75		180		1755
N. Sholveler		300						300	55	60	125	85	30	25		380
Blue-Winged Teal								0	380	180				30		590
Green-Winged Teal	300	700	500					1500	115	400	45	35	20	25		640
Woodduck								0	245	105	120	20				490
Red Head								0					20			20
Canvasback			750	9300				10050				890	4430	3830		9150
Ringneck			1300	2600				3900		60	385	100	40			585
Scaup								0			495	30	210	10	250	995
C. Goldeneye				200	500			700								0
Bufflehead						300		300								0
Merganser								0							30	30
Ruddy Duck								0					10		20	30
Great Blue Heron								0				2	2	11	1	16
Great Egret	1	55						56				1	4			5
Bald Eagle	1			1	2	1	1	6				14	11	5	31	61
Coot	5700	7000	11650	10400		10		34760				2930	740	90	465	4225
White Pelican	325	75	305	190	490	125		1510				105	65	15		185
Cormorant								0								0