**POST-CONSTRUCTION PERFORMANCE
EVALUATION REPORT – YEAR 10 (2007)**

COTTONWOOD ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT

**UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM**

JANUARY 2007

US Army Corps
of Engineers
Rock Island District

**POOL 21
MISSISSIPPI RIVER MILES 328.5-331.0R
LEWIS AND MARION COUNTIES, MISSOURI**

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT CORPS OF ENGINEERS
CLOCK TOWER BUILDING – P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO
ATTENTION OF

CEMVR-PM-M

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ACKNOWLEDGMENT

Many individuals of the Rock Island District, United States Army Corps of Engineers; the United States Fish and Wildlife Service; and the Missouri Department of Conservation contributed to the development of this Post-Construction Performance Evaluation Report for the Cottonwood Island Habitat Rehabilitation and Enhancement Project. These individuals are listed below:

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EXECUTIVE SUMMARY

1. General. As stated in the Definite Project Report, the Cottonwood HREP was initiated in response to a rapid accumulation of sediment that had greatly reduced the quantity and quality of the important wetland habitat in the low swales present on Cottonwood Island and the deep water aquatic habitat in Cottonwood Chute. Sedimentation has been especially acute in the chute's upper end and in forested portions of the island adjacent to the Mississippi River. In the chute's shallow areas, dissolved oxygen values had fallen to critical levels and fish species diversity had decreased.

2. Purpose. The purpose of this report is to provide a summary of the monitoring data and field observations, as well as project operation and maintenance, since completion of the last Performance Evaluation Report in June 2002.

3. Project Goals, Objectives, and Features. The three goals and associated objectives for the Cottonwood HREP are as follows:

Goals	Objectives	Project Features
Restore Aquatic Overwintering Habitat	Improve water quality for fish	Chute restoration & enhancement
	Provide overwintering water habitat for fish	Create deep holes
Restore Main Channel Border Habitat	Provide flowing water habitat for fish	Notch wing dams
	Provide additional habitat and substrate for benthic and aquatic organisms	Rock placement below wing dams
Restore Wetland Habitat	Increase food, shelter, and breeding habitat for wildlife	Potholes
	Increase bottomland hardwood diversity and quality	Establish hardwood trees in existing forest management, crop, and dredge placement areas

4. Observations. For the evaluation period of February 2003 through March 2006, the objectives to meet each goal had the following observations and conclusions.

a. Restore Aquatic Overwintering Habitat

Improve Water Quality for Fish. Year 50 Target is to maintain a DO concentration greater than or equal to 5 milligrams per Liter (mg/L). Based on water quality data, Year 9 (2006) reported minimum, maximum, and average DO concentrations of 5.31, 22.71, and 12.08 mg/L for station W-M328.7B and 4.43, 22.49, and 11.81 mg/L for station W-M329.3B, respectively. During Year 9 (2006), the DO concentration fell below 5 mg/L on no occasions at station W-M328.7B and 3 out 35 occasions at station W-M329.3B. Post-project DO concentrations showed some improvement relative to pre-project values.

Provide Overwintering Water Habitat for Fish. Year 50 Target for chute excavation is to maintain greater than or equal to 4.5 acres of water area with a flat pool depth between 6 and 10 feet while the Year 50 Target for deep hole creation is to maintain greater than or equal to 0.3 acres per hole of water area with a flat pool depth greater than or equal to 10 feet. Based on water quality data in lieu of sedimentation transects, Year 8 (2005) reported an average water depth of 5.18 feet for chute excavation and 8.85 feet for deep hole creation. Sedimentation transects according to the monitoring plan will more accurately assess sediment deposition and allow determination of overwintering water habitat in acres. Additional sedimentation transects should be accomplished in the near future to fully evaluate this objective. Annual average sedimentation rates have varied from Year 0 (1997) to Year 8 (2005), with an average sedimentation rate at station W-M329.3B of 7.9 inches per year, and 10.21 inches per year at station W-M328.7B. Another Year 50 Target is to establish increasing fish numbers.

b. Restore Main Channel Border Habitat

Provide Flowing Water Habitat for Fish. Year 50 Target is to maintain velocities greater than or equal to 0.35, 0.5, and 0.4 feet per second at the following locations; 100 feet upstream of the notch, at the notch, and 100 feet downstream of the notch, respectively. Year 3 (2000) reported average velocities for Wing Dams No. 6 and No. 15 of 1.17 and 1.67 feet per second, respectively. Average velocity measurements at the notch and 100 feet downstream from the notch were considerably higher than those observed 100 feet upstream, which agrees with the results of similar studies reported by the IADNR and WES.

Provide Additional Habitat and Substrate for Benthic and Aquatic Organisms. Year 50 Targets include maintaining consistent numbers of benthic and aquatic organisms as well as maintaining a scour area downstream of each notch with depths greater than or equal to one foot. Based on water quality data in lieu of transects, Year 3 (2000) reported average scour depths for Wing Dams No. 6 and No. 15 of 3.88 and 1.71 feet, respectively. Transects measured according to the monitoring plan will more accurately assess and quantify scour area in square feet. Additional transects should be accomplished in the near future to fully evaluate this objective.

c. Restore Wetland Habitat

Increase Food, Shelter, and Breeding Habitat for Wildlife. Year 50 Target is to maintain a cross-sectional area (short chord) below elevation 475 feet MSL similar to that determined at project completion with some allowance for sediment deposition. At project completion, the average short chord area for all five pot holes was 850 ft^2. Sedimentation transects according to the monitoring plan will more accurately assess sediment deposition and allow determination of wildlife habitat in square feet. Additional sedimentation transects were measured in Year 5 (2002). They indicate that the average short chord area for all five potholes was 762 ft^2, an average loss of 88 ft^2, a 10.3% reduction in short chord area from the time of project completion in 1997. They will be measured again as funds allow and should provide a better indication of trends that may be developing and assist in further evaluation of this objective. Post-construction field observations of the potholes have shown regular use by various animals but limited use by waterfowl.

Increase Bottomland Hardwood Diversity and Quality. Year 50 Target is to maintain a survival rate greater than or equal to 10% within the forest management units. Another Year 50 Target is to maintain greater than or equal to 30 acres of mast trees within the forest management units. Although measurements have not been taken, a visual inspection of the planting indicates that the acreage and survival goals are being met. Forest management units were mowed twice during 2000 and at least once in 2001.

5. Conclusions and Recommendations. Based on data and observations collected since project completion, the goal of providing aquatic overwintering habitat, with the objective of maintaining an average chute depth of 6-10 feet and an average deep hole depth of 10 feet or greater, is not being met. Data collection from 2005 indicated that the average depth of the deep hole habitat was 9.47 feet and the average chute depth was 5.92 feet. Continued data collection should better define the levels to which all goals and objectives are not being met. In general, monitoring efforts for the Cottonwood HREP have been performed according to the Post-Construction Performance Evaluation Plan in Appendix B, Table B-1, and Resource Monitoring and Data Collection Summary in Appendix C, Table C-2. The next PER will be completed in March of 2012 following collection of field data from January through December 2011.

Project operation and maintenance has been conducted in accordance with the O&M Manual. There are no operational requirements attached to the Cottonwood HREP. The maintenance of project features has been adequate. Annual project inspections by the MDOC have resulted in proper corrective maintenance actions.

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1. INTRODUCTION

The Cottonwood Island Habitat Rehabilitation and Enhancement Project (HREP), hereafter referred to as "the Cottonwood HREP," is a part of the Upper Mississippi River System (UMRS) Environmental Management Program (EMP). The Cottonwood HREP is located in Pool 21 on the Missouri side or right descending bank of the Mississippi River navigation channel between River Miles (RM) 328.5 and 331.0. Plate 1 in Appendix K contains the vicinity map for the Cottonwood HREP. The Cottonwood HREP is managed under a Cooperative Agreement between the United States Army Corps of Engineers (Corps) and United States Fish and Wildlife Service (USFWS) dated February 14, 1963. Likewise, the Cottonwood HREP is maintained and operated by the Missouri Department of Conservation (MDOC) under the terms of a Cooperative Agreement with USFWS dated May 5, 1954.

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

(1) Supplement monitoring results and project operation and maintenance discussed in the April 2002 Post-Construction Supplemental PER;

(2) Summarize the performance of the Cottonwood HREP, based on the project goals and objectives;

(3) Review the monitoring plan for possible revision;

(4) Summarize project operation and maintenance efforts to date; and

(5) Review engineering performance criteria to aid in the design of future projects.

b. Scope. This report summarizes available project monitoring data, inspection records, and field observations made by the Corps, USFWS, and MDOC for the period from February 13, 2003 through March 16, 2006.

2. PROJECT GOALS AND OBJECTIVES

a. General. As stated in the Definite Project Report (DPR), the Cottonwood HREP was initiated in response to a rapid accumulation of sediment that had greatly reduced the quantity and quality of the important wetland habitat in the low swales present on Cottonwood Island and aquatic overwintering habitat in the deep areas of Cottonwood Chute. Sedimentation had been especially acute in the chute's upper end and in forested portions of the island adjacent to the Mississippi River. In the shallow areas of Cottonwood Chute, dissolved oxygen values had fallen to critical levels and fish species diversity had decreased.

b. Goals and Objectives. Goals and objectives, formulated during the project design phase, are summarized in Table 2-1.

TABLE 2-1
Project Goals and Objectives

Goals	Objectives	Project Features
Restore Aquatic Overwintering Habitat	Improve water quality for fish	Chute restoration & enhancement
	Provide overwintering water habitat for fish	Create deep holes
Restore Main Channel Border Habitat	Provide flowing water habitat for fish	Notch wing dams
	Provide additional habitat and substrate for benthic and aquatic organisms	Rock placement below wing dams
Restore Wetland Habitat	Increase food, shelter, and breeding habitat for wildlife	Potholes
	Increase bottomland hardwood diversity and quality	Establish hardwood trees in existing forest management, crop, and dredge placement areas

3. PROJECT DESCRIPTION

a. Project Features. The Cottonwood HREP consists of a mechanically excavated side channel and deep holes to restore aquatic overwintering habitat, notched wing dams to restore main channel border habitat, mechanically excavated potholes, and planting mast trees to restore wetland habitat. Plate 2 in Appendix K contains the site plan for the Cottonwood HREP.

(1) Side Channel Excavation. The lower 4,550 feet of Cottonwood Chute was mechanically excavated to improve water quality and provide overwintering habitat for fish. The bottom width of the dredge cut was 40 feet, with a depth of 9 feet below flat pool (elevation 470 feet MSL 1912). Cottonwood Chute includes four (4) deep holes, 300 feet long and 15 feet below flat pool. Side slopes are approximately 3 to 1 horizontal on vertical. For side channel cross sections, refer to the Operation and Maintenance (O&M) Manual, Plates 11 through 13. For side channel profiles, refer to the O&M Manual, Plates 14 through 16.

(2) Wing Dam Notches. Six (6) wing dams were notched to provide flowing water habitat for fish and additional habitat and substrate for benthic and aquatic organisms. The notches were created by removing existing wing dam material to the original river bottom or a maximum of 10 feet below flat pool. Each notch was 100 feet long. For wing dam notching details, refer to O&M Manual, Plate 17. Notches were staggered in anticipation that flow would increase in the vicinity of the notch, creating a scour hole behind the wing dams and stimulating a meander to the next wing dam. Preliminary post-construction monitoring efforts indicate the formation of scour holes behind the wing dams and an increase in velocity at and below the notches.

(3) Potholes. For the Cottonwood HREP, two (2) 1-acre potholes, one (1) ¾-acre pothole, and two (2) ½-acre potholes were mechanically excavated to increase food, shelter, and breeding habitat for wildlife. In general, the potholes are larger and feature a 20-foot bottom width and final elevation approximately 3 feet below flat pool. The sides of the potholes are stepped. Each “step” is approximately 10 feet wide, with a 1-foot transition zone to the next step. The transition slope is 3 to 1 horizontal on vertical. For pothole details and transects, refer to the O&M Manual, Plates 18 through 23. The potholes have filled with water and were being used by deer, herons, frogs, and tadpoles less than a week after completion of construction in 1997. Fish were observed in the potholes following high water in the spring of 1998.

(4) Mast Trees. As a preparatory measure, the MDOC in June of 1998 constructed raised planting beds in the agricultural field and reseeded those areas with redtop grass. During Stage II of the Cottonwood HREP, mast trees were planted in the agricultural field / forest management areas (FMAs), around the pothole perimeters, and on top of the excavated dredged material berm to increase bottomland hardwood diversity and quality. In the agricultural field and FMAs, trees were planted on 8-inch to 10-inch berms with 30 feet between berms.

As part of a field study during the Stage II contract, 75 trees received protective fencing while another 75 trees were sprayed with deer repellent in the agricultural field and FMAs 5 & 6. The MDOC is responsible for maintaining this protective fencing and annual application of the deer repellent over a 3-year period. At the end of this period, the efficacy of both methods was to be summarized and conclusions drawn for the best method of protecting the saplings from deer. Although an official report has not been written as of April 2008, correspondence with Mike Flashpoler of MDOC explains that the fencing was significantly more effective than repellants. The repellants wore off too quickly to be effective and had to be reapplied many times. The main downsides of the fencing were problems caused during high water and vines growing up the fence. For mast tree details, refer to the O&M Manual, Plates 25 through 29.

b. Project Construction. There were three construction phases for the Cottonwood HREP. The Stage I contract was awarded to Massman Construction Company, in February 1997. This Contract included all the major project features except for the planting of the mast trees. The planting of the mast trees was completed in the Stage II contract during the 1999 construction season. Stage III of the Cottonwood HREP consisted of a modification to the existing causeway road. Construction was complete in spring 2001.

c. Project Operation and Maintenance. Operation and maintenance of the Cottonwood HREP is the responsibility of the MDOC in accordance with Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-508. These functions are further defined in the O&M Manual. The following paragraphs outline the operation and maintenance instructions for the major project features. These features were designed and constructed to minimize the operation and maintenance requirements.

Specific operation requirements for the Cottonwood HREP shall be performed as determined by the MDOC Site Manager. Annual maintenance inspections of the side channel excavation, wing dam notches, and potholes shall be completed by the MDOC Site Manager, who records the presence of undesirable debris, waste materials, and unauthorized structures. The potholes should be inspected following high water events.

The Corps shall monitor survival and growth of mast trees through annual inspections of the planting sites. The MDOC Site Manager shall perform remedial action as necessary to ensure survival. Records shall be kept of any herbicide or deer repellant application in addition to records of inspections and any corrective actions taken to ensure survival of the saplings. Vegetation between mast trees shall be controlled for a minimum of two growing seasons by either mowing or herbicide application. Vegetation between the planted rows shall not be allowed to exceed a height of 1 foot during this maintenance period.

4. PROJECT MONITORING

a. General. Appendix B presents the Post-Construction Evaluation Plan (Table B-1), along with the Sedimentation Transect Project Objectives Evaluation (Table B-2). These references were developed during the design phase and serve as a guide for measuring and documenting project performance. The Post-Construction Evaluation Plan also outlines the monitoring responsibilities for each agency. Appendix C contains the Monitoring and Performance Evaluation Matrix (Table C-1) and Resource Monitoring and Data Collection Summary (Table C-2). The Monitoring and Performance Evaluation Matrix outlines the monitoring responsibilities for each agency. The Resource Monitoring and Data Collection Summary presents the types and frequency of data needed to meet the requirements of the Post-Construction Evaluation Plan. Plate 3 in Appendix K contains the monitoring plan for the Cottonwood HREP.

b. U.S. Army Corps of Engineers. The success of the project relative to original project objectives shall be measured by the Corps, USFWS, and MDOC through monitoring data, inspection records, and field observations. The Corps has the overall responsibility to evaluate and document project performance.

The Corps is responsible for collecting field data as outlined in the Post-Construction Evaluation Plan at the specified time intervals. The Corps shall also perform joint inspections with the USFWS and MDOC in accordance with ER 1130-2-339. The purpose of these inspections is to assure that adequate maintenance is being performed as presented in the DPR and O&M Manual. Joint inspections should also occur after any event that causes damage in excess of annual operation and maintenance costs.

c. U.S. Fish and Wildlife Service. The USFWS does not have project-specific monitoring responsibilities. However, the USFWS should be present at the joint inspections with the Corps and MDOC as described in the previous paragraph.

d. Missouri Department of Conservation. The MDOC is responsible for O&M, as well as monitoring the project through field observations during inspections. Project inspections should be performed on an annual basis following the guidance presented in the O&M Manual. It is recommended that the inspections be conducted in May or June, which is representative of conditions after spring floods. Joint inspections with the Corps and USFWS shall also be conducted as described above. During all inspections, the MDOC should complete the checklist form as provided in the O&M Manual. This form should also include a brief summary of the overall condition of the project and any maintenance work completed since the last inspection. Once completed, a copy of the form shall be sent to the Corps.

5. EVALUATION OF AQUATIC HABITAT OBJECTIVES

a. Improve Water Quality for Fish.

(1) Monitoring Results. A goal of the Cottonwood Island HREP is to restore aquatic overwintering habitat. One of the objectives is to improve water quality for fish through chute restoration and enhancement. Over the years, sediment accumulation in Cottonwood Chute had resulted in a loss of deep, off-channel aquatic habitat. The reduction of main channel flow into the upper end of the chute adversely impacted dissolved oxygen (DO) concentrations. Previous researchers reported DO concentrations below the Missouri State Standard for the Protection of Aquatic Life (5 mg/L) in the chute. As shown in Appendix B, Table B-1, the Year 50 Target is to maintain a DO concentration greater than 5 mg/L.

One objective of deepening the chute was to improve water quality by allowing for a greater volume of oxygen to sustain fish during extended periods of ice cover. The goal was to maintain a DO concentration above 5 mg/L during the winter months. In order to determine the effectiveness of the project in attaining this goal, post-project water quality monitoring commenced on December 23, 1997 at stations W-M328.7B and W-M329.3B (see Appendix K, Plate 3 for water quality station locations). This report discusses data collected during the monitoring period of February 2003 through March 2006.

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 11 occasions during the 2002 period and 35 occasions during the 2003-2006 period. The two stations were visited approximately twice per month from June through September and monthly from December through March. Sampling was not performed during March 2002-2003, April 2002, 2004 & 2005, May 2002-2005, October to November 2002-2005, or December 2004. 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, turbidity, suspended solids, chlorophyll (a, b and c) and pheophytin a.

The results from periodic grab samples collected from stations W-M328.7B and W-M329.3B are found in Appendix E, Tables E-2 and E-3, respectively. The tables include the results from DO and ancillary parameters that are useful in the interpretation of DO data. During the monitoring period of February 2003 to March 2006, at station M329.3B no concentrations were found below the 5 mg/L Missouri State Standard for the Protection of Aquatic Life. For the same monitoring period at station W-M328.7B only three concentrations below 5 mg/L were measured. Of the three measured samples below 5 mg/L, two came in the month of June, which has come to be expected for Cottonwood Chute. Supersaturated conditions were observed on most sampling days. This was due to algal photosynthesis. The chlorophyll a data indicate there was an algal bloom at both stations for much of the summer. The accompanying high pH values are also a result of intense algal photosynthesis.

This pattern of relatively low DO concentrations during June and supersaturated conditions during much of the remainder of the summer is typical of what has been observed in recent years at Cottonwood Chute.

In-situ continuous water quality monitors (YSI model 6000UPG or 6600UPG sondes) were deployed at stations W-M328.7B and W-M329.3B. Sondes were positioned near the surface at both monitoring stations. Deployments were typically for a period of two weeks during the summer months and seven weeks during the winter. The sondes were normally equipped to measure DO, temperature, pH, specific conductance, depth and turbidity.

In-situ continuous monitors were deployed twice during the winter (February 14 through April 11, 2003 and from February 22 through March 22, 2005) at station W-M328.7B and three times (February 14 through April 11, 2003, December 23, 2003 through February 13, 2004 and again from February 22 through March 22, 2005) at station W-M329.3B. At both stations from March 23 to April 5, 2003, the DO concentrations fell well below the target DO concentration of 5 mg/L and remained below the target concentration for majority of this time period, as seen in Figure E-1. This is a trend that has been seen before in this location. During the winter, fish become frozen in the ice while some other fish die in the chute during the winter. Since the chute has little to no flow at times, when the ice melts, the fish begin to decompose, increasing the oxygen demand in the chute. The increase in oxygen demand will cause the DO to fall until eventually, over the span of a few weeks, new water will flush the chute and decomposing rates will decline, replenishing and increasing DO. The pH of the water declined in the same fashion as the DO concentration further supporting the cause of DO drop due to the decomposing organic material, fish. The pH also exhibited a similar rebound at the same time of the DO rebound.

During the summer months of the monitoring period, continuous monitors were deployed at each station on two occasions. DO concentration fluctuated over a much wider range during the summer than in the winter. This is due to the algae that saturate the water with DO during the daytime in the summer months. During the night, the algae does not produce oxygen and will actually consume oxygen, further playing a role in the drop of DO during night time hours. Most summer deployments at station W-M328.7B produced results similar to those shown in Figure E-2, for the period August 5 – 19, 2003. Near the surface, DO concentrations often fell below 5 mg/L during the night, but quickly recovered the following day, often to supersaturated levels. The difference between nighttime lows and daytime highs was commonly in the 5 to 10 mg/L range, but were seen at 15 mg/L as well. Figures E-2 and E-5 are representative of the range of concentrations seen during summer deployments at station W-M328.7B.

Most summer deployments at station W-M329.3B produced results similar to those shown in Figure E-4 and Figure E-7, for the periods July 7 - 19, 2004 and August 30 – September 13. 2005, respectively. The most adverse summer conditions at station W-M329.3B were experienced during the July 7 - 19, 2004 deployment (see Figure E-4). There was one period during this deployment when the DO concentration was below 5 mg/L for at least five consecutive days.

(2) Conclusions. During the 2003 - 2006 monitoring period, the project was successful in attaining the target DO concentration (>5 mg/L) during the critical winter months. Throughout the monitoring period, all but three grab sample DO concentrations were >5 mg/L and most were supersaturated. *In-situ* continuous monitor measurements during the summer

were often less than 5 mg/L near the bottom; however, near the surface, DO concentrations exceeded 5 mg/L for at least a portion of every day. Another indication of the project's success is that according to Ken Brummett, Fisheries Management Biologist with the Missouri Department of Conservation, no fish kills were reported in 2002.

Comparisons of pre- and post-project DO data from surface grab samples collected at Station W-M328.7B are summarized in the table below. The number of DO concentrations < 5 mg/L, minimum DO concentration, and maximum DO concentration values for 2003 - 2006 were similar to those for the 2001 and 2002 monitoring year. The 2006 average DO concentration was nearly 3 mg/L lower than the average for any for the 2002 monitoring period. Like previous post-project monitoring periods, all DO concentrations during the critical winter months exceeded 5 mg/L.

Table 5-1 summarizes the sample concentrations taken at station W-M328.7B from the dates of February 13, 2003 through March 16, 2006. At station W-M328.7 B For the monitoring period of February 2003 to March 2006, no sample concentrations measured were below 5 mg/L. The average DO concentration during this time was 12.08 mg/L, which is down from the 2002 average of 14.80 mg/L. The 2003 – 2006 average DO of 12.08 mg/L is still above the current post-project monitoring average of 11.80 mg/L. The minimum DO concentration recorded during this monitoring period was 5.31 mg/L and a maximum 22.71 mg/L. Comparing the monitoring period of 2003 – 2006 to the previous monitoring years of 1997 – 2002, the chute water quality, in terms of DO, is showing a decrease from 2001 to the present, although it is still meeting the necessary objective of maintaining a DO concentration of above 5 mg/L.

TABLE 5-1
Improve Water Quality for Fish-Dissolved Oxygen Sampling

Parameter Description	**Station W-M328.7B**				
	Pre-Project 04/07/92–11/17/95	**Post-Project 12/23/97–09/19/00**	**Post-Project 01/03/01–09/18/01**	**Post-Project 01/08/02–12/17/02**	**Post-Project 02/13/03-03/16/06**
Total Number of Samples	41	34	12	11	35
Winter Samples (Oct-Mar)	16	10	4	3	10
Summer Samples (Apr-Sep)	25	24	8	8	25
Total DO Samples < 5 mg/L	2 (4.9%)	1 (2.9%)	0	0	0
Winter DO Samples < 5 mg/L	0	0	0	0	0
Summer DO Samples < 5 mg/L	2 (8.0%)	1 (4.2%)	0	0	0
Minimum DO (mg/L)	2.96	4.67	5.02	5.78	5.31
Maximum DO (mg/L)	22.70	23.08	>20	28.29	22.71
Average DO (mg/L)	10.39	11.36	11.92	14.80	12.08

Pre-project data were not collected at station W-M329.3B. Comparisons of post-project DO data from surface samples collected at this station are summarized in Table 5-2 below. Similar to station W-M328.7B, the 2002 average DO concentration was about 3 mg/L higher than the average for any previous monitoring period. Also, like previous monitoring periods, almost all DO concentrations during the winter months exceeded 5 mg/L. There was only one occasion since the creation of the project where DO has been monitored as falling below 5 mg/L.

In the monitoring period of February 13, 2003 through March 16, 2006 there were no occasions where the DO concentration dropped below 5 mg/L. The average DO concentration during this period was 12.08 mg/L. The minimum and maximum DO concentrations were 5.31 mg/L and 22.71 mg/L respectively.

TABLE 5-2
Improve Water Quality for Fish
Dissolved Oxygen Sampling

Parameter Description	Station W-M329.3B			
	Post-Project 12/23/97–09/19/00	Post-Project 01/03/01–09/18/01	Post-Project 01/08/02–12/17/02	Post-Project 02/13/03-03/16/06
Total Number of Samples	34	12	11	35
Winter Samples (Oct-Mar)	10	4	3	10
Summer Samples (Apr-Sep)	24	8	8	25
Total DO Samples < 5 mg/L	2 (5.9%)	2 (16.7%)	0	3 (0.09%)
Winter DO Samples < 5 mg/L	0	0	0	1 (0.1%)
Summer DO Samples < 5 mg/L	2 (8.3%)	2 (25.0%)	0	2 (0.08%)
Minimum DO (mg/L)	2.41	3.80	5.68	4.43
Maximum DO (mg/L)	21.13	26.01	17.72	22.49
Average DO (mg/L)	11.34	11.51	14.56	11.81

b. Provide Overwintering Water Habitat for Fish.

(1) Monitoring Results. The other objective for restoring aquatic overwintering habitat is to provide overwintering water habitat for fish through chute excavation and deep hole creation. As shown in Appendix B, Table B-1, the Year 50 Target for chute excavation is to

maintain 4.5 acres of water area with a flat pool depth between 6 and 10 feet. The Year 50 Target for deep hole creation is to maintain 0.3 acres per hole of water area with a flat pool depth greater than or equal to 10 feet. Sedimentation transects for Cottonwood Chute were conducted in October 1997 to reflect as-built conditions of the overwintering water habitat. Since then, additional transects have not been completed but should be in the foreseeable future. According to Table C-2 in Appendix C, sedimentation transects are required every five years.

However, during water quality monitoring, chute depths at both stations were recorded. Station W-M328.7B is located adjacent to sedimentation Transect C. This portion of the chute was designed to have an ideal water depth greater than or equal to 10 feet at Year 50 and is labeled as a deep hole on the monitoring plan. Station W-M329.3B is located adjacent to sedimentation Transect J. This portion of the chute was designed to have an ideal water depth of 6 to 10 feet at Year 50.

TABLE 5-3.
Provide Overwintering Water Habitat for Fish
Monitoring Stations W-M328.7B and W-M329.3B

Year	W-M328.7B Flat Pool Depth (feet)	W-M328.7B Sediment Rate (in/yr)	W-M329.3B Flat Pool Depth (feet)	W-M329.3B Sediment Rate (in/yr)
0 (1997)	15.00		10.00	
0-1		16.56		9.96
1 (1998)	13.62		9.17	
1-2		14.88		18.12
2 (1999)	12.38		7.66	
2-3		8.64		7.44
3 (2000)	11.66		7.04	
3-4		0.60		4.32
4 (2001)	11.61		6.68	
4-5		11.64		8.04
5 (2002)	10.64		6.01	
5-6		9.80		9.62
6 (2003)	10.48		5.68	
6-7		9.12		4.68
7 (2004)	9.72		5.29	
7-8		10.44		1.32
8 (2005)	8.85		5.18	
8-9				
50 (Target)	**10.00**		**6.00**	

As seen in Table 5-3, Station W-M328.7B along Transect C, has an average depth of 8.85 feet at Year 8, which does not meet the project goal of 10 feet. Station W-M329.3B along Transect J, has an average depth of 5.18 feet at Year 8, which does not meet the ideal water depth of 6 to 10 feet. The flat pool depths for both transects were determined by adjusting the water depths recorded during site visits from February 2003 to September 2005. Using historical water profiles, the pool elevation at the Cottonwood HREP was estimated by interpolating between two stream gages. To view individual water depths for each site visit and the steps taken to adjust these values to depths relative to flat pool, refer to Tables F-1 and F-2 in Appendix F. Based on this data, annual sedimentation rates were also determined as shown in Table 5-3.

Based on 1938 through 1994 data, the DPR estimated an overall average sedimentation rate for the Cottonwood Island area of 0.46 inches per year, or 2.16 feet over 56 years. Sedimentation as stated in the DPR varies greatly throughout the Cottonwood HREP, with the majority of the sediment deposition occurring in Cottonwood Chute upstream of the causeway. The DPR estimate of the sedimentation rate in the lower portion of Cottonwood Chute, or near Transect C, was lower than the estimated overall average. This rate was estimated to be approximately 0.11 inches per year. In general, deep aquatic habitat depths in 1997 at project completion averaged 15 feet. In 2005, deep aquatic habitat depths averaged 8.85 feet. The average annual sedimentation rate for the prior year, 2004, was 10.44 inches per year. At the current depth of 8.85 feet at station W-M328.7B, the project goal of 10 feet of aquatic habitat in the chute is not being met. It was noted that the average sedimentation rates from 1997 to 2001 steadily decreased from year to year. This may suggest that the slough is approaching a stable condition. This appeared to be the case for Transect C, but as more current data has shown, the annual sedimentation rate was more closely dictated by the occurrence and length of high water periods. During 2004, the average sedimentation rate was approximately 10.44 inches per year.

The DPR estimate of the sedimentation rate in the middle portion of Cottonwood Chute, or near Transect J, was also lower than the estimated overall average. This rate was estimated to be approximately 0.16 inches per year. In general, chute excavation depths in 1997 at project completion averaged 10 feet. Although the annual sedimentation rate for 2004 was only 1.32 inches per year, much lower than all other previous years, the average deep aquatic habitat in 2005 was 5.18 feet, falling below of the target depth of 6 to 10 feet.

A couple of factors may explain why the overall average sedimentation rate of approximately 9.71 inches per year for both transects is higher than the estimated numbers in 2002. First, the deep holes were excavated to a depth of approximately 15 feet, as illustrated in the O&M Manual on Plates 11 through 13. In essence, these holes were over-excavated to allow for sloughing of the vertical slopes. Therefore, it appears logical to assume that some of the chute bottom deposits are a result of the deep holes attempting to reach a stable condition or a more gradual slope. Another factor that may explain the higher sedimentation rate is the occurrence of spring flood events; however, there was no spring flood on 2002. At high river levels, the causeway is overtopped, which carries sediment-laden water into the chute. According to the MDOC, the causeway was overtopped three times in the first two years following project completion. Both of these factors allow Cottonwood Chute to be more susceptible to sediment deposition.

Figure F-3 illustrates that a gradual rise in the river level caused an increase in sedimentation at both stations resulting in periods of raised bottom elevations, while gradual water level drops over an extended period of time caused chute depths to increase until a sudden rise in MR Pool 21 depths. In the most drastic and sudden flood event, the period of 5/13/00 to 9/19/00, a sudden rise in MR Pool 21 depths initially caused sediment washout at station W-M329.3B and at the same time sediment deposit at station W-M328.7B. These occurrences at the two stations continued at roughly the same rate as the increasing pool depth. As the river level fell, Transect J began to fill with sediments and Transect C was washed out. This same pattern occurred over the cycle of that particular flood season. The overall effect of the flood cycle on the chute is to increase the amount of sedimentation. .

Response by fishes

In November 2000, the MDOC conducted an electrofishing survey in Cottonwood Chute. A water surface temperature of 53° Fahrenheit was recorded at the time of the sample. Secchi visibility was not measured, but water transparency was variable with distance along the chute from the mouth to the upper end. The upper end of the chute had a light coverage of duckweed and watermeal. The Mississippi River was estimated at one to two feet below normal pool elevation due to drought conditions at that time.

A total of 340 fish were captured, representing 19 species and one hybrid. Two sampling runs along the portion of the chute where deep holes were constructed comprised nearly two-thirds of the effort and yielded nearly three-fourths of the catch. A summary of this survey is presented in Table 5-4.

TABLE 5-4
Summary of Electrofishing Survey, November 2000

Species	No.	Length Range (Inches)	Average Length (Inches)
Paddlefish	1	33.0	-
Bowfin	2	17.6 - 21.1	19.4
Gizzard shad	37	3.9 - 8.6	6.1
Grass carp	1	18.2	-
Common carp	29	17.0 - 27.2	20.8
Emerald shiner	2	1.5 - 1.8	1.7
River carpsucker	12	14.6 - 17.3	16.3
Quillback	1	14.1	-
Smallmouth buffalo	8	10.7 - 16.7	13.4
Bigmouth buffalo	16	13.2 - 20.8	16.0
Channel catfish	7	15.9 - 24.8	19.7
Brook silversides	1	2.8	-
White bass	4	12.8 - 14.5	13.6
Green sunfish	5	2.4 - 8.7	4.6
Orangespotted sunfish	6	2.0 - 3.0	2.5
Bluegill	93	1.8 - 6.6	4.3
Largemouth bass	69	3.1 - 13.8	5.8
White crappie	35	3.0 - 13.0	9.4
Black crappie	10	4.7 - 10.6	7.7
Hybrid sunfish	1	4.4	-
TOTAL	**340**	**1.5 – 33.0**	**11.7**

A previous electrofishing survey was conducted by the MDOC in October 1998. This survey yielded 398 fish representing 20 species. When comparing the two surveys, fewer gizzard shad, carp, and white bass were found in 2000. The combination of these lower numbers with the absence of freshwater drum resulted in a decrease of the total count. However, the 2000 survey did contain more largemouth bass, bluegill, and white crappie. Most of the largemouth bass consisted of young-of-the-year and yearlings, causing the average length to be lower than in 1998.

The MDOC has expressed concerns about the construction of an impermeable causeway road and the effects this may have on fish numbers in Cottonwood Chute. MDOC explained that the advantage of a permeable road is that it does allow some water to flow through the structure and therefore creates better water quality both upstream and downstream of the structure. If a similar structure were built on a future project, MDOC would still recommend the permeable structure. Further monitoring of water quality parameters and fish numbers should determine these effects.

(2) Conclusions. The Cottonwood HREP is not meeting the objective of providing overwintering water habitat for fish in areas where an ideal depth of 10 feet is desired as well as areas where an ideal depth of 6 to 10 feet is desired. It could be assumed that these depths are representative of the entire project area but since the monitoring results were based solely on data collected at the two water quality stations, it is not known for sure if this is indeed the case. In addition, the locations of the water quality stations are determined through use of landmarks rather than coordinates, so chute depths are not necessarily recorded in the exact same spot each time. While the data from the water quality stations give some idea of overwintering habitat for fish, it is not their intended purpose. Therefore, future sedimentation transects based on the monitoring plan should provide adequate data to better define overwintering water habitat for fish throughout the entire project area.

Average sedimentation rates are higher in the lower portion of Cottonwood Chute than estimated in the DPR. It was expected that sedimentation rates would stabilize over time, but this has not been the case. However, some of the differentiation between actual results and DPR estimates is due to the fact that the chute had been previously dredged during the construction of the adjacent levee system. At the time of writing of the DPR, this was not known and results in an incorrect assumption of artificially low sediment rates. The yearly sedimentation rate is dependent heavily on drastic pool depth changes, extended high water periods, and gradual rise or fall in MR Pool 21 depths.

Despite concerns about the higher average sedimentation rate in the lower portion of the chute, the project has increased the quality of fish habitat. Before the project, there was little fishery value in most areas along the chute. Results of the electrofishing surveys showed a decrease in overall fish numbers from 1998 to 2000, with the majority of this decline seen in the numbers of gizzard shad, carp, and white bass. However, there was an increase in largemouth bass, bluegill, and white crappie. Overall, the results of these investigations suggest a positive response by fisheries to chute and deep hole excavation.

6. EVALUATION OF MAIN CHANNEL BORDER REHABILITATION

a. Provide Flowing Water Habitat for Fish.

(1) Monitoring Results. In order to attain the goal of restoring main channel border habitat, several wing dams extending from Cottonwood Island were notched. This was done in an effort to provide flowing water habitat for fish. The Year 50 Target is to maintain velocities of 0.35, 0.5, and 0.4 feet per second (ft/sec) at the following locations: 100 feet upstream of the notch, at the notch, and 100 feet downstream from the notch, respectively (see Appendix B, Table B-1). It was anticipated that water velocity would increase downstream of the notch and create a scour hole, as was the case in Iowa DNR and Waterways Experiment Station (WES) studies referenced in Appendix I of the Cottonwood Island Definite Project Report. During previous monitoring periods, velocity and depth measurements were taken at points 100 feet upstream of the notch, at the notch, and 100 feet downstream from the notch. The results of these velocity measurements, including ancillary data, are found in Appendix E, Tables E-4 through E-9. A summary of velocities at the individual notches is illustrated in Table F-10, Appendix F. Velocity and depth measurements were not taken during the 2002 monitoring period.

TABLE 6-1.

Summary of Notch Velocities at Wing Dams

Year	100' U/S No. 6 (Ft/s)	100' U/S No. 15 (Ft/s)	At No. 6 (Ft/s)	At No. 15 (Ft/s)	100' D/S No. 6 (Ft/s)	100' D/S No. 15 (Ft/s)
0 (1997)	1.05	0.88	2.06	1.29	1.93	1.32
Average	0.97		1.67		1.62	
1 (1998)	1.68	1.33	2.18	1.57	1.80	1.64
Average	1.50		1.87		1.72	
2 (1999)	1.22	1.10	1.85	1.33	1.47	1.47
Average	1.16		1.59		1.47	
3 (2003)	0.57	0.51	1.24	0.77	0.81	0.60
Average	0.54		1.01		0.70	
0-3 (97-00)	1.13	0.96	1.37	1.24	1.50	1.26
Average	1.05		1.31		1.38	
50 (Target)	**0.35**		**0.50**		**0.40**	

As seen in Table 6-1, the average velocity 100 feet upstream from Wing Dam No. 6 was 1.13 feet per second. This value increased to 1.37 feet per second at the notch and then rose to 1.50 feet per second 100 feet downstream from the notch. At Wing Dam No. 15, the average velocity 100 feet upstream was 0.96 feet per second. This value increased to 1.24 feet per second at the notch and 1.26 feet per second 100 feet downstream from the notch. Although the velocity measurements observed do not support the FastTABS modeling results, the refuge manager has been very pleased with the results of the notches over the years. Potential for damaging scouring and excessive velocities as stated in the DPR appear to not be of concern.

(2) Conclusions. Post-project measurements taken at Wing Dam Nos. 6 and 15 indicate that notching does have an impact on velocity. At both wing dams, average velocity measurements both at the notch and 100 feet downstream, were considerably higher than those observed 100 feet upstream. These findings tend to agree with the results of similar studies reported by the Iowa DNR and WES.

b. Provide Additional Habitat and Substrate for Benthic and Aquatic Organisms.

(1) Monitoring Results. The other objective for restoring main channel border habitat is to provide additional habitat and substrate for benthic and aquatic organisms through rock placement below the wing dams. As shown in Appendix B, Table B-1, the Year 50 Target is to maintain constant numbers of benthic and aquatic organisms. As part of the ancillary data for the velocity measurements, water depths were recorded. These water depths were used to analyze the scour depth downstream of the wing dams. The flat pool depths for both wing dams, as shown in Table 6-2, were determined by adjusting the channel depths recorded during site visits from June 1997 to September 2000. Using historical water profiles, the pool elevation at the Cottonwood HREP could be determined by interpolating between two stream gages. To view individual channel depths for each site visit and the intermediate used to compare the values to depths relative to flat pool, refer to Appendix F, Tables F-3 through F-8. A summary of individual scour depths is illustrated in Appendix F, Table F-9.

TABLE 6-2.
Summary of Notch Scour Depths 100' D/S of Wing Dams

Year	No. 6 Water Depth (Feet)	No. 6 Scour Depth (Feet)	No. 15 Water Depth (Feet)	No. 15 Scour Depth (Feet)
0 (1997)	19.39		10.95	
0-1		1.39		0.21
1 (1998)	20.78		11.16	
1-2		0.18		0.33
2 (1999)	20.96		11.49	
2-3		2.31		1.17
3 (2000)	23.27		12.66	
0-4		3.88		1.71

The average flat pool channel depth for Year 0 was used as the base line in determining scour depth. The average scour depth 100 feet downstream from Wing Dam No. 6 was 3.88 feet. At Wing Dam No. 15, the average scour depth 100 feet downstream was 1.71 feet. As seen in Table 6-2, Wing Dams No. 6 and 15 achieved a scour depth greater than one foot by Years 2 and 3, respectively.

(2) Conclusions. The Cottonwood HREP is meeting the goal of rehabilitating main channel border habitat by creating scour depths greater than or equal to 1 foot downstream

from the notch with respect to Wing Dam No. 6 and No. 15. It could be assumed that these depths are representative of all notched wing dams but since the monitoring results were based solely on ancillary data collected at only two wing dams, it is not known for sure if this is indeed the case. In addition, the locations of the velocity measurements are determined through use of landmarks rather than coordinates, so channel depths are not necessarily recorded in the exact same spot each time. Therefore, future sedimentation transects based on the monitoring plan should provide more adequate data to better define scour depths and size for all of the notched wing dams. At both wing dams, average channel depths at the notch and 100 feet upstream from the notch essentially remained the same while those depths 100 feet downstream from the notch gradually increased. By the end of Year 4, both wing dams had scour depths greater than one foot. Cross sections are necessary downstream from the notches to determine the extent and size of these scour areas.

In addition to the point velocity and depth measurements discussed above, it is recommended that Acoustic Doppler Current Profiler (ADCP) measurements be taken annually at Wing Dam Nos. 6 and 15. The ADCP measurements would generate a near complete velocity profile (top to bottom) and show the bottom contour over a given transect. ADCP transect measurements could be taken 100 feet upstream of the notch, at the notch, and 100 feet downstream from the notch. Attempts would be made to take the measurements at varying flow regimes in order to determine how velocities vary with discharge. The ADCP measurements would allow for a more comprehensive evaluation of the impacts of the project on velocity and depth.

7. EVALUATION OF WETLAND HABITAT RESTORATION

a. Increase Food, Shelter, and Breeding Habitat for Wildlife

(1) Monitoring Results. One of the objectives for restoring wetland habitat is to increase food, shelter, and breeding habitat for wildlife through pothole creation. As shown in Appendix B, Table B-1, the Year 50 Target is to maintain a cross-sectional area (short chord) below elevation 475 feet MSL similar to that determined at project completion with some allowance for sedimentation. Pothole transects were conducted in October 1997 and August 2002 to reflect as-built conditions of the food, shelter, and breeding habitat. According to Table C-2 in Appendix C, pothole transects are only required every five years.

Areas surrounding the potholes have been planted with millet. However, general comments regarding pothole use have been made by the MDOC. In particular, the MDOC Site Manager has not observed any pothole use by waterfowl. However, field observations indicate that these areas are receiving use by amphibians, particularly bullfrogs and possibly tree frogs, and are visited regularly by great blue herons. In addition, deer and turkey tracks are typically abundant around the perimeter of the potholes. In the past year, waterfowl surveys or any other type of scientific survey based on wildlife usage for Cottonwood Island have not been conducted. Waterfowl surveys are only performed every other year.

(2) Conclusions. Overall, the Cottonwood HREP appears to be meeting the objective of increasing food, shelter, and breeding habitat for wildlife through pothole creation. Post–construction field observations have shown pothole use by various animals. Future monitoring will show pothole use by waterfowl.

b. Increase Bottomland Hardwood Diversity and Quality

(1) Monitoring Results. The other objective for restoring wetland habitat is to increase bottomland hardwood diversity and quality through establishment of hardwood trees within the forest management units. As shown in Appendix B, Table B-1, the Year 50 Target is to maintain a survival rate greater than or equal to 20%. The MDOC Site Manager has performed regular maintenance of the forest management units. A survival rate of 65% was observed for the Upper site, 75-80% for the Middle site and 80-85% for the Lower site. The red top grass that was planted has successfully choked out the other weeds and has required relatively minimal mowing. The MDOC Site Manager reports that the grass is typically mowed about twice per year. These sites were being mowed during the site visit in November 2001 as illustrated in Appendix G. Discussion of the efficacy of tree fences versus deer repellant was intended for inclusion in this report. Unfortunately, due to changes in MDOC personnel, routine observation of this response was not maintained. However, during the August 13, 2006 site visit, MDOC Site Manager reported that the trees with fence protection were susceptible to competition from vines that readily grow up along the fences. These vines often shade and choke out the saplings. Furthermore it was noted that the fences can cause branches to get stuck, resulting in damage as the tree grows. Beginning in Fall 2004 wheat was planted between the rows of trees as a weed reduction measure. This has proven successful based on feedback from the MDOC site manager.

(2) Conclusions. Based on results from the mast tree survey taken on August 13, 2006, the over all survival rates for each of the mast tree planting sites are meeting the 50 year goal of 20%. Although routine monitoring of the efficacy of deer repellant spray versus tree fences is no longer ongoing, we can make some general conclusions regarding the performance of the tree fences. The overall effectiveness of the tree fences as a deer repellant may be outweighed due to increased weed growth with which the fences are associated.

8. OPERATIONS AND MAINTENANCE SUMMARY

a. Operation. The Cottonwood HREP has no general operating requirements.

b. Maintenance.

(1) Inspections. The MDOC has visited the Cottonwood HREP on various occasions since project completion.

(2) Maintenance Based on Inspections. The MDOC has not observed any waste materials or unauthorized structures within the project area. In addition, the access control remains in place. Therefore, no maintenance has been required since project completion.

9. CONCLUSIONS AND RECOMMENDATIONS

a. Project Goals, Objectives, and Management Plan. Based on data and observations collected since project completion, the goals of restoring main channel border habitat and restoring wetland habitat, along with each of their objectives, are being met. The goal of restoring aquatic overwintering habitat, based on the objective of maintaining 4.5 acres of deep water habitat 6-10 feet deep and providing 0.3 acres of deep holes >10 foot of depth, is not being met. Data supporting conclusions for each goal and objective is in Tables 9-1 and 9-2 below.

TABLE 9-1
Project Goals and Objectives

Goals	Objectives	Project Features	Unit	Year 9 (2006)	Year 50 Target	Status
Restore Aquatic Over-wintering Habitat	Improve water quality for fish	Chute restoration & enhancement	mg/L DO		5	Met
		(Station W-M328.7B)	(min)	5.31[1/]		
			(max)	22.71[1/]		
			(avg)	12.08[1/]		
		(Station W-M329.3B)	(min)	4.43[1/]		
			(max)	22.49[1/]		
			(avg)	11.81[1/]		
	Provide overwintering water habitat for fish	Create deep holes	Fish count	340 [1/]	--	Met
		(6’ ≤ Depth ≤ 10’)	Acre	<4.5 [3/]	4.5	Not Met
		(Depth ≥ 10’)	Acre/hole	<0.3 [3/]	0.3	Not Met
Restore Main Channel Border Habitat	Provide flowing water habitat for fish	Notch wing dams				
		(100’ upstream)	Ft/s	1.05	0.35	Met
		(at wing dam)	Ft/s	1.31	0.5	Met
		(100’ downstream)	Ft/s	1.38	0.4	Met
		Scour depth ≥ 1’				
		(wing dam no. 6)	Ft^2	3.88	1.00	Met
		(wing dam no. 15)	Ft^2	1.71	1.00	Met
	Provide additional habitat & substrate for benthic & aquatic organisms	Rock placement below wing dams	Organism numbers	-- [3/]	--	--
Restore Wetland Habitat	Increase food, shelter, & breeding habitat for wildlife	Potholes				
		(water surface area)	Ft^2	-- [3/]	--	--
		(cross sectional area)	Ft^2	762 [2/],[3/]	--	Met
	Increase bottomland hardwood diversity & quality	Establish hardwood trees in selected areas				
		(survival rate)	%	100 [3/]	10	Met
		(survival area)	Acres	--	30	Met

[1/] This number reflects that summarized in the June 2006 PER
[2/] Cross sectional area is average of all potholes using short chord below elevation 475 feet MSL
[3/] This number reflects that summarized at project completion since sedimentation transects are only required every five years – the next round of transects should be completed in 2002

b. Post-Construction Evaluation and Monitoring Schedules. In general, monitoring efforts for the Cottonwood HREP have been performed according to the Post-Construction

Performance Evaluation Plan in Appendix B and the Resource Monitoring and Data Collection Summary in Appendix C.

TABLE 9-2
Project Goals and Objectives (revised for this PER only)

Goals	Objectives	Project Features	Unit	Year 9 (2006)	Year 50 Target	Status
Restore	Improve water quality	Chute restoration	Mg/L DO		5	Met
Aquatic	for fish	& enhancement				
Over-		(Station W-M328.7B)	(min)	5.31[1/]		
wintering	Provide overwintering		(max)	22.71[1/]		
Habitat	water habitat for fish		(avg)	12.08[1/]		
		(Station W-M329.3B)	(min)	4.43[1/]		
			(max)	22.49[1/]		
			(avg)	11.81[1/]		
		Create deep holes	Fish count	340 [1/]	--	Met
		(6' ≤ Depth ≤ 10')	Feet	5.18[1/]	6	Not Met
		(Depth ≥ 10')	Feet	8.85[1/]	10	Not Met
Restore	Provide flowing water	Notch wing dams				
Main	habitat for fish	(100' upstream)	Ft/s	1.05[1/]	0.35	Met
Channel		(at wing dam)	Ft/s	1.31[1/]	0.5	Met
Border		(100' downstream)	Ft/s	1.38[1/]	0.4	Met
Habitat		Scour depth ≥ 1'				
		(wing dam no. 6)	Feet	3.88[1/]	1.00	Met
		(wing dam no. 15)	Feet	1.71[1/]	1.00	Met
				-- [3/]		
	Provide additional habitat	Rock placement	Organism		--	--
	& substrate for benthic	below wing dams	numbers			
	& aquatic organisms					
Restore	Increase food, shelter,	Potholes				
Wetland	& breeding habitat	(water surface area)	Ft^2	-- [3/]	--	--
Habitat	for wildlife	(cross sectional area)	Ft^2	762[2/1/]	--	Met
	Increase bottomland	Establish hardwood				
	hardwood diversity	trees in selected areas				
	& quality	(survival rate)	%	100 [3/]	10	Met
		(survival area)	Acres	--	30	Met

[1/] This number reflects that summarized in the June 2006 PER
[2/] Cross sectional area is average of all potholes using short chord below elevation 475 feet MSL
[3/] This number reflects that summarized at project completion since sedimentation transects are only required every five years – the next round of transects should be completed in 2010

For this PER only, a revised table was developed in order to quantify and evaluate certain project objectives. Since additional sediment transects have not been completed post-construction, the following objectives were evaluated based on depth in feet rather than area in acres, provide overwintering water habitat for fish and provide flowing water habitat for fish. As a result, the "Unit" and "Year 50 Target" columns were modified. These objectives and their modified performance evaluation parameters are highlighted in Table 9-2.

(1) Improve Water Quality for Fish. Due to expressed concerns by the MDOC about the construction of an impermeable causeway road and the associated effects this may

have on fish numbers in Cottonwood Chute, a detailed analysis of DO concentrations to note any extreme changes just downstream of this area should be included in the next PER. In addition, any related observations of fish stress or kills should be recorded in the MDOC Site Manager's project inspection report.

When the Resource Monitoring and Data Collection Summary (Appendix C, Table C-2) was prepared for the DPR, it was determined that point measurements at the water quality stations would be performed twice per week during the summer months (April through September) and monthly during the winter months (October through March). This sampling would be similar for all phases of the Cottonwood HREP: pre-project, design, and post-construction. However, due to the increasing number of HREPs and weather constraints, post-construction water quality sampling has been generally conducted twice per month from June through September and monthly from December through March. Typically, sampling has not been performed during April, May, October, and November. Therefore, Table C-2 in Appendix C has been modified to reflect current water quality sampling frequencies.

(2) <u>Provide Overwintering Water Habitat for Fish</u>. It is not only apparent for the Cottonwood HREP but for other HREPs as well that the annual sedimentation rates are consistently underestimated. This may be due to the fact that many of the existing HREPs are still in the younger years of their design life and that sediment deposition is not linear, but depends on the change in river levels and the length of time at which they occur. Higher sedimentation rates are still expected in the earlier years of the project due to chute stabilization, but overall the flooding characteristics of the river in a given year will most likely govern the sedimentation rate. If this is indeed the case, then it seems practical to conduct sediment transects on a similar scale. More transects should be performed more frequently in the first ten years, and a representative sample of those transects should be performed less often in later years. This in turn would closely follow the implementation schedule for PERs. More importantly, a better relationship between sedimentation rates versus project life could be determined and used in the design of future HREPs.

c. Project Operation and Maintenance. Project operation and maintenance has been conducted in accordance with the O&M Manual. There are no operational requirements attached to the Cottonwood HREP. Annual project inspections by the MDOC have resulted in proper corrective maintenance actions.

d. Project Design Enhancement. Discussions with those involved in operation, maintenance, and monitoring activities at the Cottonwood HREP have resulted in the following general conclusions regarding project features that may affect future design of other HREPs.

(1) <u>Causeway</u>. The intent of raising the causeway was to reduce flow through Cottonwood Chute except during high river levels. If the average DO concentration falls below the Year 50 Target and as a result, fish kills are observed, then the option of rehabilitation may be considered. Any decision would be carried forth only upon written mutual agreement between the Corps, USFWS, and MDOC. Included within this agreement would be a description of the agreed-upon course of action and funding responsibilities, if any. The likely course of

action would be to replace the existing rock in the causeway with a larger stone, so that in future floods it would not be displaced as it had been previously.

e. Additional Monitoring Needs. As was discussed earlier in the section, sediment transects have not been done and need to be completed before the next PER. More focus also needs to be placed on areas currently not meeting the 50 Year Target. Currently, there are occasional DO readings below 5 mg/L and the overwintering habitat depth is not as deep as necessary. Focus may also need to be placed on causeway maintenance as well.

APPENDIX A

ACRONYMS

ACRONYMS

CEMVR	Corps of Engineers, Mississippi Valley Division, Rock Island District
DO	Dissolved Oxygen
DNR	Department of Natural Resources
DPR	Definite Project Report
EMP	Environmental Management Program
ER	Engineer Regulation
FMA	Forest Management Areas
HREP	Habitat Rehabilitation and Enhancement Project
LTRMP	Long-Term Resource Monitoring Program
MDOC	Missouri Department of Conservation
MSL	Mean Sea Level
O&M	Operation and Maintenance
PER	Performance Evaluation Report
RM	River Mile
UMRS	Upper Mississippi River System
USFWS	United States Fish and Wildlife Service

APPENDIX B

POST-CONSTRUCTION EVALUATION PLAN
AND
SEDIMENTATION TRANSECT PROJECT OBJECTIVES EVALUATION

TABLE B-1
Post-Construction Evaluation Plan

Goal	Objective	Enhancement Feature	Unit	Year 0 (1997) Without Project	Year 0 (1997) With Project	Year 9 (2006) With Project	Year 50 Target With Project	Feature Measurement	Annual Field Observations by MDOC Site Manager
Restore Aquatic Over-wintering Habitat	Improve water quality for fish	Chute restoration & enhancement	Mg/L DO	<5	>5		5	Perform water quality tests at stations	Describe presence of fish stress or kills
		(Station W-M328.7B)	(min)			5.31[1]			
			(max)			22.71[1]			
			(avg)			12.08[1]			
		(Station W-M329.3B)	(min)			4.43[1]			
			(max)			22.49[1]			
			(avg)			11.81[1]			
	Provide overwintering water habitat for fish	Create deep holes	Fish count	--	--	340 [1]	--	Electrofishing, netting	Qualitative observations
		(6’ ≤ Depth ≤ 10’)	Acre	1.9	4.5	<4.5 [1]	4.5	Sediment transects	Describe presence or absence of debris snags, chute sedimentation, or vegetation
		(Depth ≥ 10’)	Acre/hole	0	0.3	<0.3 [1]	0.3	Sediment transects	
Restore Main Channel Border Habitat	Provide flowing water habitat for fish	Notch wing dams						Velocity measurements	Describe presence or absence of debris snags, channel sedimentation, or vegetation
		(100’ upstream)	Ft/s	0.3	0.35	1.05[1]	0.35		
		(at wing dam)	Ft/s	1.0	0.5	1.31[1]	0.5		
		(100’ downstream)	Ft/s	0.3	0.4	1.38[1]	0.4		
		Scour area ≥ 1’						Sediment transects	
		(wing dam no. 6)	Ft^2	0	0	3.88[3]	--		
		(wing dam no. 15)	Ft^2	0	0	1.71[1]	--		
	Provide additional habitat & substrate for benthic & aquatic organisms	Rock placement below wing dams	Organism numbers	--	--	-- [3]	--	Substrate evaluation	Qualitative observations
Restore Wetland Habitat	Increase food, shelter, & breeding habitat for wildlife	Potholes						Sediment transects	Arial survey of wildlife use, vegetation types, & density as well as invertebrate studies
		(water surface area)	Ft^2	0	--	-- [3]	--		
		(cross sectional area)	Ft^2	0	850 [2]	762 [2] [1]	--		
	Increase bottomland hardwood diversity & quality	Establish hardwood trees in selected areas							Estimate effective acreage and wildlife use
		(survival rate)	%	0	100	100 [3]	10	Tree count	
		(survival area)	Acres	0	54	54 [3]	30	Survey	Presence or absence of mast

<u>LEGEND</u>

[1] This number reflects that summarized in the June 2006 PER

[2] Cross sectional area is average of all five potholes using short chord below elevation 475 feet MSL

[3] This number reflects that summarized at project completion since sedimentation transects are only required every five years

TABLE B-2
Sedimentation Transect Project Objectives Evaluation

Transect	**Project Objectives to Be Evaluated**			
	Improve Water Quality for Fish	**Provide Overwintering Water Habitat for Fish**	**Provide Flowing Water Habitat for Fish**	**Increase Food, Shelter, and Breeding Habitat for Wildlife**
Cottonwood Chute				
(A)	X			
(B)	X			
(C)	X	X		
(D)	X	X		
(E)	X	X		
(F)	X	X		
(G)	X			
(H)	X			
(I)	X			
(J)	X			
Wing Dam Notches [1/]			X	
Potholes				
(1a)				X
(1b)				X
(2a)				X
(2b)				X
(3a)				X
(3b)				X
(4a)				X
(4b)				X
(5a)				X
(5b)				X

[1/] Bathymetric mapping of the dike field as water levels permit

APPENDIX C

MONITORING AND PERFORMANCE EVALUATION MATRIX
AND
RESOURCE MONITORING AND DATA COLLECTION SUMMARY

TABLE C-1
Monitoring and Performance Evaluation Matrix

Project Phase	Type of Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source	Implementation Instructions
Pre-Project	Sedimentation Problem Analysis	System-wide problem definition; Evaluates planning assumptions	USGS	USGS	LTRMP	--
	Pre-Project Monitoring	Identifies and defines problems at HREP site; Establishes need of proposed project features	MDOC	MDOC	MDOC	--
	Baseline Monitoring	Establishes baselines for performance evaluation	Corps	Corps / MDOC	HREP / MDOC	See Table C-2
Design	Data Collection for Design	Includes quantification of project objectives, design of project, and development of performance evaluation plan	Corps	Corps	HREP	See Table C-2
Construction	Construction Monitoring	Assesses construction impacts; Assures permit conditions are met	Corps	Corps	HREP	See State Section 401 Stipulations
Post-Construction	Performance Evaluation Monitoring	Determines success of project as related to objectives	Corps / MDOC	Corps / MDOC	HREP / MDOC	See Table C-2
	Analysis of Biological Responses to Projects	Evaluates predictions and assumptions of habitat unit analysis; studies beyond scope of performance evaluation, or if projects do not have desired biological results	Corps	Corps	HREP	--

TABLE C-2
Resource Monitoring and Data Collection Summary [1/]

Type Measurement	Water Quality Data: Pre-Project Phase		Water Quality Data: Design Phase		Water Quality Data: Post-Const Phase		Engineering Data: Pre-Project Phase	Engineering Data: Design Phase	Engineering Data: Post-Const Phase	Natural Resource Data: Pre-Project Phase	Natural Resource Data: Design Phase	Natural Resource Data: Post-Const Phase	Sampling Agency	Remarks
	Apr-Sep	**Oct-Mar**	**Apr-Sep**	**Oct-Mar**	**Jun-Sep**	**Dec-Mar**								
POINT MEASUREMENTS														
Water Quality Stations [2/]													Corps	
Turbidity			2W	M	2M	M								
Secchi Disk Depth	2W		2W	M	2M	M								
Suspended Solids	2W		2W	M	2M	M								
Dissolved Oxygen	2W		2W	M	2M	M								
Specific Conductance	2W		2W	M	2M	M								
Water Temperature	2W		2W	M	2M	M								
pH	2W		2W	M	2M	M								
Total Alkalinity	--		2W	M	2M	M								
Chlorophyll (a,b,c)	2W		2W	M	2M	M								
Velocity	--		2W	M	2M	M								
Water Depth	2W		2W	M	2M	M								
Pheophytin (a)	2W		2W	M	2M	M								
Percent Ice Cover				M		M								
Ice Depth				M		M								
Percent Snow Cover				M		M								
Snow Depth				M		M								
Wind Direction			2W	M	2M	M								
Wind Speed			2W	M	2M	M								
Wave Height			2W	M	2M	M								
Air Temperature			2W	M	2M	M								
Percent Cloud Cover			2W	M	2M	M								
Bulk Sediment Sampling [3/]			1											
Column Settling Stations [4/]													Corps	
Column Settling Analysis								1						

TABLE C-2 (Continued)
Resource Monitoring and Data Collection Summary [1/]

Type Measurement	Water Quality Data						Engineering Data			Natural Resource Data			Sampling Agency	Remarks
	Pre-Project Phase		Design Phase		Post-Const Phase		Pre-Project Phase	Design Phase	Post-Const Phase	Pre-Project Phase	Design Phase	Post-Const Phase		
	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar	Jun-Sep	Dec-Mar								
POINT MEASUREMENTS														
Boring Stations [5/]													Corps	
Geotechnical Borings									1					
Fish Stations [6/]													MDOC	
Electrofishing											2Y			
Potholes [7/]													MDOC	
Waterfowl / Wading Bird Use											2Y			
TRANSECT MEASUREMENTS														
Sedimentation Transects [8/]													Corps	
Hydrographic Soundings							1		5Y					
Potholes									5Y					
AREA MEASUREMENTS														
Mast Tree Survey [9/]													Corps	
Tree Count												5Y		
Mapping [10/]													Corps	
Aerial Photos/Remote Sensing										1		5Y		

W = Weekly
M = Monthly
Y = Yearly
nW = n-Weekly interval
nY = n-Yearly interval
1,2,3, --- = number of times data is collected within designated project phase

TABLE C-2 (Continued)
Resource Monitoring and Data Collection Summary [1/]

[1/] Resource Monitoring and Data Collection Summary - See Plate 3 for Monitoring Plan

[2/] Water Quality Stations – W-M328.7B and W-M329.3B

[3/] Bulk Sediment Stations (Design Phase) – E-M328.7B, E-M329.6A, and E-M330.1A

[4/] Column Settling Stations (Design Phase)

Station Code	*Boring Number*
C-M330.4A	C-94-2, EMP #1
C-M329.2A	C-94-2, EMP #2

[5/] Boring Stations (Design Phase)

Station Code	*Boring Number*	*Date*
C-M330.4A	C-94-1	02-08-94
C-M329.2A	C-94-2	02-08-94
B-M330.8D	C-94-3	11-29-94
B-M330.7C	C-94-4	11-30-94
B-M329.7A	C-94-5	11-30-94
B-M330.0H	C-94-6	11-30-94
B-M330.2H	C-94-7	11-30-94
B-M330.5H	C-94-8	12-01-94
B-M330.5B	C-94-9	12-01-94
B-M330.3D	C-94-10	12-01-94
B-M330.5M	C-94-11	12-01-94
B-M330.8H	C-94-12	12-01-94
B-M328.7B	C-95-1	12-05-95
B-M328.9B	C-95-2	12-05-95
B-M329.2B	C-95-3	12-05-95

[6/] Fish Stations – Monitor overwintering and midsummer use of side channel and deep holes

[7/] Potholes – Monitor waterfowl / wading bird use

[8/] Sedimentation Transects (Pre-Project Phase)

Station Code	*to*	*Station Code*
S-M328.7A		S-M328.7C
S-M329.2A		S-M329.2B
S-M329.5A		S-M329.5C
S-M330.0G		S-M330.0I
S-M330.2A		S-M330.2B
S-M330.2H		S-M330.2I
S-M330.6D		S-M330.6D
S-M330.7B		S-M330.7D
S-M330.9D		S-M330.9E

Sedimentation Transects (Post-Construction Phase) – See Table B-2 for Sediment Transect Project Objectives Evaluation

[9/] Mast Tree Survey (Post-Construction Phase) – Test of treatment effects for alternative exclusion methods shall be evaluated by an analysis of variance for tree growth

[10/] Mapping (Post-Construction Phase)

APPENDIX D

COOPERATING AGENCY CORRESPONDENCE

MISSOURI DEPARTMENT OF CONSERVATION

MEMORANDUM

Date: January 12, 2001

FROM: Ken Brummett

TO: Cottonwood Island HREP File

SUBJECT: Fall 2000 Electrofishing Survey

Randy Haydon, Kristin Goodrich, and I took advantage of the prolonged good weather in November 2000 to obtain an electrofishing sample of Cottonwood Chute. The survey was conducted during the morning of November 7, 2000. The water surface temperature was 53° F. Secchi visibility was not measured, but water transparency was variable with distance from the mouth of the chute to the upper end of the wetted area. The upper end of the chute had a light coverage of duckweed and watermeal. The Mississippi River was estimated to be between 1 and 2 feet below normal pool elevation due to the drought.

We captured a total of 340 fish, representing 19 species and one hybrid (see attached table). Two sampling runs along the deepened portion of the chute comprised nearly two-thirds of the effort and yielded nearly 75% of the catch.

In October 1998, a one-hour daytime electrofishing survey yielded 398 fish representing 20 species. Fewer gizzard shad, carp, and white bass, and no freshwater drum in the 2000 sample made the total catch figure lower, although the 2000 sample contained more largemouth bass, bluegill, and white crappie. Most of the largemouth bass sample consisted of young-of-the-year and yearlings, causing the average length to be lower.

I will reserve judgment of the effects of creating an impermeable channel blockage with the causeway until water quality parameters can be compared to the earlier period when there was minimal flow in the chute. Design of the causeway was not what I had requested.

COTTONWOOD ISLAND HREP

11/7/00
60 m. daytime electrofishing, all species

species	no.	length range (inches)	average length (inches)
Paddlefish	1	33.0 (eye to fork of tail)	
Bowfin	2	17.6 - 21.1	19.4
Gizzard shad	37	3.9 - 8.6	6.1
Grass carp	1	18.2	
Common carp	29	17.0 - 27.2	20.8
Emerald shiner	2	1.5 - 1.8	1.7
River carpsucker	12	14.6 - 17.3	16.3
Quillback	1	14.1	
Smallmouth buffalo	8	10.7 - 16.7	13.4
Bigmouth buffalo	16	13.2 - 20.8	16.0
Channel catfish	7	15.9 - 24.8	19.7
Brook silversides	1	2.8	
White bass	4	12.8 - 14.5	13.6
Green sunfish	5	2.4 - 8.7	4.6
Orangespotted sunfish	6	2.0 - 3.0	2.5
Bluegill	93	1.8 - 6.6	4.3
Largemouth bass	69	3.1 - 13.8	5.8
White crappie	35	3.0 - 13.0	9.4
Black crappie	10	4.7 - 10.6	7.7
Hybrid sunfish	1	4.4	

APPENDIX E

WATER QUALITY DATA

TABLE E-1

Pre-Project Monitoring Results at Station W-M328.7B

Date	Water Depth (m)	Velocity (ft/s)	Water Temp (^oC)	DO (mg/L)	pH (SU)	Chlorophyll a (mg/m^3)
04/07/92	1.97	--	11.4	10.96	7.97	19
05/05/92	3.23	0.22	15.8	8.56	8.18	15
05/19/92	1.92	0.09	26.6	15.10	8.92	40
07/23/92	2.04	0.06	26.5	8.96	8.22	37
08/13/92	1.78	0.05	25.1	4.52	7.55	33
08/27/92	1.80	0.17	24.7	2.96	7.52	20.7
09/17/92	1.84	0.27	23.8	6.11	--	21.9
10/27/92	1.74	0.11	13.7	8.62	7.95	67.8
01/25/93	1.98	0.00	0.7	11.30	8.35	20.8
10/27/93	2.03	0.12	12.3	5.78	7.95	43.4
11/10/93	1.89	0.13	6.7	20.40	8.98	8.2
02/08/94	1.51	0.00	0.4	9.92	8.04	45.2
03/23/94	2.21	0.13	11.0	9.63	8.17	38
04/19/94	2.07	0.08	18.3	12.34	8.69	110
05/10/94	2.55	0.05	17.7	7.62	7.42	17
05/24/94	1.95	0.08	26.1	7.14	7.91	15
06/14/94	1.34	0.12	29.8	6.70	8.02	14
07/07/94	1.84	--	29.8	8.69	8.24	29
07/19/94	1.87	0.14	30.3	9.35	8.21	33
08/09/94	1.52	0.00	29.1	12.94	8.81	56
08/30/94	1.62	0.15	25.8	8.81	8.19	86
09/13/94	1.52	0.07	26.1	12.03	8.63	96
10/04/94	1.65	0.00	21.2	10.42	8.46	53
10/25/94	1.46	0.22	14.0	8.46	8.48	18
12/06/94	1.71	0.13	5.5	11.48	8.23	16
01/10/95	1.48	0.00	0.3	17.70	8.90	44
02/15/95	1.43	0.01	1.7	20.70	--	65
03/14/95	1.60	0.15	14.0	22.70	9.03	--
04/11/95	3.72	0.16	6.4	9.74	7.84	8.9
05/02/95	3.35	0.33	13.7	7.76	8.38	20
05/16/95	3.23	0.88	17.9	7.70	7.72	4
06/13/95	2.36	0.05	24.7	6.72	7.97	8.1
07/11/95	1.74	--	30.6	9.75	8.38	24
07/25/95	1.62	0.00	31.6	14.31	8.63	51
08/29/95	1.77	--	32.8	12.99	8.59	31
09/12/95	1.68	0.00	23.0	8.39	--	34
09/27/95	1.69	0.00	18.9	12.62	--	31
10/10/95	1.86	0.00	18.2	9.53	8.26	12
10/24/95	1.52	0.00	11.8	7.87	8.10	16
11/07/95	1.89	0.16	6.3	8.46	8.00	9.8
06/18/96	1.77	0.170	24.2	4.06	7.45	13
07/17/96	2.29	0.122	25.8	8.43	8.31	32
08/12/96	1.74	0.087	27.0	9.11	8.42	36
09/04/96	1.52	0.068	27.6	6.72	8.19	59
09/19/96	1.84	0.202	21.0	10.10	8.31	39
12/23/96	1.58	0.000	2.3	10.78	--	50
MIN	1.34	0.00	0.3	2.96	7.42	4.0
MAX	3.72	0.88	32.8	22.70	9.03	110
AVG	1.96	0.12	18.3	10.15	--	34

TABLE E-2

Post-Project Monitoring Results at Station W-M328.7B

Date	Water Depth (m)	Velocity (ft/s)	Water Temp (^oC)	DO (mg/L)	pH (SU)	Chlorophyll a (mg/m^3)
12/23/97	4.42	0.00	2.6	17.44	--	18
01/27/98	4.63	0.00	1.5	12.41	8.19	11
02/24/98	4.50	--	7.3	10.76	8.13	18
03/24/98	4.80	0.06	5.7	11.17	6.79	7.5
06/03/98	4.48	0.15	22.9	4.67	7.49	11
07/02/98	6.28	0.12	29.8	5.99	7.57	4.4
07/14/98	5.65	0.05	29.0	7.20	7.90	6.7
07/28/98	4.34	0.00	29.6	13.90	8.44	42
08/13/98	4.11	0.14	27.9	9.13	8.20	59
08/25/98	4.18	0.11	30.6	11.95	8.53	93
09/10/98	3.98	0.05	26.6	8.92	8.14	33
09/29/98	4.34	0.12	24.2	6.30	7.28	34
12/29/98	3.90	0.00	1.6	21.26	8.40	52
01/28/99	4.33	0.00	0.7	13.65	7.90	2.9
02/25/99	4.19	0.00	4.6	19.18	8.80	54
03/23/99	4.11	0.10	9.9	19.68	9.00	80
05/27/99	6.37	0.40	20.3	7.48	7.32	4.9
06/22/99	4.88	0.08	26.8	9.29	8.20	19
07/08/99	4.07	0.20	31.2	10.19	8.50	26
07/27/99	4.37	0.00	34.3	16.65	8.90	120
08/10/99	3.96	0.11	29.6	13.42	8.60	54
08/24/99	3.90	--	25.5	7.07	8.10	45
09/08/99	3.78	--	26.4	10.04	8.40	33
09/21/99	3.88	--	20.7	7.40	8.00	27
02/08/00	3.80	0.00	2.9	23.08	8.70	70
03/07/00	3.95	0.10	13.8	10.53	8.00	31
05/31/00	3.77	0.08	27.4	7.51	8.10	14
06/15/00	4.74	--	27.4	9.33	8.40	17
07/06/00	4.78	--	29.6	11.03	8.40	22
07/25/00	3.97	--	27.8	12.24	8.50	34
08/08/00	3.55	--	26.2	5.75	7.80	6.2
08/22/00	3.95	--	28.6	11.66	8.70	28
09/05/00	3.75	--	27.8	8.98	8.20	45
09/19/00	3.62	--	23.6	10.81	8.30	5.7
01/03/01	3.64	--	0.8	6.79	7.90	<1
02/13/01	4.00	--	0.9	15.27	8.10	<1
03/06/01	3.83	0.00	3.1	10.86	7.60	1.5
03/20/01	4.60	0.00	9.1	10.12	7.70	<1
06/05/01	6.07	0.07	15.7	8.45	7.60	<1
06/19/01	5.00	0.00	25.6	6.81	7.80	<1
07/03/01	4.94	0.10	26.6	7.62	7.90	<1
07/18/01	3.82	--	28.4	12.08	8.50	<1
07/31/01	3.77	0.00	33.4	>20	9.00	<1
08/14/01	3.63	0.00	30.9	>20	9.20	16
08/28/01	3.73	0.11	30.6	>20	9.30	14
09/18/01	3.66	0.00	21.3	5.02	7.80	--

TABLE E-2 (Continued)

Post-Project Monitoring Results at Station W-M328.7B

Date	Water Depth (m)	Velocity (ft/s)	Water Temp (^oC)	DO (mg/L)	pH (SU)	Chlorophyll a (mg/m^3)
01/08/02	3.71	0.00	3.8	15.60	8.30	41.0
02/28/02	3.77	--	25.0	5.78	7.40	36.0
06/18/02	4.41	--	31.2	13.22	8.60	1.4
07/02/02	3.32	--	30.9	17.82	8.80	66.0
07/18/02	3.40	0.00	34.5	17.96	9.10	125.0
08/01/02	3.28	--	29.8	11.15	8.50	75.0
08/14/02	3.44	--	28.2	13.78	8.60	29.0
08/29/02	3.68	--	3.5	11.53	8.50	83.0
09/10/02	3.45	0.12	21.8	7.39	7.90	69.0
09/24/02	3.15	--	1.8	28.29	--	30.0
12/17/02	3.37	0.000	3.8	15.60	8.30	--
2/13/2003	3.275	0.47	1.9	19.67	8.76	-
4/10/2003	3.170	-	15.2	12.93	8.40	-
6/10/2003	3.675	-	23.2	15.36	8.70	86.0
6/24/2003	3.250	-	29.6	13.76	8.40	29.0
7/8/2003	3.860	-	30.3	12.76	8.70	83.0
7/22/2003	3.850	-	28.8	10.27	8.40	53.0
8/5/2003	3.350	4.48	29.1	14.33	9.00	87.0
8/19/2003	3.250	-	30.5	8.68	8.40	34.0
9/2/2003	3.140	-	26.3	5.31	7.70	11.0
9/16/2003	3.130	3.51	24.3	5.62	7.90	18.0
12/23/2003	3.250	-	2.0	11.18	8.13	-
2/12/2004	3.040	0.29	1.2	6.22	7.70	-
3/23/2004	3.150	-	8.4	10.09	7.60	-
6/8/2004	5.705	9.53	24.8	5.75	7.30	4.3
6/22/2004	5.560	10.48	23.0	5.92	7.20	<1
7/7/2004	3.590	1.01	27.3	9.37	7.40	53.0
7/20/2004	3.090	0.63	30.2	16.08	8.60	18.3
8/3/2004	2.980	0.31	29.9	7.18	7.70	9.0
8/17/2004	3.400	1.06	25.8	18.59	8.90	-
8/31/2004	2.980	0.90	26.8	8.04	7.60	29.0
9/14/2004	3.170	0.55	26.0	12.42	8.80	69.0
1/4/2005	3.050	0.84	2.4	22.71	9.10	52.0
2/22/2005	3.350	0.56	4.3	13.20	7.90	5.2
3/22/2005	2.980	-	7.7	15.67	8.80	98.0
6/8/2005	2.840	-	25.8	6.56	8.10	30.0
6/21/2005	3.215	1.51	30.3	17.75	8.60	54.0
7/6/2005	3.050	4.01	29.4	11.84	8.60	67.0
7/19/2005	2.775	1.75	31.3	14.01	8.50	58.0
8/2/2005	2.700	-	31.4	16.44	8.60	51.0
8/17/2005	2.600	-	27.4	9.84	8.40	110.0
8/30/2005	2.740	1.65	27.8	11.60	8.60	70.0
9/13/2005	2.460	2.36	27.6	8.31	8.20	51.0
12/22/2005	2.920	0.34	1.5	16.56	8.40	13.0
1/25/2006	2.740	-	2.3	20.19	8.80	92.0
3/16/2006	2.700	-	9.8	8.55	7.70	7.1
MIN	2.46	0.00	0.70	4.67	6.79	1.40
MAX	6.37	10.48	34.50	28.29	9.30	125.00
AVG	3.82	0.87	20.31	11.80	8.24	40.76

TABLE E-3

Post-Project Monitoring Results at Station W-M329.3B

Date	Water Depth (m)	Velocity (ft/s)	Water Temp (^oC)	DO (mg/L)	pH (SU)	Chlorophyll a (mg/m^3)
12/23/97	3.05	0.00	3.6	14.30	--	18
01/27/98	3.03	0.00	2.1	13.68	8.08	17
02/24/98	3.32	--	7.4	12.45	8.15	15
03/24/98	2.99	0.00	6.5	9.53	6.77	7.7
06/03/98	3.35	0.07	22.7	3.55	7.35	22
07/02/98	5.04	0.22	26.4	5.18	7.46	8
07/14/98	4.57	0.00	27.8	5.51	7.71	4.3
07/28/98	2.85	0.00	33.9	>20	8.75	78
08/13/98	2.88	0.11	28.3	8.71	8.03	110
08/25/98	3.25	0.00	28.8	2.41	7.64	24
09/10/98	--	--	27.8	14.39	8.49	129
09/29/98	2.70	0.10	24.0	6.60	7.44	150
12/29/98	2.70	0.00	3.0	21.13	8.80	50
01/28/99	3.14	0.00	1.0	11.99	7.80	7.1
02/25/99	2.73	0.00	6.5	18.75	8.90	32
03/23/99	2.94	0.00	11.4	20.13	9.00	81
05/27/99	5.09	0.59	20.0	7.57	7.53	4.8
06/22/99	3.69	0.16	25.6	7.82	8.20	12
07/08/99	2.71	0.21	34.0	13.92	8.70	52
07/27/99	2.94	0.00	34.6	19.27	8.60	210
08/10/99	2.53	0.00	28.0	11.19	8.60	53
08/24/99	2.27	--	25.1	7.06	8.10	85
09/08/99	2.44	--	25.9	8.61	8.30	28
09/21/99	2.30	0.00	18.8	5.65	7.80	39
02/08/00	2.27	0.00	3.0	9.50	7.70	16
03/07/00	2.60	0.10	16.1	8.90	7.90	85
05/31/00	2.47	0.03	31.0	12.02	8.50	47
06/15/00	3.95	--	28.8	9.85	8.50	9
07/06/00	3.70	--	28.5	9.70	8.00	69
07/25/00	2.44	--	29.6	>20	9.00	430
08/08/00	2.30	--	26.7	6.48	8.00	9
08/22/00	2.05	--	30.4	16.20	8.90	46
09/05/00	2.16	--	29.1	8.87	8.20	43
09/19/00	2.19	--	24.8	14.80	8.70	190
01/03/01	2.22	--	0.8	6.70	7.70	444
02/13/01	2.45	--	0.8	12.24	8.00	92
03/06/01	2.41	--	4.3	26.01	9.30	170
03/20/01	3.40	0.000	5.5	9.00	7.60	1.8
06/05/01	4.65	0.081	15.6	8.5	7.7	<1
06/19/01	3.54	0.000	25.6	3.80	7.60	31
07/03/01	3.55	0.000	26.6	8.37	8.10	39
07/18/01	2.27	--	29.3	13.90	8.60	57
07/31/01	2.27	0.000	36.5	>20	9.10	143
08/14/01	2.11	0.000	30.2	17.98	--	126
08/28/01	2.21	--	27.2	6.77	8.10	43
09/18/01	2.27	0.000	21.1	4.83	7.80	--

TABLE E-3 (Continued)

Post-Project Monitoring Results at Station W-M329.3B

Date	Water Depth (m)	Velocity (ft/s)	Water Temp (°C)	DO (mg/L)	pH (SU)	Chlorophyll a (mg/m^3)
01/08/02	2.220	0.000	2.1	16.86	8.10	38.0
02/28/02	2.250	--	6.0	12.11	8.00	12.0
06/18/02	2.900	--	26.6	5.68	7.40	28.0
07/02/02	2.350	--	32.3	15.72	8.60	179.0
07/18/02	2.070	0.000	32.7	16.33	8.80	158.0
08/01/02	2.030	--	34.7	17.72	--	57.0
08/14/02	2.070	--	30.8	16.08	8.80	58.0
08/29/02	2.230	--	28.6	14.11	8.60	76.0
09/10/02	2.000	0.000	29.0	13.84	8.40	171.0
09/24/02	1.950	--	22.4	14.81	8.60	124.0
12/17/02	2.000	--	3.9	16.89	--	--
2/13/2003	1.930	0.13	1.7	10.66	8.08	-
4/10/2003	1.950	-	11.5	10.05	8.00	-
6/10/2003	2.110	-	24.1	15.38	8.60	158.0
6/24/2003	2.000	-	31.4	15.25	8.40	107.0
7/8/2003	2.190	2.46	32.4	14.20	8.70	84.0
7/22/2003	2.300	1.76	27.6	7.36	8.00	62.0
8/5/2003	1.900	2.42	30.4	>20	9.30	234.0
8/19/2003	1.750	-	33.9	12.06	8.80	67.0
9/2/2003	1.670	0.33	25.5	10.34	8.20	88.0
9/16/2003	1.820	-	27.2	7.19	7.70	34.0
12/23/2003	1.900	-	2.4	11.38	8.15	-
2/12/2004	1.775	0.16	1.2	4.88	7.60	-
3/23/2004	1.980	-	10.2	10.66	7.70	-
6/8/2004	4.270	2.97	23.8	4.64	7.10	5.1
6/22/2004	4.300	9.20	22.9	6.09	7.30	1.2
7/7/2004	2.200	-	28.3	11.50	7.50	71.0
7/20/2004	2.080	1.06	31.3	18.35	8.70	106.0
8/3/2004	1.740	0.56	31.8	7.89	7.90	40.0
8/17/2004	1.900	0.97	28.5	18.99	9.00	-
8/31/2004	1.740	0.66	28.5	10.08	7.70	36.0
9/14/2004	1.780	-	28.5	13.38	8.60	134.0
1/4/2005	1.880	0.48	3.8	21.88	8.70	33.0
2/22/2005	1.990	1.18	5.5	12.19	7.90	13.0
3/22/2005	1.780	-	9.3	12.58	8.40	151.0
6/8/2005	2.030	-	26.9	4.43	7.80	61.0
6/21/2005	2.000	2.18	29.8	>20	8.90	120.0
7/6/2005	1.920	0.11	27.6	10.61	8.30	100.0
7/19/2005	1.675	0.97	34.4	19.27	8.70	81.0
8/2/2005	1.640	0.45	34.6	18.61	8.80	120.0
8/17/2005	2.600	-	29.9	>20	9.10	280.0
8/30/2005	1.630	0.57	26.6	6.70	7.80	44.0
9/13/2005	1.690	1.88	28.5	6.28	8.00	73.0
12/22/2005	1.660	0.39	1.8	16.79	8.30	22.0
1/25/2006	1.630	-	3.2	22.49	8.90	81.0
3/16/2006	1.740	-	10.9	5.68	7.70	6.3
MIN	1.63	0.00	0.80	2.41	6.77	1.20
MAX	5.09	9.20	36.50	26.01	9.30	444.00
AVG	2.50	0.60	21.19	11.65	8.21	80.02

FIGURE E-1. POST-PROJECT DISSOLVED OXYGEN CONCENTRATIONS COLLECTED WITH A CONTINUOUS MONITOR NEAR THE SURFACE AT SITES W-M328.7B AND W-M329.3B

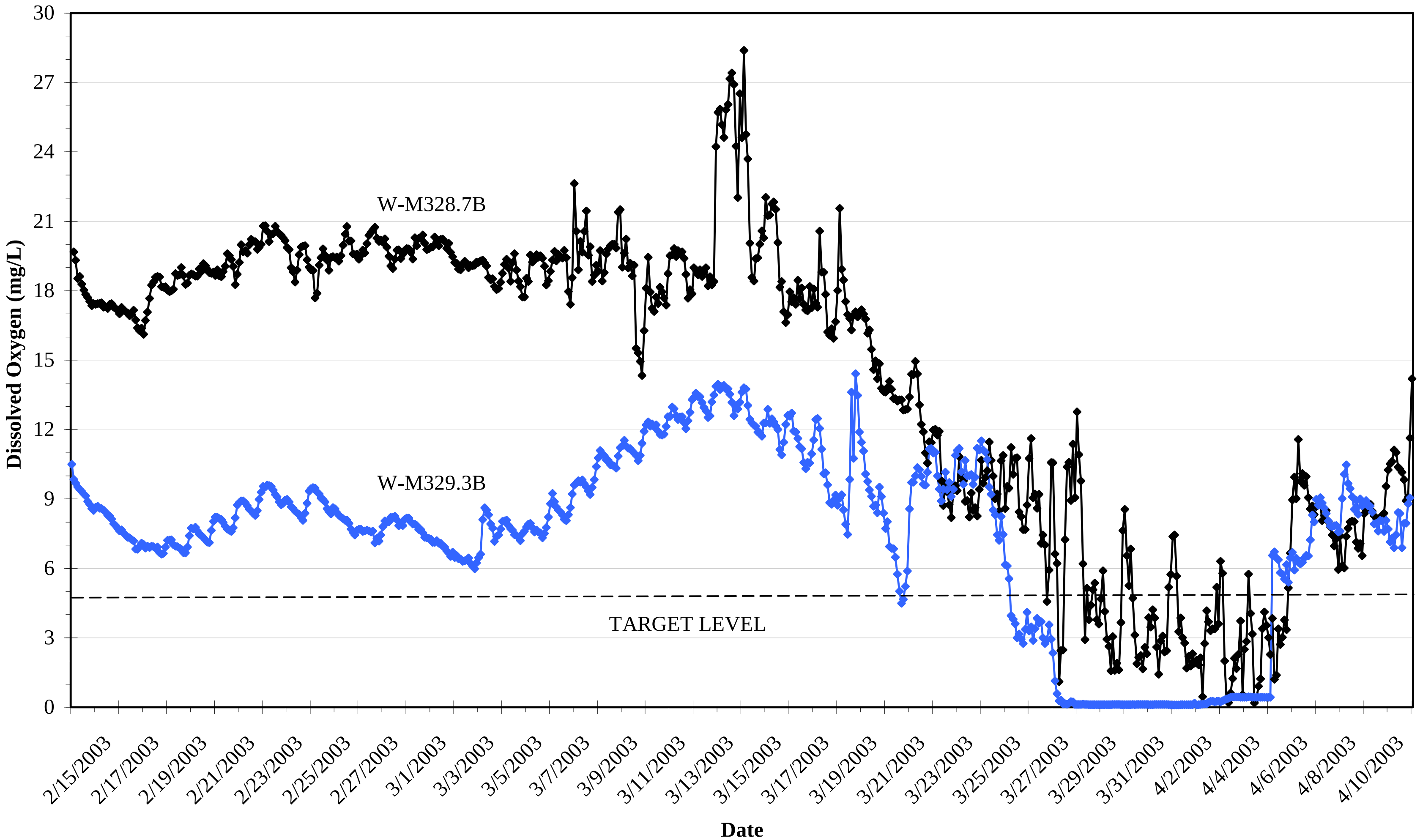


FIGURE E-2. POST-PROJECT DISSOLVED OXYGEN CONCENTRATIONS COLLECTED WITH A CONTINUOUS MONITOR NEAR THE SURFACE AT SITE W-M328.7B

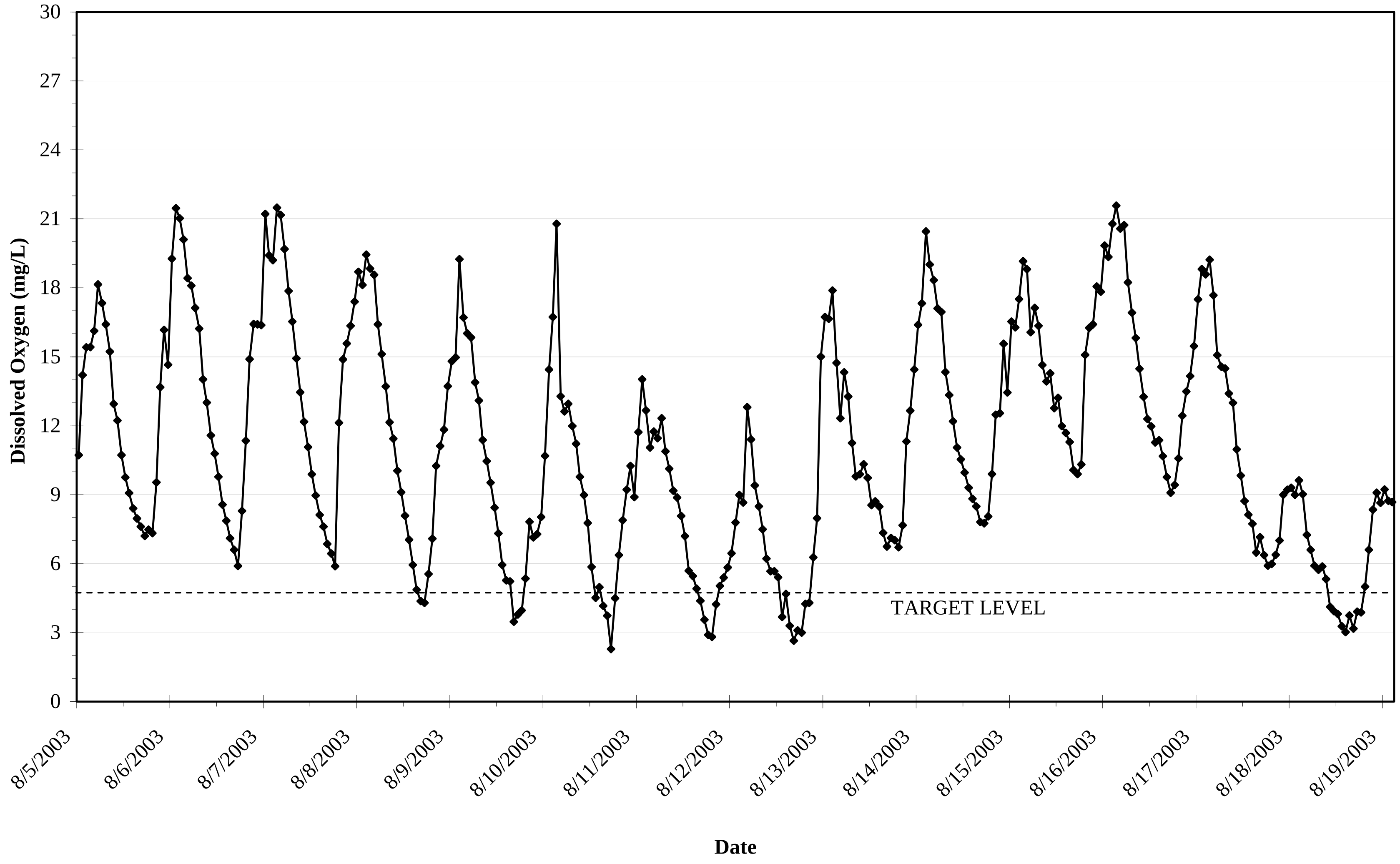


FIGURE E-3. POST-PROJECT DISSOLVED OXYGEN CONCENTRATIONS COLLECTED WITH A CONTINUOUS MONITOR NEAR THE SURFACE AT SITE W-M329.3B

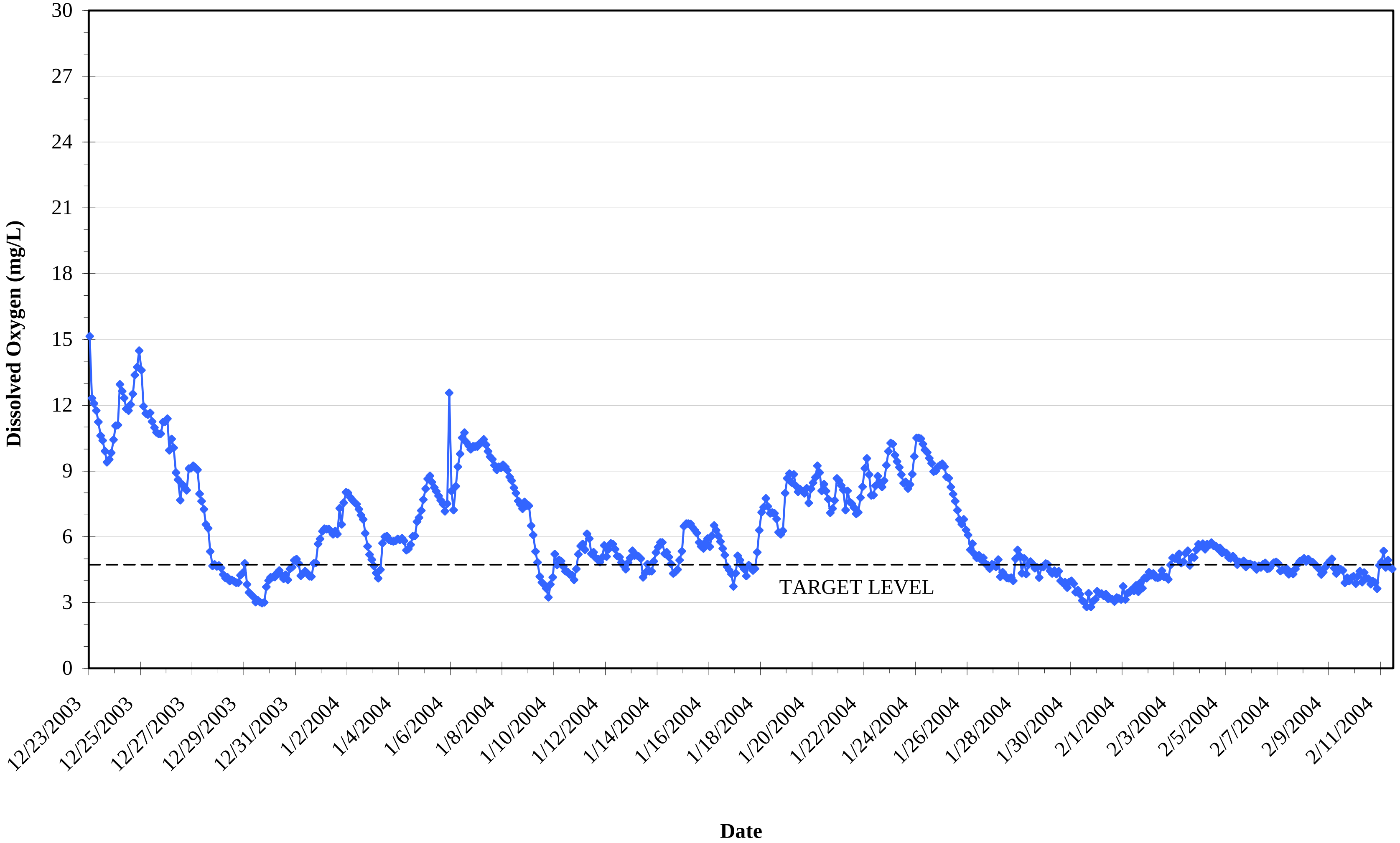


FIGURE E-4. POST-PROJECT DISSOLVED OXYGEN CONCENTRATIONS COLLECTED WITH A CONTINUOUS MONITOR NEAR THE SURFACE AT SITE W-M329.3B

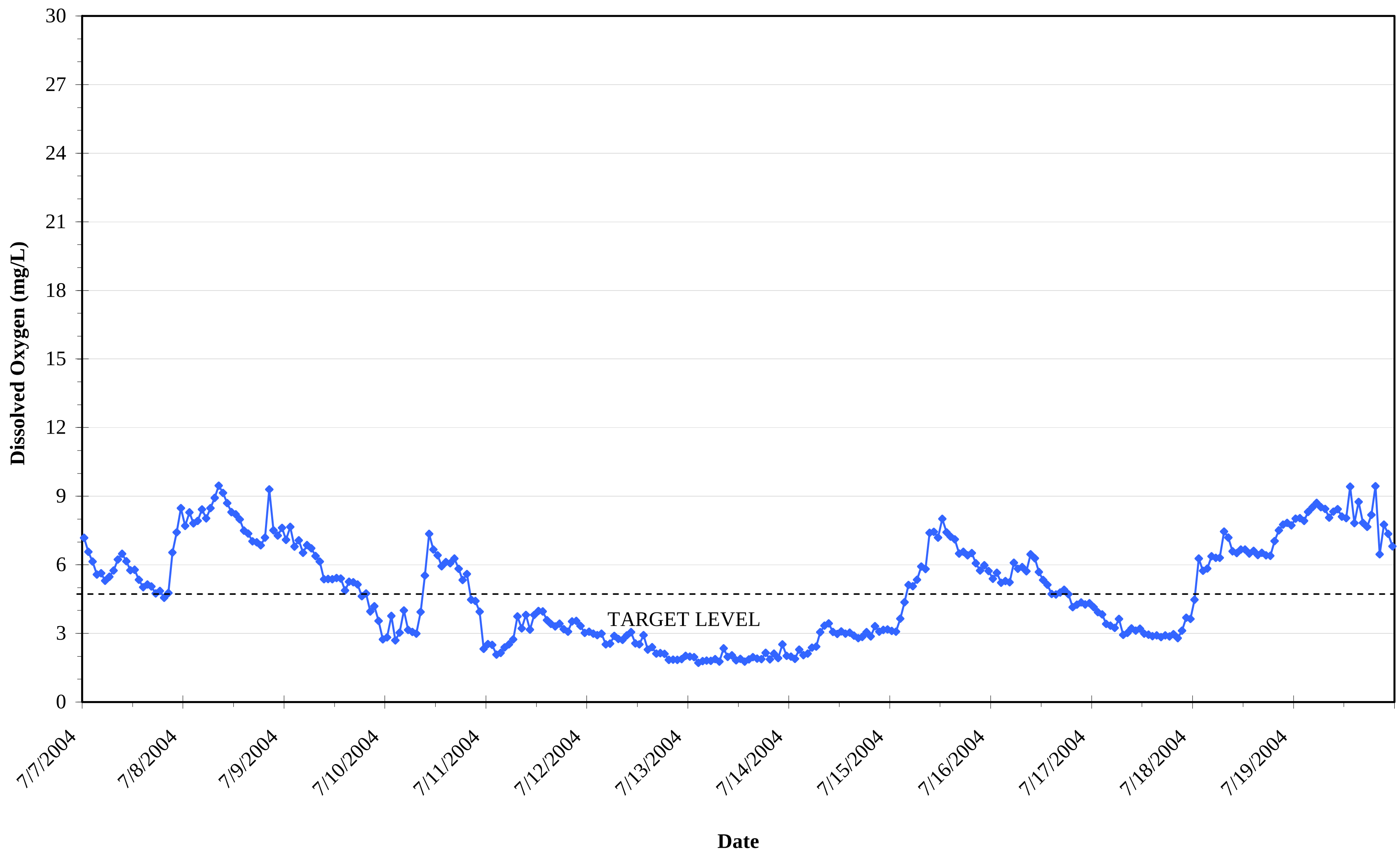


FIGURE E-5. POST-PROJECT DISSOLVED OXYGEN CONCENTRATIONS COLLECTED WITH A CONTINUOUS MONITOR NEAR THE SURFACE AT SITE W-M328.7B

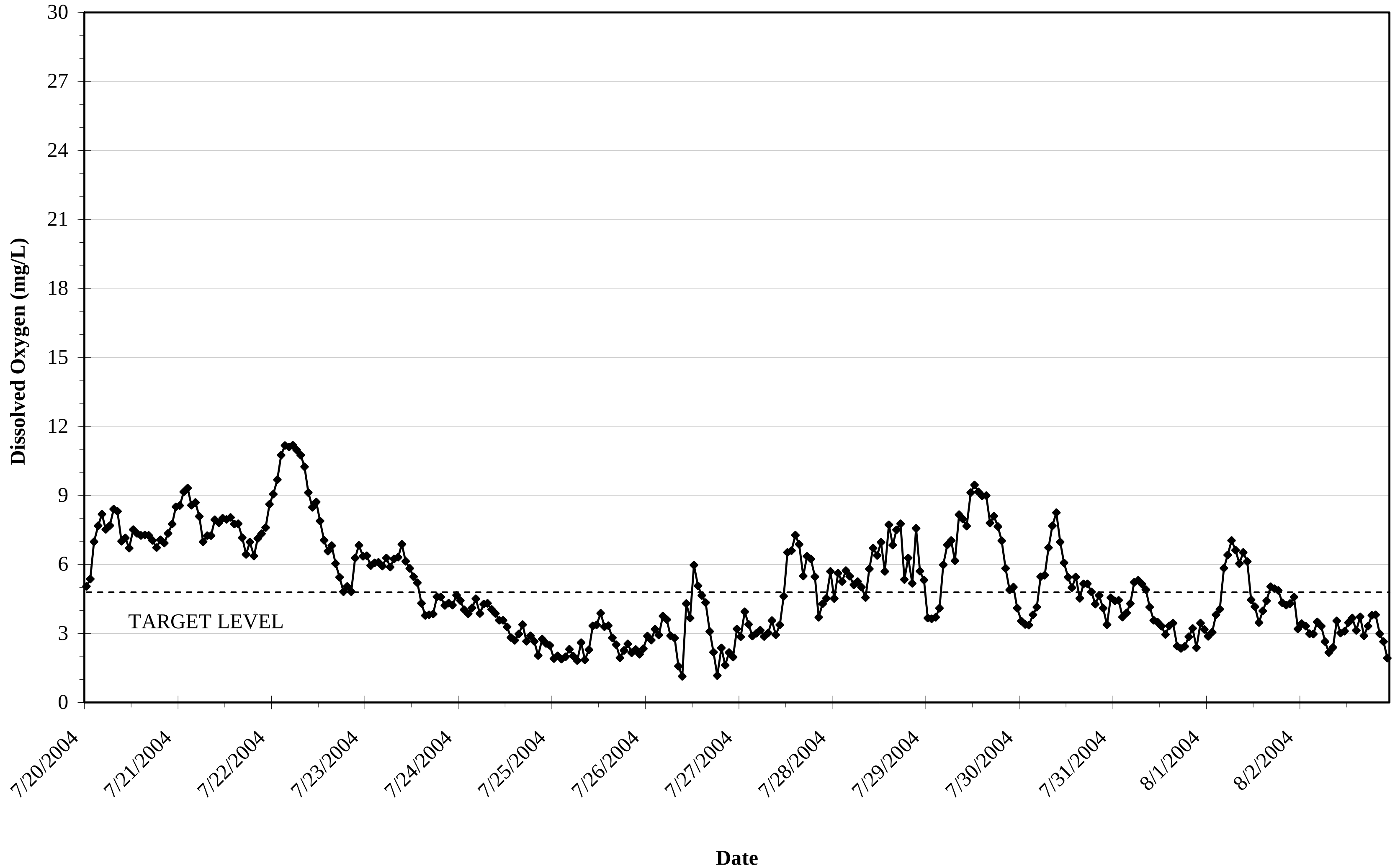


FIGURE E-6. POST-PROJECT DISSOLVED OXYGEN CONCENTRATIONS COLLECTED WITH A CONTINUOUS MONITOR NEAR THE SURFACE AT SITES W-M328.7B AND W-M329.3B

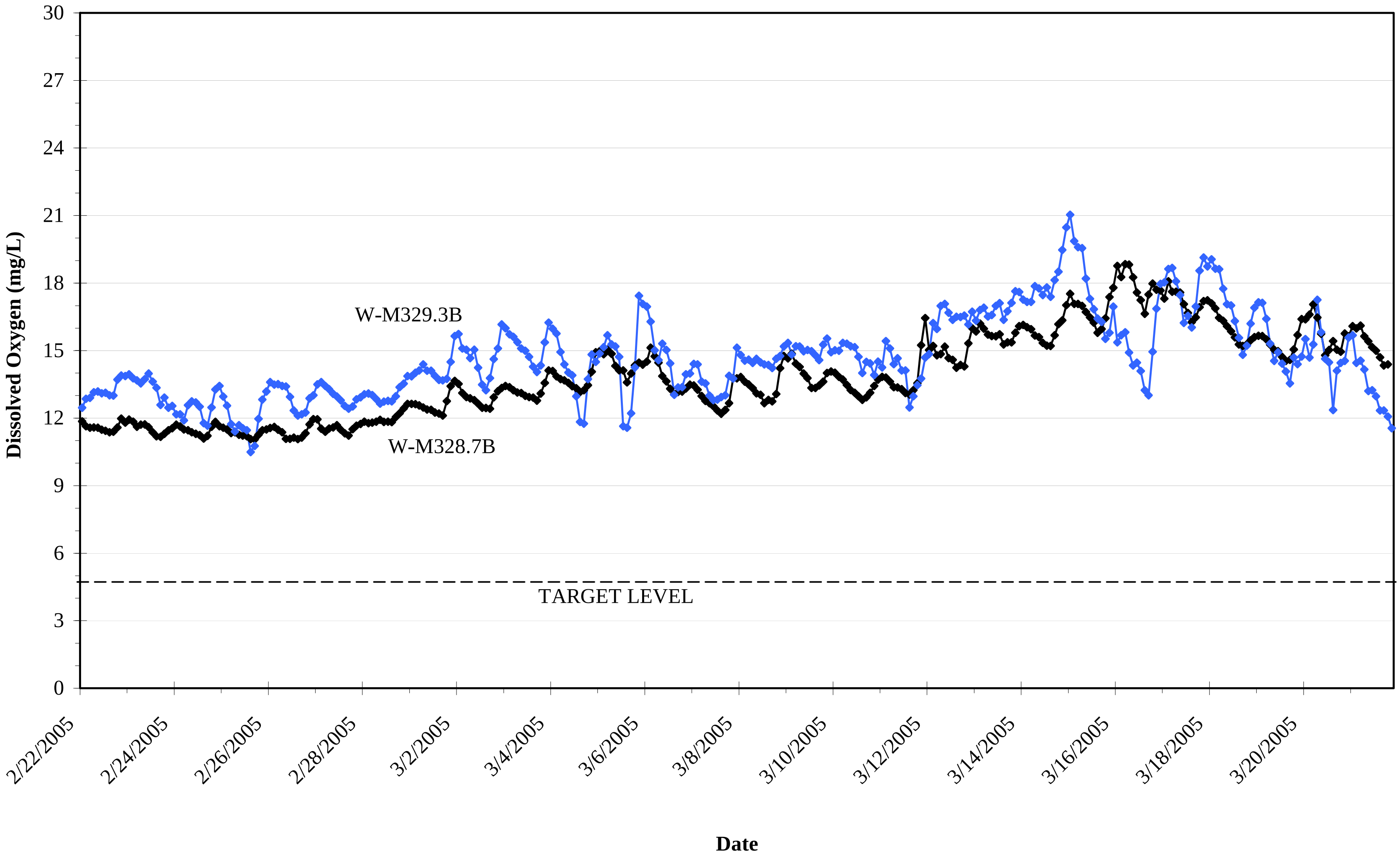


FIGURE E-7. POST-PROJECT DISSOLVED OXYGEN CONCENTRATIONS COLLECTED WITH A CONTINUOUS MONITOR NEAR THE SURFACE AT SITE W-M329.3B

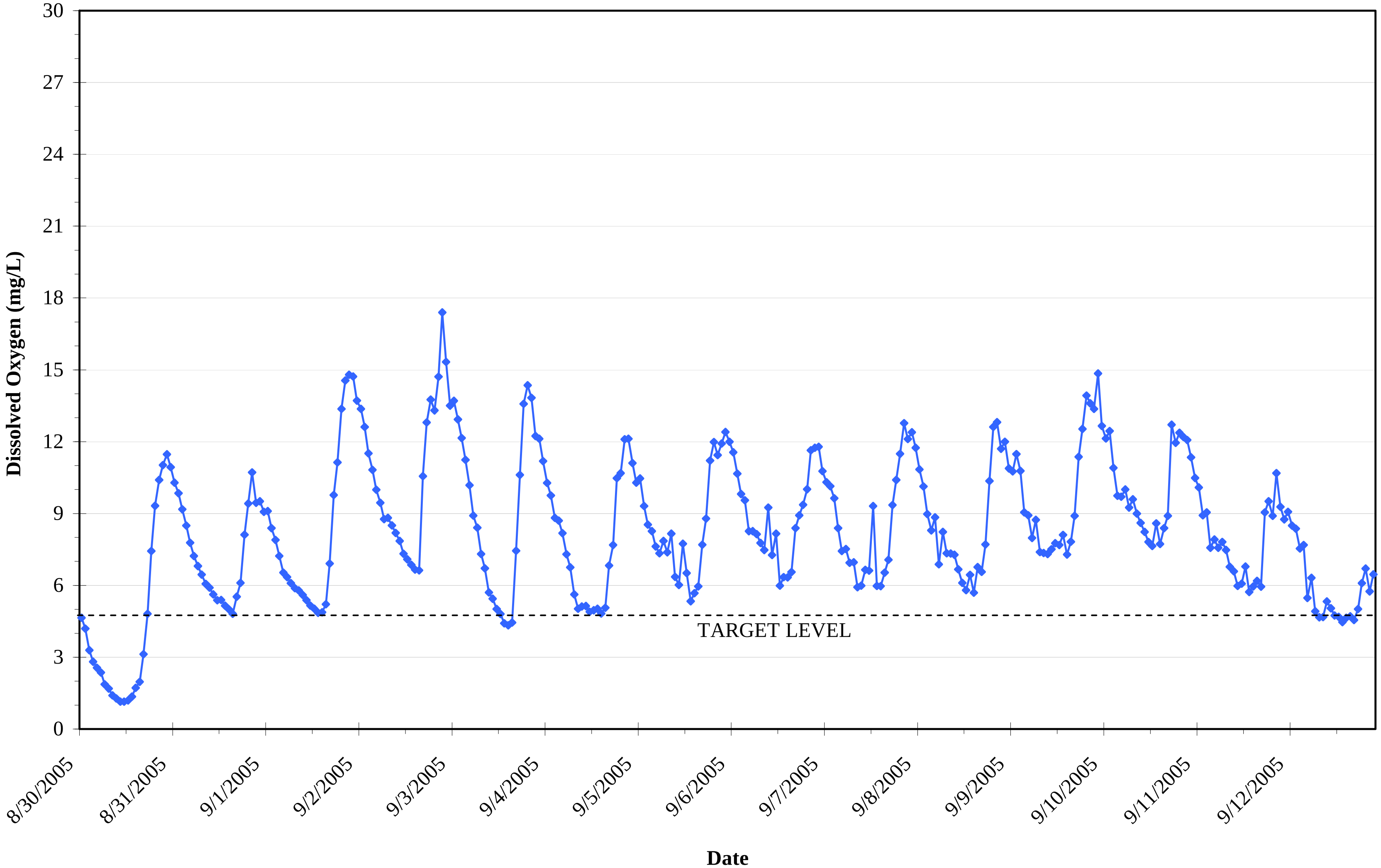


FIGURE E-8 POST-PROJECT DISSOLVED OXYGEN CONCENTRATIONS AT STATION W-M329.3B WITH SURFACE SAMPLES ON THE DATES 2/13/03 - 3/16/06

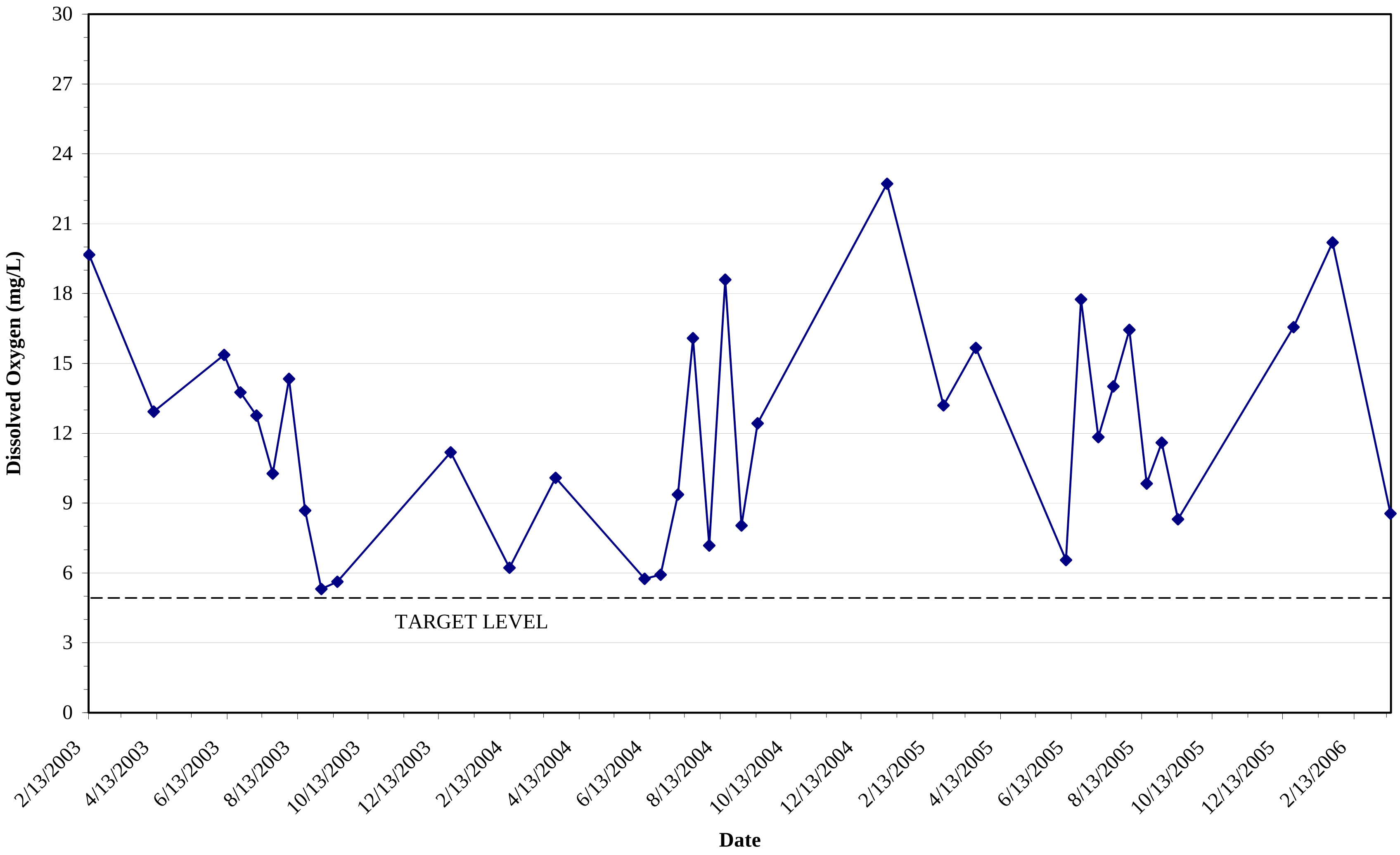


FIGURE E-9 POST-PROJECT DISSOLVED OXYGEN CONCENTRATIONS AT SITE W-M328.7B WITH SURFACE SAMPLES ON THE DATES 2/13/03 - 3/16/06

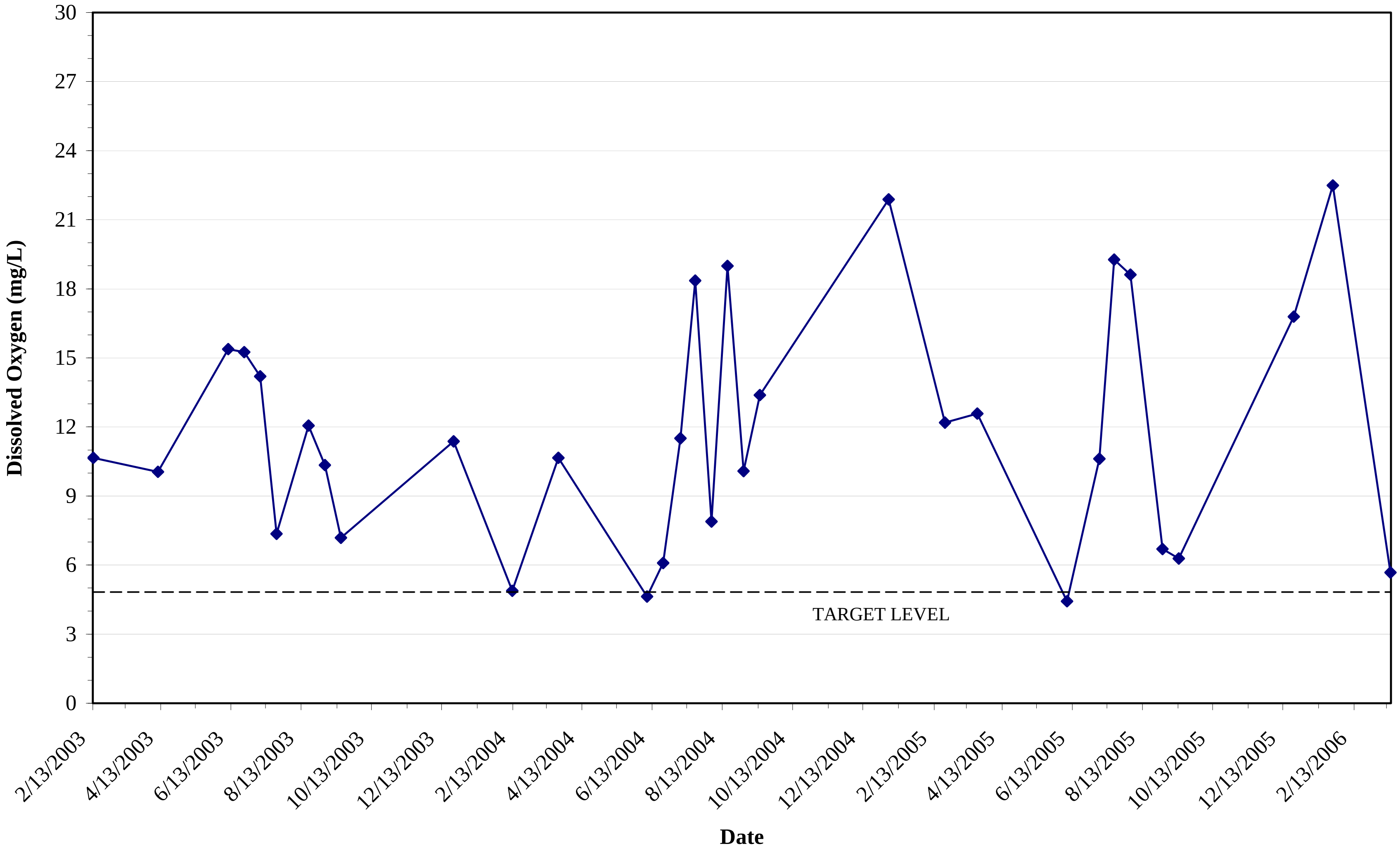


TABLE E-4

Post-Project Monitoring Results 100' U/S Notch in Wing Dam No. 6

Date	Air Temp (°C)	Wind Speed (mph)	Wind Direction	Cloud Cover (%)	Water Depth (m)	Wave Height (cm)	Velocity (ft/s)
06/18/97	30	6	NW	15	2.225	9	1.078
07/02/97	28	7	NW	0	2.103	9	1.456
07/17/97	31	6	S	35	2.103	6	1.217
07/31/97	26	3	SE	40	2.164	6	1.364
08/19/97	18	8	E	100	2.195	6	0.846
09/03/97	20	7	NE	35	1.951	9	0.618
09/25/97	18	2	NW	0	2.225	3	0.785
06/03/98	15	13	N	95	2.667	12	1.655
07/02/98	29	4	NE	35	2.835	6	4.229
07/14/98	31	8	S	90	--	12	3.235
07/28/98	29	2	S	5	2.819	6	1.525
08/13/98	26	2	N	80	2.423	3	1.269
08/25/98	29	8	N	45	2.164	12	0.785
09/10/98	27	6	SE	0	1.951	9	0.409
09/29/98	21	8	S	95	1.920	9	0.366
07/08/99	--	--	--	--	3.002	9	1.977
08/10/99	--	--	--	--	2.499	9	1.610
09/08/99	--	--	--	--	2.408	24	0.728
09/21/99	--	--	--	--	2.420	12	0.574
09/05/00	--	--	--	--	2.800	15	0.431
09/19/00	--	--	--	--	2.850	13	0.704
Min	15	2	--	0	1.920	3	0.366
MAX	31	13	--	100	3.002	24	4.229
AVG	25	6	--	45	2.386	10	1.279

TABLE E-5
Post-Project Monitoring Results at Notch in Wing Dam No. 6

Date	Air Temp (°C)	Wind Speed (mph)	Wind Direction	Cloud Cover (%)	Water Depth (m)	Wave Height (cm)	Velocity (ft/s)
06/18/97	30	6	NW	15	3.018	9	1.361
07/02/97	28	7	NW	0	3.795	9	3.135
07/17/97	31	6	S	35	2.865	6	2.359
07/31/97	26	3	SE	40	2.957	6	2.521
08/19/97	18	8	E	100	2.728	3	1.874
09/03/97	20	7	NE	35	3.414	6	1.392
09/25/97	18	2	NW	0	3.399	3	1.764
06/03/98	15	13	N	95	3.246	9	2.468
07/02/98	29	4	NE	35	4.755	6	2.682
07/14/98	31	8	S	90	--	15	3.100
07/28/98	29	2	S	5	3.536	6	3.073
08/13/98	26	2	N	80	2.972	3	2.359
08/25/98	29	8	N	45	3.277	9	1.719
09/10/98	27	6	SE	0	2.728	15	1.016
09/29/98	21	8	S	95	3.825	12	0.993
07/08/99	--	--	--	--	--	24	2.326
08/10/99	--	--	--	--	2.301	6	3.135
09/08/99	--	--	--	--	3.536	21	1.810
09/21/99	--	--	--	--	3.020	9	0.145
09/05/00	--	--	--	--	3.040	9	0.873
09/19/00	--	--	--	--	3.545	15	1.614
MIN	15	2	--	0	2.301	3	0.145
MAX	31	13	--	100	4.755	24	3.135
AVG	25	6	--	45	3.261	10	1.987

TABLE E-6
Post-Project Monitoring Results 100' D/S Notch in Wing Dam No. 6

Date	Air Temp (°C)	Wind Speed (mph)	Wind Direction	Cloud Cover (%)	Water Depth (m)	Wave Height (cm)	Velocity (ft/s)
06/18/97	30	6	NW	15	5.532	12	1.354
07/02/97	28	7	NW	0	5.974	9	3.046
07/17/97	31	6	S	35	5.913	15	2.013
07/31/97	26	3	SE	40	6.523	12	2.669
08/19/97	18	8	E	100	6.706	6	2.125
09/03/97	20	7	NE	35	5.639	6	1.673
09/25/97	18	2	NW	0	6.797	3	0.602
06/03/98	15	13	N	95	6.629	12	1.891
07/02/98	29	4	NE	35	6.614	12	3.581
07/14/98	31	8	S	90	4.877	9	2.071
07/28/98	29	2	S	5	6.553	3	1.310
08/13/98	26	2	N	80	7.803	6	2.729
08/25/98	29	8	N	45	6.340	9	1.460
09/10/98	27	6	SE	0	5.944	9	0.669
09/29/98	21	8	S	95	6.325	9	0.696
07/08/99	--	--	--	--	5.700	21	1.914
08/10/99	--	--	--	--	6.888	6	2.348
09/08/99	--	--	--	--	6.126	15	1.491
09/21/99	--	--	--	--	7.050	12	0.140
09/05/00	--	--	--	--	7.310	12	0.863
09/19/00	--	--	--	--	7.130	13	0.747
MIN	15	2	--	0	4.877	3	0.140
MAX	31	13	--	100	7.803	21	3.581
AVG	25	6	--	45	6.399	10	1.685

TABLE E-7
Post-Project Monitoring Results 100' U/S Notch in Wing Dam No. 15

Date	Air Temp (°C)	Wind Speed (mph)	Wind Direction	Cloud Cover (%)	Water Depth (m)	Wave Height (cm)	Velocity (ft/s)
06/18/97	30	6	NW	15	1.478	9	0.937
07/02/97	28	7	NW	0	1.463	12	1.132
07/17/97	31	6	S	35	1.494	6	0.993
07/31/97	26	3	SE	40	1.737	9	1.132
08/19/97	18	8	E	100	2.195	6	0.846
09/03/97	20	7	NE	35	1.265	15	0.528
09/25/97	18	2	NW	0	1.311	3	0.581
06/03/98	15	13	N	95	1.737	15	1.418
07/02/98	29	4	NE	35	4.633	6	2.851
07/14/98	31	8	S	90	3.109	9	2.648
07/28/98	29	2	S	5	1.494	3	1.273
08/13/98	26	2	N	80	1.509	6	0.973
08/25/98	29	8	N	45	1.615	18	0.645
09/10/98	27	6	SE	0	1.494	9	0.492
09/29/98	21	8	S	95	1.600	6	0.300
07/08/99	--	--	--	--	2.179	9	1.936
08/10/99	--	--	--	--	1.814	9	1.375
09/08/99	--	--	--	--	1.478	24	0.675
09/21/99	--	--	--	--	1.480	21	0.419
09/05/00	--	--	--	--	1.620	18	0.501
09/19/00	--	--	--	--	1.620	5	0.515
Min	15	2	--	0	1.625	3	0.300
MAX	31	13	--	100	4.633	24	2.851
AVG	25	6	--	45	1.825	11	1.056

TABLE E-8

Post-Project Monitoring Results at Notch in Wing Dam No. 15

Date	Air Temp (°C)	Wind Speed (mph)	Wind Direction	Cloud Cover (%)	Water Depth (m)	Wave Height (cm)	Velocity (ft/s)
06/18/97	30	6	NW	15	3.094	12	1.467
07/02/97	28	7	NW	0	2.850	15	1.810
07/17/97	31	6	S	35	3.078	12	1.358
07/31/97	26	3	SE	40	3.307	12	1.378
08/19/97	18	8	E	100	2.896	9	1.357
09/03/97	20	7	NE	35	2.606	12	0.789
09/25/97	18	2	NW	0	3.033	3	0.877
06/03/98	15	13	N	95	2.896	12	1.641
07/02/98	29	4	NE	35	5.822	6	2.608
07/14/98	31	8	S	90	4.343	15	2.810
07/28/98	29	2	S	5	2.576	3	1.596
08/13/98	26	2	N	80	2.667	6	1.477
08/25/98	29	8	N	45	2.941	15	1.132
09/10/98	27	6	SE	0	2.560	6	0.627
09/29/98	21	8	S	95	2.454	6	0.630
07/08/99	--	--	--	--	2.804	9	1.624
08/10/99	--	--	--	--	2.835	9	1.837
09/08/99	--	--	--	--	2.377	21	1.124
09/21/99	--	--	--	--	2.600	18	0.730
09/05/00	--	--	--	--	2.800	16	0.550
09/19/00	--	--	--	--	3.030	7	0.989
MIN	15	2	--	0	2.377	3	0.550
MAX	31	13	--	100	5.822	21	2.810
AVG	25	6	--	45	3.027	11	1.353

TABLE E-9

Post-Project Monitoring Results 100’ D/S Notch in Wing Dam No. 15

Date	Air Temp (°C)	Wind Speed (mph)	Wind Direction	Cloud Cover (%)	Water Depth (m)	Wave Height (cm)	Velocity (ft/s)
06/18/97	30	6	NW	15	3.048	9	0.910
07/02/97	28	7	NW	0	3.048	15	1.501
07/17/97	31	6	S	35	2.865	15	1.719
07/31/97	26	3	SE	40	3.932	15	1.536
08/19/97	18	8	E	100	4.511	9	1.436
09/03/97	20	7	NE	35	3.932	6	1.170
09/25/97	18	2	NW	0	3.048	3	0.939
06/03/98	15	13	N	95	3.856	12	1.923
07/02/98	29	4	NE	35	5.578	6	2.513
07/14/98	31	8	S	90	4.999	12	2.251
07/28/98	29	2	S	5	2.758	3	1.941
08/13/98	26	2	N	80	3.520	6	1.901
08/25/98	29	8	N	45	3.490	15	1.225
09/10/98	27	6	SE	0	3.459	9	0.762
09/29/98	21	8	S	95	4.450	6	0.600
07/08/99	--	--	--	--	2.957	18	1.855
08/10/99	--	--	--	--	4.115	9	1.990
09/08/99	--	--	--	--	3.962	18	1.208
09/21/99	--	--	--	--	3.960	15	0.846
09/05/00	--	--	--	--	4.090	14	0.606
09/19/00	--	--	--	--	3.795	5	0.592
MIN	15	2	--	0	2.758	3	0.592
MAX	31	13	--	100	5.578	18	2.513
AVG	25	6	--	45	3.780	11	1.401

APPENDIX F

TECHNICAL COMPUTATIONS

TABLE F-1.
Summary of Chute Depths at Station W-M328.7B

Date	W-M 328.7B Chute Depth (feet)	LGGM7 335.7 Gage Reading (feet)	LGGM7 335.7 Pool ElevatioN (feet) 1/	UINI2 327.0 Gage Reading (feet)	UINI2 327.0 Pool Elevation (feet) 2/	W-M 328.7B Pool Elevation (feet)	W-M 328.7B Bottom Elevation (feet) 3/	W-M 328.7B Flat Pool Depth (feet) 4/
12/23/97	14.50	6.53	471.13	11.48	470.07	470.28	455.78	14.22
01/27/98	15.20	6.73	471.33	11.46	470.05	470.30	455.10	14.90
02/24/98	14.75	8.65	473.25	11.47	470.06	470.68	455.94	14.06
03/24/98	15.75	7.67	472.27	11.83	470.42	470.78	455.04	14.96
06/03/98	14.70	9.50	474.10	11.70	470.29	471.03	456.34	13.66
07/02/98	20.59	15.60	480.20	17.43	476.02	476.84	456.24	13.76
07/14/98	18.55	14.75	479.35	16.57	475.16	475.98	457.43	12.57
07/28/98	14.25	8.70	473.30	11.66	470.25	470.85	456.60	13.40
08/13/98	13.50	8.55	473.15	11.33	469.92	470.55	457.05	12.95
08/25/98	13.70	7.45	472.05	11.68	470.27	470.62	456.92	13.08
09/10/98	13.05	6.43	471.03	11.45	470.04	470.23	457.19	12.81
09/29/98	14.25	6.20	470.80	11.42	470.01	470.16	455.92	14.08
12/29/98	12.80	6.30	470.90	11.45	470.04	470.21	457.41	12.59
01/28/99	14.20	9.10	473.70	11.89	470.48	471.11	456.91	13.09
02/25/99	13.75	7.95	472.55	11.81	470.40	470.82	457.07	12.93
03/23/99	13.50	8.68	473.28	11.91	470.50	471.04	457.55	12.45
05/27/99	20.89	16.60	481.20	18.37	476.96	477.79	456.89	13.11
06/22/99	16.00	13.15	477.75	14.62	473.21	474.10	458.10	11.90
07/08/99	13.35	10.40	475.00	11.82	470.41	471.31	457.96	12.04
07/27/99	14.35	11.75	476.35	12.54	471.13	472.15	457.80	12.20
08/10/99	13.00	9.75	474.35	11.80	470.39	471.16	458.17	11.83
08/24/99	12.80	7.75	472.35	11.26	469.85	470.34	457.54	12.46
09/08/99	12.40	7.30	471.90	11.75	470.34	470.64	458.25	11.75
09/21/99	12.73	6.75	471.35	11.40	469.99	470.26	457.53	12.47
05/31/00	12.37	8.00	472.60	11.47	470.06	470.56	458.19	11.81
06/15/00	15.55	13.65	478.25	14.80	473.39	474.34	458.79	11.21
07/06/00	15.66	13.70	478.30	14.86	473.45	474.40	458.74	11.26
07/25/00	13.02	9.20	473.80	11.79	470.38	471.05	458.03	11.97
08/08/00	11.64	6.85	471.45	11.92	470.51	470.69	459.05	10.95
08/22/00	12.96	6.90	471.50	11.64	470.23	470.48	457.52	12.48
09/05/00	12.28	5.90	470.50	11.48	470.07	470.15	457.87	12.13
09/19/00	11.87	7.05	471.65	11.52	470.11	470.41	458.54	11.46
01/03/01	11.94	7.70	472.30	11.65	470.24	470.64	458.70	11.30
02/13/01	13.12	9.40	474.00	11.87	470.46	471.15	458.03	11.97
03/06/01	12.56	8.40	473.00	11.71	470.30	470.83	458.27	11.73
03/20/01	15.09	13.05	477.65	14.63	473.22	474.09	459.00	11.00
06/05/01	19.91	16.30	480.90	18.48	477.07	477.82	457.91	12.09
06/19/01	16.40	13.55	478.15	15.19	473.78	474.63	458.23	11.77
07/03/01	16.20	13.70	478.30	15.36	473.95	474.80	458.60	11.40
07/18/01	12.53	8.55	473.15	11.77	470.36	470.91	458.38	11.62
07/31/01	12.37	8.10	472.70	11.87	470.46	470.90	458.53	11.47
08/14/01	11.91	6.30	470.90	11.53	470.12	470.27	458.37	11.63
08/28/01	12.23	6.60	471.20	11.68	470.27	470.45	458.22	11.78
09/18/01	12.00	6.60	471.20	11.75	470.34	470.51	458.50	11.50

TABLE F-1. (Continued)
Summary of Chute Depths at Station W-M328.7B

Date	W-M 328.7B Chute Depth (feet)	LGGM7 335.7 Gage Reading (feet)	LGGM7 335.7 Pool Elevation (feet) [1/]	UINI2 327.0 Gage Reading (feet)	UINI2 327.0 Pool Elevation (feet) [2/]	W-M 328.7B Pool Elevation (feet)	W-M 328.7B Bottom Elevation (feet) [3/]	W-M 328.7B Flat Pool Depth (feet) [4/]
1/8/2002	12.17	7.30	471.90	11.75	470.34	470.64	458.47	11.53
2/28/2002	12.37	7.60	472.20	11.67	470.26	470.64	458.27	11.73
6/18/2002	14.47	12.70	477.30	14.06	472.65	473.56	459.09	10.91
7/2/2002	10.89	9.90	474.50	11.86	470.45	471.24	460.35	9.65
7/18/2002	11.16	8.92	473.52	11.72	470.31	470.94	459.78	10.22
8/1/2002	10.76	8.10	472.70	11.59	470.18	470.67	459.91	10.09
8/14/2002	11.29	8.00	472.60	11.74	470.33	470.77	459.49	10.51
8/29/2002	12.07	9.30	473.90	11.89	470.48	471.15	459.07	10.93
9/10/2002	11.32	7.40	472.00	11.53	470.12	470.49	459.17	10.83
9/24/2002	10.34	6.90	471.50	11.49	470.08	470.36	460.02	9.98
2/13/2003	10.75	6.60	471.20	11.87	470.46	470.61	459.86	10.14
4/10/2003	10.40	7.15	471.75	11.34	469.93	470.28	459.88	10.12
6/10/2003	12.06	9.10	473.70	12.19	470.78	471.35	459.29	10.71
6/24/2003	10.66	8.00	472.60	11.33	469.92	470.44	459.78	10.22
7/8/2003	12.66	9.60	474.20	11.94	470.53	471.24	458.58	11.42
7/22/2003	12.63	9.50	474.10	12.39	470.98	471.59	458.96	11.04
8/5/2003	10.99	6.80	471.40	11.99	470.58	470.74	459.75	10.25
8/19/2003	10.66	6.45	471.05	11.41	470.00	470.20	459.54	10.46
9/2/2003	10.30	5.40	470.00	11.11	469.70	469.76	459.46	10.54
9/16/2003	10.27	6.60	471.20	11.18	469.77	470.05	459.78	10.22
12/23/2003	10.66	6.90	471.50	11.69	470.28	470.52	459.86	10.14
2/12/2004	9.97	6.70	471.30	11.49	470.08	470.31	460.34	9.66
3/23/2004	10.34	8.80	473.40	12.07	470.66	471.20	460.86	9.14
6/8/2004	18.72	17.10	481.70	19.12	477.71	478.49	459.77	10.23
6/22/2004	18.24	17.10	481.70	18.85	477.44	478.27	460.03	9.97
7/7/2004	11.78	10.10	474.70	12.06	470.65	471.44	459.66	10.34
7/20/2004	10.14	10.10	474.70	11.88	470.47	471.30	461.16	8.84
8/3/2004	9.78	7.50	472.10	11.52	470.11	470.50	460.72	9.28
8/17/2004	11.16	7.10	471.70	11.86	470.45	470.70	459.54	10.46
8/31/2004	9.78	8.90	473.50	11.10	469.69	470.44	460.66	9.34
9/14/2004	10.40	6.70	471.30	11.70	470.29	470.49	460.09	9.91
1/4/2005	10.01	7.30	471.90	11.59	470.18	470.52	460.51	9.49
2/22/2005	10.99	10.50	475.10	12.16	470.75	471.60	460.61	9.39
3/22/2005	9.78	7.60	472.20	11.74	470.33	470.70	460.92	9.08
6/8/2005	9.32	9.20	473.80	11.37	469.96	470.71	461.39	8.61
6/21/2005	10.55	9.80	474.40	11.70	470.29	471.09	460.54	9.46
7/6/2005	10.01	10.10	474.70	11.61	470.20	471.08	461.07	8.93
7/19/2005	9.10	6.90	471.50	11.48	470.07	470.34	461.24	8.76
8/2/2005	8.86	6.80	471.40	11.44	470.03	470.30	461.44	8.56
8/17/2005	8.53	5.95	470.55	11.13	469.72	469.88	461.35	8.65
8/30/2005	8.99	6.50	471.10	11.54	470.13	470.32	461.33	8.67
9/13/2005	8.07	6.00	470.60	11.61	470.20	470.28	462.21	7.79
98 MIN	12.80	6.20	470.80	11.33	469.92	470.16	455.04	12.57
98 MAX	20.59	15.60	480.20	17.43	476.02	476.84	457.43	14.96
98 AVG	15.04	8.70	473.30	12.38	470.97	471.42	456.38	13.62

99 MIN	12.40	6.75	471.35	11.26	469.85	470.26	456.89	11.75
99 MAX	20.89	16.60	481.20	18.37	476.96	477.79	458.25	13.11
99 AVG	14.27	9.93	474.53	12.65	471.24	471.88	457.62	12.38
00 MIN	11.64	5.90	470.50	11.47	470.06	470.15	457.52	10.95
00 MAX	15.66	13.70	478.30	14.86	473.45	474.40	459.05	12.48
00 AVG	13.17	8.91	473.51	12.44	471.03	471.51	458.34	11.66
01 MIN	11.91	6.30	470.90	11.53	470.12	470.27	457.91	11.00
01 MAX	19.91	16.30	480.90	18.48	477.07	477.82	459.00	12.09
01 AVG	13.86	9.85	474.45	13.12	471.71	472.25	458.39	11.61
02 MIN	10.33	6.90	471.50	11.49	470.08	470.36	458.27	9.65
02 MAX	14.47	12.70	477.30	14.06	472.65	473.56	460.35	11.73
02 AVG	11.68	8.61	473.21	11.93	470.52	471.05	459.36	10.64
03 MIN	10.27	5.40	470.00	11.11	469.70	469.76	458.58	10.12
03 MAX	12.66	9.60	474.20	12.39	470.98	471.59	459.88	11.42
03 AVG	11.09	7.46	472.06	11.68	470.27	470.62	459.52	10.48
04 MIN	9.78	6.70	471.30	11.10	469.69	470.31	459.54	8.84
04 MAX	18.72	17.10	481.70	19.12	477.71	478.49	461.16	10.46
04 AVG	12.03	10.01	474.61	13.17	471.76	472.31	460.28	9.72
05 MIN	8.07	5.95	470.55	11.13	469.72	469.88	460.51	7.79
05 MAX	10.99	10.50	475.10	12.16	470.75	471.60	462.21	9.49
05 AVG	9.47	7.88	472.48	11.58	470.17	470.62	461.15	8.85
98-05 MIN	8.07	5.40	470.00	11.10	469.69	469.76	455.04	7.79
98-05 MAX	20.89	17.10	481.70	19.12	477.71	478.49	462.21	14.96
98-05 AVG	12.62	8.94	473.54	12.38	470.97	471.47	458.85	11.15

[1/] LGGM7 335.7 Pool Elevation = LGGM7 335.7 Gage Reading + Gage Zero
where Gage Zero = 464.6 feet MSL (1912)

[2/] UINI2 327.0 Pool Elevation = UINI 327.0 Gage Reading + Gage Zero
where Gage Zero = 458.59 feet MSL (1912)

[3/] W-M328.7B Bottom Elevation = W-M328.7B Pool Elevation - W-M328.7B Chute Depth

[4/] W-M328.7B Flat Pool Depth = Flat Pool - W-M328.7B Bottom Elevation
where Flat Pool = 470 feet MSL

TABLE F-2.
Summary of Chute Depths at Station W-M329.3B

Date	W-M 329.3B Chute Depth (feet)	LGGM7 335.7 Gage Reading (feet)	LGGM7 335.7 Pool Elevation (feet) 1/	UINI2 327.0 Gage Reading (feet)	UINI2 327.0 Pool Elevation (feet) 2/	W-M 329.3B Pool Elevation (feet)	W-M 329.3B Bottom Elevation (feet) 3/	W-M 329.3B Flat Pool Depth (feet) 4/
12/23/97	10.00	6.53	471.13	11.48	470.07	470.35	460.35	9.65
01/27/98	9.95	6.73	471.33	11.46	470.05	470.39	460.44	9.56
02/24/98	10.90	8.65	473.25	11.47	470.06	470.90	460.01	9.99
03/24/98	9.80	7.67	472.27	11.83	470.42	470.91	461.11	8.89
06/03/98	11.00	9.50	474.10	11.70	470.29	471.30	460.30	9.70
07/02/98	16.55	15.60	480.20	17.43	476.02	477.13	460.58	9.42
07/14/98	15.00	14.75	479.35	16.57	475.16	476.27	461.27	8.73
07/28/98	9.35	8.70	473.30	11.66	470.25	471.06	461.71	8.29
08/13/98	9.45	8.55	473.15	11.33	469.92	470.77	461.33	8.67
08/25/98	10.65	7.45	472.05	11.68	470.27	470.74	460.09	9.91
09/29/98	8.85	6.20	470.80	11.42	470.01	470.22	461.37	8.63
12/29/98	8.85	6.30	470.90	11.45	470.04	470.27	461.42	8.58
01/28/99	10.30	9.10	473.70	11.89	470.48	471.33	461.03	8.97
02/25/99	8.95	7.95	472.55	11.81	470.40	470.97	462.02	7.98
03/23/99	9.65	8.68	473.28	11.91	470.50	471.23	461.59	8.41
05/27/99	16.70	16.60	481.20	18.37	476.96	478.08	461.39	8.61
06/22/99	12.10	13.15	477.75	14.62	473.21	474.41	462.31	7.69
07/08/99	8.90	10.40	475.00	11.82	470.41	471.62	462.73	7.27
07/27/99	9.65	11.75	476.35	12.54	471.13	472.51	462.86	7.14
08/10/99	8.30	9.75	474.35	11.80	470.39	471.44	463.14	6.86
08/24/99	7.45	7.75	472.35	11.26	469.85	470.51	463.06	6.94
09/08/99	8.00	7.30	471.90	11.75	470.34	470.75	462.75	7.25
09/21/99	7.54	6.75	471.35	11.40	469.99	470.35	462.81	7.19
05/31/00	8.10	8.00	472.60	11.47	470.06	470.73	462.63	7.37
06/15/00	12.96	13.65	478.25	14.80	473.39	474.67	461.72	8.28
07/06/00	12.14	13.70	478.30	14.86	473.45	474.73	462.59	7.41
07/25/00	8.00	9.20	473.80	11.79	470.38	471.28	463.28	6.72
08/08/00	7.54	6.85	471.45	11.92	470.51	470.76	463.21	6.79
08/22/00	6.72	6.90	471.50	11.64	470.23	470.57	463.84	6.16
09/05/00	7.08	5.90	470.50	11.48	470.07	470.18	463.10	6.90
09/19/00	7.18	7.05	471.65	11.52	470.11	470.52	463.33	6.67
01/03/01	7.28	7.70	472.30	11.65	470.24	470.78	463.50	6.50
02/13/01	8.04	9.40	474.00	11.87	470.46	471.40	463.36	6.64
03/06/01	7.90	8.40	473.00	11.71	470.30	471.01	463.11	6.89
03/20/01	11.15	13.05	477.65	14.63	473.22	474.39	463.24	6.76
06/05/01	15.25	16.30	480.90	18.48	477.07	478.08	462.83	7.17
06/19/01	11.61	13.55	478.15	15.19	473.78	474.94	463.32	6.68
07/03/01	11.64	13.70	478.30	15.36	473.95	475.10	463.46	6.54
07/18/01	7.45	8.55	473.15	11.77	470.36	471.10	463.65	6.35
07/31/01	7.45	8.10	472.70	11.87	470.46	471.05	463.61	6.39
08/14/01	6.92	6.30	470.90	11.53	470.12	470.33	463.41	6.59
08/28/01	7.25	6.60	471.20	11.68	470.27	470.52	463.27	6.73
09/18/01	7.45	6.60	471.20	11.75	470.34	470.57	463.12	6.88

TABLE F-2. (Continued)
Summary of Chute Depths at Station W-M329.3B

Date	W-M 329.3B Chute Depth (feet)	LGGM7 335.7 Gage Reading (feet)	LGGM7 335.7 Pool Elevation (feet) [1/]	UINI2 327.0 Gage Reading (feet)	UINI2 327.0 Pool Elevation (feet) [2/]	W-M 329.3B Pool Elevation (feet)	W-M 329.3B Bottom Elevation (feet) [3/]	W-M 329.3B Flat Pool Depth (feet) [4/]
01/08/02	7.28	7.30	471.90	11.75	470.34	470.75	463.47	6.53
02/28/02	7.38	7.60	472.20	11.67	470.26	470.77	463.39	6.61
06/18/02	9.51	12.70	477.30	14.06	472.65	473.88	464.36	5.64
07/02/02	7.71	9.90	474.50	11.86	470.45	471.52	463.81	6.19
07/18/02	6.79	8.92	473.52	11.72	470.31	471.16	464.37	5.63
08/01/02	6.66	8.10	472.70	11.59	470.18	470.85	464.19	5.81
08/14/02	6.79	8.00	472.60	11.74	470.33	470.93	464.14	5.86
08/29/02	7.32	9.30	473.90	11.89	470.48	471.38	464.07	5.93
09/10/02	6.56	7.40	472.00	11.53	470.12	470.62	464.06	5.94
09/24/02	6.40	6.90	471.50	11.49	470.08	470.46	464.06	5.94
2/13/2003	6.33	6.60	471.20	11.87	470.46	470.65	464.32	5.68
4/10/2003	6.40	7.15	471.75	11.34	469.93	470.41	464.01	5.99
6/10/2003	6.92	9.10	473.70	12.19	470.78	471.55	464.63	5.37
6/24/2003	6.56	8.00	472.60	11.33	469.92	470.63	464.07	5.93
7/8/2003	7.19	9.60	474.20	11.94	470.53	471.50	464.31	5.69
7/22/2003	7.55	9.50	474.10	12.39	470.98	471.81	464.26	5.74
8/5/2003	6.23	6.80	471.40	11.99	470.58	470.79	464.56	5.44
8/19/2003	5.74	6.45	471.05	11.41	470.00	470.28	464.54	5.46
9/2/2003	5.48	5.40	470.00	11.11	469.70	469.78	464.30	5.70
9/16/2003	5.97	6.60	471.20	11.18	469.77	470.15	464.18	5.82
12/23/2003	6.23	6.90	471.50	11.69	470.28	470.60	464.37	5.63
2/12/2004	5.82	6.70	471.30	11.49	470.08	470.40	464.58	5.42
3/23/2004	6.50	8.80	473.40	12.07	470.66	471.39	464.89	5.11
6/8/2004	14.01	17.10	481.70	19.12	477.71	478.76	464.75	5.25
6/22/2004	14.11	17.10	481.70	18.85	477.44	478.57	464.46	5.54
7/7/2004	7.22	10.10	474.70	12.06	470.65	471.72	464.50	5.50
7/20/2004	6.82	10.10	474.70	11.88	470.47	471.58	464.76	5.24
8/3/2004	5.71	7.50	472.10	11.52	470.11	470.64	464.93	5.07
8/17/2004	6.23	7.10	471.70	11.86	470.45	470.78	464.55	5.45
8/31/2004	5.71	8.90	473.50	11.10	469.69	470.70	464.99	5.01
9/14/2004	5.84	6.70	471.30	11.70	470.29	470.56	464.72	5.28
1/4/2005	6.17	7.30	471.90	11.59	470.18	470.64	464.47	5.53
2/22/2005	6.53	10.50	475.10	12.16	470.75	471.90	465.37	4.63
3/22/2005	5.84	7.60	472.20	11.74	470.33	470.82	464.98	5.02
6/8/2005	6.66	9.20	473.80	11.37	469.96	470.97	464.31	5.69
6/21/2005	6.56	9.80	474.40	11.70	470.29	471.37	464.81	5.19
7/6/2005	6.30	10.10	474.70	11.61	470.20	471.39	465.09	4.91
7/19/2005	5.50	6.90	471.50	11.48	470.07	470.45	464.95	5.05
8/2/2005	5.38	6.80	471.40	11.44	470.03	470.39	465.01	4.99
8/17/2005	5.25	5.95	470.55	11.13	469.72	469.94	464.69	5.31
8/30/2005	5.35	6.50	471.10	11.54	470.13	470.39	465.04	4.96
9/13/2005	5.54	6.00	470.60	11.61	470.20	470.30	464.76	5.24
98 MIN	8.85	6.20	470.80	11.33	469.92	470.22	460.01	8.29
98 MAX	16.55	15.60	480.20	17.43	476.02	477.13	461.71	9.99
98 AVG	10.86	8.89	473.49	12.46	471.05	471.69	460.83	9.17

99 MIN	7.45	6.75	471.35	11.26	469.85	470.35	461.03	6.86
99 MAX	16.70	16.60	481.20	18.37	476.96	478.08	463.14	8.97
99 AVG	9.77	9.93	474.53	12.65	471.24	472.11	462.34	7.66
00 MIN	6.72	5.90	470.50	11.47	470.06	470.18	461.72	6.16
00 MAX	12.96	13.70	478.30	14.86	473.45	474.73	463.84	8.28
00 AVG	8.72	8.91	473.51	12.44	471.03	471.68	462.96	7.04
01 MIN	6.92	6.30	470.90	11.53	470.12	470.33	462.83	6.35
01 MAX	15.25	16.30	480.90	18.48	477.07	478.08	463.65	7.17
01 AVG	9.12	9.85	474.45	13.12	471.71	472.44	463.32	6.68
02 MIN	6.40	6.90	471.50	11.49	470.08	470.46	463.39	5.63
02 MAX	9.51	12.70	477.30	14.06	472.65	473.88	464.37	6.61
02 AVG	7.24	8.61	473.21	11.93	470.52	471.23	463.99	6.01
03 MIN	5.48	5.40	470.00	11.11	469.70	469.78	464.01	5.37
03 MAX	7.55	9.60	474.20	12.39	470.98	471.81	464.63	5.99
03 AVG	6.42	7.46	472.06	11.68	470.27	470.74	464.32	5.68
04 MIN	5.71	6.70	471.30	11.10	469.69	470.40	464.46	5.01
04 MAX	14.11	17.10	481.70	19.12	477.71	478.76	464.99	5.54
04 AVG	7.80	10.01	474.61	13.17	471.76	472.51	464.71	5.29
05 MIN	5.25	5.95	470.55	11.13	469.72	469.94	464.31	4.63
05 MAX	6.66	10.5	475.1	12.16	470.75	471.9	465.37	5.69
05 AVG	5.92	7.88	472.48	11.58	470.17	470.78	464.86	5.14
98-05 MIN	5.25	5.40	470.00	11.10	469.69	469.78	460.01	4.63
98-05 MAX	16.70	17.10	481.70	19.12	477.71	478.76	465.37	9.99
98-05 AVG	8.25	8.97	473.57	12.39	470.98	471.67	463.42	6.58

[1/] LGGM7 335.7 Pool Elevation = LGGM7 335.7 Gage Reading + Gage Zero
where Gage Zero = 464.6 feet MSL (1912)

[2/] UINI2 327.0 Pool Elevation = UINI 327.0 Gage Reading + Gage Zero
where Gage Zero = 458.59 feet MSL (1912)

[3/] W-M329.3B Bottom Elevation = W-M329.3B Pool Elevation - W-M329.3B Chute Depth

[4/] W-M329.3B Flat Pool Depth = Flat Pool - W-M329.3B Bottom Elevation
where Flat Pool = 470 feet MSL

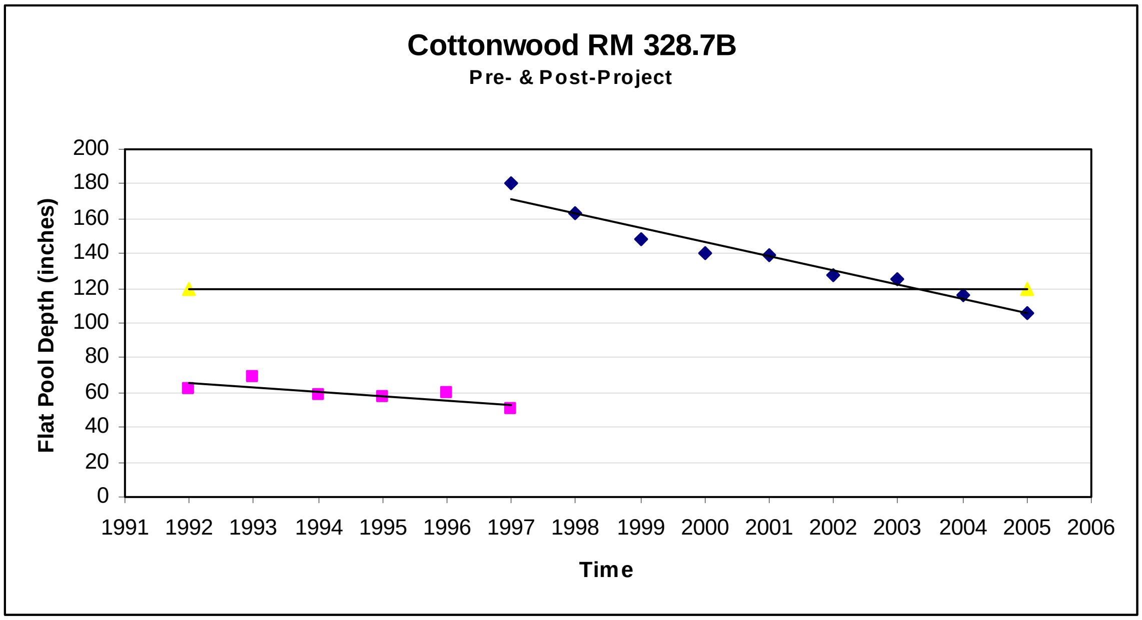


FIGURE F-1. Sedimentation Rates at Station W-M328.7B

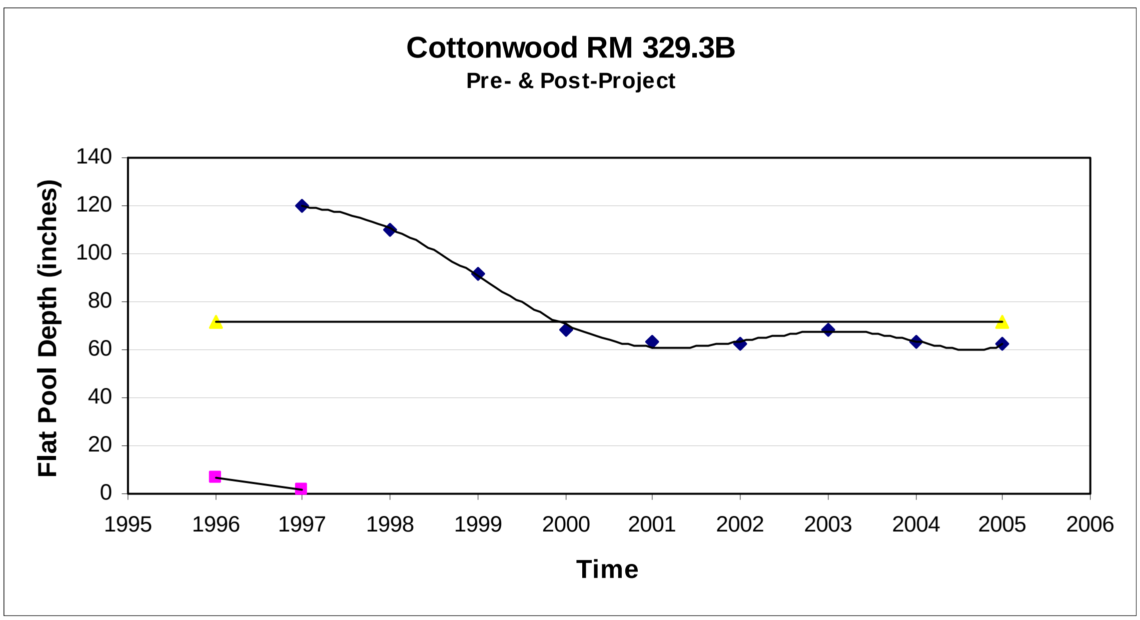


FIGURE F-2. Sedimentation Rates at Station W-M329.3B

FIGURE F-3: MR POOL 21 ELEVATION AND ITS AFFECT ON BOTTOM ELEVATIONS AT SITES W-M328.7B AND W-M329.3B FROM 12/23/97-9/13/05

TABLE F-3.
Summary of Channel Depths 100' U/S Notch in Wing Dam No. 6

Date	U/S #6 329.8 Channel Depth (feet)	LGGM7 335.7 Gage Reading (feet)	LGGM7 335.7 Pool Elevation (feet) 1/	UINI2 327.0 Gage Reading (feet)	UINI2 327.0 Pool Elevation (feet) 2/	U/S #6 329.8 Pool Elevation (feet)	U/S #6 329.8 Bottom Elevation (feet) 3/	U/S #6 329.8 Flat Pool Depth (feet) 4/
06/18/97	7.30	7.40	472.00	11.25	469.84	470.54	463.24	6.76
07/02/97	6.90	8.52	473.12	11.55	470.14	471.10	464.20	5.80
07/17/97	6.90	8.52	473.12	11.78	470.37	471.26	464.36	5.64
07/31/97	7.10	8.51	473.11	11.89	470.48	471.33	464.23	5.77
08/19/97	7.20	7.20	471.80	11.17	469.76	470.42	463.22	6.78
09/03/97	6.40	7.05	471.65	11.09	469.68	470.31	463.92	6.08
09/25/97	7.30	7.05	471.65	11.55	470.14	470.63	463.33	6.67
06/03/98	8.75	9.50	474.10	11.70	470.29	471.52	462.77	7.23
07/28/98	9.25	8.70	473.30	11.66	470.25	471.23	461.98	8.02
08/13/98	7.95	8.55	473.15	11.33	469.92	470.96	463.01	6.99
08/25/98	7.10	7.45	472.05	11.68	470.27	470.84	463.74	6.26
09/10/98	6.40	6.43	471.03	11.45	470.04	470.36	463.96	6.04
09/29/98	6.30	6.20	470.80	11.42	470.01	470.26	463.97	6.03
07/08/99	9.85	10.40	475.00	11.82	470.41	471.89	462.04	7.96
08/10/99	8.20	9.75	474.35	11.80	470.39	471.66	463.47	6.53
09/08/99	7.90	7.30	471.90	11.75	470.34	470.84	462.94	7.06
09/21/99	7.94	6.75	471.35	11.40	469.99	470.43	462.49	7.51
09/05/00	9.18	5.90	470.50	11.48	470.07	470.21	461.02	8.98
09/19/00	9.35	7.05	471.65	11.52	470.11	470.61	461.26	8.74
97 MIN	6.40	7.05	471.65	11.09	469.68	470.31	463.22	5.64
97 MAX	7.30	8.52	473.12	11.89	470.48	471.33	464.36	6.78
97 AVG	7.01	7.75	472.35	11.47	470.06	470.80	463.78	6.22
98 MIN	6.30	6.20	470.80	11.33	469.92	470.26	461.98	6.03
98 MAX	9.25	15.60	480.20	17.43	476.02	477.37	463.97	8.02
98 AVG	7.62	9.65	474.25	12.91	471.50	472.38	463.24	6.76
99 MIN	7.90	6.75	471.35	11.40	469.99	470.43	462.04	6.53
99 MAX	9.85	10.40	475.00	11.82	470.41	471.89	463.47	7.96
99 AVG	8.47	8.55	473.15	11.69	470.28	471.21	462.74	7.26
00 MIN	9.18	5.90	470.50	11.48	470.07	470.21	461.02	8.74
00 MAX	9.35	7.05	471.65	11.52	470.11	470.61	461.26	8.98
00 AVG	9.27	6.48	471.08	11.50	470.09	470.41	461.14	8.86
97-00 MIN	6.30	5.90	470.50	11.09	469.68	470.21	461.02	5.64
97-00 MAX	9.85	15.60	480.20	17.43	476.02	477.37	464.36	8.98
97-00 AVG	7.75	8.50	473.10	12.06	470.65	471.44	463.11	6.89

1/ LGGM7 335.7 Pool Elevation = LGGM7 335.7 Gage Reading + Gage Zero
where Gage Zero = 464.6 feet MSL (1912)

2/ UINI2 327.0 Pool Elevation = UINI 327.0 Gage Reading + Gage Zero
where Gage Zero = 458.59 feet MSL (1912)

3/ U/S #6 329.8 Bottom Elevation = U/S #6 329.8 Pool Elevation – U/S #6 329.8 Channel Depth

4/ U/S #6 329.8 Flat Pool Depth = Flat Pool - U/S #6 329.8 Bottom Elevation
where Flat Pool = 470 feet MSL

TABLE F-4.
Summary of Channel Depths At Notch in Wing Dam No. 6

Date	At #6 329.8 Channel Depth (feet)	LGGM7 335.7 Gage Reading (feet)	LGGM7 335.7 Pool Elevation (feet) [1/]	UINI2 327.0 Gage Reading (feet)	UINI2 327.0 Pool Elevation (feet) [2/]	At #6 329.8 Pool Elevation (feet)	At #6 329.8 Bottom Elevation (feet) [3/]	At #6 329.8 Flat Pool Depth (feet) [4/]
06/18/97	9.90	7.40	472.00	11.25	469.84	470.54	460.64	9.36
07/02/97	12.45	8.52	473.12	11.55	470.14	471.10	458.65	11.35
07/17/97	9.40	8.52	473.12	11.78	470.37	471.26	461.86	8.14
07/31/97	9.70	8.51	473.11	11.89	470.48	471.33	461.63	8.37
08/19/97	8.95	7.20	471.80	11.17	469.76	470.42	461.47	8.53
09/03/97	11.20	7.05	471.65	11.09	469.68	470.31	459.12	10.88
09/25/97	11.15	7.05	471.65	11.55	470.14	470.63	459.48	10.52
06/03/98	10.65	9.50	474.10	11.70	470.29	471.52	460.87	9.13
07/02/98	15.60	15.60	480.20	17.43	476.02	477.37	461.77	8.23
07/28/98	11.60	8.70	473.30	11.66	470.25	471.23	459.63	10.37
08/13/98	9.75	8.55	473.15	11.33	469.92	470.96	461.21	8.79
08/25/98	10.75	7.45	472.05	11.68	470.27	470.84	460.10	9.90
09/10/98	8.95	6.43	471.03	11.45	470.04	470.36	461.41	8.59
09/29/98	12.55	6.20	470.80	11.42	470.01	470.26	457.72	12.28
08/10/99	7.55	9.75	474.35	11.80	470.39	471.66	464.12	5.88
09/08/99	11.60	7.30	471.90	11.75	470.34	470.84	459.25	10.75
09/21/99	9.91	6.75	471.35	11.40	469.99	470.43	460.52	9.48
09/05/00	9.97	5.90	470.50	11.48	470.07	470.21	460.24	9.76
09/19/00	11.63	7.05	471.65	11.52	470.11	470.61	458.98	11.02
97 MIN	8.95	7.05	471.65	11.09	469.68	470.31	458.65	8.14
97 MAX	12.45	8.52	473.12	11.89	470.48	471.33	461.86	11.35
97 AVG	10.39	7.75	472.35	11.47	470.06	470.80	460.41	9.59
98 MIN	8.95	6.20	470.80	11.33	469.92	470.26	457.72	8.23
98 MAX	15.60	15.60	480.20	17.43	476.02	477.37	461.77	12.28
98 AVG	11.40	9.65	474.25	12.91	471.50	472.38	460.39	9.61
99 MIN	7.55	6.75	471.35	11.40	469.99	470.43	459.25	5.88
99 MAX	11.60	10.40	475.00	11.82	470.41	471.89	464.12	10.75
99 AVG	9.68	8.55	473.15	11.69	470.28	471.21	461.29	8.71
00 MIN	9.97	5.90	470.50	11.48	470.07	470.21	458.98	9.76
00 MAX	11.63	7.05	471.65	11.52	470.11	470.61	460.24	11.02
00 AVG	10.80	6.48	471.08	11.50	470.09	470.41	459.61	10.39
97-00 MIN	7.55	5.90	470.50	11.09	469.68	470.21	457.72	5.88
97-00 MAX	15.60	15.60	480.20	17.43	476.02	477.37	464.12	12.28
97-00 AVG	10.70	8.50	473.10	12.06	470.65	471.44	460.46	9.54

[1/] LGGM7 335.7 Pool Elevation = LGGM7 335.7 Gage Reading + Gage Zero
where Gage Zero = 464.6 feet MSL (1912)
[2/] UINI2 327.0 Pool Elevation = UINI 327.0 Gage Reading + Gage Zero
where Gage Zero = 458.59 feet MSL (1912)
[3/] At #6 329.8 Bottom Elevation = At #6 329.8 Pool Elevation - At #6 329.8 Channel Depth
[4/] At #6 329.8 Flat Pool Depth = Flat Pool - At #6 329.8 Bottom Elevation
where Flat Pool = 470 feet MSL

TABLE F-5.
Summary of Channel Depths 100' D/S Notch in Wing Dam No. 6

Date	D/S #6 329.8 Channel Depth (feet)	LGGM7 335.7 Gage Reading (feet)	LGGM7 335.7 Pool Elevation (feet) 1/	UINI2 327.0 Gage Reading (feet)	UINI2 327.0 Pool Elevation (feet) 2/	D/S #6 329.8 Pool Elevation (feet)	D/S #6 329.8 Bottom Elevation (feet) 3/	D/S #6 329.8 Flat Pool Depth (feet) 4/
06/18/97	18.15	7.40	472.00	11.25	469.84	470.54	452.39	17.61
07/02/97	19.59	8.52	473.12	11.55	470.14	471.10	451.50	18.50
07/17/97	19.40	8.52	473.12	11.78	470.37	471.26	451.86	18.14
07/31/97	21.39	8.51	473.11	11.89	470.48	471.33	449.93	20.07
08/19/97	21.99	7.20	471.80	11.17	469.76	470.42	448.42	21.58
09/03/97	18.50	7.05	471.65	11.09	469.68	470.31	451.82	18.18
09/25/97	22.29	7.05	471.65	11.55	470.14	470.63	448.33	21.67
06/03/98	21.74	9.50	474.10	11.70	470.29	471.52	449.77	20.23
07/28/98	21.49	8.70	473.30	11.66	470.25	471.23	449.74	20.26
08/13/98	25.59	8.55	473.15	11.33	469.92	470.96	445.37	24.63
08/25/98	20.79	7.45	472.05	11.68	470.27	470.84	450.05	19.95
09/10/98	19.50	6.43	471.03	11.45	470.04	470.36	450.86	19.14
09/29/98	20.74	6.20	470.80	11.42	470.01	470.26	449.52	20.48
08/10/99	22.59	9.75	474.35	11.80	470.39	471.66	449.07	20.93
09/08/99	20.09	7.30	471.90	11.75	470.34	470.84	450.75	19.25
09/21/99	23.12	6.75	471.35	11.40	469.99	470.43	447.30	22.70
09/05/00	23.98	5.90	470.50	11.48	470.07	470.21	446.23	23.77
09/19/00	23.39	7.05	471.65	11.52	470.11	470.61	447.22	22.78
97 MIN	18.15	7.05	471.65	11.09	469.68	470.31	448.33	17.61
97 MAX	22.29	8.52	473.12	11.89	470.48	471.33	452.39	21.67
97 AVG	20.19	7.75	472.35	11.47	470.06	470.80	450.61	19.39
98 MIN	19.50	6.20	470.80	11.33	469.92	470.26	445.37	19.14
98 MAX	25.59	15.60	480.20	17.43	476.02	477.37	450.86	24.63
98 AVG	21.64	9.65	474.25	12.91	471.50	472.38	449.22	20.78
99 MIN	20.09	6.75	471.35	11.40	469.99	470.43	447.30	19.25
99 MAX	23.12	10.40	475.00	11.82	470.41	471.89	450.75	22.70
99 AVG	21.94	8.55	473.15	11.69	470.28	471.21	449.04	20.96
00 MIN	23.39	5.90	470.50	11.48	470.07	470.21	446.23	22.78
00 MAX	23.98	7.05	471.65	11.52	470.11	470.61	447.22	23.77
00 AVG	23.68	6.48	471.08	11.50	470.09	470.41	446.73	23.27
97-00 MIN	18.15	5.90	470.50	11.09	469.68	470.21	445.37	17.61
97-00 MAX	25.59	15.60	480.20	17.43	476.02	477.37	452.39	24.63
97-00 AVG	21.35	8.50	473.10	12.06	470.65	471.44	449.45	20.55

1/ LGGM7 335.7 Pool Elevation = LGGM7 335.7 Gage Reading + Gage Zero
where Gage Zero = 464.6 feet MSL (1912)

2/ UINI2 327.0 Pool Elevation = UINI 327.0 Gage Reading + Gage Zero
where Gage Zero = 458.59 feet MSL (1912)

3/ D/S #6 329.8 Bottom Elevation = D/S #6 329.8 Pool Elevation - D/S #6 329.8 Channel Depth

4/ D/S #6 329.8 Flat Pool Depth = Flat Pool - D/S #6 329.8 Bottom Elevation
where Flat Pool = 470 feet MSL

TABLE F-6.
Summary of Channel Depths 100' U/S Notch in Wing Dam No. 15

Date	U/S #15 328.6 Channel Depth (feet)	LGGM7 335.7 Gage Reading (feet)	LGGM7 335.7 Pool Elevation (feet) 1/	UINI2 327.0 Gage Reading (feet)	UINI2 327.0 Pool Elevation (feet) 2/	U/S #15 328.6 Pool Elevation (feet)	U/S #15 328.6 Bottom Elevation (feet) 3/	U/S #15 328.6 Flat Pool Depth (feet) 4/
06/18/97	4.85	7.40	472.00	11.25	469.84	470.24	465.39	4.61
07/02/97	4.80	8.52	473.12	11.55	470.14	470.69	465.89	4.11
07/17/97	4.90	8.52	473.12	11.78	470.37	470.88	465.98	4.02
07/31/97	5.70	8.51	473.11	11.89	470.48	470.96	465.27	4.73
08/19/97	7.20	7.20	471.80	11.17	469.76	470.14	462.94	7.06
09/03/97	4.15	7.05	471.65	11.09	469.68	470.04	465.89	4.11
09/25/97	4.30	7.05	471.65	11.55	470.14	470.42	466.12	3.88
06/03/98	5.70	9.50	474.10	11.70	470.29	470.99	465.29	4.71
07/14/98	10.20	14.75	479.35	16.57	475.16	475.93	465.73	4.27
07/28/98	4.90	8.70	473.30	11.66	470.25	470.81	465.91	4.09
08/13/98	4.95	8.55	473.15	11.33	469.92	470.51	465.57	4.43
08/25/98	5.30	7.45	472.05	11.68	470.27	470.60	465.30	4.70
09/10/98	4.90	6.43	471.03	11.45	470.04	470.22	465.32	4.68
09/29/98	5.25	6.20	470.80	11.42	470.01	470.16	464.91	5.09
07/08/99	7.15	10.40	475.00	11.82	470.41	471.25	464.11	5.89
08/10/99	5.95	9.75	474.35	11.80	470.39	471.12	465.17	4.83
09/08/99	4.85	7.30	471.90	11.75	470.34	470.63	465.78	4.22
09/21/99	4.85	6.75	471.35	11.40	469.99	470.24	465.39	4.61
09/05/00	5.31	5.90	470.50	11.48	470.07	470.15	464.84	5.16
09/19/00	5.31	7.05	471.65	11.52	470.11	470.39	465.08	4.92
97 MIN	4.15	7.05	471.65	11.09	469.68	470.04	462.94	3.88
97 MAX	7.20	8.52	473.12	11.89	470.48	470.96	466.12	7.06
97 AVG	5.13	7.75	472.35	11.47	470.06	470.48	465.35	4.65
98 MIN	4.90	6.20	470.80	11.33	469.92	470.16	464.91	4.09
98 MAX	10.20	15.60	480.20	17.43	476.02	476.79	465.91	5.09
98 AVG	5.88	9.65	474.25	12.91	471.50	472.00	465.43	4.57
99 MIN	4.85	6.75	471.35	11.40	469.99	470.24	464.11	4.22
99 MAX	7.15	10.40	475.00	11.82	470.41	471.25	465.78	5.89
99 AVG	5.70	8.55	473.15	11.69	470.28	470.81	465.11	4.89
00 MIN	5.31	5.90	470.50	11.48	470.07	470.15	464.84	4.92
00 MAX	5.31	7.05	471.65	11.52	470.11	470.39	465.08	5.16
00 AVG	5.31	6.48	471.08	11.50	470.09	470.27	464.96	5.04
97-00 MIN	4.15	5.90	470.50	11.09	469.68	470.04	462.94	3.88
97-00 MAX	10.20	15.60	480.20	17.43	476.02	476.79	466.12	7.06
97-00 AVG	5.53	8.50	473.10	12.06	470.65	471.10	465.29	4.71

1/ LGGM7 335.7 Pool Elevation = LGGM7 335.7 Gage Reading + Gage Zero
where Gage Zero = 464.6 feet MSL (1912)

2/ UINI2 327.0 Pool Elevation = UINI 327.0 Gage Reading + Gage Zero
where Gage Zero = 458.59 feet MSL (1912)

3/ U/S #15 328.6 Bottom Elevation = U/S #15 328.6 Pool Elevation – U/S #15 328.6 Channel Depth

4/ U/S #15 328.6 Flat Pool Depth = Flat Pool - U/S #15 328.6 Bottom Elevation
where Flat Pool = 470 feet MSL

TABLE F-7.
Summary of Channel Depths At Notch in Wing Dam No. 15

Date	At #15 328.6 Channel Depth (feet)	LGGM7 335.7 Gage Reading (feet)	LGGM7 335.7 Pool Elevation (feet) [1/]	UINI2 327.0 Gage Reading (feet)	UINI2 327.0 Pool Elevation (feet) [2/]	At #15 328.6 Pool Elevation (feet)	At #15 328.6 Bottom Elevation (feet) [3/]	At #15 328.6 Flat Pool Depth (feet) [4/]
06/18/97	10.15	7.40	472.00	11.25	469.84	470.24	460.09	9.91
07/02/97	9.35	8.52	473.12	11.55	470.14	470.69	461.34	8.66
07/17/97	10.10	8.52	473.12	11.78	470.37	470.88	460.78	9.22
07/31/97	10.85	8.51	473.11	11.89	470.48	470.96	460.12	9.88
08/19/97	9.50	7.20	471.80	11.17	469.76	470.14	460.64	9.36
09/03/97	8.55	7.05	471.65	11.09	469.68	470.04	461.49	8.51
09/25/97	9.95	7.05	471.65	11.55	470.14	470.42	460.47	9.53
06/03/98	9.50	9.50	474.10	11.70	470.29	470.99	461.49	8.51
07/14/98	14.25	14.75	479.35	16.57	475.16	475.93	461.68	8.32
07/28/98	8.45	8.70	473.30	11.66	470.25	470.81	462.36	7.64
08/13/98	8.75	8.55	473.15	11.33	469.92	470.51	461.77	8.23
08/25/98	9.65	7.45	472.05	11.68	470.27	470.60	460.95	9.05
09/10/98	8.40	6.43	471.03	11.45	470.04	470.22	461.82	8.18
09/29/98	8.05	6.20	470.80	11.42	470.01	470.16	462.11	7.89
07/08/99	9.20	10.40	475.00	11.82	470.41	471.25	462.06	7.94
08/10/99	9.30	9.75	474.35	11.80	470.39	471.12	461.82	8.18
09/08/99	7.80	7.30	471.90	11.75	470.34	470.63	462.83	7.17
09/21/99	8.53	6.75	471.35	11.40	469.99	470.24	461.71	8.29
09/05/00	9.18	5.90	470.50	11.48	470.07	470.15	460.97	9.03
09/19/00	9.94	7.05	471.65	11.52	470.11	470.39	460.45	9.55
97 MIN	8.55	7.05	471.65	11.09	469.68	470.04	460.09	8.51
97 MAX	10.85	8.52	473.12	11.89	470.48	470.96	461.49	9.91
97 AVG	9.78	7.75	472.35	11.47	470.06	470.48	460.70	9.30
98 MIN	8.05	6.20	470.80	11.33	469.92	470.16	460.95	7.64
98 MAX	14.25	15.60	480.20	17.43	476.02	476.79	462.36	9.05
98 AVG	9.58	9.65	474.25	12.91	471.50	472.00	461.74	8.26
99 MIN	7.80	6.75	471.35	11.40	469.99	470.24	461.71	7.17
99 MAX	9.30	10.40	475.00	11.82	470.41	471.25	462.83	8.29
99 AVG	8.71	8.55	473.15	11.69	470.28	470.81	462.10	7.90
00 MIN	9.18	5.90	470.50	11.48	470.07	470.15	460.45	9.03
00 MAX	9.94	7.05	471.65	11.52	470.11	470.39	460.97	9.55
00 AVG	9.56	6.48	471.08	11.50	470.09	470.27	460.71	9.29
97-00 MIN	7.80	5.90	470.50	11.09	469.68	470.04	460.09	7.17
97-00 MAX	14.25	15.60	480.20	17.43	476.02	476.79	462.83	9.91
97-00 AVG	9.47	8.50	473.10	12.06	470.65	471.10	461.35	8.65

[1/] LGGM7 335.7 Pool Elevation = LGGM7 335.7 Gage Reading + Gage Zero
where Gage Zero = 464.6 feet MSL (1912)

[2/] UINI2 327.0 Pool Elevation = UINI 327.0 Gage Reading + Gage Zero
where Gage Zero = 458.59 feet MSL (1912)

[3/] At #15 328.6 Bottom Elevation = At #15 328.6 Pool Elevation – At #15 328.6 Channel Depth

[4/] At #15 328.6 Flat Pool Depth = Flat Pool - At #15 328.6 Bottom Elevation
where Flat Pool = 470 feet MSL

TABLE F-8.
Summary of Channel Depths 100' D/S Notch in Wing Dam No. 15

Date	D/S #15 328.6 Channel Depth (feet)	LGGM7 335.7 Gage Reading (feet)	LGGM7 335.7 Pool Elevation (feet) [1/]	UINI2 327.0 Gage Reading (feet)	UINI2 327.0 Pool Elevation (feet) [2/]	D.S #15 328.6 Pool Elevation (feet)	D/S #15 328.6 Bottom Elevation (feet) [3/]	D/S #15 328.6 Flat Pool Depth (feet) [4/]
06/18/97	10.00	7.40	472.00	11.25	469.84	470.24	460.24	9.76
07/02/97	10.00	8.52	473.12	11.55	470.14	470.69	460.69	9.31
07/17/97	9.40	8.52	473.12	11.78	470.37	470.88	461.48	8.52
07/31/97	12.90	8.51	473.11	11.89	470.48	470.96	458.07	11.93
08/19/97	14.80	7.20	471.80	11.17	469.76	470.14	455.34	14.66
09/03/97	12.90	7.05	471.65	11.09	469.68	470.04	457.15	12.85
09/25/97	10.00	7.05	471.65	11.55	470.14	470.42	460.42	9.58
06/03/98	12.65	9.50	474.10	11.70	470.29	470.99	458.34	11.66
07/02/98	18.30	15.60	480.20	17.43	476.02	476.79	458.49	11.51
07/14/98	16.40	14.75	479.35	16.57	475.16	475.93	459.53	10.47
07/28/98	9.05	8.70	473.30	11.66	470.25	470.81	461.76	8.24
08/13/98	11.55	8.55	473.15	11.33	469.92	470.51	458.97	11.03
08/25/98	11.45	7.45	472.05	11.68	470.27	470.60	459.15	10.85
09/10/98	11.35	6.43	471.03	11.45	470.04	470.22	458.87	11.13
09/29/98	14.60	6.20	470.80	11.42	470.01	470.16	455.56	14.44
07/08/99	9.70	10.40	475.00	11.82	470.41	471.25	461.56	8.44
08/10/99	13.50	9.75	474.35	11.80	470.39	471.12	457.62	12.38
09/08/99	13.00	7.30	471.90	11.75	470.34	470.63	457.63	12.37
09/21/99	12.99	6.75	471.35	11.40	469.99	470.24	457.25	12.75
09/05/00	13.42	5.90	470.50	11.48	470.07	470.15	456.73	13.27
09/19/00	12.45	7.05	471.65	11.52	470.11	470.39	457.95	12.05
97 MIN	9.40	7.05	471.65	11.09	469.68	470.04	455.34	8.52
97 MAX	14.80	8.52	473.12	11.89	470.48	470.96	461.48	14.66
97 AVG	11.43	7.75	472.35	11.47	470.06	470.48	459.05	10.95
98 MIN	9.05	6.20	470.80	11.33	469.92	470.16	455.56	8.24
98 MAX	18.30	15.60	480.20	17.43	476.02	476.79	461.76	14.44
98 AVG	13.17	9.65	474.25	12.91	471.50	472.00	458.84	11.16
99 MIN	9.70	6.75	471.35	11.40	469.99	470.24	457.25	8.44
99 MAX	13.50	10.40	475.00	11.82	470.41	471.25	461.56	12.75
99 AVG	12.29	8.55	473.15	11.69	470.28	470.81	458.51	11.49
00 MIN	12.45	5.90	470.50	11.48	470.07	470.15	456.73	12.05
00 MAX	13.42	7.05	471.65	11.52	470.11	470.39	457.95	13.27
00 AVG	12.93	6.48	471.08	11.50	470.09	470.27	457.34	12.66
97-00 MIN	9.05	5.90	470.50	11.09	469.68	470.04	455.34	8.24
97-00 MAX	18.30	15.60	480.20	17.43	476.02	476.79	461.76	14.66
97-00 AVG	12.40	8.50	473.10	12.06	470.65	471.10	458.71	11.29

[1/] LGGM7 335.7 Pool Elevation = LGGM7 335.7 Gage Reading + Gage Zero
where Gage Zero = 464.6 feet MSL (1912)
[2/] UINI2 327.0 Pool Elevation = UINI 327.0 Gage Reading + Gage Zero
where Gage Zero = 458.59 feet MSL (1912)
[3/] D/S #15 328.6 Bottom Elevation = D/S #15 328.6 Pool Elevation – D/S #15 328.6 Channel Depth
[4/] D/S #15 328.6 Flat Pool Depth = Flat Pool – D/S #15 328.6 Bottom Elevation
where Flat Pool = 470 feet MSL

TABLE F-9.
Summary of Wing Dam Notch Scour Depth

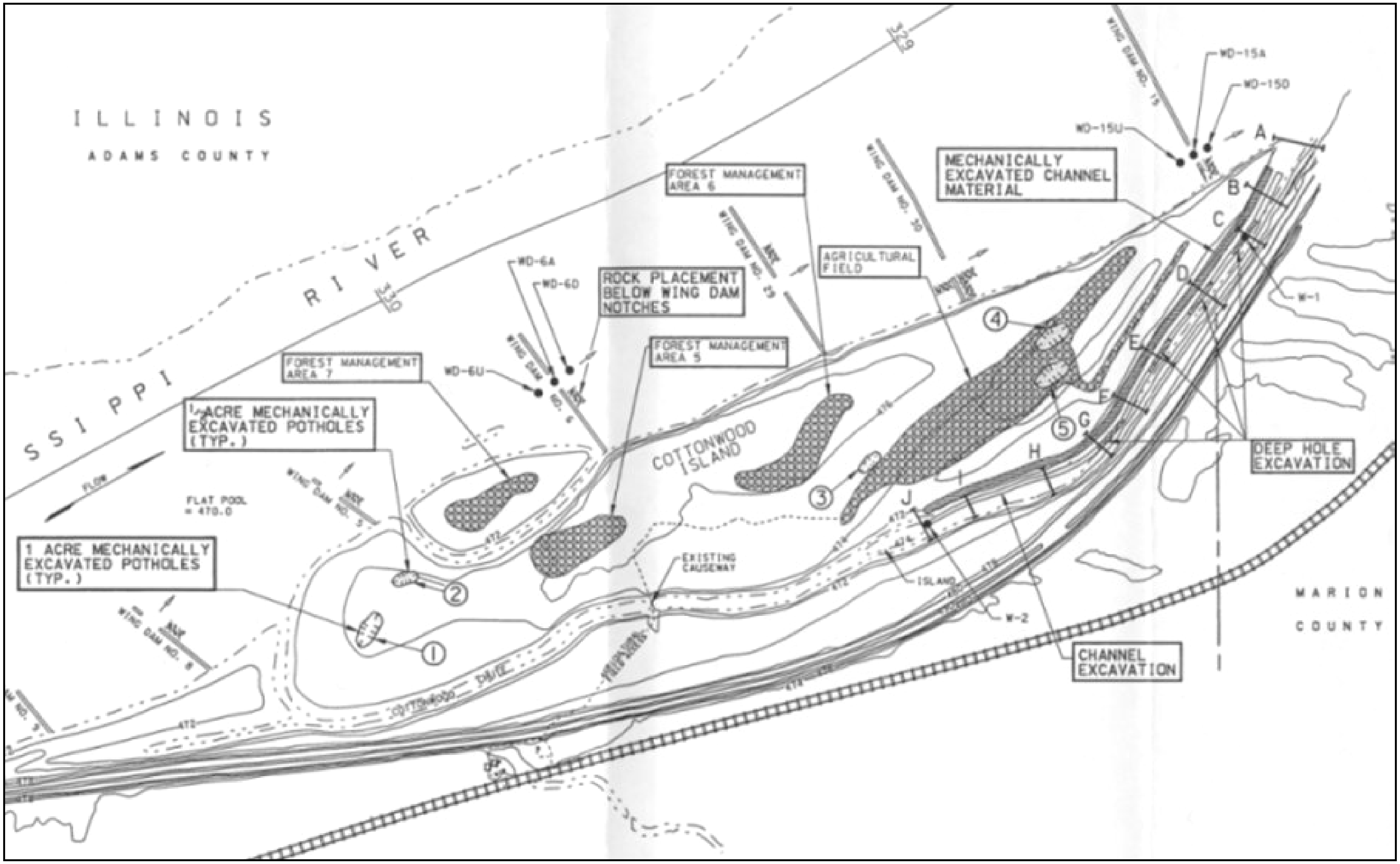
Date	100' U/S No. 6 (feet)	100' U/S #15 (feet)	At No. 6 (feet)	At No. 15 (feet)	100' D/S No. 6 (feet)	100' D/S No. 15 (feet)
06/18/97	6.76	4.61	9.36	9.91	17.61	9.76
07/02/97	5.80	4.11	11.35	8.66	18.50	9.31
07/17/97	5.64	4.02	8.14	9.22	18.14	8.52
07/31/97	5.77	4.73	8.37	9.88	20.07	11.93
08/19/97	6.78	7.06	8.53	9.36	21.58	14.66
09/03/97	6.08	4.11	10.88	8.51	18.18	12.85
09/25/97	6.67	3.88	10.52	9.53	21.67	9.58
06/03/98	7.23	4.71	9.13	8.51	20.23	11.66
07/02/98	--	--	8.23	--	--	11.51
07/14/98	--	4.27	--	8.32	--	10.47
07/28/98	8.02	4.09	10.37	7.64	20.26	8.24
08/13/98	6.99	4.43	8.79	8.23	24.63	11.03
08/25/98	6.26	4.70	9.90	9.05	19.95	10.85
09/10/98	6.04	4.68	8.59	8.18	19.14	11.13
09/29/98	6.03	5.09	12.28	7.89	20.48	14.44
07/08/99	7.96	5.89	--	7.94	--	8.44
08/10/99	6.53	4.83	5.88	8.18	20.93	12.38
09/08/99	7.06	4.22	10.75	7.17	19.25	12.37
09/21/99	7.51	4.61	9.48	8.29	22.70	12.75
09/05/00	8.98	5.16	9.76	9.03	23.77	13.27
09/19/00	8.74	4.92	11.02	9.55	22.78	12.05
97 MIN	5.64	3.88	8.14	8.51	17.61	8.52
97 MAX	6.78	7.06	11.35	9.91	21.67	14.66
97 AVG	6.22	4.65	9.59	9.30	19.39	10.95
98 MIN	6.03	4.09	8.23	7.64	19.14	8.24
98 MAX	8.02	5.09	12.28	9.05	24.63	14.44
98 AVG	6.76	4.57	9.61	8.26	20.78	11.16
99 MIN	6.53	4.22	5.88	7.17	19.25	8.44
99 MAX	7.96	5.89	10.75	8.29	22.70	12.75
99 AVG	7.26	4.89	8.71	7.90	20.96	11.49
00 MIN	8.74	4.92	9.76	9.03	22.78	12.05
00 MAX	8.98	5.16	11.02	9.55	23.77	13.27
00 AVG	8.86	5.04	10.39	9.29	23.27	12.66
97-00 MIN	5.64	3.88	5.88	7.17	17.61	8.24
97-00 MAX	8.98	7.06	12.28	9.91	24.63	14.66
97-00 AVG	6.89	4.71	9.54	8.65	20.55	11.29

TABLE F-10.
Summary of Wing Dam Notch Velocity

Date	100' U/S No. 6 (ft/s)	100' U/S No. 15 (ft/s)	At No. 6 (ft/s)	At No. 15 (ft/s)	100' D/S No. 6 (ft/s)	100' D/S No. 15 (ft/s)
06/18/97	1.08	0.94	1.36	1.47	1.35	0.91
07/02/97	1.46	1.13	3.14	1.81	3.05	1.50
07/17/97	1.22	0.99	2.36	1.36	2.01	1.72
07/31/97	1.36	1.13	2.52	1.38	2.67	1.54
08/19/97	0.85	0.85	1.87	1.36	2.13	1.44
09/03/97	0.62	0.53	1.39	0.79	1.67	1.17
09/25/97	0.79	0.58	1.76	0.88	0.60	0.94
06/03/98	1.66	1.42	2.47	1.64	1.89	1.92
07/02/98	4.23	2.85	2.68	2.61	3.58	2.51
07/14/98	3.24	2.65	3.10	2.81	2.07	2.25
07/28/98	1.53	1.27	3.07	1.60	1.31	1.94
08/13/98	1.27	0.97	2.36	1.48	2.73	1.90
08/25/98	0.79	0.65	1.72	1.13	1.46	1.23
09/10/98	0.41	0.49	1.02	0.63	0.67	0.76
09/29/98	0.37	0.30	0.99	0.63	0.70	0.60
07/08/99	1.98	1.94	2.33	1.62	1.91	1.86
08/10/99	1.61	1.38	3.14	1.84	2.35	1.99
09/08/99	0.73	0.68	1.81	1.12	1.49	1.21
09/21/99	0.57	0.42	0.15	0.73	0.14	0.85
09/05/00	0.43	0.50	0.87	0.55	0.86	0.61
09/19/00	0.70	0.52	1.61	0.99	0.75	0.59
97 MIN	0.62	0.53	1.36	0.79	0.60	0.91
97 MAX	1.46	1.13	3.14	1.81	3.05	1.72
97 AVG	1.05	0.88	2.06	1.29	1.93	1.32
97 AVG	0.97				1.67	
98 MIN	0.37	0.30	0.99	0.63	0.67	0.60
98 MAX	4.23	2.85	3.10	2.81	3.58	2.51
98 AVG	1.68	1.33	2.18	1.57	1.80	1.64
98 AVG	1.50				1.87	
99 MIN	0.57	0.42	0.15	0.73	0.14	0.85
99 MAX	1.98	1.94	3.14	1.84	2.35	1.99
99 AVG	1.22	1.10	1.85	1.33	1.47	1.47
99 AVG	1.16				1.59	
00 MIN	0.43	0.50	0.87	0.55	0.75	0.59
00 MAX	0.70	0.52	1.61	0.99	0.86	0.61
00 AVG	0.57	0.51	1.24	0.77	0.81	0.60
00 AVG	0.54				1.01	
97-00 MIN	0.37	0.30	0.15	0.55	0.14	0.59
97-00 MAX	4.23	2.85	3.14	2.81	3.58	2.51
97-00 AVG	1.28	1.06	1.99	1.35	1.69	1.40
97-00 AVG	1.17				1.67	

APPENDIX G

PHOTOGRAPHS OF PROJECT FEATURES


ILLINOIS
ADAMS COUNTY
MISSISSIPPI RIVER
FLOW
FLAT POOL = 470.0
1 ACRE MECHANICALLY EXCAVATED POTHOLES (TYP.)
FOREST MANAGEMENT AREA 7
ROCK PLACEMENT BELOW WING DAM NOTCHES
FOREST MANAGEMENT AREA 5
FOREST MANAGEMENT AREA 6
AGRICULTURAL FIELD
MECHANICALLY EXCAVATED CHANNEL MATERIAL
COTTONWOOD ISLAND
EXISTING CAUSEWAY
ISLAND
DEEP HOLE EXCAVATION
CHANNEL EXCAVATION
WD-6A
WD-6D
WD-6U
WD-15A
WD-15D
WD-15U
W-1
W-2
WING DAM NO. 15
WING DAM NO. 30
WING DAM NO. 29
WING DAM NO. 6
WING DAM NO. 5
WING DAM NO. 8
MARION COUNTY

31
32
33
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29,30
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12
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10
9
7
6,8


Photo 1. Agricultural Field


Photo2. Mast Tree in Agricultural Field


Photo 3. Tree Has Grown Bigger Than Tree Mat


Photo 4. Healthy Tree in Agricultural Field


Photo 5. Facing Northwest – Trees in Agricultural Field


Photo 6. Exposed Fabric on Causeway


Photo 9. Facing South – Cottonwood Chute


Photo 7. Facing North – Cottonwood Chute


Photo 10. Trail East of Causeway


Photo 8. Rock and Driftwood on Causeway

Photo 11. Burr Oak in Field Management Area 55

Photo 12. Distressed Pin Oak in Field Management Area 5

Photo 13. Distressed Pin Oak in Field Management Ar

Photo 14. Facing Southwest – Field Management Area


Photo 15. Healthy Tree in Field Management Area 5


Photo 16. Slightly Distressed Pin Oak in FMA 5


Photo 17. Oak - Browsed by Deer and Re-sprouting


Photo 18. Oak Tree in Field Management Area 5

Photo 19. Pecan Tree Browsed by Deer

Photo 20. Pecan Tree in Field Management Area 5

Photo 21. Pecan Tree in Field Management Area 5

Photo 22. Tree Overtaken by Cucumber Vine


Photo 23. Burr Oak in Field Management Area 6


Photo 24. Distressed Pin Oak


Photo 25. Facing Northwest – Field Management Area


Photo 26. Facing Southeast – Field Management Area 6


Photo 27. Swamp White Oak in FMA 6


Photo 28. Sycamore in Field Management Area 6

Photo 29. Animal Tracks at Pothole #3

Photo 30. Pothole #3

Photo 31. Pothole #4

Photo 32. Mussels Found at Pothole #5

Photo 33. Millet Growing Around Pothole #5

APPENDIX H

PROJECT TEAM MEMBERS

COTTONWOOD HREP TEAM MEMBERS									
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Wade Conn Nate Goodrich	Resource Forester	MDOC	653 Clinic Rd	Hannibal	MO	63401	573-248-2530	573-248-2532	connj@mail.conservation.state.mo.us goodrn@mail.conservation.state.mo.us

APPENDIX I

REFERENCES

REFERENCES

Published reports relating to the Cottonwood HREP or which were used as references in the production of this document are presented below.

(1) *Definite Project Report with Integrated Environmental Assessment (R-16F), Cottonwood Island Habitat Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program, Pool 21, Mississippi River Miles 328.5 – 331.0, Lewis and Marion Counties, Missouri, June 1996.* The report marks the conclusion of the planning process and serves as a basis for approval of the preparation of final plans and specifications and subsequent project construction.

(2) Plans and Specifications, *Upper Mississippi River, Environmental Management Program, Pool 21, River Miles 328.5 thru 331.0, Cottonwood Island Rehabilitation and Enhancement*, Solicitation No. DACW25-97-B-0011. These documents were prepared to provide sufficient detail for construction of the hydraulically dredged chutes / deep holes and mechanically excavated potholes, as well as notching of the existing wing dams.

(3) Plans and Specifications, *Upper Mississippi River, Environmental Management Program, Pool 21, River Miles 328.5 thru 331.0, Cottonwood Island Rehabilitation and Enhancement, Stage II*, Solicitation No. DACW25-99-B-0005. These documents were prepared to provide sufficient detail for construction of the mast tree areas.

(4) Plans and Specifications, *Upper Mississippi River System, Environmental Management Program, Pool 21, Cottonwood Island, Stage III, Causeway Road Raise*, Solicitation No. DACW25-00-T-0006. These documents were prepared to provide sufficient detail for construction of the causeway road.

(5) *Operation and Maintenance Manual, Cottonwood Island Rehabilitation and Enhancement, Upper Mississippi River Environmental Management Program, Pool 21, River Miles 328.5 Through 331.0, Lewis and Marion Counties, Missouri, January 2001*. This manual was prepared to serve as a guide for the operation and maintenance of the Cottonwood HREP. Operation and maintenance instructions for major features of the project are presented.

(6) *Post-Construction Performance Evaluation Report – Year 3 (2000), Cottonwood Island Habitat Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program, Pool 21, Upper Mississippi River Miles 328.5 – 331.0, Lewis and Marion Counties, Missouri*, June 2001, April 2002, June 2007.

APPENDIX J

DISTRIBUTION LIST

DISTRIBUTION LIST

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Site Manager / Wildlife Biologist
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Mr. Mike Griffin
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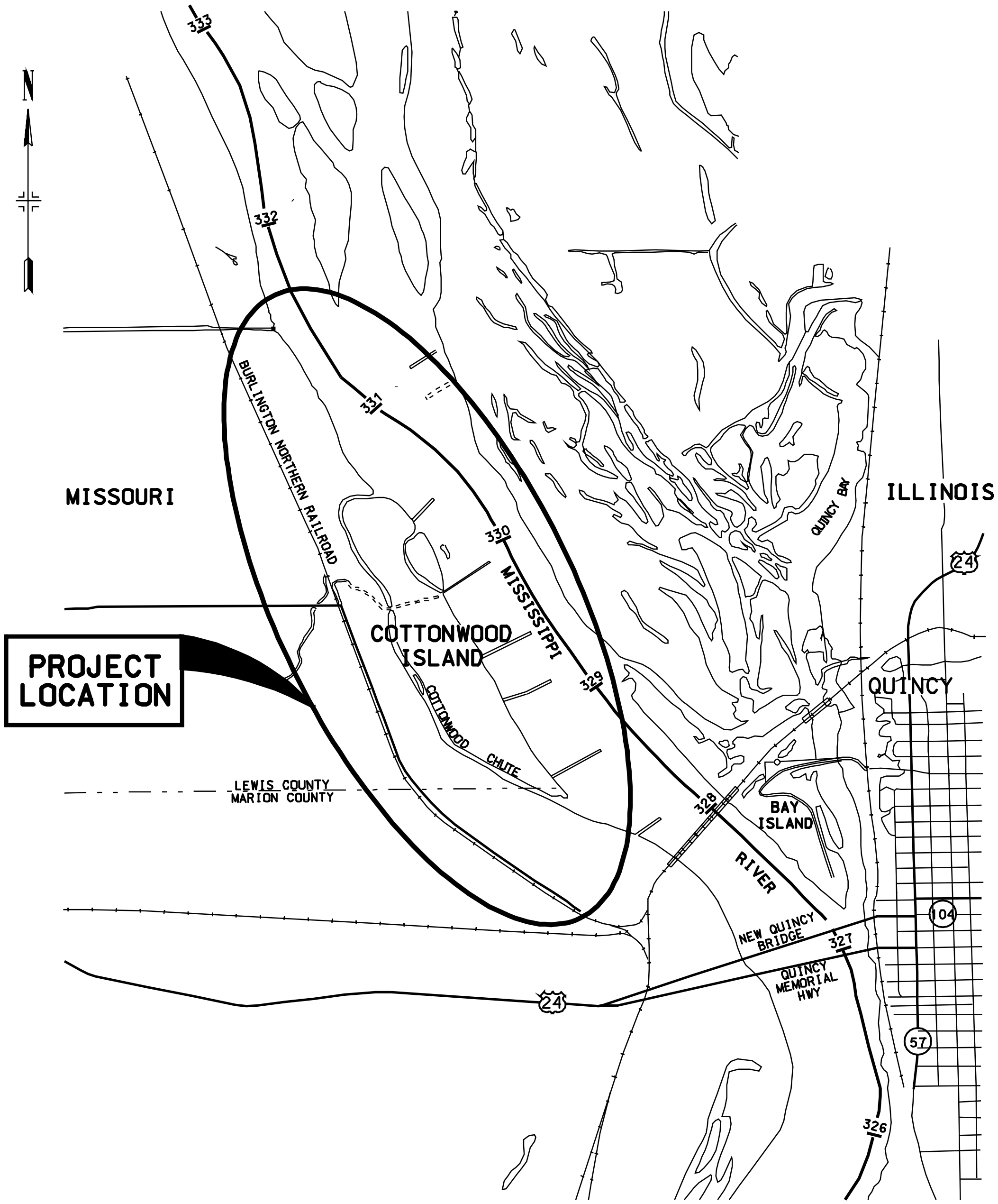
CEMVR-CE-C
CEMVR-EC
CEMVR-EC-D

CEMVR-EC-DN (2)
CEMVR-EC-H
CEMVR-EC-HQ (Bierl)
CEMVR-EC-G
CEMVR-EC-S
CEMVR-OD-M
CEMVR-OD-MN
CEMVR-OD-MN (Lundh)

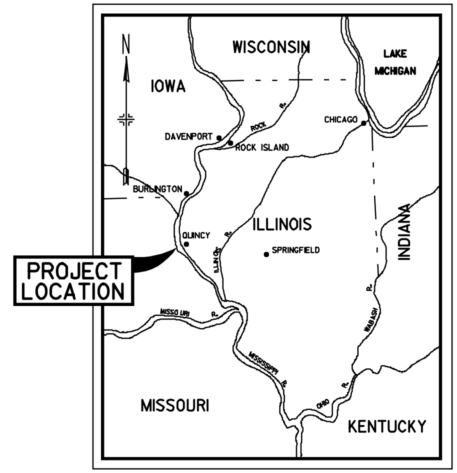
APPENDIX K

PLATES



LOCATION PLAN

1500 750 0 1500 3000FT
SCALE



VICINITY MAP

25 0 25 50 75
SCALE IN MILES

US Army Corps of Engineers Rock Island District

Symbol	Description	Date	Approved

Revisions

Designed By:	Date: XX JAN 03	
Drawn By:	Scale: AS SHOWN	
Checked By:	Project Code: XXXXX	
Reviewed By:	Solicitation Number: DACW25-XX-B-XXXX	

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

UPPER MISSISSIPPI RIVER
COTTONWOOD ISLAND
PERFORMANCE EVALUATION

VICINITY MAP AND LOCATION PLAN

Sheet Reference Number:

Sheet of XX

PLATE 1

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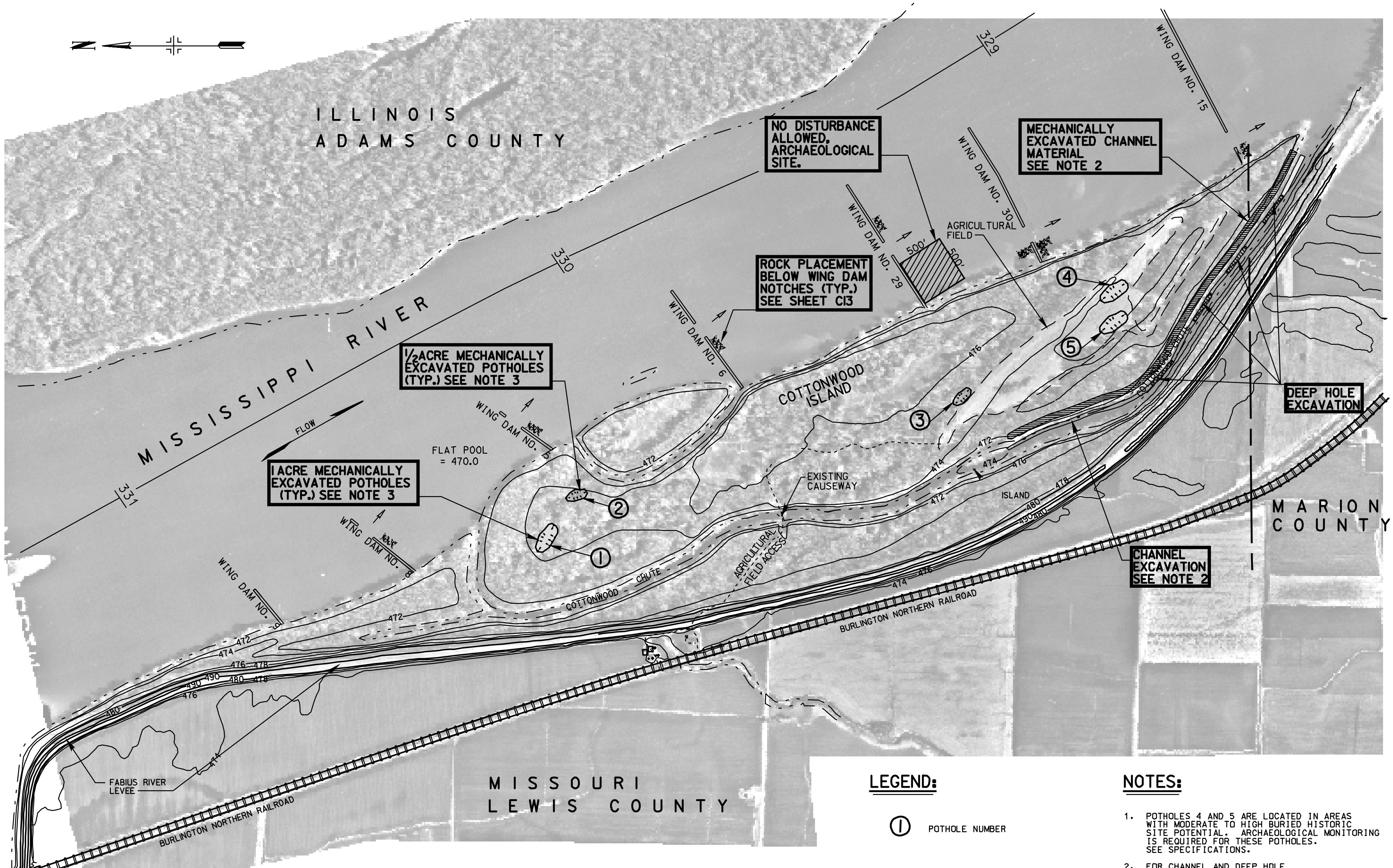

LEGEND:

1 POTHOLE NUMBER

SITE PLAN

500 250 0 500 1000FT
SCALE

NOTES:

1. POTHOLES 4 AND 5 ARE LOCATED IN AREAS WITH MODERATE TO HIGH BURIED HISTORIC SITE POTENTIAL. ARCHAEOLOGICAL MONITORING IS REQUIRED FOR THESE POTHOLES. SEE SPECIFICATIONS.
2. FOR CHANNEL AND DEEP HOLE EXCAVATION PLAN. SEE SHEET C6.
3. POTHOLE LOCATIONS ARE IN AREAS OF GENERALLY LOWER ELEVATION. EXACT POTHOLE LOCATIONS SHALL BE DETERMINED IN THE PRESENCE OF THE CONTRACTING OFFICER'S REPRESENTATIVE.

US Army Corps of Engineers Rock Island District

Symbol	Description	Date	Approved
	Revisions		

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CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

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Drawn By: JCO | Scale: AS SHOWN
Checked By: XXX | Project Code: XXXXX
Reviewed By: JWB | Solicitation Number: DACW25-XX-B-XXXX

UPPER MISSISSIPPI RIVER
COTTONWOOD ISLAND
PERFORMANCE EVALUATION

SITE PLAN

Sheet Reference Number:
Sheet of XX

PLATE 2

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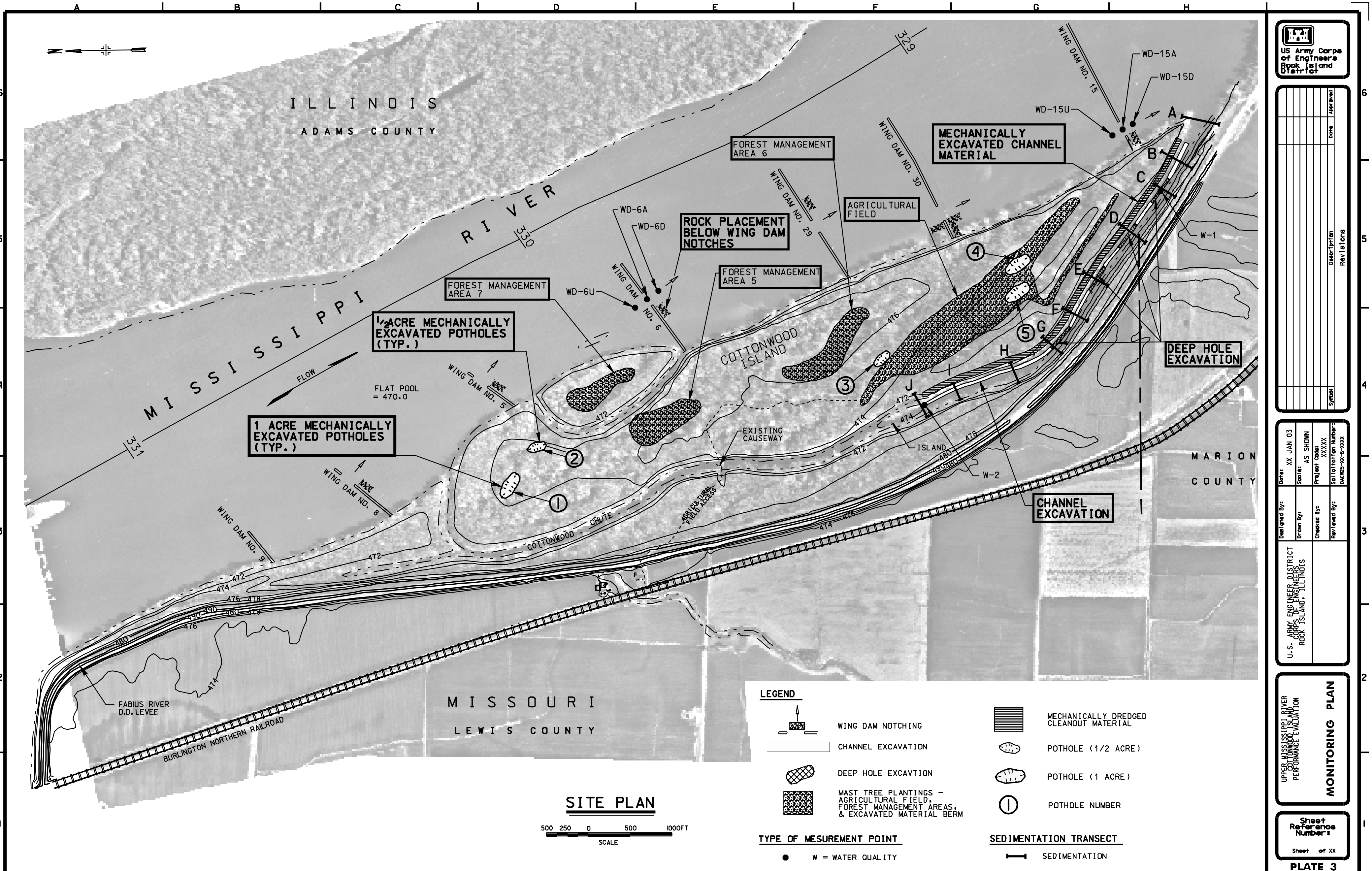
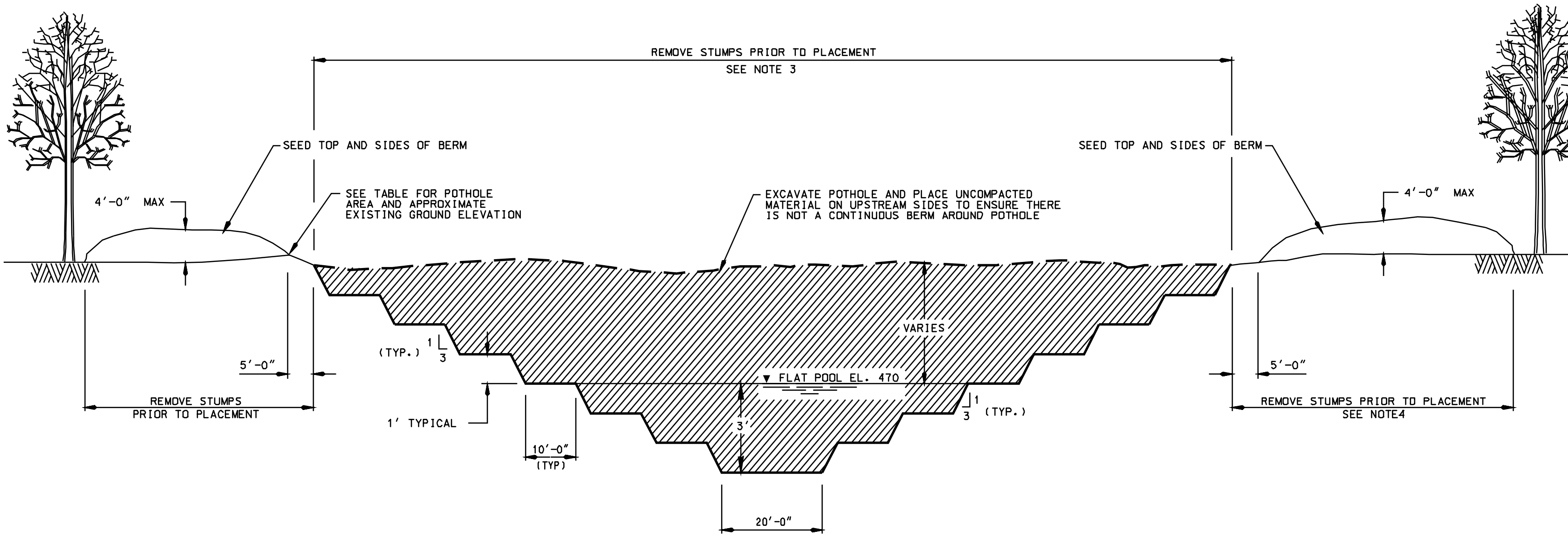

ILLINOIS
ADAMS COUNTY
MISSISSIPPI RIVER
FLOW
FLAT POOL = 470.0
MISSOURI
LEWIS COUNTY
MARION COUNTY
COTTONWOOD ISLAND
COTTONWOOD CHUTE
EXISTING CAUSEWAY
AGRICULTURAL FIELD ACCESS
BURLINGTON NORTHERN RAILROAD
FABIUS RIVER D.D. LEVEE
FOREST MANAGEMENT AREA 5
FOREST MANAGEMENT AREA 6
FOREST MANAGEMENT AREA 7
AGRICULTURAL FIELD
ROCK PLACEMENT BELOW WING DAM NOTCHES
1/2 ACRE MECHANICALLY EXCAVATED POTHOLES (TYP.)
1 ACRE MECHANICALLY EXCAVATED POTHOLES (TYP.)
MECHANICALLY EXCAVATED CHANNEL MATERIAL
DEEP HOLE EXCAVATION
CHANNEL EXCAVATION
ISLAND
WING DAM NO. 5
WING DAM NO. 6
WING DAM NO. 8
WING DAM NO. 9
WING DAM NO. 15
WING DAM NO. 29
WING DAM NO. 30
WD-6A
WD-6D
WD-6U
WD-15A
WD-15D
WD-15U
W-1
W-2
329
330
331
SITE PLAN
500 250 0 500 1000FT
SCALE
LEGEND
WING DAM NOTCHING
CHANNEL EXCAVATION
DEEP HOLE EXCAVTION
MAST TREE PLANTINGS - AGRICULTURAL FIELD, FOREST MANAGEMENT AREAS, & EXCAVATED MATERIAL BERM
MECHANICALLY DREDGED CLEANOUT MATERIAL
POTHOLE (1/2 ACRE)
POTHOLE (1 ACRE)
POTHOLE NUMBER
TYPE OF MESUREMENT POINT
W = WATER QUALITY
SEDIMENTATION TRANSECT
SEDIMENTATION
US Army Corps of Engineers Rock Island District
Symbol
Description
Date
Approved
Revisions
Designed By:
Drawn By:
Checked By:
Reviewed By:
Date: XX JAN 03
Scale: AS SHOWN
Project Code: XXXXX
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER COTTONWOOD ISLAND PERFORMANCE EVALUATION
MONITORING PLAN
Sheet Reference Number:
Sheet of XX
PLATE 3



MECHANICALLY CONSTRUCTED POTHOLE TYPICAL SECTION

NO SCALE

TABLE 1

POTHOLE NUMBER	AREA (ACRES)	APPROXIMATE EXISTING GROUND ELEVATION	APPROXIMATE WIDTH, FT.	APPROX. LENGTH, FT.	APPROX. CLEARED AREA, ACRES
1	1	474	180	200	3.5
2	1/2	474	180	180	2
3	1/2	474	180	185	2
4	1	475	208	267	4
5	1	475	208	267	4

NOTES

1. FOR APPROXIMATE POTHOLE LOCATIONS SEE SHEET C1.
2. POTHOLES 4 AND 5 ARE LOCATED IN AREAS WITH MODERATE TO HIGH BURIED HISTORIC SITE POTENTIAL. ARCHAEOLOGICAL MONITORING IS REQUIRED FOR THESE POTHOLES. SEE SPECS.
3. ALL MECHANICALLY CONSTRUCTED POTHOLES TO BE STAKED BY THE CONTRACTOR AND APPROVED BY THE C.O.R. PRIOR TO CONSTRUCTION.
4. FOR POTHOLES 1, 2, & 3 STUMPS SHALL BE BURIED DOWNSTREAM AND BEYOND LIMITS OF BERM.
5. LENGTH & WIDTH OF POTHOLES VARY. SEE TABLE 1.

US Army Corps of Engineers Rock Island District

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Date: XX JAN 03 | Scale: AS SHOWN | Project Code: XXXXX | Solicitation Number: DACW25-XX-B-XXXX

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

UPPER MISSISSIPPI RIVER COTTONWOOD ISLAND PERFORMANCE EVALUATION

POTHOLE DETAILS

Sheet Reference Number:

Sheet of XX

PLATE 4

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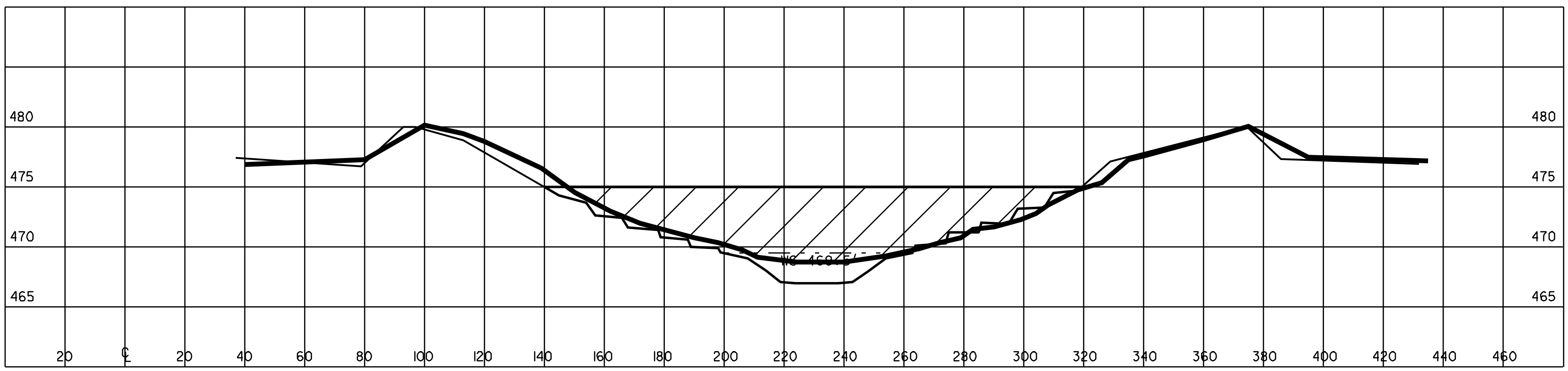
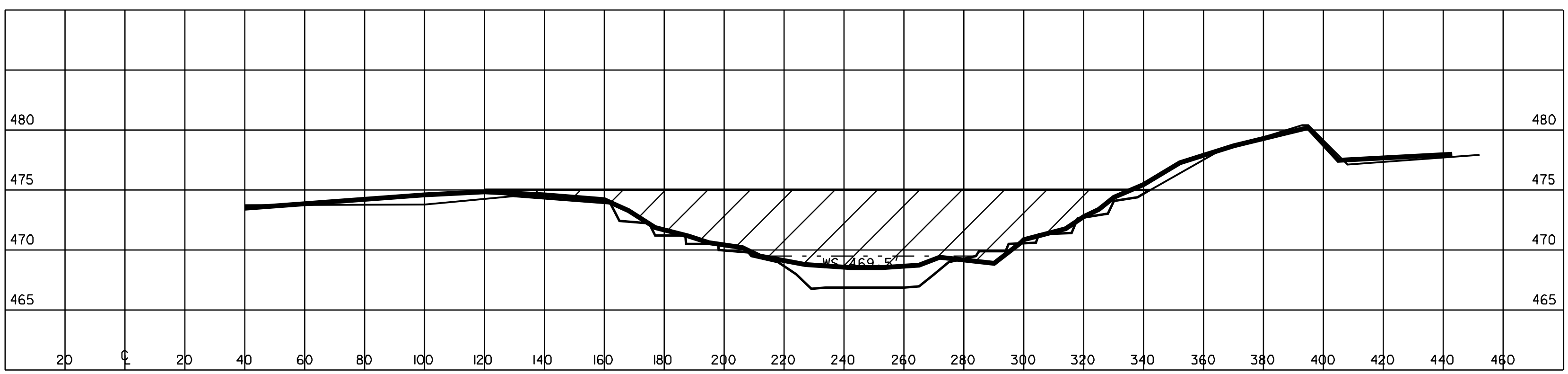


POTHOLE #1 - SHORT CHORD



POTHOLE #1 - LONG CHORD

DATA COMPARISON CHART			
AREA	1997 DATAM	2002 DATAM	DATAM DIFFERENCE
SHORT CHORD	784 SQ. FT.	698 SQ. FT.	86 SQ. FT.
LONG CHORD	928 SQ. FT.	808 SQ. FT.	120 SQ. FT.

LEGEND:

21 OCT.1997; FIELD BOOK FC-97-4

5-6 NOV. 2002; FIELD BOOK FC-02-3

US Army Corps of Engineers Rock Island District

REVISED AS CONSTRUCTED-ADDED SHEET TO SET

Symbol | Description | Date | Approved

Revisions

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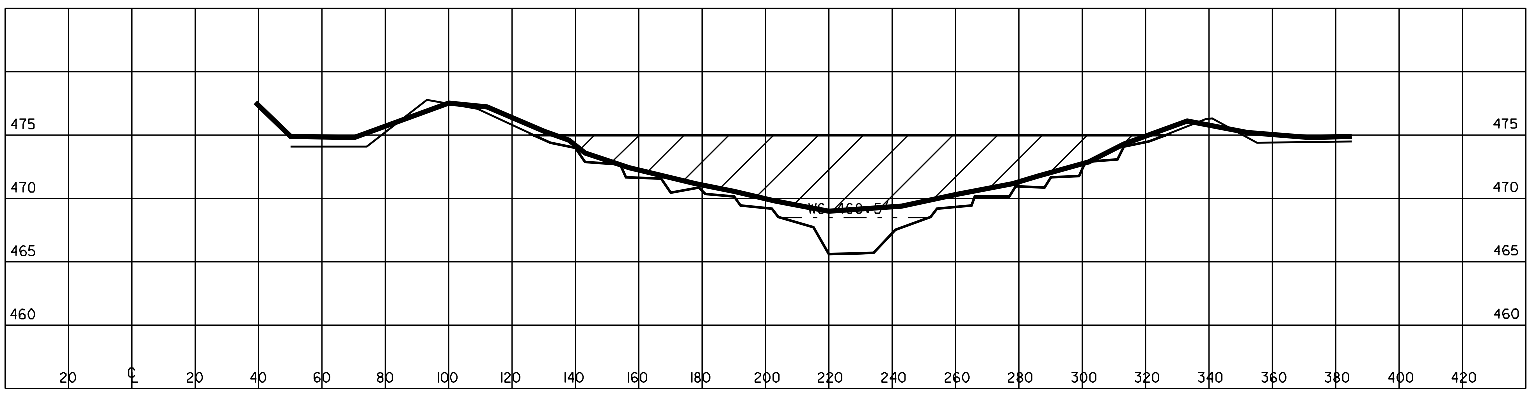
UPPER MISSISSIPPI RIVER COTTONWOOD ISLAND PERFORMANCE EVALUATION

POTHOLE 1 TRANSECTS

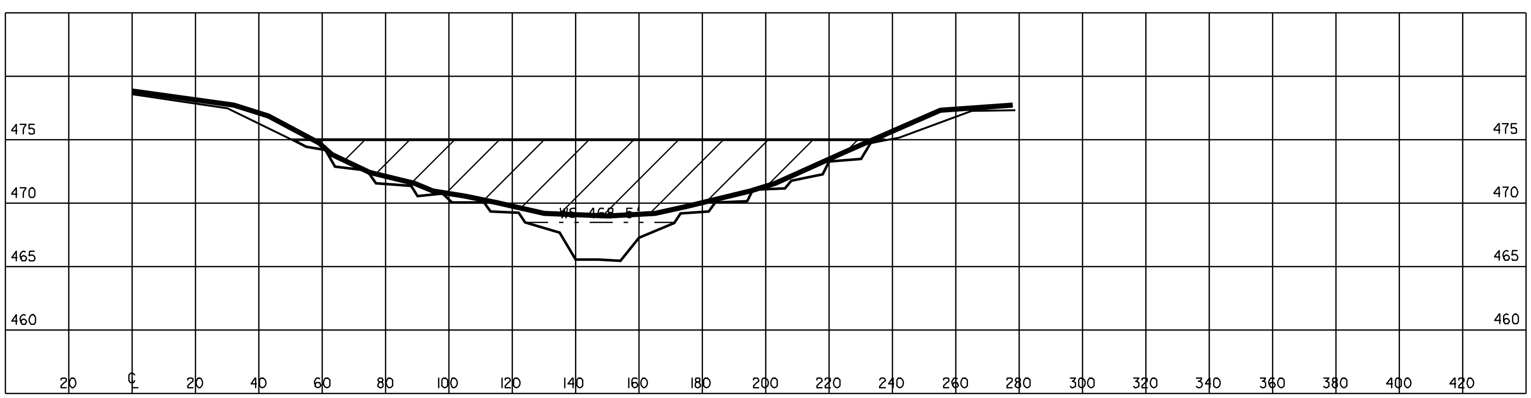
Sheet Reference Number:

Sheet of XX

PLATE 5



POTHOLE #2 - SHORT CHORD



POTHOLE #2 - LONG CHORD

DATA COMPARISON CHART

AREA	1997 DATAM	2002 DATAM	DATAM DIFFERENCE
SHORT CHORD	899 SQ. FT.	698 SQ. FT.	201 SQ. FT.
LONG CHORD	869 SQ. FT.	694 SQ. FT.	175 SQ. FT.

LEGEND:

- (thin line) 21 OCT.1997; FIELD BOOK FC-97-4
- (thick line) 5-6 NOV. 2002; FIELD BOOK FC-02-3

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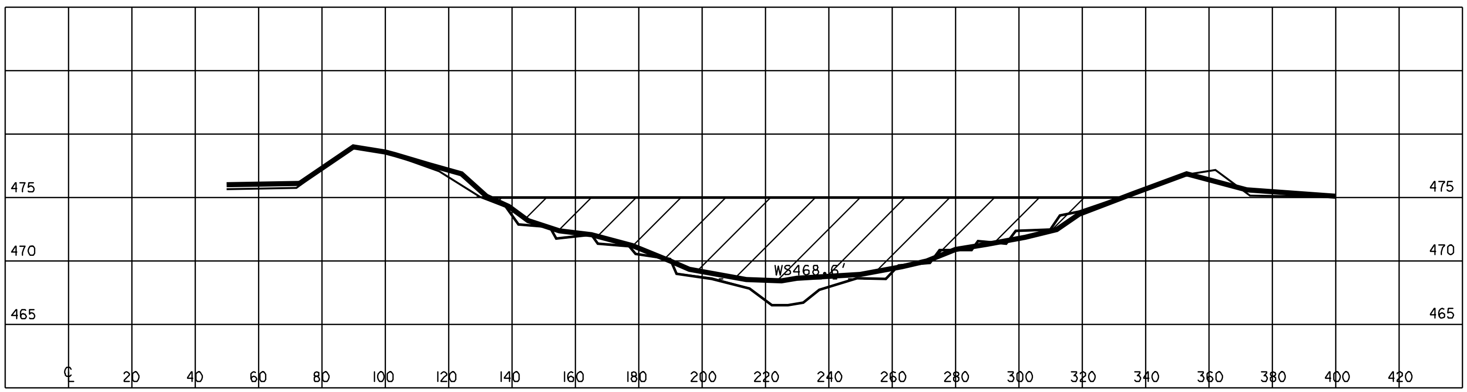
UPPER MISSISSIPPI RIVER COTTONWOOD ISLAND PERFORMANCE EVALUATION

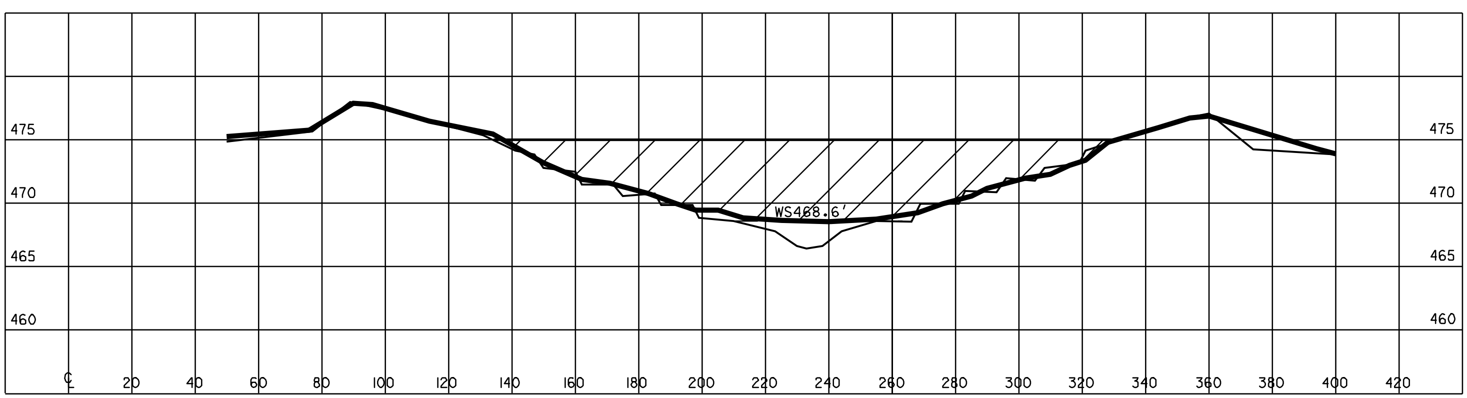
POTHOLE 2 TRANSECTS

Sheet Reference Number:

PLATE 6



POTHOLE #3 – SHORT CHORD



POTHOLE #3 – LONG CHORD

DATA COMPARISON CHART

AREA	1997 DATAM	2002 DATAM	DATAM DIFFERENCE
SHORT CHORD	881 SQ. FT.	815 SQ. FT.	66 SQ. FT.
LONG CHORD	880 SQ. FT.	816 SQ. FT.	64 SQ. FT.

LEGEND:

- (thin line) 21 OCT, 1997; FIELD BOOK FC-97-4
- (thick line) 5-6 NOV, 2002; FIELD BOOK FC-02-3

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Reviewed By: JWB | Solicitation Number: DACW25-XX-B-XXXX

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

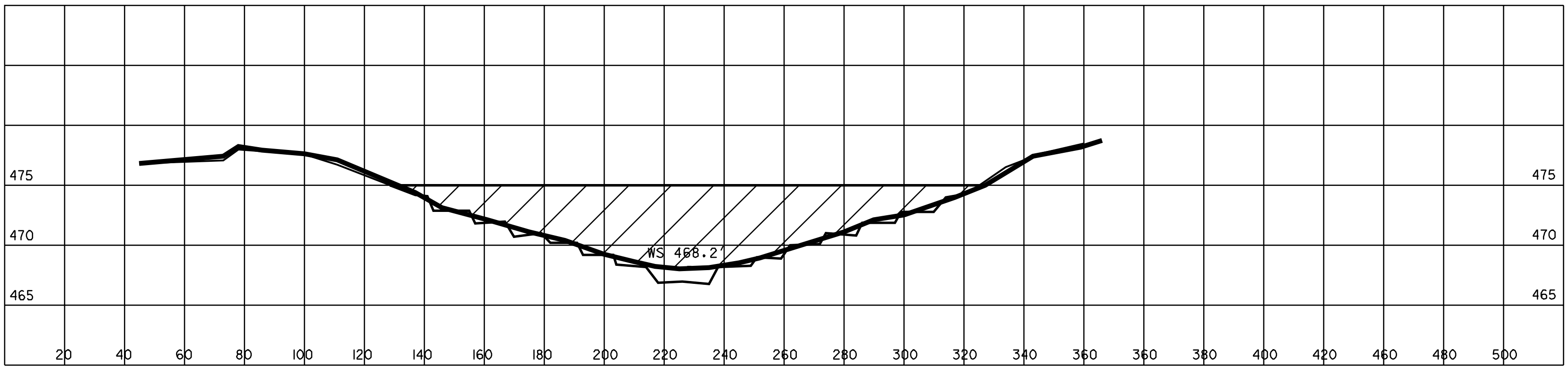
UPPER MISSISSIPPI RIVER
COTTONWOOD ISLAND
PERFORMANCE EVALUATION

POTHOLE 3 TRANSECTS

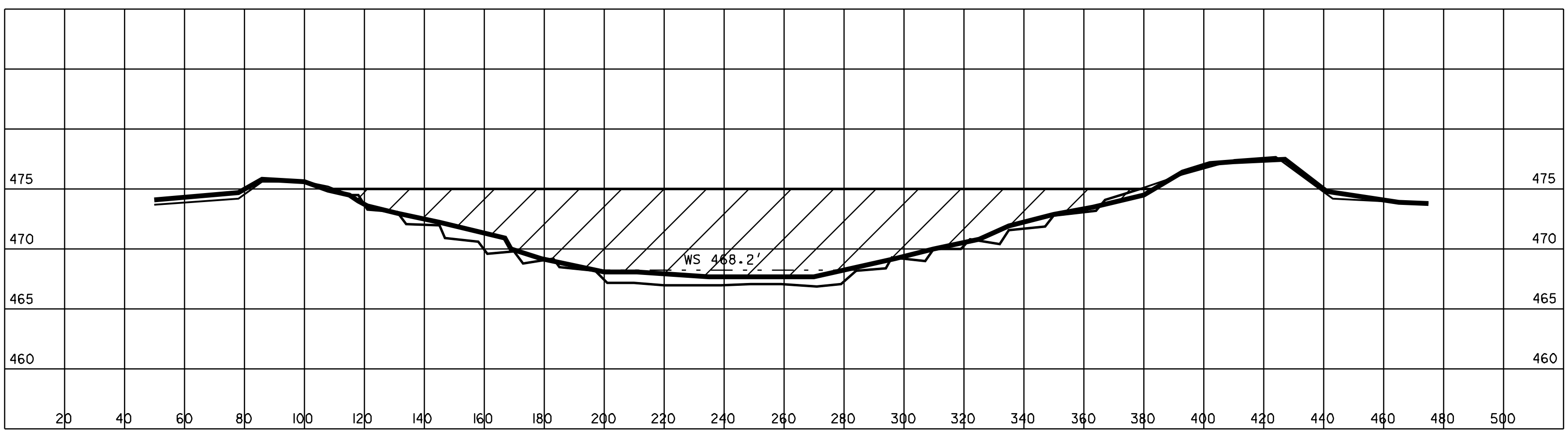
Sheet Reference Number:

Sheet of XX

PLATE 7



POTHOLE #4 – SHORT CHORD



POTHOLE #4 – LONG CHORD

DATA COMPARISON CHART			
AREA	1997 DATAM	2002 DATAM	DATAM DIFFERENCE
SHORT CHORD	848 SQ. FT.	792 SQ. FT.	56 SQ. FT.
LONG CHORD	1,398 SQ. FT.	1,268 SQ. FT.	130 SQ. FT.

LEGEND:

- (thin line) 21 OCT,1997; FIELD BOOK FC-97-4
- (thick line) 5-6 NOV, 2002; FIELD BOOK FC-02-3

US Army Corps of Engineers Rock Island District

Symbol | Description | Date | Approved
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Reviewed By: JWB
Date: XX JAN 03
Scale: AS SHOWN
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Solicitation Number: DACW25-XX-B-XXXX

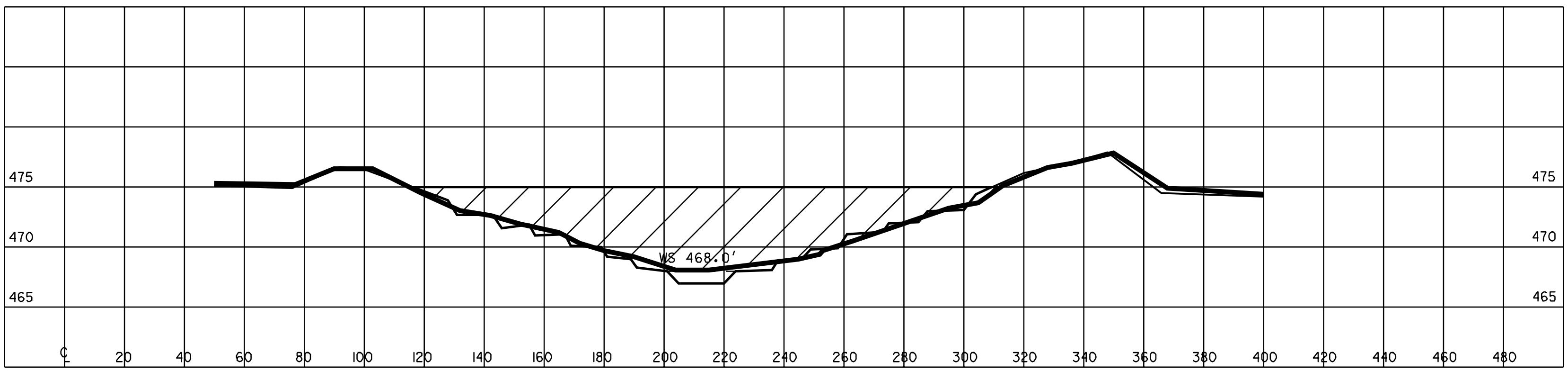
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

UPPER MISSISSIPPI RIVER
COTTONWOOD ISLAND
PERFORMANCE EVALUATION

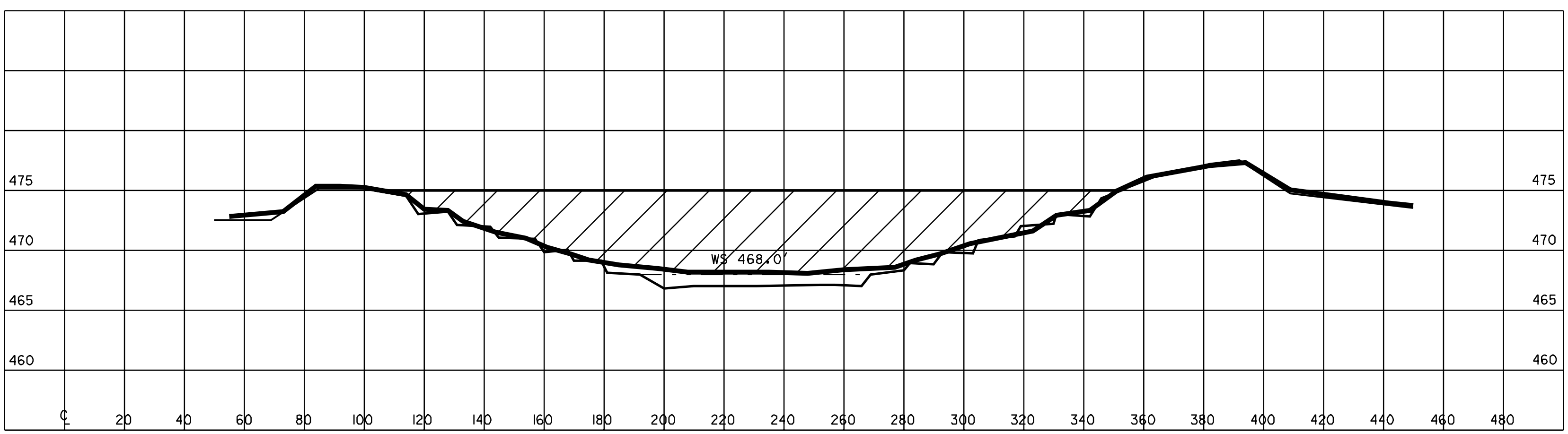
POTHOLE 4 TRANSECTS

Sheet Reference Number:
Sheet of XX

PLATE 8



POTHOLE #5 - SHORT CHORD



POTHOLE #5 - LONG CHORD

DATA COMPARISON CHART

AREA	1997 DATAM	2002 DATAM	DATAM DIFFERENCE
SHORT CHORD	842 SQ. FT.	808 SQ. FT.	34 SQ. FT.
LONG CHORD	1,274 SQ. FT.	1,148 SQ. FT.	126 SQ. FT.

NOTE: DATAM BASED OFF ELEVATION OF 475.0

LEGEND:

- (thin line) 21 OCT, 1997; FIELD BOOK FC-97-4
- (thick line) 5-6 NOV, 2002; FIELD BOOK FC-02-3

US Army Corps of Engineers Rock Island District

Designed By: RCF | Drawn By: JCO | Checked By: XXX | Reviewed By: JWB
Date: XX JAN 03 | Scale: AS SHOWN | Project Code: XXXXX

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

UPPER MISSISSIPPI RIVER
COTTONWOOD ISLAND
PERFORMANCE EVALUATION

POTHOLE 5 TRANSECTS

Sheet Reference Number:

PLATE 9