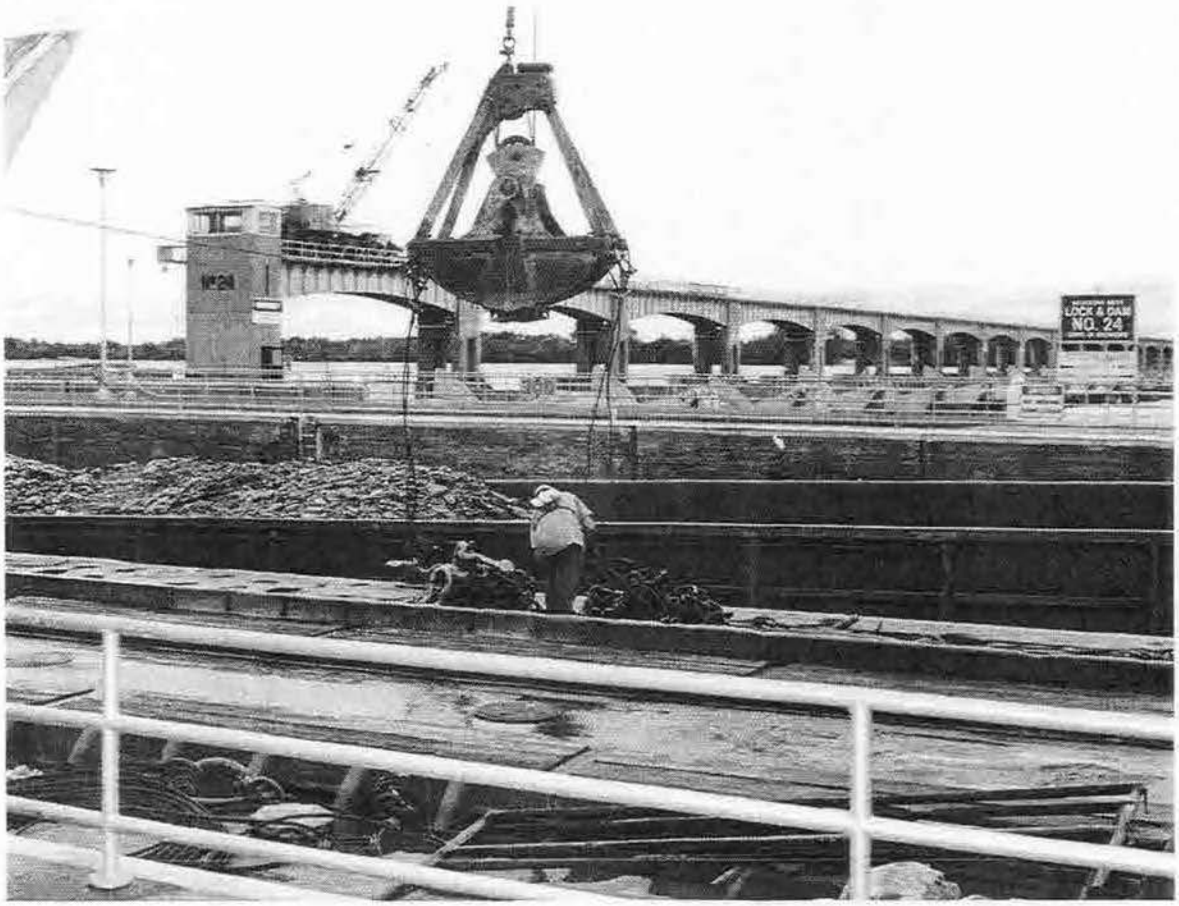
MELVIN PRICE LOCKS & DAM

UPPER MISSISSIPPI RIVER BASIN
MISSISSIPPI RIVER MISSOURI AND ILLINOIS

PROGRESS REPORT 1995



DESIGN MEMORANDUM NO. 24
AVOID AND MINIMIZE MEASURES

"Good engineering enhances the environment"

US Army Corps of Engineers
St. Louis District

DECEMBER 1995

19 December 95

AVOID AND MINIMIZE PROGRAM, CELMS
PROGRESS REPORT--1995

In October 1992, the St. Louis District issued Design Memorandum No. 24, "Avoid and Minimize Measures" developed as a commitment made in the Record of Decision (signed in 1988) to the Melvin Price Locks and Dam EIS for the Second Lock. The implementation program is now funded from 1996 to 2002 through the operation and maintenance (O&M) budget. The District, in 1993, begin to reprogram O&M funds to initiate implementation of the eight Avoid and Minimize (A&M) selected measures (Table I). The District was able to make little additional progress in 1994 because of the 1993 flood recovery effort. In 1995, the St. Louis District initiated a series of actions to construct the A&M measures utilizing O&M and Middle River Regulating Works project dollars:

1. chevron dike physical and biological monitoring (measure A-16, D.M. 24);
2. thalweg disposal physical monitoring (measure A-13);
3. bendway weir physical and biological monitoring (measure A-19);
4. installation of additional mooring facilities near the locks and dams (measure A-3);
5. pallid sturgeon monitoring (measure A-19).

A&M 1). The first blunt nosed chevron dikes were constructed by CELMS in the fall of 1993--they have performed as designed by diverting flows from the side channel and into the main channel. The rock structures have also proved to increase biological diversity and habitat. The placement of these rip-rap river training structures was discussed with the natural resource agencies on a river trip in Pool 24 in the summer of 1993. Biologists were present from Missouri Department of Conservation (MDC), Illinois Department of Natural Resources (IDNR), National Biological Service (NBS) and Fish and Wildlife Service (FWS). The biologists agreed that the dikes would add additional aquatic diversity, increase productivity and if dredging of the point bar was reduced, as is their planned function, the structures would contribute additional environmental enhancement benefits (Appendix A). Unfortunately, no pre-construction biological monitoring of the river bottom took place. A contractor for CELMS sampled the river bottom between the chevrons and macroinvertebrates on the chevrons (utilizing rock baskets) in the fall of 1994. Monitoring continued in 1995 with a spring and fall investigation. A marked increase (twenty-sixfold) in macroinvertebrates was noted in the spring monitoring period. Staff from the IDNR conducted a electrofishing survey around and inside a chevron. The survey noted 18 fish species present and 199 fishes total (7.1 fish/min.). It is the

TABLE I

DESIGN MEMORANDUM NO. 24

AVOID AND MINIMIZE MEASURES RECOMMENDED FOR IMPLEMENTATION

NUMBER	MEASURE
A-3.	Designate locks approach waiting areas--provide on-bank anchor points or mooring buoys.
A-10.	Reduce open water dredge material disposal--create recreation beaches.
A-11.	Reduce open water dredge material disposal--create wetlands.
A-13.	Place dredge material in the thalweg.
A-16.	Continue dike configuration studies (i.e., notched dikes, chevron dikes and bullnose dikes.
A-17.	Place off-bank revetment on islands.
A-19.	Monitor bendway weirs.
B-8.	Study reduction of tow waiting times.

opinion of the investigator that "these structures are very beneficial to riverine fish communities and fish populations". Five small chevrons will be constructed in 1996 in Pool 25 and biological monitoring will be conducted prior to rock placement.

A&M 2). Thalweg disposal of dredge material has proven successful in the Rock Island District and has been conducted by the St. Louis District in the Middle River. Boulter's Bar in Pool 26 is a major dredging site and has a deep area downstream of the point bar. The Dredge Potter performed thalweg disposal in the summer of 1995 and physical monitoring of the site was conducted. A site visit to the thalweg disposal area was completed prior to dredging in 1995. Representatives of the FWS and IDNR and MDC were present and the action received concurrence with little discussion required. The natural resource agency team did not appear to be interested in any long term monitoring with this type of dredge disposal. There is, however, an operational need for the Corps to monitor these sites in order to track the dredged material, to assure that the navigation channel is not adversely affected and to assure that quality aquatic habitat does not suffer long term negative effects. Data analysis of this effort is continuing. The District has established a thalweg disposal team to recommend sites and to establish a study plan. The team is designing a program which will use some of the monitoring materials produced by the Rock Island District, WaterWays Experiment Station (WES) dredge material reports and FWS in order to gain from their experiences and coordination. Thalweg disposal monitoring, with physical and possible biological components, will be a part of the 1996 and 97 A&M program.

A&M 3). The St. Louis District placed the first bendway weir in the Mississippi River in 1989. The river training structure has proved successful and is now recognized as a structure which increases biological habitat and diversity. Natural resource agencies have had many questions as to the effect of the rock in the thalweg on the aquatic environment. One of the results of this interest was the formation of a Bendway Weir Fish Sampling Team to coordinate sampling efforts in and around weir fields as well as in bends where weirs had not yet been placed. The team consists of representatives from CELMS, MDC, IDNR, NBS, FWS and Southern Illinois University-Carbondale. In DM 24, Appendix B, the A&M natural resource agency team estimated that the Habitat Suitability Index would increase from 1 to 7 with placement of the weir. CELMS-ED-HP has contracted with WES in 1992, 1994 and 1995 to conduct hydroacoustic surveys in four river bends in the Middle Mississippi River. Bends with and without weirs have been surveyed. The results indicated that fish were more abundant in bends having weirs than in bends without. During the summer of 1995, explosives were utilized to sample a portion of a weir field and staff from the natural resource agencies and Corps biologists cooperated in the effort. Hoop nets, gill nets and trotlines were also utilized for fish sampling in and around the weir field. A deep-water shocking device (operated from the motor vessel Pathfinder) was tried for the first time near the weir field with some success. The device is presently undergoing design modification. Results of the biological monitoring are being compiled and appear to substantiate the initial "desk estimation" of habitat improvement revealed in DM 24 (see Appendix B). In the spring of 1996, CELMS staff will lower rock baskets in the weir field for the collection of macroinvertebrates.

A&M 4). Mooring points around locks and dams have proven to be popular with the river industry, the lockmasters and the natural resource agencies as the mooring sites provide safe mooring, increase efficiency of the locks and reduce environmental impacts of barge traffic. CELMS initiated the placement of ship anchors and connecting chains above L&D 24 and 25 in 1989 for on-bank mooring. These early A&M measures were initiated as an informal program. On-shore mooring sites are to provide alternative tie-off points other than cables placed around trees. The natural resource agencies have expressed concerns for many years about the practice of using trees for mooring because the trees are eventually killed due to the cables. The River Industry was also satisfied with the placement of the large anchors because of the safety of the mooring point. In 1991, the St. Louis District moved mooring buoys to midchannel areas below L&D 24 and 25 to provide a safe alternative to "nosing" into the bank. The buoys have been moved several times and the design altered per the requests from the river industry. The buoys also help decrease the locking time due to the close proximity of the mooring point to the downstream lock entrance. The program was continued in 1995 with two new on-shore anchors installed on Clarksville Refuge above L&D 24. MDC placed signs, approved by the Corps and the river industry, next to the anchors. High water during the spring of 1995 delayed the remainder of the program and funds were transferred to ongoing physical and biological monitoring and engineering requirements necessary for the FY 1996 A&M program.

A&M 5). Initiation of pallid sturgeon monitoring in relationship to Corps river training structures. The pallid sturgeon was listed as an endangered species in September of 1990 by the FWS. The St. Louis District was a participant in a meeting to discuss the status and needs of the pallid sturgeon in January, 1995. This meeting included representatives for several midwestern states and federal agencies and was conducted under the auspices of the Pallid Sturgeon Recovery Team. The result was a scope of work for a tracking study entitled "Habitat Utilization by the Pallid Sturgeon (Scaphirynchus albus) in the Middle Mississippi River" (Appendix C). The objective of the monitoring is to obtain information on habitats used by the sturgeon in the Middle River and their relationship with river regulating works constructed by the COE. O&M funds were utilized, in 1995, to fund the CELMS share of the initial year of the study. Southern Illinois University-Carbondale is the contractor selected by the Service to conduct the three year effort. Sonic transmitters will be placed in pallid sturgeon and pallid/shovelnose sturgeon hybrids to determine their movements and habitats utilized in the Middle River. These fish will be purchased from commercial fisherman that fish the river and incidentally catch pallid sturgeon and their hybrids. Radio receivers will be supplied by the contractor for the COE vessels that routinely operate in this section of the river. Monitoring is underway with the placement of the first six transmitters in fall 1995. Movement of the tagged fish will be monitored by determining their location utilizing a global positioning system and then plotted on COE navigation charts. A special effort will be made to determine whether these fish are using river training structures such as bendway weirs and notched dikes. During a fall 1995 tracking trip, the pallids moved upstream and to the Missouri side of the river. They appear to be utilizing the main channel and scour holes, downstream of dikes.

A&M 6). 1996 and 1997 planned A&M activities. Implementation of the eight measures for 1996 and 1997 follows the plan outlined in D.M. 24 (Table II). **1). Bull nose dikes.** Bull nose dikes and off-shore revetment has the highest natural resource benefit, in the opinion of the natural resource agencies. Erosion of the heads of islands occurred during the 93 flood and was identified as a major concern, the District A&M team decided to build bull-nose dikes around critical islands in the pools. The bull-nose dike can be considered a form of off-shore revetment because it is notched and only attached to the land at one or both ends. One experimental multiple round point structure is planned with bank revetment and five experimental small chevron dikes are planned. These rock structures comprise approximately 55 percent of the 96 A&M budget. Physical and biological monitoring will occur prior to placement of the experimental structures and will continue for several years. Thus, as reflected in D.M. 24, structural placement is the major objective of the 96 program. **2). Mooring points at locks and dams.** Buoy and on-bank anchors placement will continue in 1996 and is 10 percent of the program budget. **3). Administrative costs.** Planning, engineering and design, including physical modeling and monitoring, biological monitoring, contracting and hired labor, is 35 percent of the 1996/A&M budget.

St. Louis District A&M team. The CELMS A&M team, composed of representatives from PM, CO, ED and PD, have met on several occasions, concerning the 1997 program and will propose to the natural resource agencies in March 1996 that part of the A&M implementation program shift to the Middle River with placement of structures (Table II). **a). Least Tern island.** There has been an interest for several years by District staff and the natural resource agencies in creating a least tern island in the Middle River by utilizing dredge material. By constructing a rock bullnose dike and then placing dredge material behind the structure, an island will be created that may be attractive to nesting least terns and form a semi-permanent sandbar for dredge material

OPEN PLAN (R)
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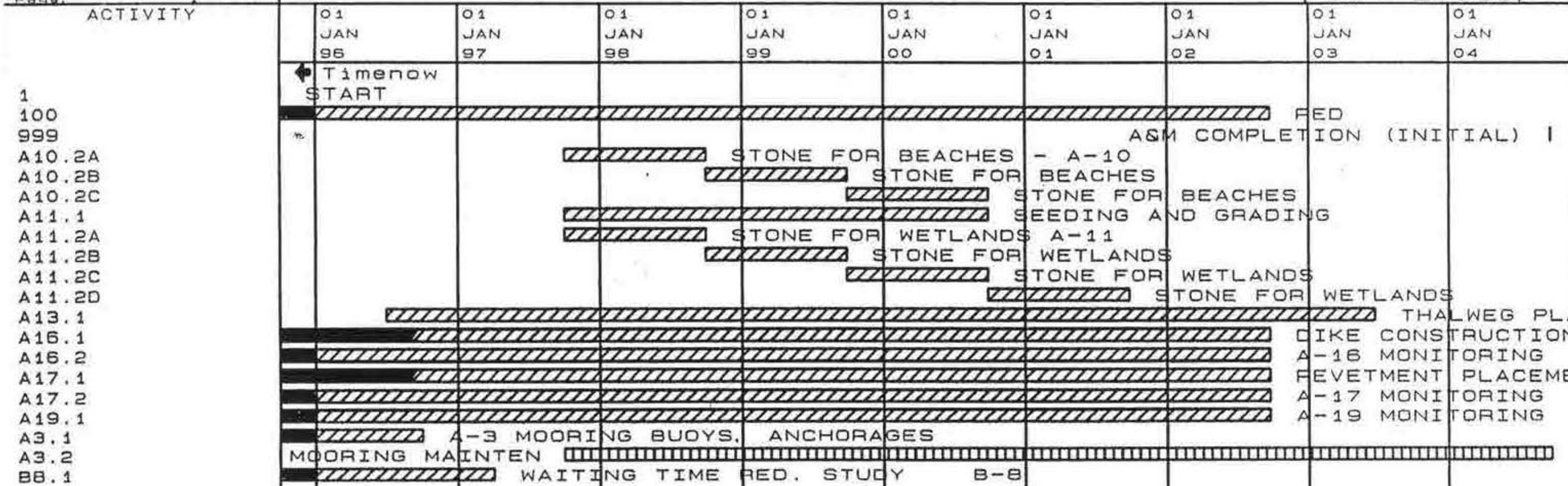
A&M MEASURES

Army Corps of Engineers, St. Louis,



	FY 96		FY 97
A3.1	$122,000	A3.2	$ 42,000
A13.1	$ 88,000	A13.1	$ 96,000
A16.1	$497,000	A16.1	$552,000
A16.2	$132,000	A16.2	$181,000
A17.1	$297,000	A17.1	$309,000
A17.2	$ 62,000	A17.2	$ 71,000
A19.1	$ 86,000	A19.1	$109,000
B8.1	$ 34,000	B8.1	$ 24,000
PED	$ 92,000	PED	$ 114,000
TOTAL:	$1.41 million		$1.498 million

Legend
- In progress
- Planned
- Critical

Bar Chart Key: Early Dates

Signatures
Prep: ____________
Aprv: ____________

placement. **b). Schenimann Chute.** Schenimann Chute, m. 57 to 63, right bank--is a waterway that has been of interest to the Corps and the natural resource agencies for several years. The chute averages about 100 feet in width and has two closure structures which were placed about 40 years ago. It is the opinion of CELMS staff, that the Chute can have increased aquatic diversity by placing stone structures and notching existing dikes in the waterway. St. Louis District staff conducted a channel sweep of the chute and identified several scour holes while mapping the bottom of the Chute. During FY 96, the CELMS river engineering lab will conduct physical modeling to determine the types and location of the proposed structures. Also, CELMS and natural resource agency staff will conduct water quality sampling and biological base line data gathering prior to modification and placement of structures in Schenimann Chute.

Interagency Cooperation. In spite of high water, during the past three years, with resultant personnel constraints, the St. Louis District has continued to work on the A&M program since 1988 and to pursue the eight recommended measures since 1992. During meetings with the natural resource agencies, the program has been discussed and they have cooperated with Corps staff to continue to gather field data, attend discussions and to plan for the future.

APPENDIX A

BLUNTNOSED CHEVRON DIKES

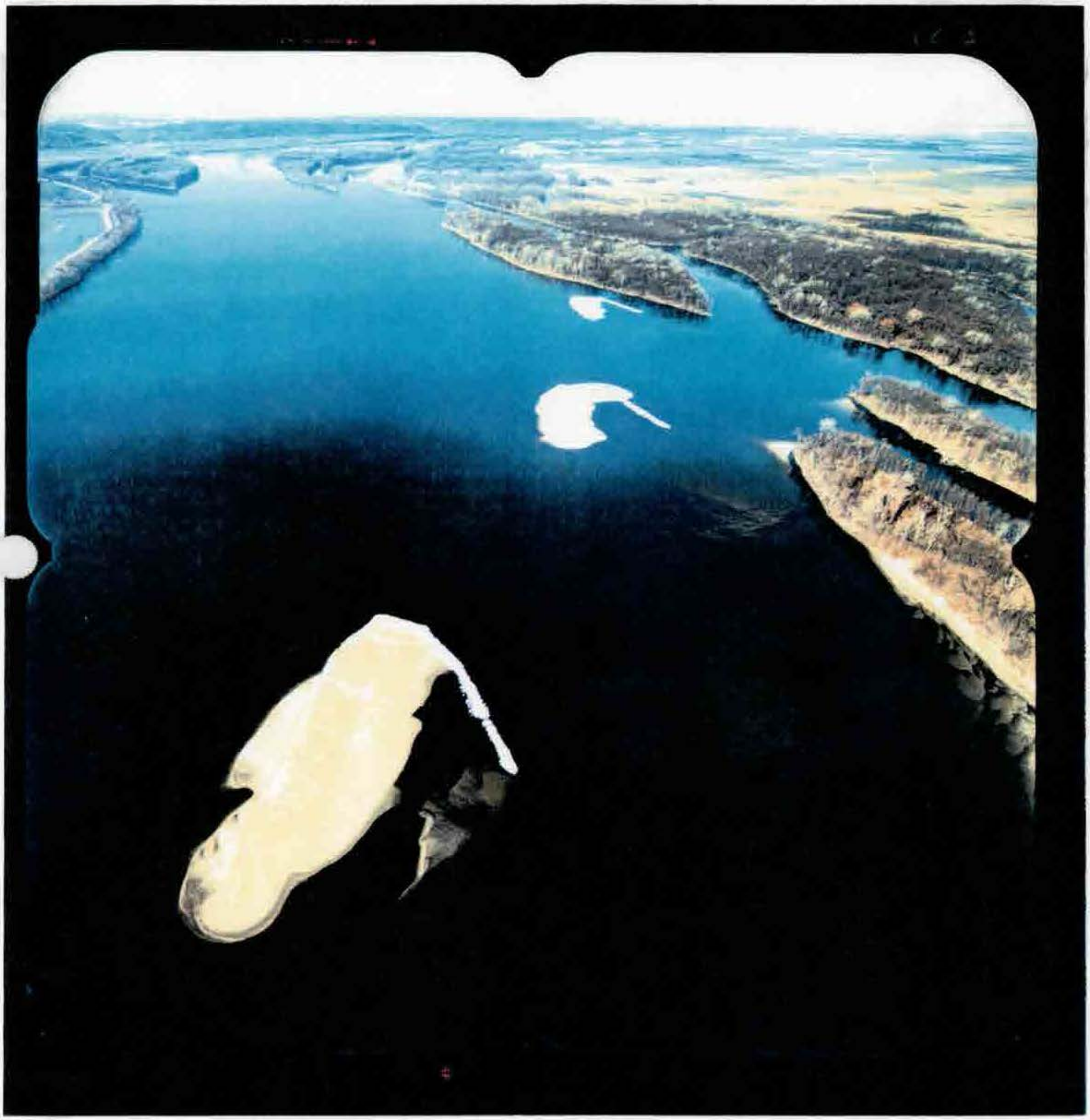
A. Air view of three chevron dikes, Pool 24, mile 289.5, UMR. Construction, Fall-1993, Dredge Material Placement, Fall-1993.

B. Paper-"Design of Blunt Nosed Chevrons".

C. Memorandum-Chevron Dike Fish Sampling.

D. Summary of Contract Report-Macroinverterbrates Study, Fall 1994.

E. Letter Report-Macroinvertebrate Study, Spring, 1995.



DESIGN OF BLUNT NOSED CHEVRONS IN THE MISSISSIPPI RIVER FOR SEDIMENT MANAGEMENT

By Robert D. Davinroy, District Potamologist, Potamology Section, U.S. Army Corps of Engineers, St. Louis, Missouri; Stephen L. Redington, Chief, River Engineering Unit, Potamology Section, U.S. Army Corps of Engineers, St. Louis, Missouri; and Claude N. Strauser, Chief, Potamology Section, St. Louis District Corps of Engineers

INTRODUCTION

Sedimentation in a reach of the Upper Mississippi River (Mile 290.2 to Mile 289.0) has caused depth problems in the navigation channel. Annual maintenance dredging has been performed to maintain a reliable project channel. Historically, the dredge disposal material has been placed in the offside portion of the navigation channel, only later to be reintroduced back into the channel after the next high water season. To address this problem, the St. Louis District has designed and implemented new structures called Blunt Nosed Chevrons which serve as both channel improvement structures and permanent dredge disposal holding areas. The structures also create riverine habitat for a variety of fish species.

Project Location. Figure 1 is a vicinity map. Figure 2 is a plan view hydrographic survey showing the location of the first three Blunt Nosed Chevrons placed in the Mississippi River. The structures are located at the entrance of two major side channels. Construction of chevrons number 4 and 5 is planned in the near future.

Flow Splits. Historic discharge measurements have been taken to determine flow distribution trends (flow splits) between the side channels and the main navigation channel. Table 1 indicates the flow split trends have remained fairly constant, with a slight lowering of flow in the main channel in 1994 and 1995.

Figure 1. Vicinity Map.

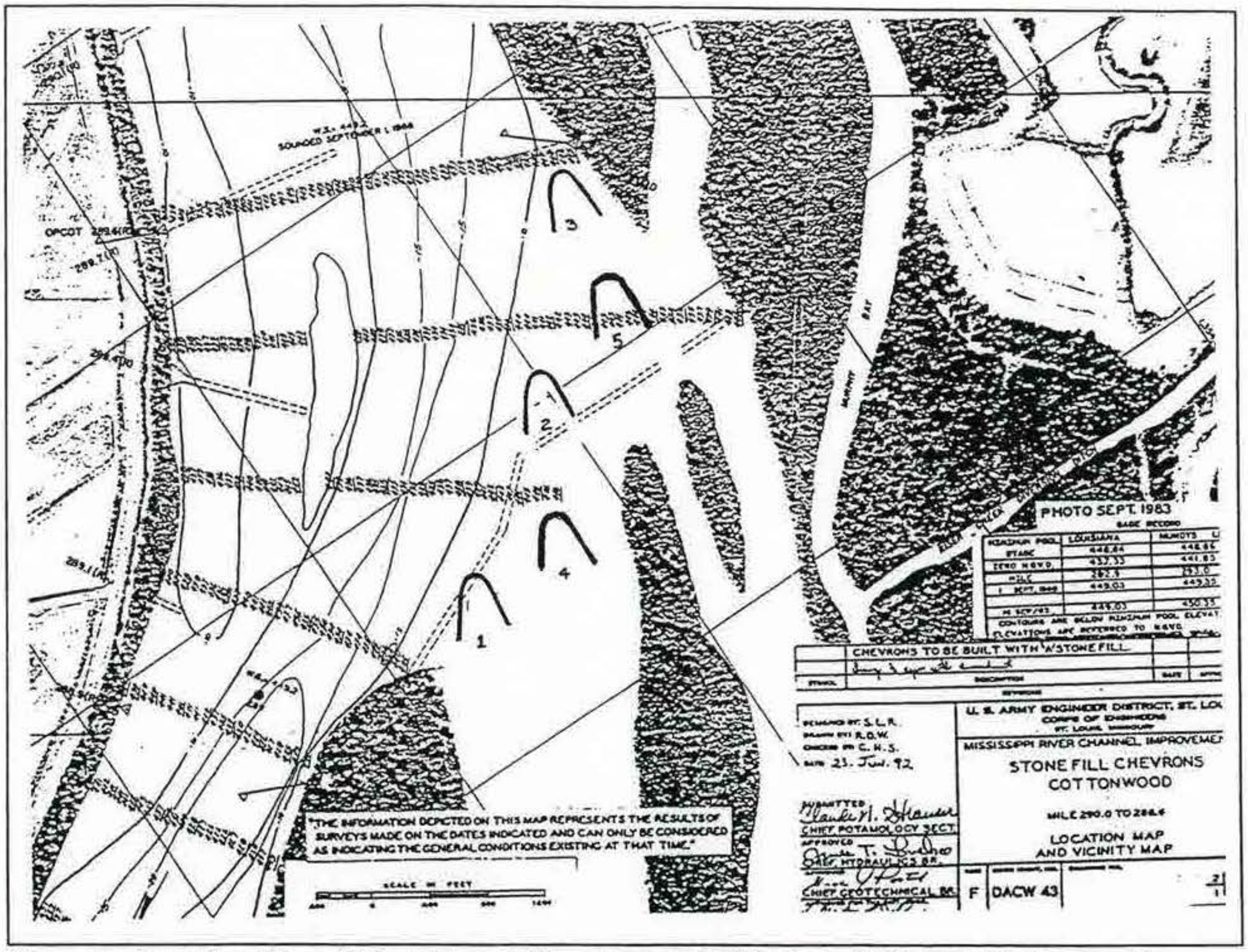


Figure 2. Location Plan of Blunt Nosed Chevrons on the Mississippi River at Cottonwood Island, Mile 289.0

DATE	Main Channel	Boyd-Fritz Side Channel	Fritz- Ill. Side Channel	TOTAL
31 July 1985	53,580 cfs 66%	5,772 cfs 7%	22,049 cfs 27%	81,401 cfs
22 July 1986	75,598 cfs			
3 Sept 1987	71,465 cfs 67%	10,093 cfs 10%	24,726 cfs 23%	106,284 cfs
Chevrons Constructed Fall of 1993				
13 July 1994	61,675 cfs 62%	10,762 cfs 11%	26,397 cfs 27%	98,834 cfs
26 ~~Apr~~ 1995	96,723 cfs 60%	20,863 cfs 13%	42,852 cfs 27%	160,438 cfs
7 June 1995	116,614 cfs 66%	16,329 cfs 9%	43,687 cfs 25%	176,630 cfs

Table 1. Historical Flow Splits at Cottonwood Island during Drawdown Conditions in Pool 24.

DESIGN

Theory. The three structures were placed in the upper end of the side channel as the first phase of an eventual five chevron configuration plan (Figure 2). This plan theorizes that placement of the Blunt Nosed Chevrons will create "added roughness" in the side channel entrance but not significantly reduce side channel flow as compared to a traditional closure structure design. In theory, increasing the n value at the critical entrance area by this method will subtly lower side channel conveyance thereby increasing main channel conveyance. In this particular reach, the problem was threefold. The structures had to encourage manageable side channel deposition for main channel navigation improvement , the structures had to contain dredge disposal material, and the structures had to improve environmental diversity.

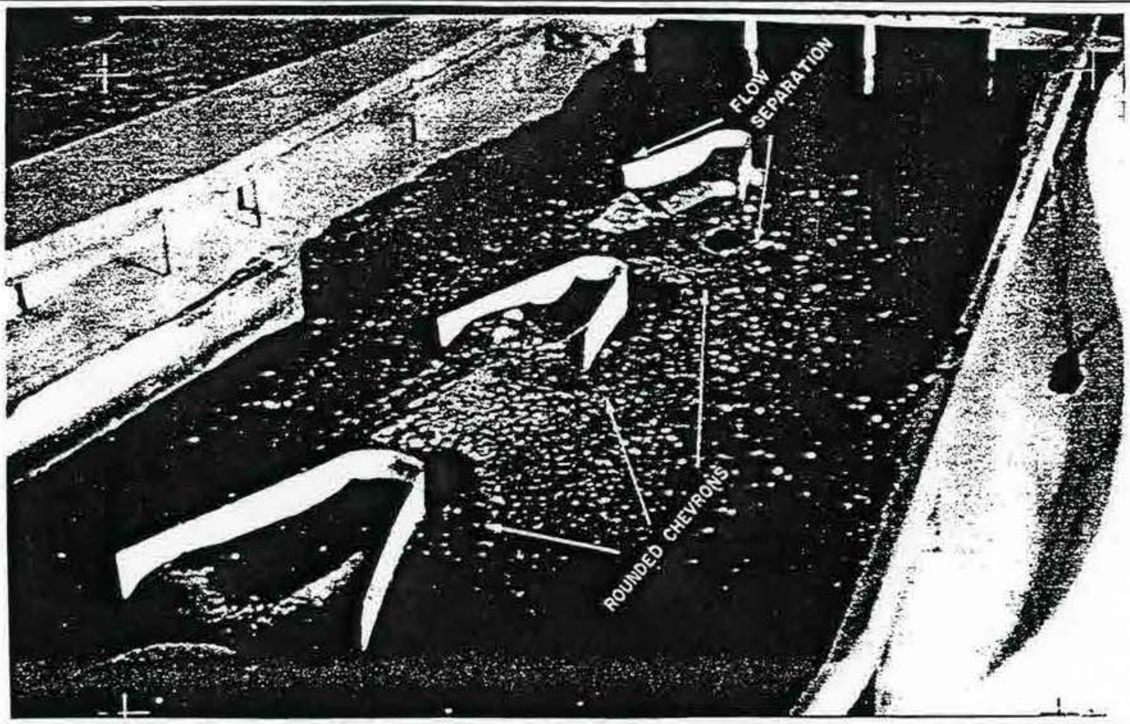


Figure 3. Blunt Nosed Chevrons in the St. Louis Harbor Model at WES

The design was based on movable bed model tests conducted at the Waterways Experiment Station for the St. Louis Harbor Navigation Study of 1986 (2) and from flow conveyance computations using HEC2. Although the model study examined a different reach of river, the study provided a sedimentation information base for the chevron concept. Traditional (pointed nose) and Blunt Nosed Chevrons were both tested in a near straight stretch of the model (Figure 3). The blunt nosed design achieved several important features including:

a. The elimination of excessive scour on the upstream head of the structure. Tests were initially conducted with pointed chevrons. These structures created an excessive amount of upper head scour directly endangering the structural integrity in the prototype. The modified blunt nose shape, although somewhat more complex to build in the prototype, significantly reduced upper head scour. This extends the life of the structure in the river while reducing maintenance costs.

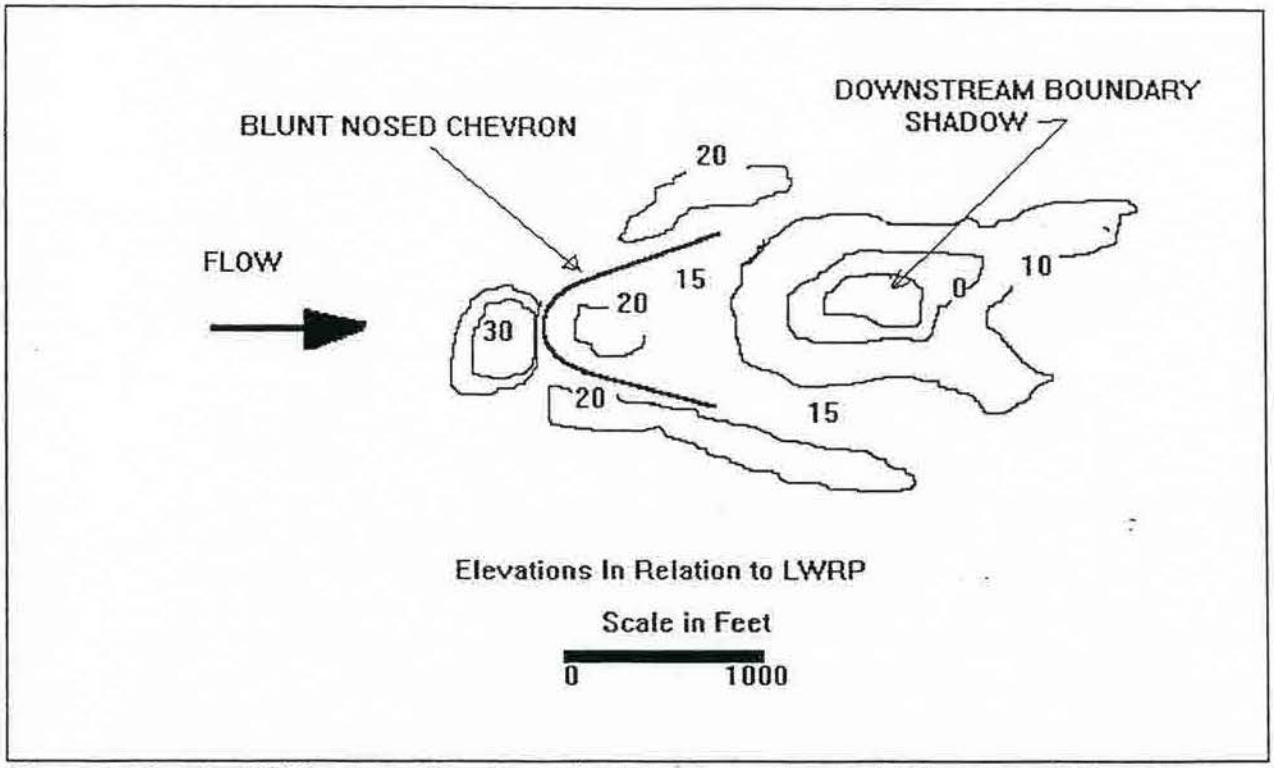


Figure 4. Sketch of Ultimate Bed Configuration Development around Blunt Nosed Chevrons

b. A permanent dredge disposal area within the ordinary high water. The design in the model demonstrated that disposal material placed within the boundary shadow of the structure stabilized (Figure 3). This was a direct result of the chevron boundary effects on the local sedimentation patterns. Placing dredge disposal material in this area will solve the short term dredge disposal problem while accelerating the long term full effect of the structure on the ultimate bed configuration.

c. Creation of habitat diversity. Several important sedimentation patterns resulted from the boundary shape in the model tests. Figure 4 is a schematic indicating the ultimate bed configuration pattern observed around a Blunt Nosed Chevron. This pattern has the potential for serving as excellent habitat for a variety of macro and micro invertebrates, fish, and fauna.

Design Specifications. The Blunt Nosed Chevron design requires the use of standard graded "A" stone or quarry run stone with a maximum top size of 5000 pounds. The typical section is trapezoidal containing the following dimensions:
Height - 2 feet above the maximum regulated pool elevation of Lock and Dam 24 (449.0 msl)
Crown Width - 6 feet
Side Slopes - 1 on 1.5
Bottom Width - Varying with bed topography
Linear Centerline Length - Approximately 1000 feet
Orientation - Angled directly into flow

Construction. Construction began on September 21, 1993 and was completed October 5, 1993. A total of 46,592 tons of stone was used. The method of placement was by floating plant equipment.

Dredging. The Dredge Natchez pumped material into the chevrons during the month of November 1993. A total of 185,959 cubic yards of material was placed on the inside and outside of the chevrons. Much of this material has remained, although some material placed outside the downstream shadow boundary has been carried away. Future dredge material, if needed, will be placed further downstream behind each structure to accelerate development of the ultimate bed configuration. Figure 5 is a photo illustrating the dredge placement within the structures.

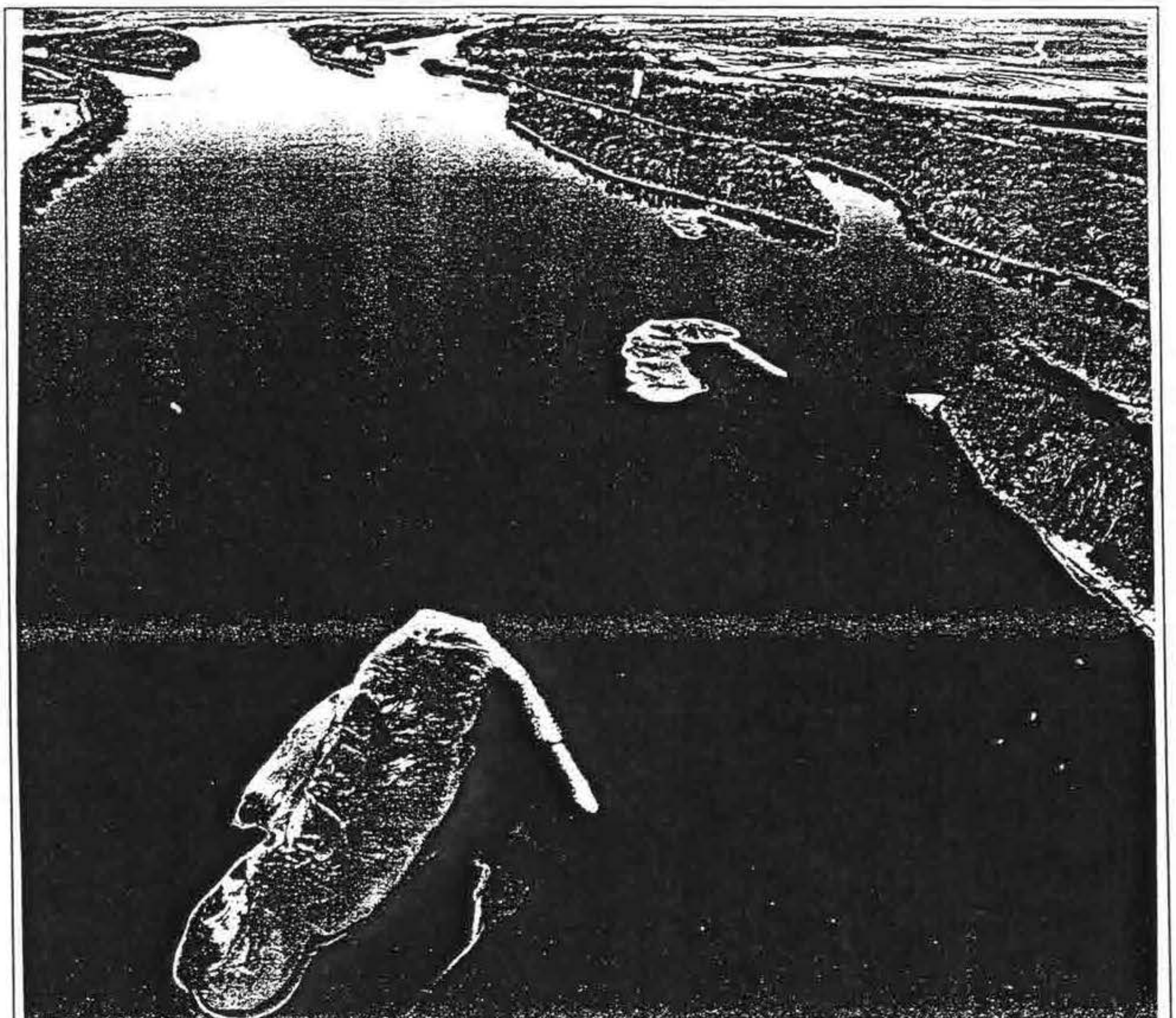


Figure 5. Blunt Nosed Chevrons on the Mississippi River With Placed Dredge Disposal Material, Looking Upstream

MONITORING

Velocity. The velocity patterns around the structures were measured on July 14, 1994 (Figure 6). The graph establishes the fact that the flow pattern is as anticipated. Velocity is smoothly transiting around the structures with no apparent turbulence or excessive velocity occuring at the heads of the structures, thereby ensuring stable, structural integrity. These types of data will continue to be collected on a more intermittent basis as the bed configuration around the structure fully develops.

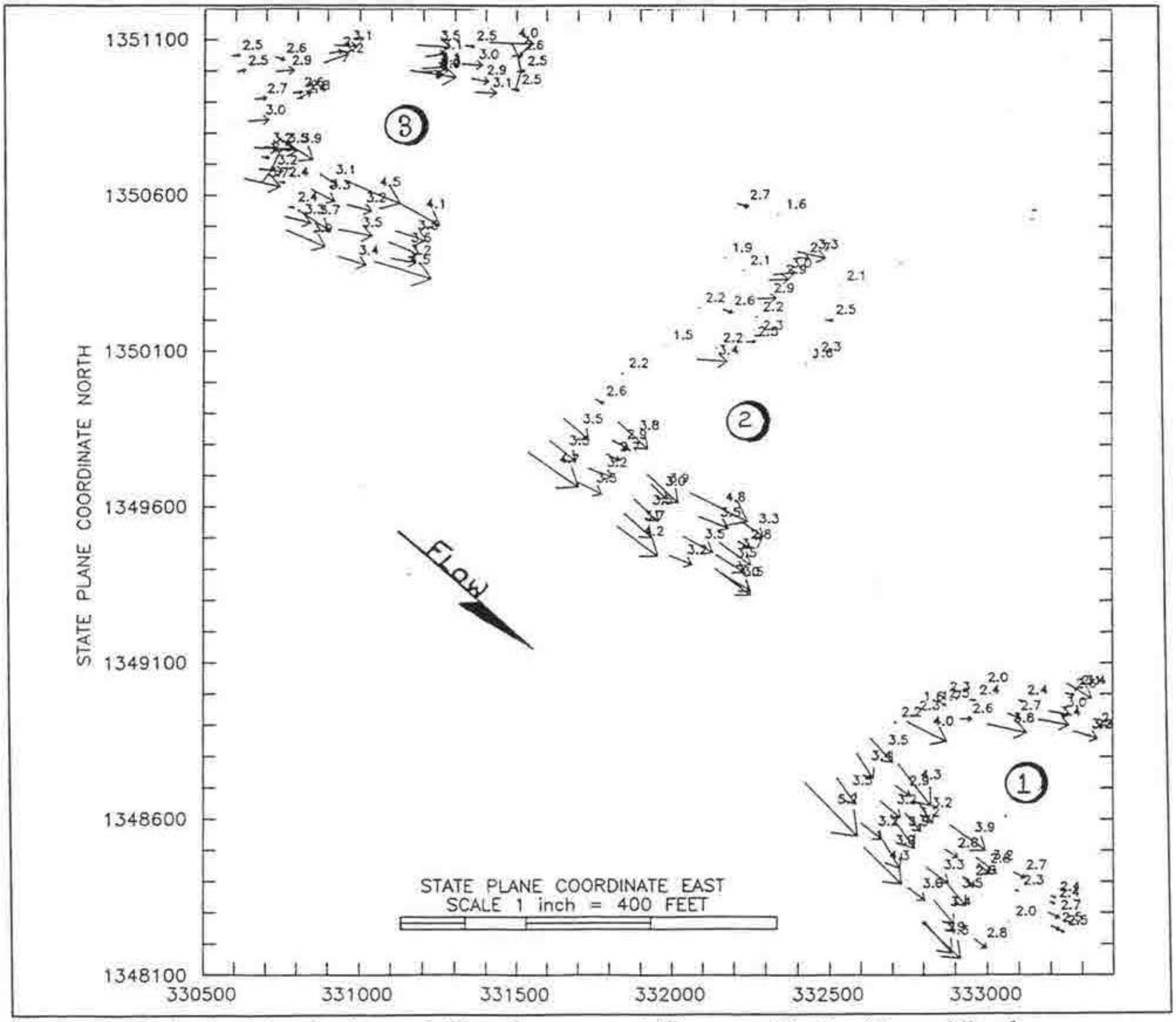


Figure 6. Velocity Magnitudes and Directions around Chevrons During Normal Pool

Water quality. Water quality samples were collected in August, September, and October of 1994 and also in August and September of 1995. A variety of indicators were analyzed. The average results are as follows:

Water temp: 24 degrees Celsius	pH : 8.0
Conductivity : 440(normal)	ORP (Oxygen Reduction Potential): 350 (good)
Silica: 11 mg/liter	Phosphates: 0.2 mg/l
Ortho: 0.1 mg/l	Nitrates: 1.0
Ammonia : less than 0.5	Suspended solids: 40 mg /liter to 10 mg/liter
Volatile SSP: 10 mg/l	Chlorophyll: 50 mg/l
Phenophytin: 6 mg/liter	DO: 10.0 (above average)

Monitoring of this type will continue in the future. The above data indicates that water quality in the chevron fields is excellent and able to sustain aquatic life (Brown 1995).

Macroinvertebrates. A macroinvertebrate study on the three chevrons was prepared in March of 1995 based upon field data collected in November of 1994. A total of 94 taxa were collected in the outside of the structures, 69 taxa were collected on the inside of the structures, and 31 taxa were collected on the surrounding river bed. Invertebrate density was high in the substrate surrounding the chevrons, although species richness and diversity were lower than other areas sampled. Dominant taxa were species generally associated with sandy substrate in large rivers. Diversity and species richness were high on the exterior and interior of the structures. Commonly collected species were those typically associated with fast flowing, rocky streams, and rock or vegetate littoral areas. The high diversity in this area reflected habitat heterogeneity. This is considered beneficial for the development of future fish communities (Miller, T. 1995).

Fish. In August of 1995, an electrofishing study was conducted along both the outside and inside of the middle Blunt-Nosed Chevron. A total of 18 different fish species totaling 199 fishes were reported at a sampling rate of 7.1 fish per minute. These results are above average and indicate that large numbers of fish are utilizing the habitat created by the structure. The data also reveals that the fish community on the inside of the structure is similar to a backwater lake community, while the community on the outside of the structure is similar to a typical river community. Although theses data are by no means conclusive, the early trends indicate these structures are very beneficial to riverine fish communities (Atwood 1995). It was also apparent during the sampling period that the Blunt Nosed Chevron field is serving as a recreational outpost for fishing and boating enthusiast.

CONCLUSIONS

Blunt Nosed Chevrons in the Mississippi River are performing as designed. The structures are reaping the multiple benefits associated with the boundary effects. Chevron design in the future will be modified to create additional environmental diversity. Top elevations may be varied, as well as the addition of notches, changes in lateral slope, etc.

Both engineering and environmental monitoring will continue to quantify the final effects. If favorable trends continue to occur, Blunt Nosed Chevrons may be used in other reaches and in other applications on the Mississippi River.

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Ecological Specialists, Inc., 1995. Macroinvertebrates Associated with Three Chevron Dikes in Pool 24 of the Mississippi River, St. Louis District Project Report, St. Louis, Missouri.

Illinois Department of Natural Resources

Division of Fisheries

Mississippi River Project

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memorandum

To: Rob Davinroy

From: Butch Atwood

Date: Aug 25, 1995

Subj: Preliminary results from Chevron Dike sampling

On August 2, 1995 we finally managed to conduct an abbreviated electrofishing (EF) survey of the upstream-most chevron dike at Cottonwood Island. Our electrofishing unit consists of a 230 volt, 4000 watt, 3 phase generator which energizes 3 - 5/8" steel cable electrodes suspended from 3 booms projecting off the bow of the boat (18' welded aluminum boat). The electrodes are approximately 5' apart, project about 6' off the bow and project into the water about 4' in depth, thus creating an electric field with an approximate diameter of 10' and reaching a depth of about 6'. Typically 6 - 10 amperes of current are generated within this field.

We made 2 - 14min EF runs on this date, one along the outside of the chevron and one along the inside of the chevron. A rough sketch of the sampling runs is attached. Summary results are shown on the attached Table 1. Please note that the EF runs for the inside and outside are separated (Inside Chevron & Outside Chevron). Total number of fish collected by species and length range of these fishes are tabulated. The field sheets for this effort are also attached. In these data the length of each fish collected is given in millimeters and weight is given in grams (i.e. Channel catfish 294-190 is a 294 mm long fish weighing 190 grams, if only one number is shown it is the length of the fish).

The EF run of the inside of the Chevron resulted in the collection of 17 fish species and 130 fishes total (9.29 fish/min) while the EF run along the outside of the Chevron resulted in collection of 9 fish species and 69 fishes (4.9 fish/min). With inside and outside combined 18 fish species and 199 fishes (7.1 fish/min) were collected. These numbers compare very favorably with results from other electrofishing samples we've completed this summer. Typically we sample a site for 60 minutes (2 - 30 min runs), so a 14 min EF run is very short and therefore one would assume would result in the collection of fewer species and, of course, fewer total fishes. In 13 other typical sites that we've sampled so far, the mean number of species collected was 21 and the mean number of fishes collected per minute was 6.15. A brief summary of this data is shown in Table 2. I think the 12 channel catfish and 20 flathead catfish collected from the outside of the chevron are significant also in that this translates to .86 fish/min and 1.4 fish/min, respectively. To put this into perspective the mean number of channel catfish collected per site at those 13 stations I mentioned above was .17 fish/min and the mean flathead catfish catch was .27 fish/min.

A quick look at this chevron data tells me that the fish community on the inside of the chevrons is similar to a community of fishes typically found in a backwater lake, while the community on the outside is a typical river community. Although these data are by no means conclusive, I really think that further sampling and more detailed analysis and comparison with other river sampling sites will show that these structures are very beneficial to riverine fish communities and fish populations.

It's also obvious that these areas are getting used by the public for fishing, duck hunting and relaxing.

I'll keep you informed as our work on these structures continues. If you need further information at this time, please don't hesitate to call (or beep).

cc: B. Bertrand
D. Bruce

Sketch of upper chevron in Cottonwood Is series

CELMS - ED CREW sampled
flow velocity, depth, subst typ
8/1/95 Ed Pelc, Beth Brown
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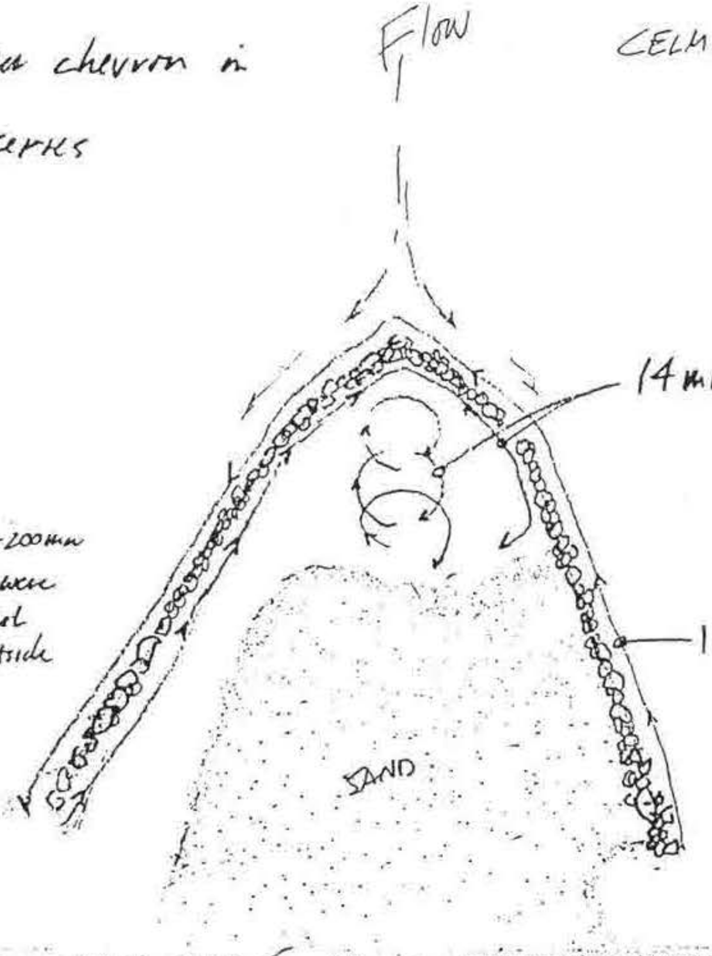


14 min run inside Chevron

Several 150-200mm Flathead catfish were observed but not collected along outside

1 14 min run outside upper Chevron

Amperage 7-10 during both runs

Sampling occurred after morning rain had stopped ~10:30A until Afternoon rain began ~1 pm

Table 1. Composition of fishes collected with electrofishing at Cottonwood Island Chevron Dike on 8/2/95
(two 14 min electrofishing runs were conducted, one inside and one outside the chevron)

	Inside Chevron		Outside Chevron	
Fish Species	total no.	length range (cm)	total no.	length range (cm)
Shortnose gar	1	47	0	
Gizzard shad	51	5 - 31	2	18 - 25
Carp	6	26 - 42	12	24 - 43
Emerald shiner	12	3 - 4	2	3 - 4
River shiner	12	5 - 7	0	
Spotfin shiner	1	5	6	5 - 8
Spottail shiner	4	5 - 6	0	
Bullhead minnow	4	5 - 6	0	
Quillback	5	7 - 23	0	
River carpsucker	2	12 - 25	0	
Smallmouth buffalo	6	22 - 27	6	24 - 30
Golden redhorse	1	27	0	
Channel catfish	3	29 - 45	12	31 - 47
Flathead catfish	0		20	19 - 47
White bass	8	6 - 18	1	21
Bluegill	3	4 - 14	0	
Largemouth bass	8	6 - 26	0	
Freshwater drum	3	6 - 8	8	23 - 36
no. species collected	17		9	
total no. fish collected	130		69	

Cottonwood I.

Station CHEVRON OUTSIDE Pool 24 2 AUG 1995

Habitat Type Chevron dikes / MCB Air Temp.

Water Depth: Water color Grn/Brn Water Temp. 82°

Range Wx – 100% Cloud cover / T Storms

Secchi 1.5" ALK 171

Ave. Water level – normal; no aquatic veg

Shoreline type 100% rip rap

Ph 7.9 COND 490

12:40 Am

11:10 UPPER 14 min

CHANNEL CATFISH	FLATHEAD CATFISH	FRESHWATER DRUM	CARP
465-800	325-335, 370-525	234-150	345-540
422-610	465-1110	231-150	425-1070
436-665	210-90	238-155	281-340
325-235	394-610	256-200	347-595
377-370	240-130	245-185	382-810
334-265	270-215	360-585	331-475
363-350	240-150	317-460	380-735
419-650	212-110	250-175	238-200
365-375	350-430		330-525
306-225	290-235		382-730
470-810	265-180		338-570
421-495	194-70		315-500
	198-80		
	383-595		
	233-115		
	222-115		
	258-190		
	265-185		
	204-85		
(12)	(20)	(8)	(12)

SMALLMOUTH BUFFALO	EMERALD SHINER	SPOTFIN SHINER	GIZZARD SHAD
270-290	36	66	248
271-280	42	55	180
288-335		54	
252-245		79	
303-400		65	
242-200		66	
(6)	(2)	(6)	(2)

WHITE BASS			
214-105			
(1)			

Sketch over

Station CHEVRON - INSIDE Pool 24 2 AUG 1995

Habitat Type Chevron dike / MCB Air Temp. 81 11 4

55E 2 MPH

Water Depth: Water Temp. 82

Range ALK 188

Secchi 5

Ave. COND 473

UPPER 14/ 11 30 Ph 8.0

140

CHANNEL CATFISH	CARP	BLUEGILL	WHITE BASS
294-190 452-750 319-255 (3)	262-270 421-1150 357-570 360-635 305-385 373-630 (6)	136-65 36 144-60 (3) EMERALD SHINER 42 42 35 37 40 35 40 35 27 40 43 40 (12)	172-50 85 80 95 75 182-70 55 65 (8)
LARGEMOUTH BASS	SHORT ~~LONG~~NOSE GAR	FRESHWATER DRUM	GIZZARD SHAD
255-260 76 62 100 74 186-90 210-115 65 (8) ~~GOLDEN REDHORSE~~ 271-210 (1)	471-275 (1) BULLHEAD MINNOW 60 60 60 49 (4)	82 84 65 (3) SPOTFIN SHINER 45 (1)	181 254 185 186 233 77 270 293 76 226 220 84 185 164 85 57 311 90 281 190 75 229 80 291 211 77 299 173 85 185 81 75 99 85 83 82 96 70 80 84 72 70 55 76 286 70 230 303 232 228 175 (51)
SMALLMOUTH BUFFALO	RIVER CARPSUCKER	SPOTTAIL SHINER	RIVER SHINER
215-130 266-275 256-230 260-225 270-270 233-175 (6)	250-190 124 (2) QUILLBACK 225-140 70 166-55 74 80 (5)	56 55 60 51 (4)	65 63 66 61 60 62 54 50 50 62 65 65 (12)

Macroinvertebrates Associated with Three Chevron Dikes in Pool 24 of the Mississippi River

Prepared for:

Harland, Bartholomew and Associates, Inc.
Chesterfield, Missouri

Under contract to:

U.S. Army Corps of Engineers
St. Louis District

Prepared by:

Ecological Specialists, Inc.
St. Peters, Missouri

4.0 Summary

1. Three Chevron dikes were constructed along the outside bend near Mississippi River Mile 289.5. Their purpose was to divert flow into the thalweg, reducing the need for dredging and therefore the need for open water dredge material disposal, create islands with dredge material, and create habitat for invertebrates and fish.

2. Macroinvertebrates, including unionids, were sampled in the river bed surrounding dikes. Macroinvertebrates were also sampled on the exterior dike face, on the interior dike face, and within the substrate behind the dike structures.

3. Principal Component Analysis was used to analyze similarities between samples and species. PCA axes generated by the analysis correlated with sample position (surrounding, exterior, and interior), but not with substrate, depth, dike, or method.

4. No unionids were collected, as this group of animals generally cannot survive in unstable substrate.

5. Invertebrate density was high in the substrate surrounding dikes, although species richness and diversity was lower than other areas sampled. Dominant taxa were species generally associated with sandy substrate in large rivers.

6. Diversity and species richness was high on the exterior of the dikes. Commonly collected species were those typically associated with fast flowing, rocky streams, and rock or vegetated littoral areas. The high diversity in this area reflects habitat heterogeneity.

7. Diversity and species richness were also high in the dike interior. Although burrowing species were most abundant, species collected on the dike exterior were also common.

Interim Report
Initial Results of the Spring 1995 Sampling

Spring and Fall 1995 Monitoring of Macroinvertebrates and Mussels Associated with Three Chevron Dikes, Pool 24, Mississippi River

As noted in the previous progress report, sampling for the Spring Sampling period occurred in June 1995 due highwater inhibiting the placement of the rock baskets. The Ponar samples were collected June 14, 1995 and the rock baskets placed on station June 14, 1995 and retrieved on July 14, 1995. The initial results of the sampling analysis is provided below.

PONAR SAMPLES. For the Ponar samples, the taxa collected in the samples were similar to those found during the 1994 sampling events. Dipteran larvae and oligochaetes are the dominant organisms. The average benthic invertebrate density was considerably lower than the Fall 1994 samples, at 1,495 organisms/m^2 vs 3,153 organisms/m^2 for the Fall 1994 sampling. A possible explanation for this change in densities could be that the high spring flows scoured and shifted sediments, therefore changing the amount of organisms surrounding and within the dikes.

Preliminary indications from the Fall 1995 samples indicate that the benthic fauna densities increased through the summer and resulted in higher densities in the Fall 1995 samples.

ROCK BASKETS. For the rock baskets, the invertebrate densities are higher for the Spring 1995 sampling event than for the Fall 1994 sampling. The 1994 densities were 1,025 organisms/m^2 and the Spring 1995 densities are 27,440 organisms/ m^2, excluding oligochaetes and chironomids. The substantial difference between the two sampling events is likely due to: (1) greater drift of animals in high flow; (2) more animal movement in warmer water; and (3) the aging of the dike structures, making them more attractive habitat for aquatic invertebrates. Taxa present were similar for both sampling events, with a very high proportion of caddis flies dominating the samples. The Fall 1995 rock baskets appear to have densities similar to, or more than, the Spring 1995 samples.

APPENDIX B

BENDWAY WEIR BIOLOGICAL SAMPLING

A. Executive Summary-Contract Report, Hydroacoustic Surveys of Fishes, Fall 1994.

B. Fact Sheet-Deep Water Fish Sampling, Fall 1995.

C. Table of Preliminary Data, Fish Sampling, Fall 1995.

D. Photos of Fish Sampling Activity, Fall 1995.

RESULTS OF AUGUST 1994 HYDROACOUSTIC SURVEYS OF FISHES IN FOUR RIVER BENDS OF THE MIDDLE MISSISSIPPI RIVER (RM 2-50)

Prepared For:

U.S. Army Corps of Engineers
St. Louis District
1222 Spruce Street
St. Louis, Missouri 63103-2833

By

Richard L. Kasul and John A. Baker
Environmental Laboratory
USAE Waterways Experiment Station
Vicksburg, Mississippi 39180-6199

May 12, 1995

EXECUTIVE SUMMARY

Hydroacoustic surveys of fishes were conducted in August 1994 in four river bends of the Middle Mississippi River between Cario, Illinois and Cape Girardeau, Missouri (RM 2-50). Two of the bends had underwater weir fields constructed along their outer bank to scour a wider channel for river navigation. The other two bends were control areas that did not contain weir fields. The bendway weirs added bottom structure in the channel and caused turbulent water flows nearby. This study examined whether the presence of the underwater weirs affected the abundance and distribution of fishes in bendways.

In river bends the navigation channel is generally found near the outer bank of the bend. Acoustic surveys in this region of river bends showed that fish density was on average twice as high where bends contained weir fields (948 fish/ha) than where they did not (441 fish/ha). In addition, in bends where weirs were present, fish were 5x more dense in the weir fields than in the lotic sandbars and channel habitats associated with the inside bank, while in bends without weirs, more fish were generally associated with the inside portion of the bend.

Many fish acoustically detected in weir fields were found near the weir structures, sometimes concentrated on the downriver side of the weirs. Other fish were found in the channel between

weirs or in open-water above the weirs. Some of these fish may have utilized open-water refugia from high flows that are associated with eddies, upwellings, and other turbulent conditions in the weir fields.

The results suggest that bendway weirs provide suitable protection from strong water currents in the main channel and that fish respond with increased utilization of channel habitats containing weirs.

INTRODUCTION

Bendway weirs were first installed in river bends of the Middle Mississippi River in the early 1990's. They were designed to increase the effective width of the navigation channel by causing scouring of the river bottom along the outer edge of the weirs. The wider navigation channel will help to reduce the hazards associated with river navigation in bendways.

Bendway weirs alter the physical environment of the river channel in at least two ways. They add bottom structure and relief in the channel thalweg. They also induce complex flow patterns containing visible upwellings and eddies. Structures in rivers typically create velocity shelters that can be beneficial for fishes, although the effects of underwater weirs in high flow channels of large rivers like the Mississippi River are poorly understood.

This report presents the results of hydroacoustic surveys of fishes in four bendways on the Middle Mississippi River that were conducted from 22-26 August 1994. The objectives of the study were to determine whether bendway weirs affect fish abundance in river bends and to document the spatial utilization of weir fields by fishes. The first objective was addressed by comparison of fish density and size distribution in bends with and without weirs. The second was addressed by mapping the distribution of fish detections within weir fields.

A previous hydroacoustic survey of these four bendways was conducted from 17-20 November 1992. Results of that survey were presented in a report to the St. Louis District, Corps of Engineers dated 30 April 1994 and titled "An Acoustic Survey Of Fishes In Four Bendways Of The Middle Mississippi River".

STUDY AREA

This study focused on four river bends of the Middle Mississippi River between River Miles (RM) 2 and 50 (Figure 1). Dogtooth (RM 22.2-24.5) and Price (RM 29-31) Bends contained bendway weir fields constructed in the early 1990's. Greenfield (RM 2-4) and Cape (RM 48-50) Bends were controls that did not contain bendway weirs.

The weir fields in Dogtooth and Price Bends contain 8 and 13 weirs, respectively. In both bendways, the weirs extended approximately 100-230 m into the river channel from the outside bank at an angle of approximately 30° upstream. The presence of the submerged weirs was indicated by eddies and upwellings on the surface.

U.S. Army
Corps of Engineers
Saint Louis District

Fact Sheet

ANOTHER FIRST FOR ST. LOUIS DISTRICT

DEEP-WATER FISH SAMPLING TAKEN TO NEW DEPTHS

The success of the Bendway Weir as an innovative and cost effective means to maintain a safe and dependable navigation channel on the Mississippi River has been well documented. The weirs significantly improve navigation conditions around bends by creating desired navigation channel dimensions. There are over 100 of these structures in 13 bends of the Mississippi River.

The effects the weirs were having on the aquatic environment were unknown. Of particular concern was what effect the weirs were having on the pallid sturgeon. The pallid sturgeon is an endangered fish species, and thus is protected under the Endangered Species Act. Until such effects could be identified and quantified, conservation groups were hesitant to fully support Bendway Weirs.

In 1994 representatives of the St. Louis District, Lower Mississippi Valley Division, Waterways Experiment Station, U.S. Fish and Wildlife, Long Term Resource Monitoring Stations, the Missouri Department of Conservation, the Illinois Department of Natural Resources, and Southern Illinois University began developing plans to sample the number and type of fish using the Bendway Weir habitat. This data would be essential in determining the environmental assessment of the bendway weirs.

There was only one major obstacle. Sampling in a deep water and high velocity environment had never before been accomplished. Conventional sampling techniques such as electro-fishing and netting has been limited to depths generally less than 20 feet and velocities below 2 to 3 feet per second. In a Bendway Weir field, depths can exceed 50 feet, and velocities can exceed 6 feet per second.

A committee was formed consisting of representatives of the aforementioned agencies and groups. The committee was labeled the Deep Water Sampling Group. Numerous meetings were held to develop different techniques to sample the deep, fast water environment. The final list of methods to be used included blasting, shocking, gill netting, trammel netting, trotlining, and hoop netting.

In order to accomplish these tasks in the deep, swift water, special techniques would have to be utilized. The placing of the charges for the blast, weighting for the nets, and the anchoring of the trotlines would be done using conventional buoy blocks from the M.V. Pathfinder. The Pathfinder would also assist in collecting the nets. For the blast, each agency provided at least one catch boat to capture fish after the charge was detonated. In the fast water, fish could surface many hundreds of feet downstream, so several boats would be required to sufficiently cover the area.

The highlight of the sampling occurred on 19 September 1995 when a 300 foot section over a Bendway Weir field was blasted. Preparation for the blast(placing charges and catch nets), took approximately 6 hours. When the blast was set off, the results were immediately apparent. Many fish began surfacing. In all, 217 fish were captured. There were 75 fresh-water drum up to 20 lbs, 58 gizzard shad, 24 blue catfish up to 35 lbs, and numerous other species, including one sturgeon. A total of 13 different fish species were collected.

The other collection methods resulted in lesser catch rates. The method with the most promise consisted of rigging an electro-shocker on the bow of the M.V. Pathfinder. This shocker could be lowered to depths exceeding 40 feet, and a charge induced through the electrodes to stun fish. A specially designed catch net then captures the fish. This worked exceptionally well when stationary. Further modifications will be required to allow more maneuverability. This procedure has potential for extended use in the future.

The other methods were not as productive. The initial consensus was that the velocity and sediment movement in the bends cause the nets to move too much, and the trotlines and hoop nets had a tendency to become silted over. These methods will be re-evaluated and modifications will be made before they are tested again. One significant catch was made in the nets consisting of a sturgeon.

In summary, the representatives of the environmental community were very excited about the results. The fact that sturgeon were collected is evidence that sturgeons inhabit the bendway weir environment. The results of the activities will be prepared into professional papers, and the methods will be further analyzed and refined to minimize complications. The sampling event was a major breakthrough in both the engineering and environmental worlds. It was proven that many species and numbers of fish, including sturgeon, utilize Bendway Weirs as habitat, and it was demonstrated that fish sampling in deep, fast flowing water can be accomplished. Environmental and conservation groups are now more confident that Bendway Weirs are not just valuable for navigation purposes, but are favorable as aquatic habitat also.

BENDWAY WIER SAMPLING 1995 - PRELIMINARY DATA

Blasting

Catch Nets

58 gizzard shad
2 skipjack herring
24 blue catfish
3 channel catfish
4 flathead catfish
1 goldeye
2 freshwater drum
2 stonecat
2 freckled madtom
1 sturgeon (presumed to be shovelnose - too small to ID positively)
(length range 30mm - 185mm)

Chase Boats

75 freshwater drum
11 carp
6 smallmouth buffalo
9 flathead catfish
12 blue catfish
2 channel catfish
2 goldeye
1 gizzard shad
(length range 125mm - 960mm)

Trotlines

1 blue catfish - 582mm

Gill Nets

1 gizzard shad - 190mm
1 carp - 653mm
1 paddlefish - 233mm
1 sturgeon, possible pallid x shovelnose hybred, 792mm

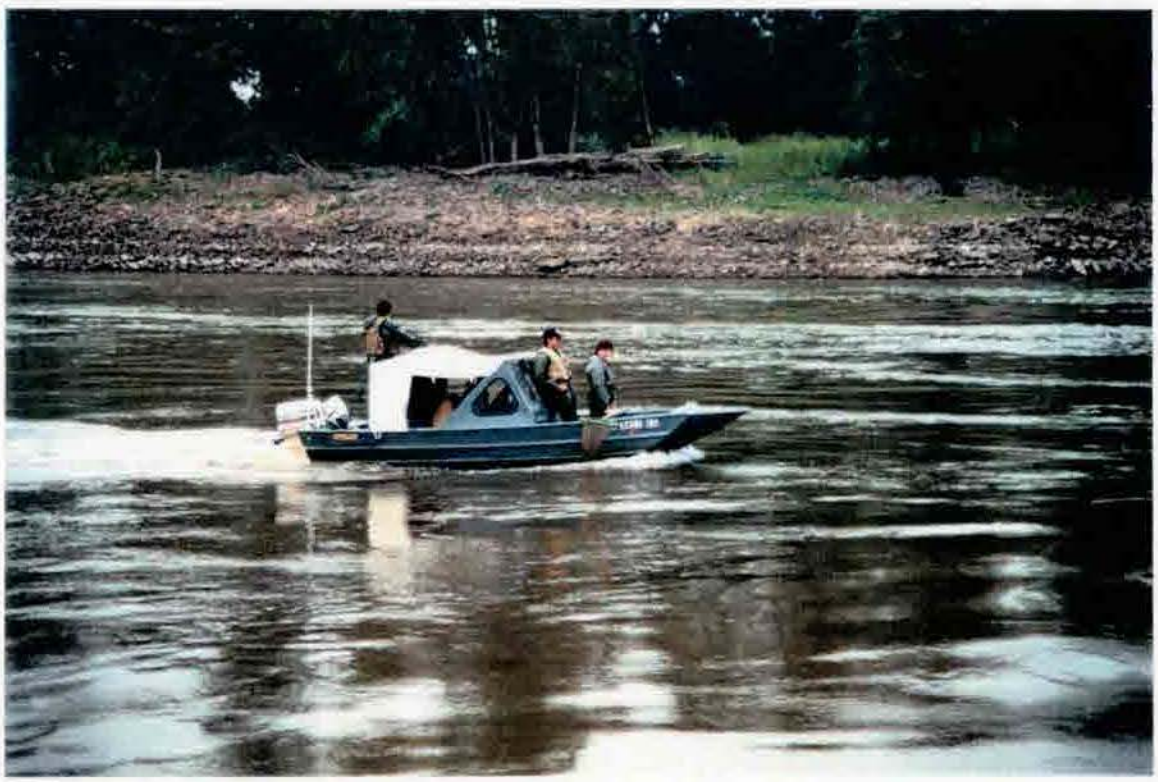
Hoop Nets

3 flathead catfish - size range 242mm - 408mm
2 blue catfish - size range 381mm - 440mm
1 channel catfish - 688mm

Safety meeting held prior to the blast.

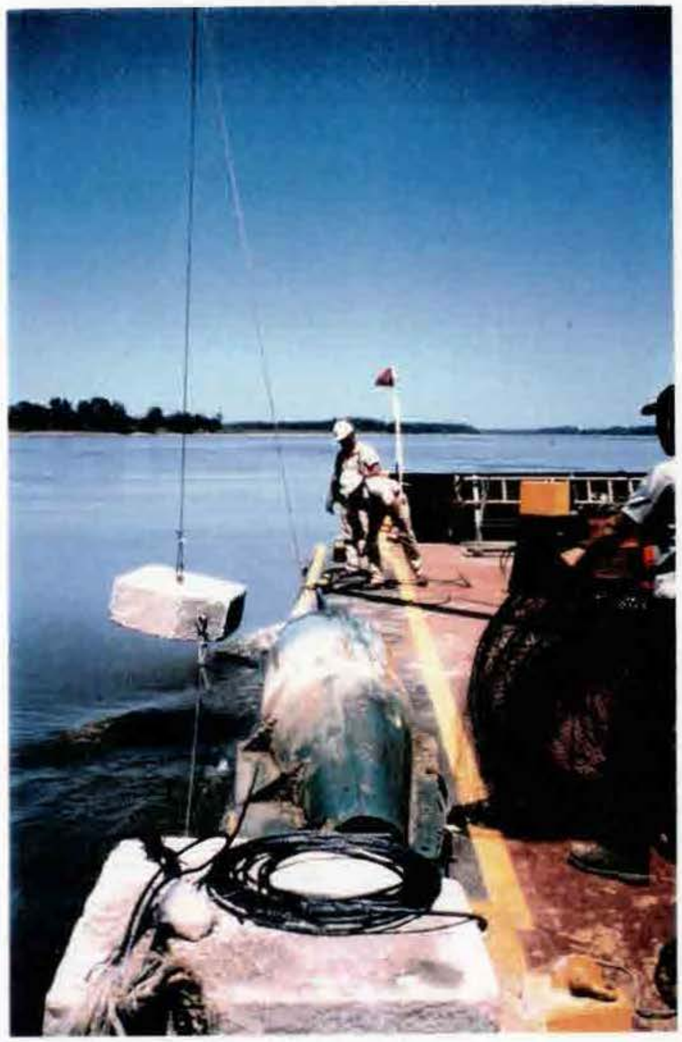
Buoys used to place explosive charges and
to mark locations of hoop nets used to harvest fish.

Catch boats deploying prior to the blast.



A catch boat crew searching for fish.

Deploying hoop net.

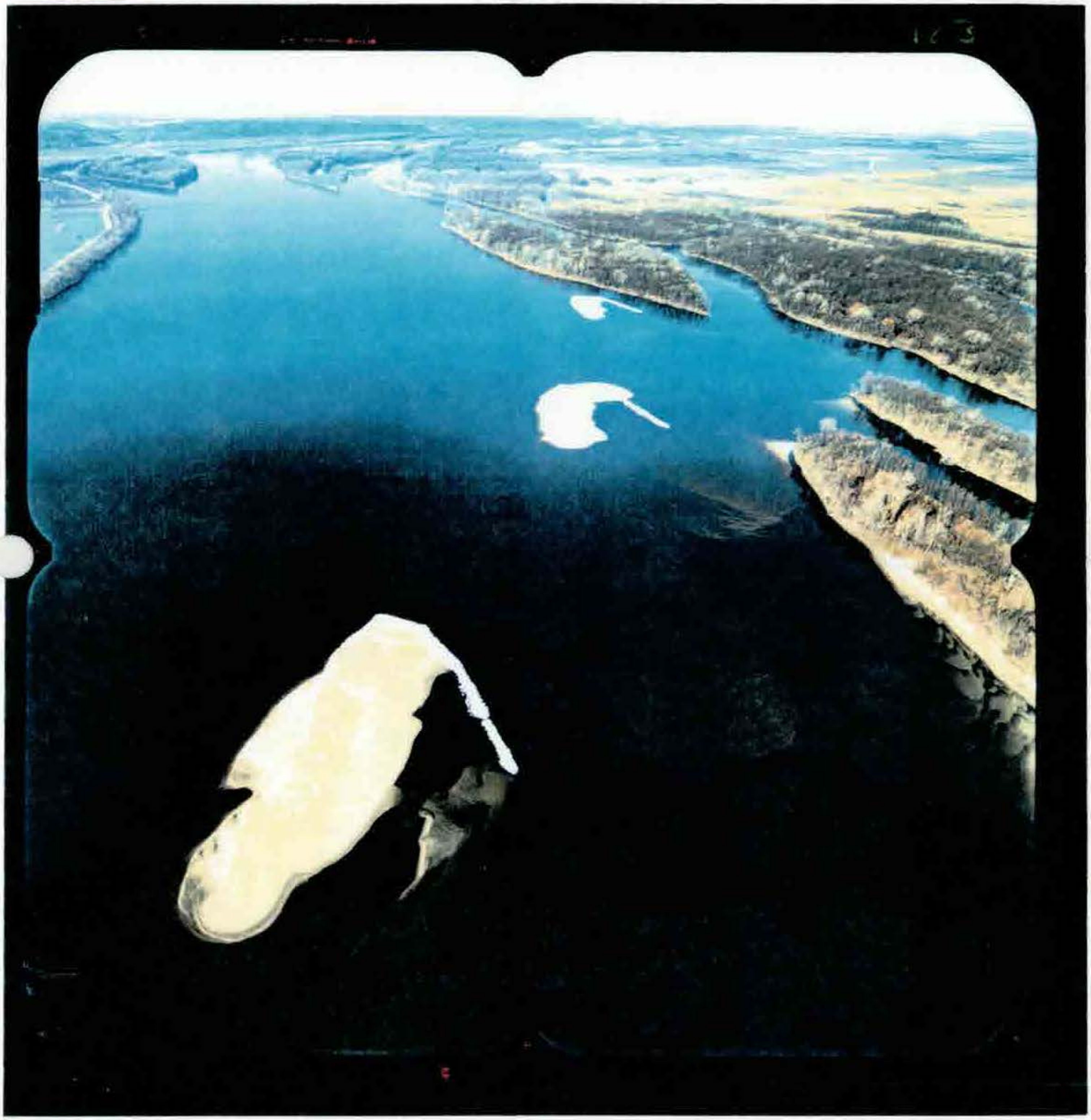


Placing buoy to mark net location.

Attaching hoop net to buoy cable.

All fish were identified and separated by species.

Each fish was measured to the nearest millimeter.



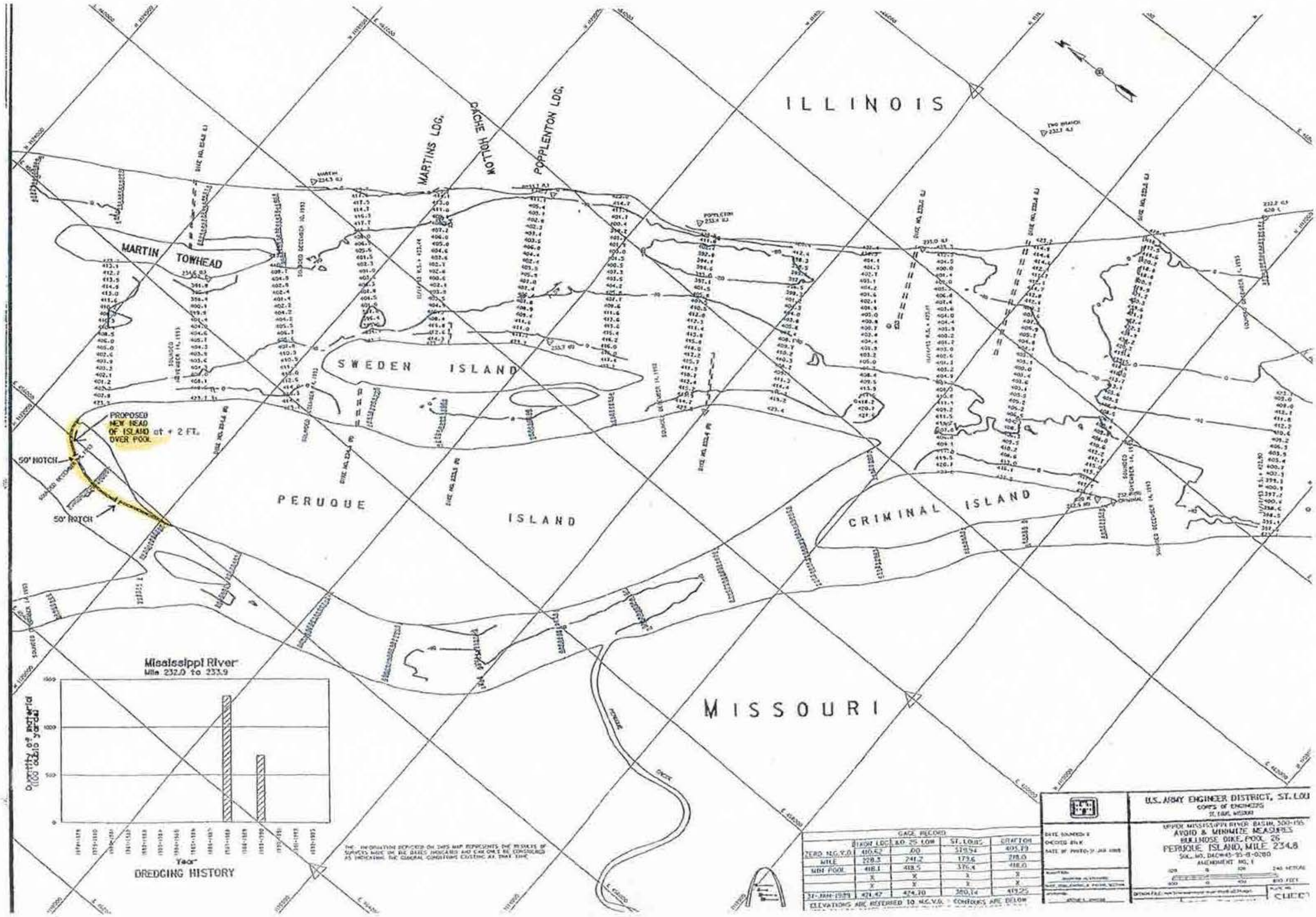
APPENDIX C

LOCATION MAPS OF CONTRACT ROCKWORK

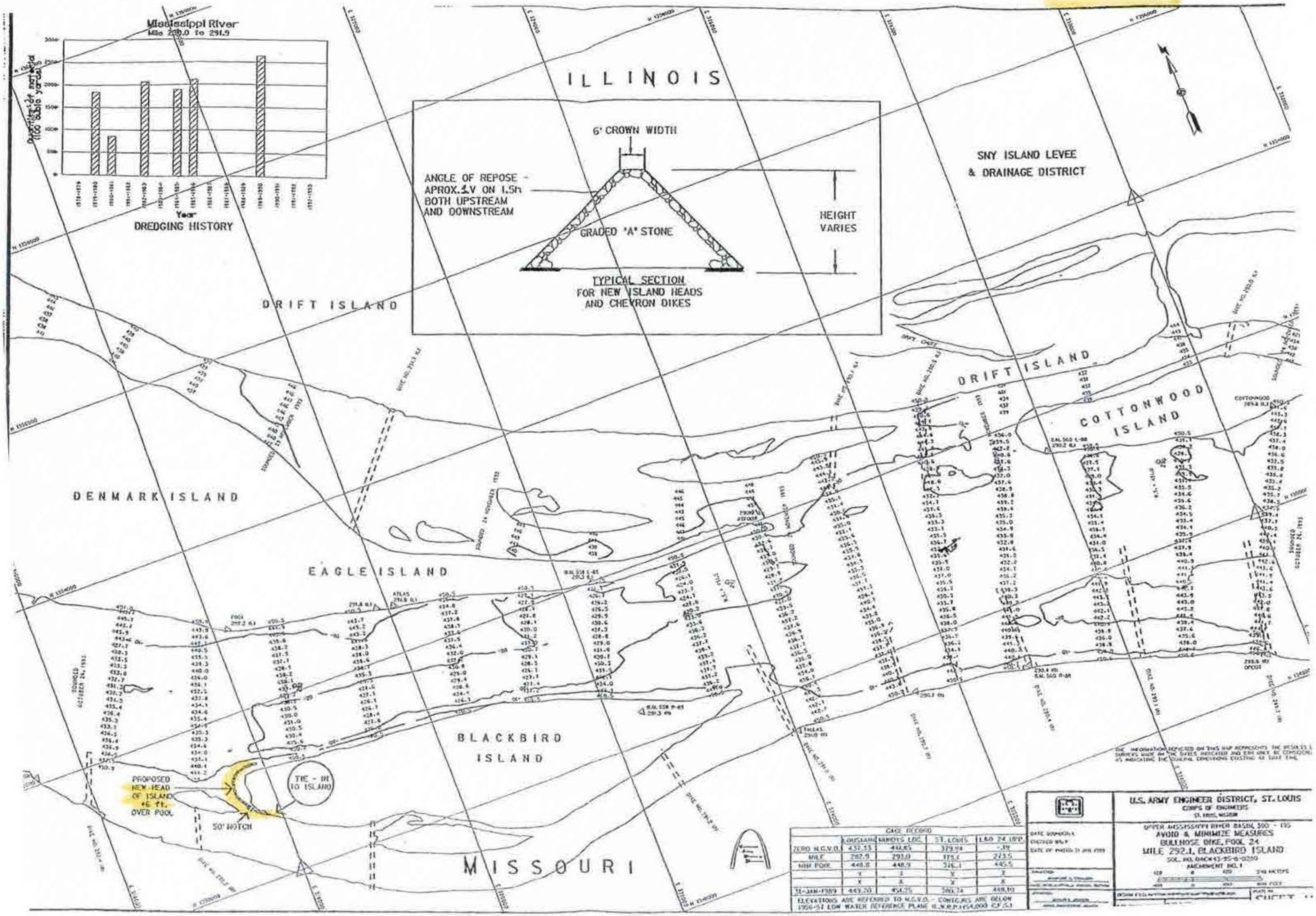
POOLS 24, 25 AND 26

SPRING 1996

Pool 24	Bullnose Dike, Blackbird Island, Mile 292.1 (R).
Pool 24	Bank Anchor Protection, Clarksville Refuge, Mile 275.1 (R).
Pool 25	Bullnose Dike, Slim Island, Mile 267.0 (R).
Pool 25	Multiple Round Point Structures with Bank Revetment, Mile 265.7 (L).
Pool 25	Five Small Chevron Dikes, Mile 250.2 (L).
Pool 26	Bullnose Dike, Peruque Island, Mile 234.8 (R).


ILLINOIS
MISSOURI
MARTIN TOWHEAD
SWEDEN ISLAND
PERUQUE ISLAND
CRIMINAL ISLAND
MARTINS LDG.
CACHE HOLLOW
POPPLENTON LDG.
PROPOSED NEW HEAD OF ISLAND at + 2 FT. OVER POOL
50' NOTCH
50' NOTCH
Mississippi River
Mile 232.0 to 233.9
Quantity of material (100 cubic yards)
Year
DREDGING HISTORY
GAGE RECORD
ZERO N.G.V.D.
MILE
MIN POOL
ELEVATIONS ARE REFERRED TO N.G.V.D. - CONTOURS ARE BELOW
U.S. ARMY ENGINEER DISTRICT, ST. LOU
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
AVOID & MINIMIZE MEASURES
BULLNOSE DIKE, POOL 26
PERUQUE ISLAND, MILE 234.8
AMENDMENT NO. 1
SHEET

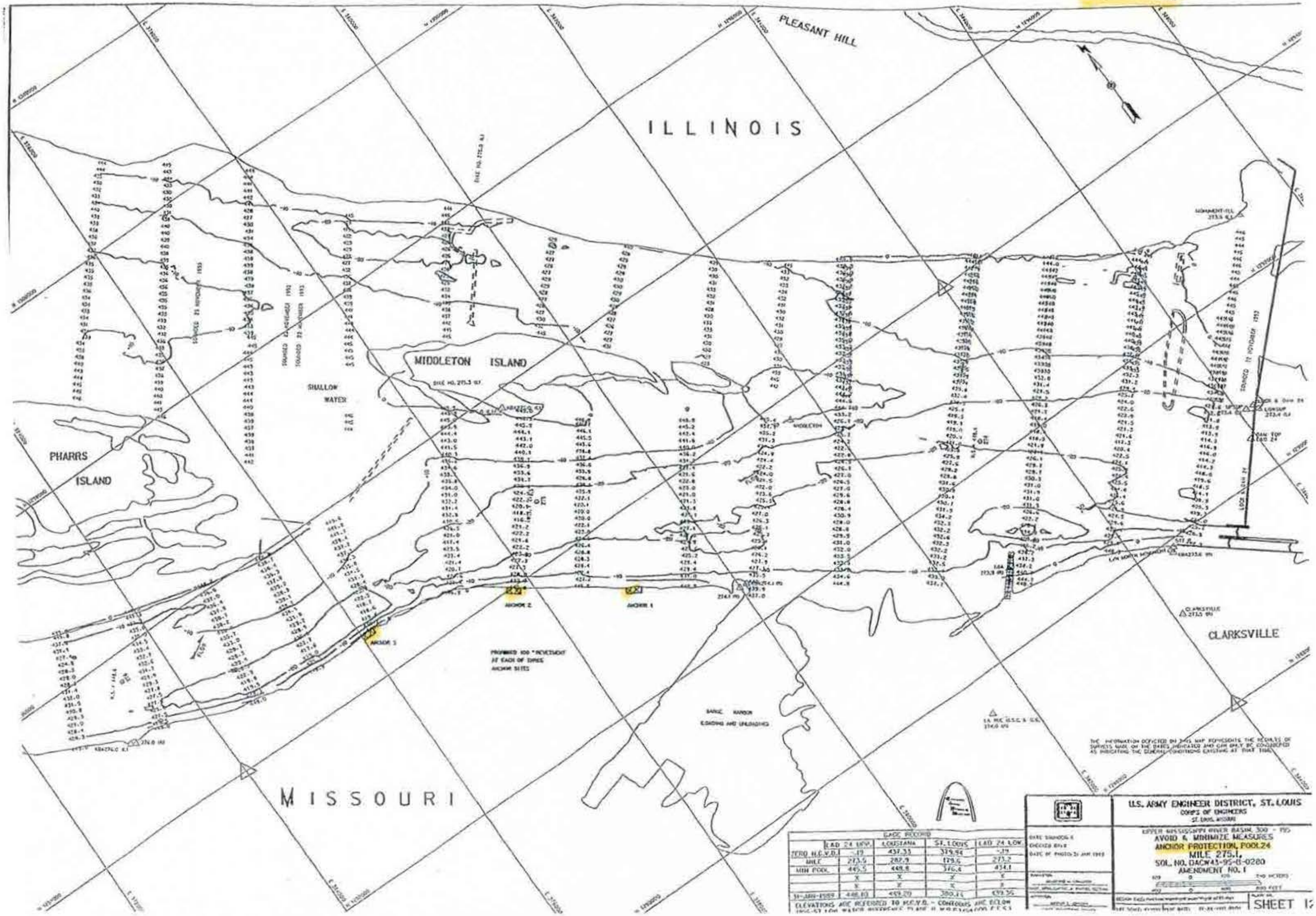
Pool 24



GAGE RECORD	LOUISIANA	ILLINOIS LDG.	ST. LOUIS	L&D 24 UPP.
ZERO N.G.V.D.	437.33	441.85	379.94	-.19
MILE	282.9	293.0	179.6	273.5
MIN POOL	448.8	448.9	326.1	445.5
	X	X	X	X
	X	X	X	X
31-JAN-1989	449.20	454.25	386.24	448.10

ELEVATIONS ARE REFERRED TO N.G.V.D. - CONTOURS ARE BELOW 1956-57 LOW WATER REFERENCE PLANE (L.W.R.P.) (54,000 C.F.S.)

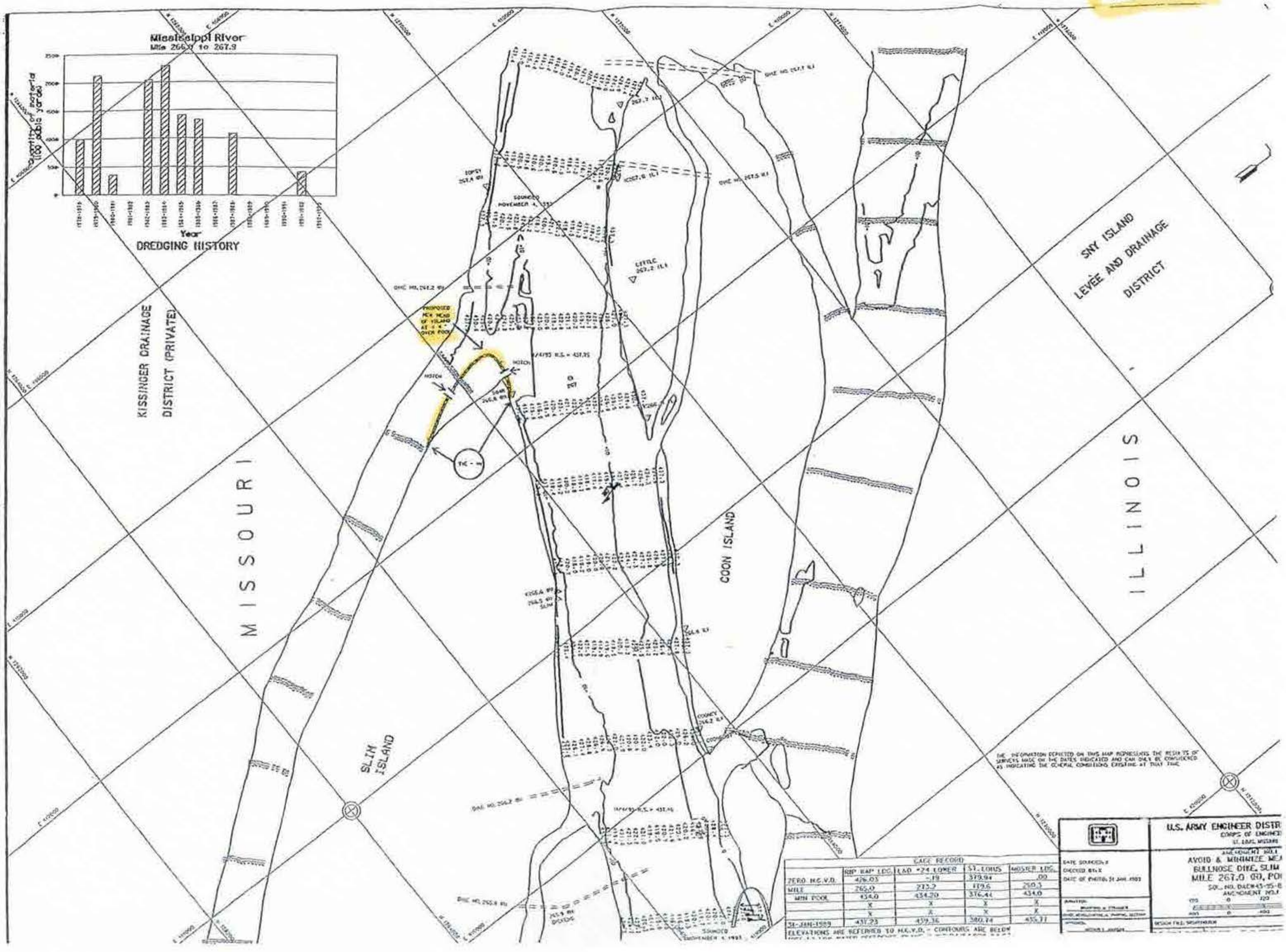
Pool 24



GAGE RECORD	L&D 24 UPR.	LOUISIANA	ST. LOUIS	L&D 24 LOW.
ZERO N.G.V.D.	-.19	437.33	379.94	-.19
MILE	273.5	282.9	179.6	273.2
MIN POOL	445.5	448.8	376.4	434.1
	X	X	X	X
	X	X	X	X
31-JAN-1989	446.10	453.20	380.11	439.36

ELEVATIONS ARE REFERRED TO N.G.V.D. - CONTOURS ARE BELOW

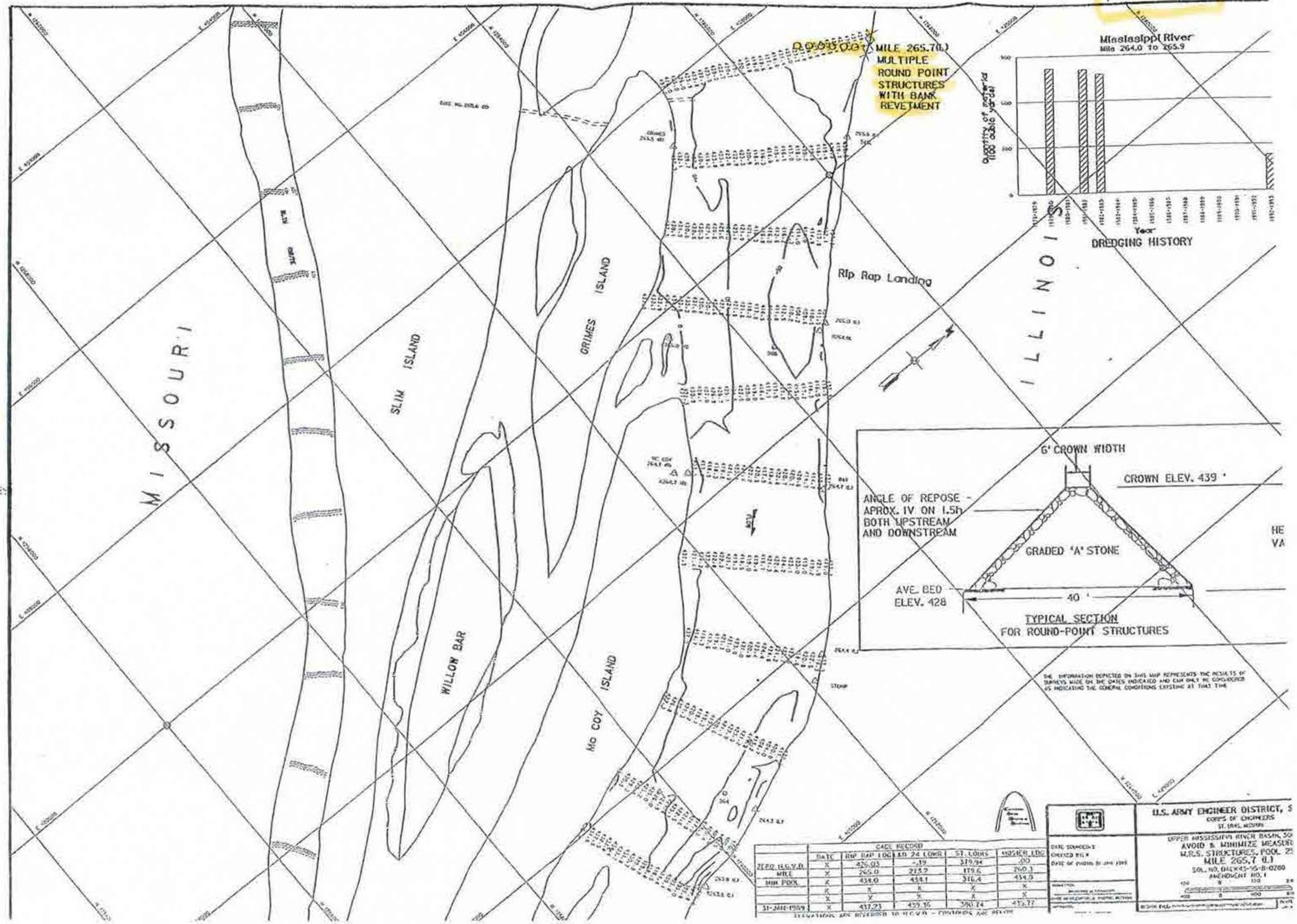
Pool 25



GAGE RECORD	RIP RAP LDG.	L&D *24 LOWER	ST. LOUIS	MOSIER LDG.
ZERO N.G.V.D.	426.03	-.19	379.94	.00
MILE	265.0	273.2	179.6	260.3
MIN POOL	434.0	434.20	376.44	434.0
	X	X	X	X
	X	X	X	X
31-JAN-1989	437.23	439.36	380.74	435.77

ELEVATIONS ARE REFERRED TO N.G.V.D. - CONTOURS ARE BELOW

Pool 25



GAGE RECORD	DATE	RIP RAP LDG	LD 24 LOWR	ST. LOUIS	MOSIER LDG
ZERO N.G.V.D.	X	426.03	-.19	379.94	.00
MILE	X	265.0	273.2	179.6	260.3
MIN POOL	X	434.0	434.1	316.4	434.0
	X	X	X	X	X
	X	X	X	X	X
31-JAN-1989	X	437.23	439.36	380.74	435.77

GAGE RECORD

	STERLING LDG.	MOSIER LDG.	ST. LOUIS	L&D 25 UPP.
ZERO N.G.V.D.	420.48	.00	379.94	.09
MILE	250.8	260.5	179.6	241.5
MIN. POOL	431.8	434.0	376.4	429.7
	X	X	X	X
	X	X	X	X
31-JAN-1989	433.78	435.77	380.74	432.75

APPENDIX D

PALLID STURGEON MONITORING

A. Letter Report-Progress on the Pallid Sturgeon Telemetry Monitoring.

Southern Illinois University at Carbondale
Carbondale, Illinois 62901-6511

Cooperative Fisheries Research Laboratory
Mailcode 6511
Phone and FAX: 618-536-7761

FYI

☐ Keep/Toss
☐ Return

Bob/sw

T 15 Dec 95

8 December 1995

Gerry Bade and Bob Clevenstein
Fish and Wildlife Service
Rock Island Field Office
4469-48th Avenue Court
Rock Island, IL 61201

Gerry and Bob:

This letter is to inform you of our progress on the pallid sturgeon telemetry study. It describes our activities through November 1995, including some work we conducted prior to formal approval of the contract.

The Sonotronics sonic transmitter, provided to us by you, was tested in the Middle Mississippi River near Cape Girardeau, Missouri. The River was at flood stage and closed to navigation during the test. Although these were probably worst-case conditions for sonic tracking, the test was very disappointing--we could only detect the transmitter over a distance of a few feet. As you know, the transmitter you sent us to test was provided to you by the Louisiana Coop Unit and is the same one they are using in their pallid sturgeon tracking study.

We contacted Sonotronics and described the problem of poor detection range to them. They provided us with a new, higher power transmitter. The new transmitter performed substantially better than the one from Louisiana. However, to get the same battery life and a tag small enough to implant into pallid sturgeon, a lower transmission frequency, 40 hertz, was necessary. The receivers we own don't operate at 40 hertz, so a new receiver from Sonotronics was purchased. The receivers we purchased for our use and for the Corps of Engineers can receive signals from the 40 hertz transmitters as well as from the higher frequency transmitters being used in the Louisiana and Missouri pallid sturgeon studies. The new transmitter can be readily detected over a distance greater than half the width of the River. Thus, we can move down the middle of the River during tracking trips and be fairly certain that pallid sturgeon in our study river reaches will be detected.

Ten sturgeon were obtained from commercial fishermen in November. Four of these were identified by the commercial fishermen and us as shovelnose. We are using the methods of Bailey and Cross (1954) as a guide for meristics and measurements (Fig. 1).

The shovelnose were used to perfect our CO_2 anesthetization and surgical techniques. The CO_2 anesthesia worked well--the sturgeon entered the surgical plane within a few minutes, remained anesthetized until they were placed in fresh water after surgery, and it appeared there was little risk of overanesthetizing them.

Six of the sturgeon were identified by the fishermen as pallids (Table 1), but we weren't so sure of this initially. Only one of the six (the last one we obtained in November) showed meristic characteristics which were all consistent with the pallid sturgeon. The others showed at least some characteristics typical of shovelnose and/or characteristics that were intermediate between pallid and shovelnose sturgeon. However, there are some inconsistencies in the literature (Table 2), so it is difficult to determine with certainty whether a given fish is a pallid or a hybrid. For example, a dorsal fin-ray count of 37 could indicate a pallid (Bailey and Cross 1954) or a hybrid (Carlson et al. 1985). A ratio of the interostral length to the mouth-to-inner-barble length (IL/MIB) of 2.19 could indicate a shovelnose (Bailey and Cross 1954), a pallid (Keenlyne et al. 1994), or a sturgeon intermediate between a hybrid and a pallid (Carlson et al. 1985).

The inconsistencies in the literature as well as our inexperience with pallid sturgeon resulted in our decision not to implant sonic transmitters in the first two (pallid sturgeon a and b in Table 1), what we are now calling, pallid sturgeon that were obtained from the commercial fishermen. There were two primary reasons which resulted in this decision. First, based on descriptions of pallid and shovelnose sturgeon and pallid/shovelnose hybrids in the literature, we were not convinced that they were pallids. Both had some scutes on the belly, and some of their other characteristics were intermediate between pallid and shovelnose sturgeon. Second, we were incorrectly counting the dorsal fin rays. Bailey and Cross (1954) included the strong spine anteriorly and all posterior rudiments in their dorsal fin-ray counts, and we did not. This caused our counts to be lower and in the shovelnose sturgeon range.

These first two fish had been held in captivity quite a while before we decided they were pallid sturgeon. The two fish were released without transmitter implants, because we believed that they were already too stressed by the extended holding and handling to subject them to further stress from the surgery.

We feel confident that we are implanting transmitters into fish which are currently considered pallid sturgeon, based on the clear differences in the mean meristic characteristics (Table 1) for shovelnose and pallid sturgeon from the reach of the Middle Mississippi River in which we are working. In essence, we are using the best methods available to identify pallid sturgeon. This will have to suffice until a genetic technique is developed to differentiate pallids from hybrids.

Four pallid sturgeon were given sonic transmitter implants in November (Fish 1-4 in Table 1 and 3). They appear to have survived the surgery. The telemetry equipment is working well and it is already providing us with information. Most of the pallids moved upstream, across the river to the Missouri side and into the main channel. Two appeared to be in scour holes during our last tracking trip.

We obtained three more pallids in December, two that we caught on trot lines and one caught by a commercial fishermen. The two we caught were too small (about 20 inches) for the telemetry study. However, one of the two had a Floy Tag inserted in its pelvic fin--it apparently was stocked by Missouri. We are contacting the Missouri DNR regarding our recovery of one of their fish. The third sturgeon was given a transmitter implant and released. Thus, we are now tracking a total of five pallid sturgeon. We will update you on the meristic characteristics of these last three pallid sturgeon in our next letter. Between our capture efforts and the efforts of the commercial fishermen, there is a very good chance that we will obtain more fish for the study over the next month and beyond.

We have provided you with identification codes for all of the transmitters we purchased this year (Table 4), so that you can inform others involved in pallid sturgeon telemetry studies. Again, these are 40 hertz transmitters.

Sincerely,

Robert J. Sheehan
Associate Professor of Fisheries

Roy C. Heidinger
Professor of Fisheries

xc: T. Miller
P. Wills
M. Schmidt

Figure 1. Diagrams of the ventral surface of the heads of *Scaphirhynchus platorynchus* (shovelnose) and *S. album* (pallid) from Bailey and Cross (1954) showing how measurements for meristic ratios were taken

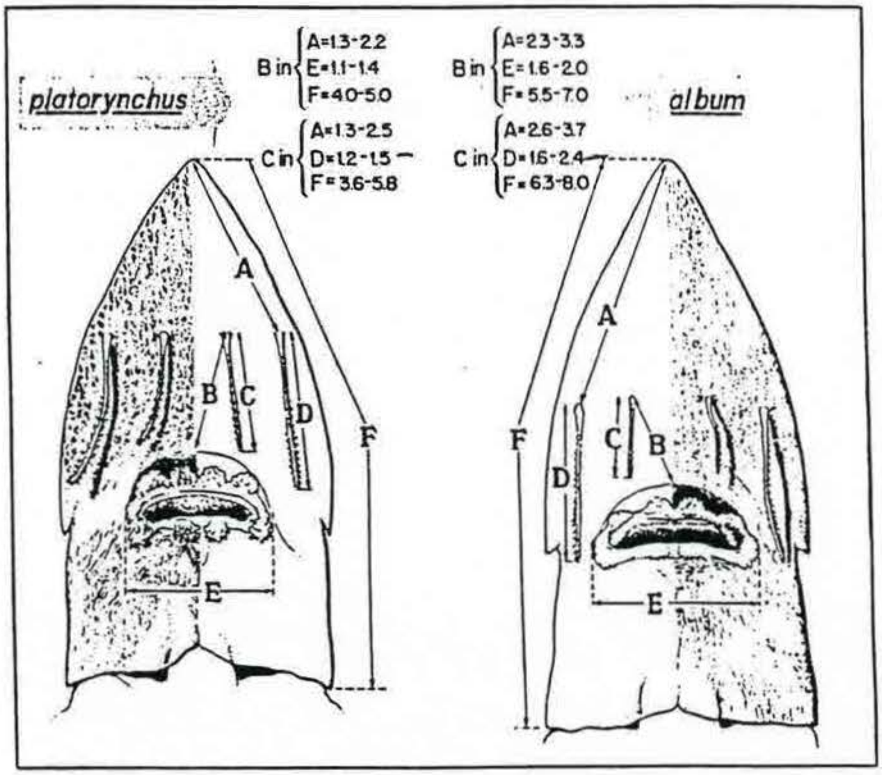


Table 1. Body measurements and measurement ratios for shovelnose and pallid sturgeon captured during October and November 1995 in the Middle Mississippi River, including pallid sturgeon (1,2,3,4) given sonic transmitter implants and then released at their capture locations. Pallid sturgeon values in parenthesis fall within the range of measurements reported in the literature for shovelnose sturgeon (see Table 1), and values which are underlined fall between values reported for shovelnose and pallid sturgeon.

	Shovelnose					Pallid						
Measurement	a	b	c	d	Mean (SD)	a	b	1	2	3	4	Mean (SD)
Dorsal fin rays	30	31	35	36	33(2.9)	37	38	(33)	37	38	39	37(2.1)
Anal fin rays	19	18	20	22	20(1.7)	25	26	22	24	24	26	24.5(1.5)
OB/IB	1.30	1.39	1.21	1.22	1.28(0.1)	1.96	1.95	1.56	1.60	1.56	2.02	1.78(0.2)
HL/IB	4.59	4.43	4.32	4.78	4.53(0.2)	5.19	4.98	-	(4.23)	5.28	6.97	5.33(1.0)
HL/MIB	4.28	4.20	4.05	4.51	4.26(0.2)	5.67	5.40	-	4.85	5.28	5.94	5.43(0.4)
IL/IB	1.75	1.72	1.71	1.96	1.79(0.1)	2.18	2.18	2.39	(1.74)	2.28	3.14	2.32(0.5)
IL/MIB	1.63	1.63	1.61	1.84	1.68(0.1)	2.39	2.35	2.67	(2.00)	2.28	2.68	2.40(0.3)
St. Length (mm)	642	612	510	619	---	756	743	620	654	681	678	---
Belly scutes	many	many	many	many	---	some	some	none	some	some	none	---

Table 2. Body measurements and measurement ratios reported in the literature for shovelnose and pallidsturgeon (OB = outer barble length; IB = inner barble length; HL = head length; MIB = mouth-to-inner-barble length; IL = interrostral length).

	Bailey and Cross (1954)		Keenlyne et al.(1994)		Carlson et al. (1985)		
Measurement	Shovelnose	Pallid	Shovelnose	Pallid	Shovelnose	Hybrid	Pallid
Dorsal fin ray count	30-36	37-43	---	---	32.4±1.6[a]	37.6±1.5[a]	38.4±1.3[a]
Anal fin ray count	18-23	24-28	---	---	20.3±0.8[a]	23.5±0.7[a]	24.5±0.9[a]
OB/IB	1.17-1.48	1.72-2.41	0.89-1.78	1.66-3.54	1.35	1.59	2.02
HL/IB	3.65-5.76	6.35-8.00	3.48-7.16	5.71-15.16	4.20	4.32	5.30
HL/MIB	4.00-5.04	5.54-7.00	3.20-5.55	5.24-9.42	4.32	4.75	5.37
IL/IB	1.26-2.50	2.63-3.73	1.06-2.46	2.07-6.55	1.60	1.83	2.36
IL/MIB	1.27-2.19	2.29-3.26	1.06-2.13	2.07-4.20	1.65	2.01	2.38

a. mean ± 2 standard errors

Table 3. Characteristics and sonic identification codes for Middle Mississippi River pallid sturgeon given sonic transmitters and released at their capture locations during November 1995.

Fish Number	Capture Date	Capture Location (river mile)	Standard Length (mm)	Weight (grams)	Sex	Sonic Tag Code Number
1	11/13/95	131	620	1050	m	348
2	11/20/95	141.5	654	1400	m	258
3	11/20/95	141.5	681	1550	m	294
4	11/25/95	142	678	1350	m	465

Table 4. Identification codes of sonic transmitters purchased in 1995 by Southern Illinois University for the Middle Mississippi River pallid sturgeon telemetry study. Transmitters implanted in pallid sturgeon during November 1995 are underlined.

249	258	267	276	285	294	339	348	357	366
375	384	447	456	465	2228	2237	2246	2255	2264
2273	2327	2336	2345	2354	2363	2426	2435	2444	2453

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