US Army Corps of Engineers
St. Louis District

TECHNICAL REPORT M13

BANK EROSION STUDY OF THE KASKASKIA RIVER, CARLYLE LAKE TO NEW ATHENS, ILLINOIS

By
David Busse
Robert Davinroy
David Gordon
David Derrick
Wayne Kinney
Steve Redington

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT
HYDROLOGIC AND HYDRAULICS BRANCH
APPLIED RIVER ENGINEERING CENTER
FOOT OF ARSENAL STREET
ST. LOUIS, MO 63118

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

In Cooperation with

Original Kaskaskia Area Wilderness, Inc.

and the Illinois Department of Natural Resources

Final Report - February, 2000

APPLIED RIVER ENGINEERING CENTER

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INTRODUCTION

An erosion and sedimentation study of the Kaskaskia River, between Carlyle Lake, Illinois and New Athens, Illinois, was conducted by the U.S. Army Corps of Engineers, St. Louis District. The study was carried out in order to define and evaluate lateral bank erosion experienced on the Kaskaskia River below Carlyle Lake and determine, if possible, remedial measures to abate this erosion in an environmentally sensitive manner.

The study was initiated as a cooperative effort between the U.S. Army Corps of Engineers St. Louis District, the Original Kaskaskia Area Wilderness, Inc. (OKAW), and the Illinois Department of Natural Resources.

OKAW was organized to develop, enhance and protect the ecological and social values of the natural resources within the Kaskaskia River corridor below Carlyle Lake downstream to Fayetteville, Illinois. OKAW was instrumental in establishing a “Cost Sharing Agreement for Planning Assistance” between the U.S. Army Corps of Engineers and the State of Illinois, which was signed on 18 December 1998. Funds for the study were issued from the Illinois Department of Natural Resources on 19 January 1999.

The study was conducted between June 1999 and October 1999. Personnel from the St. Louis District directly involved in the study included Mr. David Busse, Senior Water Control Manager, Mr. David Gordon, River Engineer, Mr. Robert Davinroy, River Engineer, and Mr. Steve Redington, River Engineer. Mr. Jerry Rapp, River Engineer, provided insight during helicopter reconnaissance. Ms. Tori Calong, Environmental Engineer, and Ms. Donna Zoeller, Environmental Technician, assisted with the boat reconnaissance. All of the above personnel were under the direct supervision of Mr. Claude N. Strauser, Chief of the Hydrologic and Hydraulics Branch, Engineering Division. Mr. Richard Astrack, project manager in the Navigation and Environmental Branch, was the study team leader. Mr. Robert Wilkins, Carlyle Lake Project Manager, and Ms. Norma Hall, Park Ranger, attended the public meetings and provided insight as well.

Contractors for the St. Louis District providing additional expertise included Mr. Wayne Kinney, Streambank Stabilization Specialist for the U.S. Department of Agriculture, Natural Resources Conservation Service, Greenville, Illinois, and Mr. David Derrick, Hydraulic Research Engineer, U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi.

Personnel from other agencies who participated in the boat reconnaissance included Mr. Randy Sauer, Fisheries Biologist for the Illinois Department of Natural Resources, and Mr. Dan Ghere, Civil Engineer for the Illinois Department of Transportation.

Mr. Larry Hasheider, president of OKAW, was the primary local representative, who was instrumental in the foundation of the study and the coordination of the public meetings.

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BACKGROUND

This report details the investigation of a bank erosion study of the Kaskaskia River between Carlyle Lake and New Athens, Illinois. The study was conducted to define and evaluate lateral bank erosion and sedimentation experienced on the Kaskaskia River in this reach and determine, if possible, remedial measures to improve conditions in an environmentally sensitive manner.

1. Problem Description

Plate 1 is a location and vicinity map of the study area. The Kaskaskia River below Carlyle Lake meanders through the largest tract of natural bottomland hardwoods within the State of Illinois. This reach of river has been the subject of much local interest. The river serves as an important natural resource to the region, providing a variety of social, economic, and environmental benefits, including water supply, fisheries and wildlife, and recreation.

The flow regime within this reach of river has been modified by the construction of two upstream multi-purpose projects, Carlyle Lake, constructed in 1967, and Shelbyville Lake, constructed in 1971. In addition, channelization of 36 miles of the Lower Kaskaskia River, from Fayetteville, Ill to the confluence with the Mississippi River, was completed in 1972 for the purpose of establishing a 9-foot deep, 300-feet wide channel for navigation.

Shortly after construction of the navigation project, several areas of significant bank caving and river widening were observed upstream of the project in the unaltered reach of the Kaskaskia River above Fayetteville. Denzel and Strauser (1982) first defined that observed, excessive bank erosion was a result of channel “headcutting” in response to the elimination of approximately 16 miles of the original river length, between Fayetteville and the mouth of the Kaskaskia

River. The original river length in this reach was approximately 52 miles. Canal construction reduced this length to approximately 36 miles. In addition, the average width of the river was widened from approximately 125 feet to 300 feet. These modifications changed the average slope of the river, from approximately 0.25 feet per mile in the natural state, to approximately 0.45 feet per mile after construction, a slope increase of approximately 80 percent during bankfull events.

Between 1972 and 1982, an estimated 2.5 million cubic yards of material had deposited within the upper 6 miles of the navigation channel reach, between Fayetteville and New Athens. The source of this material was directly attributed to upstream erosion and headcutting in the unaltered river reach above Fayetteville. Field observations concluded that the headcutting and associated bank erosion during this time period had migrated upstream approximately 6 miles above Fayetteville.

In 1982, a grade control structure was constructed just downstream of Fayetteville. The structure consisted of a rock weir and notch and was constructed perpendicular across the channel (Plate 2). A mathematical sediment model and a physical hydraulic model were employed in the design of the structure. Model studies suggested that implementation of the grade control structure was required to minimize or “slow down” depositional impacts in the navigation channel from future planned dredging. In addition, the structure was required to alleviate future upstream headcutting and channel widening.

After installation of the grade control structure, the 6-mile stretch of the navigation channel where sediment deposition had occurred was dredged between 1983 and 1985. The dredging returned the channel to the original design dimensions of the navigation project.

No dredging has occurred in the navigation channel since 1985. Hydrographic surveys of the channel conducted in 1999 indicated that approximately 1.77 million cubic yards of sediment had again accumulated in the 6-mile stretch of the navigation project, between Fayetteville and New Athens (Plate 3).

In 1998, OKAW initiated meetings with local representatives of the State of Illinois to move forward with a cooperative effort with the Corps of Engineers to study bank erosion problems downstream of Carlyle Lake and make recommendations for possible solutions. Between 1982 and 1998, private property in the form of land, clubhouses, and boat docks were lost due to bank erosion along this reach of river. At Highbanks, approximately 4 river miles upstream of Fayetteville, the Summerfield, Lebanon, and Mascoutah (SLM) municipal water intake had experienced considerable sedimentation due to channel widening and downstream bank erosion. Remedial dredging since the late 1980's has been required in front of the intake to ensure a continuous water supply for approximately 40,000 people.

2. Study Purpose and Goals

The purpose of this study was to define and evaluate lateral bank erosion and sedimentation experienced on the Kaskaskia River below Carlyle Lake and determine, if possible, remedial measures to improve conditions in an environmentally sensitive manner. To achieve this, several goals were outlined at the beginning of the study, including:

a. Conduct field reconnaissance by air and by boat to better define the extent of the erosion and sedimentation throughout the study reach
b. Assemble and analyze all available historical aerial photography to determine historical erosion rates and sedimentation trends.
c. Meet with local landowners and discuss individual problems.

d. Determine the river morphology.
e. Formulate general design solutions in the most efficient and economical manner.
f. Encompass recommended solutions with both engineering and environmental considerations.
g. Prepare cost estimates for future initiatives.
h. Meet with all interested parties to summarize findings and recommendations.

INVESTIGATION AND ANALYSIS

1. River Morphology

To determine the present day morphology and stability of the Kaskaskia River within the study reach, it was necessary to study important changes that have occurred in the **pattern**, **dimension**, and **profile** of the river. **Pattern** refers to the planform or physical geometry of the river channel, the number of bends, the size of the bends, etc. **Dimension** refers to the width and depth of the channel cross section. **Profile** refers to the gradient or slope of the channel bottom throughout the length.

This study did not allow for extensive gathering of survey data to describe the above parameters in detail. Historical aerial photography, field reconnaissance observations, and an experienced knowledge of river dynamics were instead used for interpretation of these changes.

To describe the **pattern**, the average length of the Kaskaskia River was calculated to be approximately 1.44 to 2.10 times the average length of the floodplain. This ratio is defined as the sinuosity of the river. By examining the sinuosity, a determination can sometimes be made on the extent of past modifications that have occurred in the river, either natural or man-induced.

A field reconnaissance map summary was prepared that defined the location of all observed bends within the study reach (Plate 4). The bends were studied during helicopter reconnaissance, conducted on July 7 of 1999, and boat reconnaissance, conducted on July 20 and 21 of 1999. Bend # 1 was located immediately downstream of Carlyle Lake.

The reach of river that contained the most sinuosity (2.1) was between bend #118 near Dyer Pond to bend # 87 near Muskrat Lake. The least sinuosity (1.4) was observed between bend # 62 near Horstmann Lake to bend # 37 at the confluence of Crooked Creek. By contrast, the reach downstream in the navigation project, between Fayetteville and New Athens, contained a sinuosity of 1.0, with all of the meanders having been removed as a result of the navigation project.

Many of the bends in the study reach were tortuous (sharply curved) in nature. Bends were curved as large as 180 degrees. Radii were as small as 200 ft. (similar to bend # 104) and as wide as 500 ft. (similar to bend # 96). The most common or average radius of curvature was approximately 300 ft. (bend #113).

It was apparent from field reconnaissance that several of the bends had meandered to a point where permanent cutoffs were most likely to occur in the near future regardless of any remedial measures implemented. These particular areas should be considered in the future, as permanent cutoff development could adversely effect any attempted, nearby bank stabilization works.

The **dimension** of the study reach was determined using historical aerial photography. A comparison was made with 1962 photography, which pre-dates construction of the multi-purpose lake projects and the navigation project. Conditions in 1962 were assumed as the “base dimensions”, although it must be kept in mind that bank erosion is a natural river process and has always occurred on the Kaskaskia River to some degree. Eight strategic locations along the river reach were selected, and channel widening measurements and rates were computed using 1978, 1988 and 1998 photography. A comparison of the data is presented in Plate 5.

It should be noted that in 1962 the channel contained a constant width of approximately 125 feet throughout the entire length of the project reach. The channel dimensions showed no tendency to widen below the major associated tributaries of Shoal Creek, Crooked Creek and Elkhorn Creek. Subsequent measurements taken from the 1978 through 1998 photographs showed that the channel had widened significantly over time in the lower portion of the study. The greatest changes occurred from Fayetteville to the area near “Highbanks” at bend # 124 (site 3 on Plate 5). Channel widening rates were approximately 5 feet per year in some bends within this reach. Width changes were progressively smaller as the analysis moved upstream, with the rates calculated as small as 0.1 feet per year just downstream of Carlyle Lake (site #8 on Plate 5).

2. Kaskaskia River Navigation Project Effects

The **profile** of the study reach is the most difficult to quantify without accurate survey data. Nonetheless, observations during field reconnaissance clearly indicated that the channel **profile** was still degrading within the lower part of the study reach due to headcutting as a result of the navigation project. The “knickpoint” or upper limit of the headcutting was located near bend #100, approximately 14 river miles above Fayetteville (Plate 6). The volume and density of woody material in the channel increased dramatically below this bend, which corresponded closely with the channel widening and increased bank failure limits noted in the “**dimension**” analysis. In addition, the relative height of the banks increased sharply near bend #100, further indicating channel degradation or headcutting. Upstream of this bend, there was no physical evidence indicative of major degradation of the channel. Plates 7 and 8 are reconnaissance photos illustrating typical effects of the headcutting observed on the Kaskaskia River.

Headcutting is a complex phenomena that occurs on a river or stream, whereby the channel bottom profile will deepen or scour as a result of a disruption in the flow or sediment balance of the river. Excessive bank erosion and channel widening will result. The deepening cut may translate upstream along the channel thalweg (deepest segment of the channel) until a state of equilibrium is once again reached. Plate 9 is a schematic illustrating the effects of headcutting from channelization.

The possibility exists that the headcutting along the Kaskaskia River may continue to migrate upstream during high flow events. It would be extremely difficult to make a prediction on how far upstream the headcut may continue to migrate before a state of equilibrium is reached. However, the possibility does exist that this channel degradation or channel deepening and scour may translate as far upstream as the spillway at Carlyle Dam if no remedial measures are taken.

Within a headcutting reach, it is typically not recommended to employ traditional bank stabilization structures at individual problem areas because of the instability of the degrading channel. Restoration may instead be achieved by restoring grade equilibrium of the river system with a series of grade control structures or cross-sectional weirs strategically placed along the profile of the degrading river.

3. Carlyle Lake Effects

The study of the historical aerial photographs clearly demonstrated that the multi-purpose reservoir at Carlyle has had no effect on accelerating bank erosion rates. Aerial photography analysis, starting at Fayetteville and proceeding upstream, indicated channel widening and bank erosion became progressively less the closer the analysis was moved toward Carlyle Lake. No significant changes in channel width were noted from Carlyle Lake to Crooked Creek (bend #39). The outer banks of the first three bends downstream of Carlyle Lake (bends #1, #2, and #3), which contained some of the sharper radii of curvatures within the study reach, experienced insignificant lateral erosion as compared to other bends below Crooked Creek. Bend #1 contained a lateral erosion rate of only 0.8 ft per year, which was approximately 3 to 5 times less than erosion rates calculated in other bends such as bend #70 and bend #124.

Analysis of historical peak flows at the Venedy Station and Carlyle gage sites was conducted in order to examine the effects of the multi-purpose reservoirs at Shelbyville and Carlyle. In 1995, the maximum, recorded discharge from Carlyle Lake was 5,700 cfs. Without the two reservoirs, the discharge below Carlyle would have been approximately 51,200 cfs, or 88% greater than what was released. This enormous reduction in peak flows was typical of what has been generally experienced on a yearly basis on the Lower Kaskaskia River below Carlyle Lake. Lower discharges during high water events have supplied lower energy to the river system. This has equated to the extremely low bank erosion rates observed between Carlyle and Crooked Creek.

The positive effects of the reservoirs can further be identified by examining downstream flow contributions from tributaries below Carlyle Lake during high water events. Plate 10 is a schematic illustrating the relative flow contributions at Vennedy Station (at Highway 160 Bridge) from Shoal Creek, Crooked Creek, Little Crooked Creek, and reservoir releases from Carlyle Lake. The diagram demonstrates that high flows experienced at Vennedy Station are not a result of reservoir releases but rather natural flow contributions from the tributaries.

Generally, dams act as sediment traps, storing incoming sediment and starving the river downstream of the dam. The channel then experiences degradation and associated bank erosion. In the case of the Kaskaskia River below Carlyle, this trend was not evident. The elimination of such a large percentage of the typical, yearly peak flow seems to have minimized the yearly sediment transport rate below the dam to such an extent that the downstream sediment budget has not been negatively effected.

Another analysis was conducted examining the relative project effects of flow on vegetation along the banks of the Lower Kaskaskia. Analysis of flow durations before and after construction of the reservoirs indicated that longer durations of flow at or above the 3000-cfs level have occurred since initiation of the projects. This was based upon comparisons of average flow durations made between data from the Venedy Station gage and two unregulated rivers, the Embarras (Ste. Marie, Illinois gage) and Sangamon (Riverton, Illinois gage) Rivers (Plate 11). These rivers were picked because of their relatively close proximity to the Kaskaskia. "Bankful discharge" at the three gage sites, assumed to be the discharge for the 1.5 year recurrence interval, was approximately 17,000 cfs, 10,500 cfs, and 14,000 cfs respectfully. "Bankfull stage was approximately 20 ft., 18 ft., and 17 ft.

At 3000 cfs, the respective water depths at the gage sites were 9.5 feet, 8.8 feet, and 8.3 feet. The major differences in this comparative discharge was the duration of flow at the 8 to10 foot depth, expressed as days, which was computed as 175 days on the Kaskaskia, 76 days on the Sangamon, and 69 days on the Embarras.

Relative to average channel dimensions, 3000 cfs on the Kaskaskia River at Vennedy Station correlated to approximately 50% of the bankfull depth (20 feet) of the river channel. These sustained flows have had a positive effect on reducing peak flows and conversely lowering the major erosive energy of the river. However, the longer duration flows have contributed to the loss of low-lying vegetation zones, as verified during the field reconnaissance. This means that stream restoration techniques such as Bendway Weirs, willow plantings, longitudinal peak stone, etc. that rely on the re-generation of low-lying vegetation along the bank may not be successful in this particular reach of the Kaskaskia River.

4. Land Clearing and Tree Removal Effects

Using both aerial photography analysis and field reconnaissance observations, it was evident that approximately 20 bends were experiencing low to moderate bank erosion problems in the reach between Carlyle Lake and bend #100. This erosion was primarily the result of land clearing and tree removal adjacent to the riverbanks. Reaches where trees were not cleared adjacent to the banks were more stable. The positive effects that the tree roots provide on the stability of riverbanks have been well documented. Plate 12 illustrates the typical land clearing effect on bank erosion that was observed during reconnaissance (bend #24).

The majority of bends within the reach between Carlyle Lake and bend #100 were relatively stable and experiencing minimal natural erosion. This was attributed to the positive effects the Carlyle Lake Project has provided and the heavily forested land contained on the majority of both sides of the river channel.

CONCLUSIONS AND RECOMMENDATIONS

- Aerial photography analysis and field reconnaissance observations indicated that the effects of the Carlyle Lake Project had not caused accelerated bank erosion. Bank erosion and channel widening rates along the river were smaller as the analysis moved upstream closer to Carlyle Lake. Bank erosion rates were insignificant between Carlyle Lake and Crooked Creek.

- Between Crooked Creek and bend #100, most of the low to moderate bank erosion and channel widening observed on the river was accelerated by the effects of localized removal of trees and vegetation adjacent to the riverbanks.

- It was believed that bank erosion between bend # 101 and Fayetteville was a primary result of the headcutting or channel degradation incurred by the Kaskaskia River Navigation Project. Headcutting was still occurring in the lower study reach of the Kaskaskia River, and had migrated approximately 14 river miles upstream of Fayetteville near bend #100 (Plate 6). This headcutting may continue to migrate upstream during high flow events unless immediate remedial measures are taken.

- Protecting the banks of the river from further erosion within the headcutting reach was not recommended due to the widespread instability of the channel. A series of grade control structures is instead recommended through this reach to regain profile stability and sediment equilibrium.

- Protecting the banks using stream restoration structures that rely on the re-generation of low-lying vegetation may not be successful due to the sustained flow releases from the multi-purpose reservoir at Carlyle.

PROPOSED REMEDIAL MEASURES

1. Lower Reach Measures

It is recommended that remedial measures to address the headcutting in the lower reach, between bend #100 and Fayetteville, will include the construction of 58 rock grade control structures and 1 rock headcut abatement structure. Plate 13 is a plan view map showing the proposed approximate locations of these structures.

The proposed grade control structures are relatively low in elevation as related to the top bank of the channel, with a maximum height of 3 feet above the channel invert. The number of proposed structures are based upon general, recommended spacing requirements for grade control structures of approximately four to six times the effective channel width.

This is a very conservative and subtle design. Investigations were conducted into grade control structures constructed on other rivers and streams in the United States. The information suggested that fewer structures can be built, but will then require a much higher weir elevation above the channel invert. Many of these higher structures had experienced maintenance and failure problems resulting from high scour velocities. In addition, more environmental impacts associated with fish passage were generally imposed by the higher structures, and appropriate modifications to designs had to be adjusted accordingly. Generally, a greater amount of structures containing significantly lower elevations will generate minimal construction and maintenance problems while allowing normal fish passage.

A. Rock Grade Control Structures. Plate 14 shows the conceptual, recommended design of the proposed typical grade control structure, to be implemented within the headcutting reach. The primary purpose of this design will be to:

a. Minimize the effects of erosion that has already occurred from the headcutting.
b. Alleviate and minimize channel-widening rates within the headcut reach.
c. Assist in the re-establishment of sediment equilibrium throughout the reach.

Grade "C" Stone will be the material of choice. Grade "C" Stone is graded limestone with a maximum weight of 400 lbs. The main design will consist of a level crested weir, transitioned into the banks on a 1 on 8 slope. The structure will be keyed into the banks, with a 50-foot bankline blanket proposed immediately upstream and downstream of the key axis. A minimum 3-foot crown width is recommended. The design avoids maintenance problems associated with perpendicular weirs. A center weir section will join two upstream angled legs joined together to form an upstream facing trapezoidal chevron. The angle of each leg is 30 degrees. The purpose of this configuration is to concentrate or direct velocities into the center of the river channel away from the banks. This eliminates excessive shear stress near the bank that would normally be associated with perpendicular weirs. Plate 15 shows the projected, localized bathymetry and flow patterns generally expected to occur in the river from the implementation of this structure. Similar chevron design shapes (blunt nosed) have been implemented in the Mississippi River for sediment management.

Future construction maintenance of the above structures will be a necessary and important requirement. Excessive scour experienced near the structures from extreme flow events, local changes in the soil, or other future uncertainties, may cause some launching and settling of rock, thereby possibly compromising the integrity of the structures. An annual maintenance inspection program will ensure that these considerations are quickly asserted and rectified or repaired in a timely manner.

B. Rock Headcut Abatement Structure. Plate 16 shows the conceptual, recommended design of the proposed rock headcut abatement structure. The structure will be placed in the first crossing upstream of bend #100. The structure will incorporate the same design parameters as the grade control structure, with the exception that the channel bed will be pre-excavated and filled to a depth of 5 feet. The primary purposes of this structure will be to:

a. Abate the upstream migration of the headcutting thereby eliminating future channel profile degradation and channel widening.
b. Supply the same benefits as outlined previously in the grade control structure description.

2. Upper and Middle Reach Measures

Remedial measures to address bank erosion in the upper and middle reaches of the river, between Carlyle Lake and bend #100, will involve the placement of bank stabilization measures along the banks of the river. In this particular study, both high cost, low risk measures and low cost, high-risk measures were developed. The proposed high cost design measure, although more costly, ensures a much lower degree of risk and uncertainty. The proposed low cost design measure, although less costly, provides a greater amount of risk and uncertainty.

The high cost, low risk design measure will consist of placed bank revetment using Graded C Stone along the eroding bank, from the top of bank to the toe. Plate 17 shows the typical, recommended design.

Several other bank stabilization measures were researched and analyzed during this study. Site specific problems were discussed with local landowners. The proposed lower cost, higher risk design will consist of a series of rock vanes strategically placed along the outside of the eroding bank. Plate 18 shows the typical, recommended design. Generally, the design calls for the placement of upstream angled rock structures spaced approximately 200 to 250 feet apart along the eroding bankline. The structures will be pointed upstream at a 25-degree angle from the bank. Top crown height will be at midbank elevation, and the structure is sloped 1 on 10 toward the riverbed. The structures are designed to protect the bank by directing flow away from the outer bank. A test reach for these structures is proposed at bend #80, to be tentatively constructed in the early Spring of 2000. This test case is being funded as a cooperative effort between the U.S. Army Corps of Engineers, the Illinois Department of Natural Resources, and the United States Department of Agriculture, Natural Resources Conservation Service, utilizing the C2000 program and the Environmental Quality Incentive Program.

Lower cost measures such as Bendway Weirs, longitudinal peak stone, and willow plantings were examined. However, it was determined that these measures would be of much greater risk on the Kaskaskia River due to the fact that both designs rely on the natural propagation of low-lying vegetation along the outside of the eroding bank. Field observations indicated that a low-lying, vegetation zone along the banks of the river within the study reach was non-existent. Therefore, these type bank stabilization measures would probably be unsuccessful at abating future erosion within this reach of the Kaskaskia River.

3. Cost Estimates

Cost estimates were prepared based upon engineering experience and judgement. All cost estimates were based upon total engineering, site prep, materials, and construction costs, reflective for year 2000. A 10 percent contingency was applied for unaccounted variables. Since no detailed cross sections or profiles were obtained in this study, an average, trapezoidal cross sectional channel 175 feet wide by 20 feet deep was used to represent a typical section within the headcutting reach, as dictated by aerial photographs.

In addition, total length of bank erosion along the bends within the middle and upper reaches varied. Using aerial photography, the average length of eroding bankline was computed as approximately 500 feet per bend.

A. Lower Headcutting Reach

57 Grade Control Structures at $50,000 per structure:	$2,850,000.00
1 Headcut Abatement Structure at $70,000:	$ 70,000.00
Total Construction Costs:	$2,920,000.00
10 Year Maintenance Program Cost:	$ 500,000.00
Total Project Costs:	$3,420,000.00 *****

***** These costs include no environmental impact considerations, required environmental assessment and compliance, or additional environmental structural design features, additions, or modifications. It is estimated that associated environmental costs may be between 2 and 3 million dollars, which would bring the total project costs to approximately 5.5 to 6.5 million dollars.

B. Middle to Upper Reach Above Bend 101

Higher Cost, Lower Risk Bank Protection Revetment, 20 Bends with Bank Protection Revetment, Avg. Bend Length of 500 feet, at $165 per linear foot:	$1,650,000.00
10 Year Maintenance Program Cost:	$ 280,500.00
Total Project Costs:	$1,940,500.00

Lower Cost, Higher Risk Bank Protection Structures,	
20 Bends with Rock Vane Structures, Avg. Bend Length	
of 500 feet, 2 structures per bend at $20,000 per structure:	$ 800,000.00
10 Year Maintenance Program Cost:	$ 136,000.00
Total Project Costs:	$ 936,000.00

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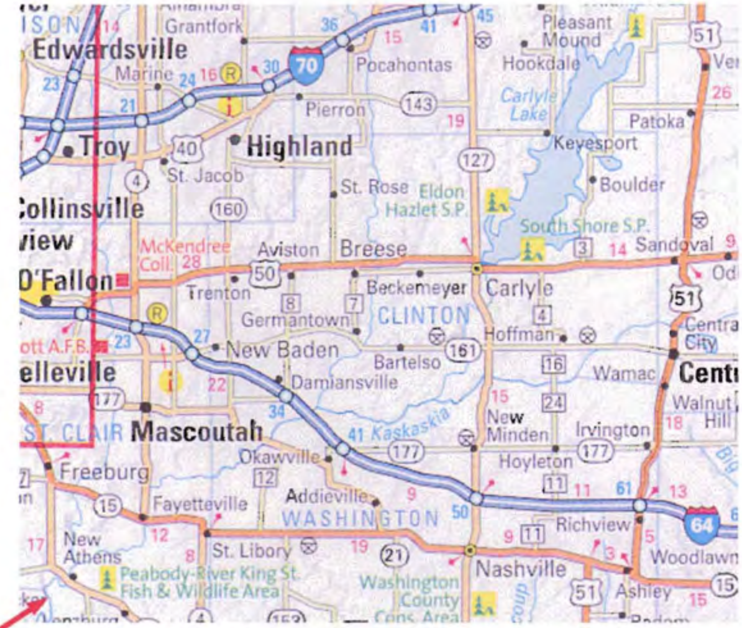
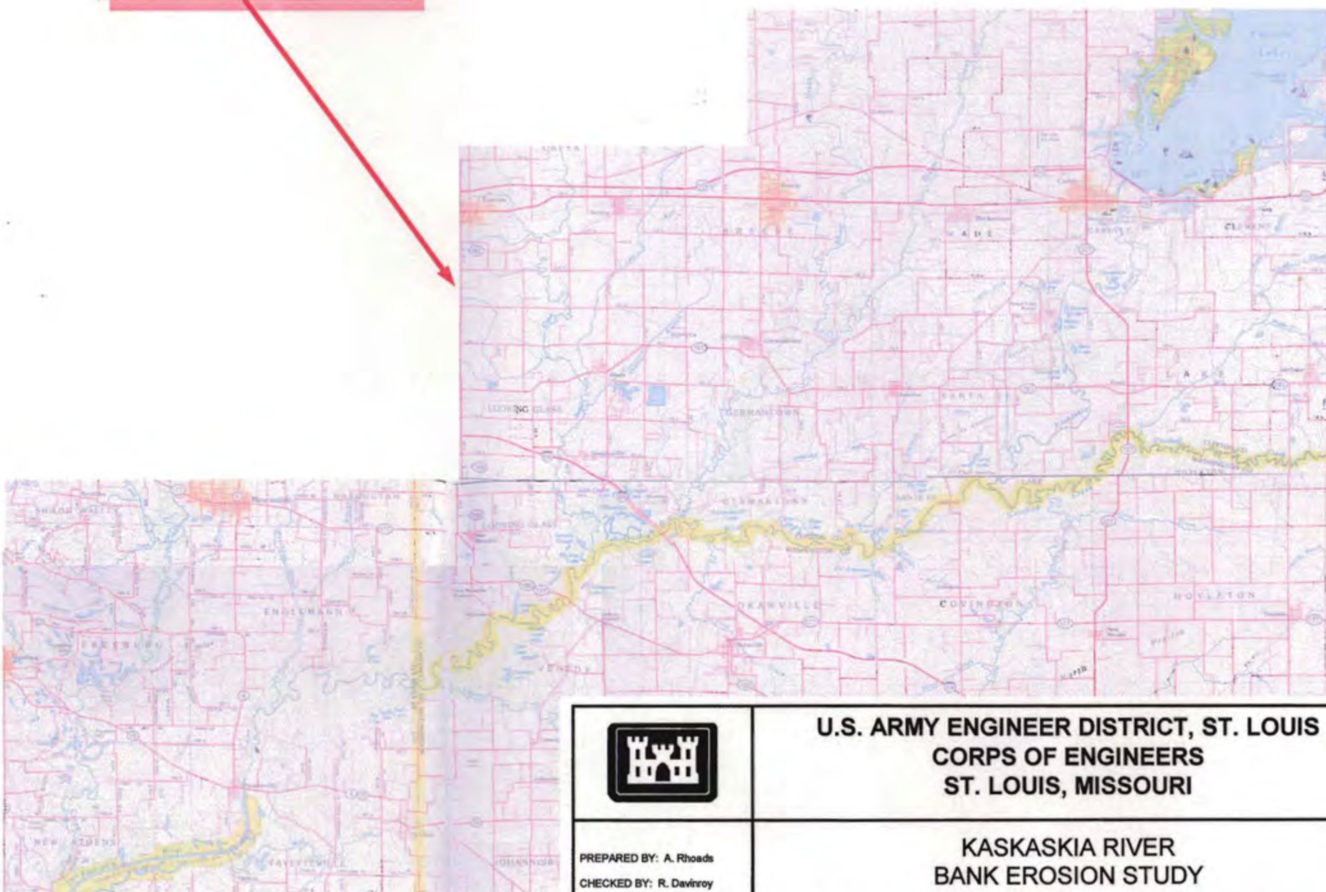
PLATES

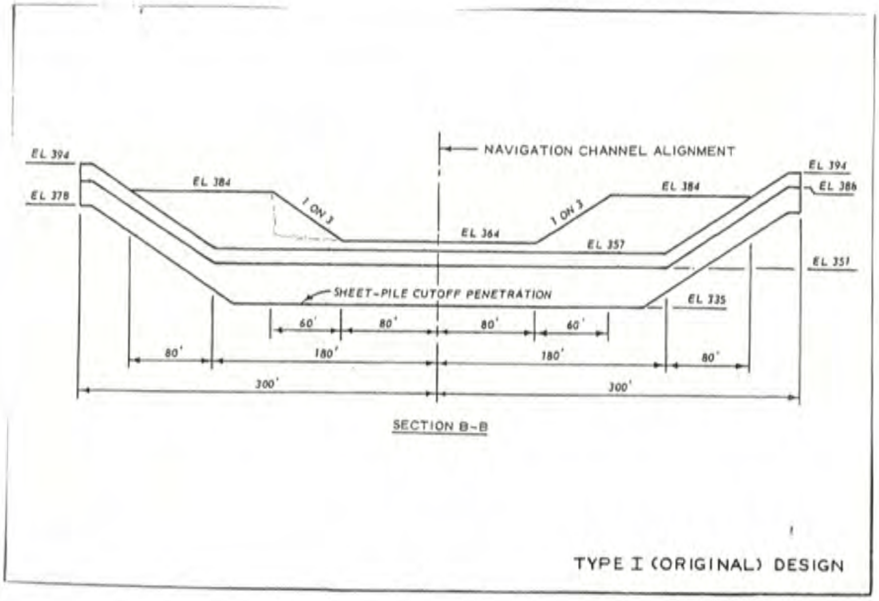
The following is a list of all plates to follow in numbered order:

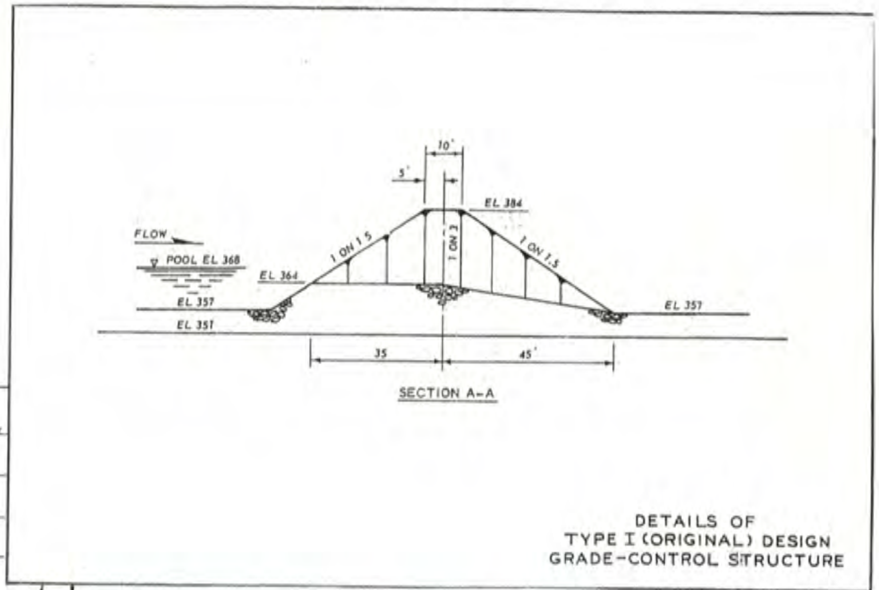


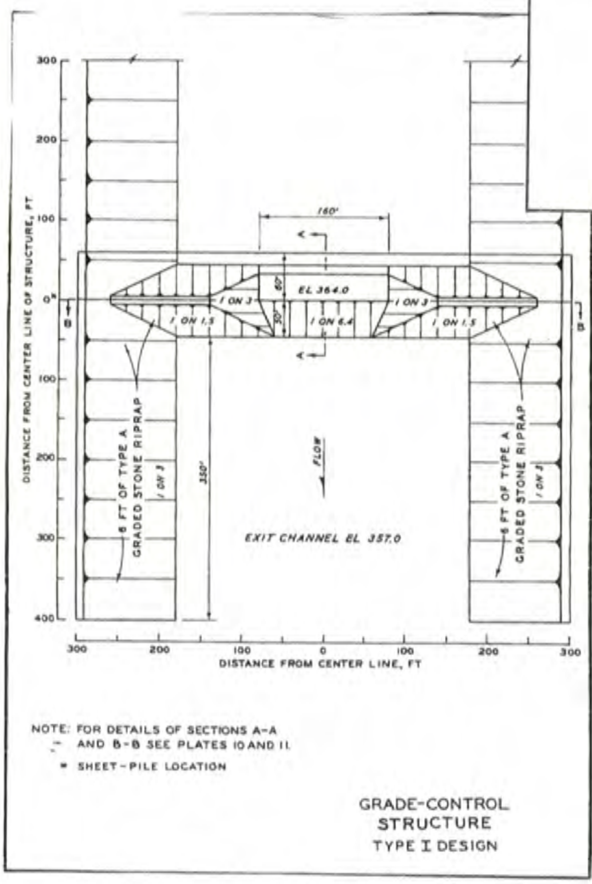
Study Reach



	U.S. ARMY ENGINEER DISTRICT, ST. LOUIS **CORPS OF ENGINEERS** **ST. LOUIS, MISSOURI**
PREPARED BY: A. Rhoads CHECKED BY: R. Davinroy	KASKASKIA RIVER BANK EROSION STUDY **LOCATION AND VICINITY MAP OF THE STUDY REACH**
	PLATE NO. 1







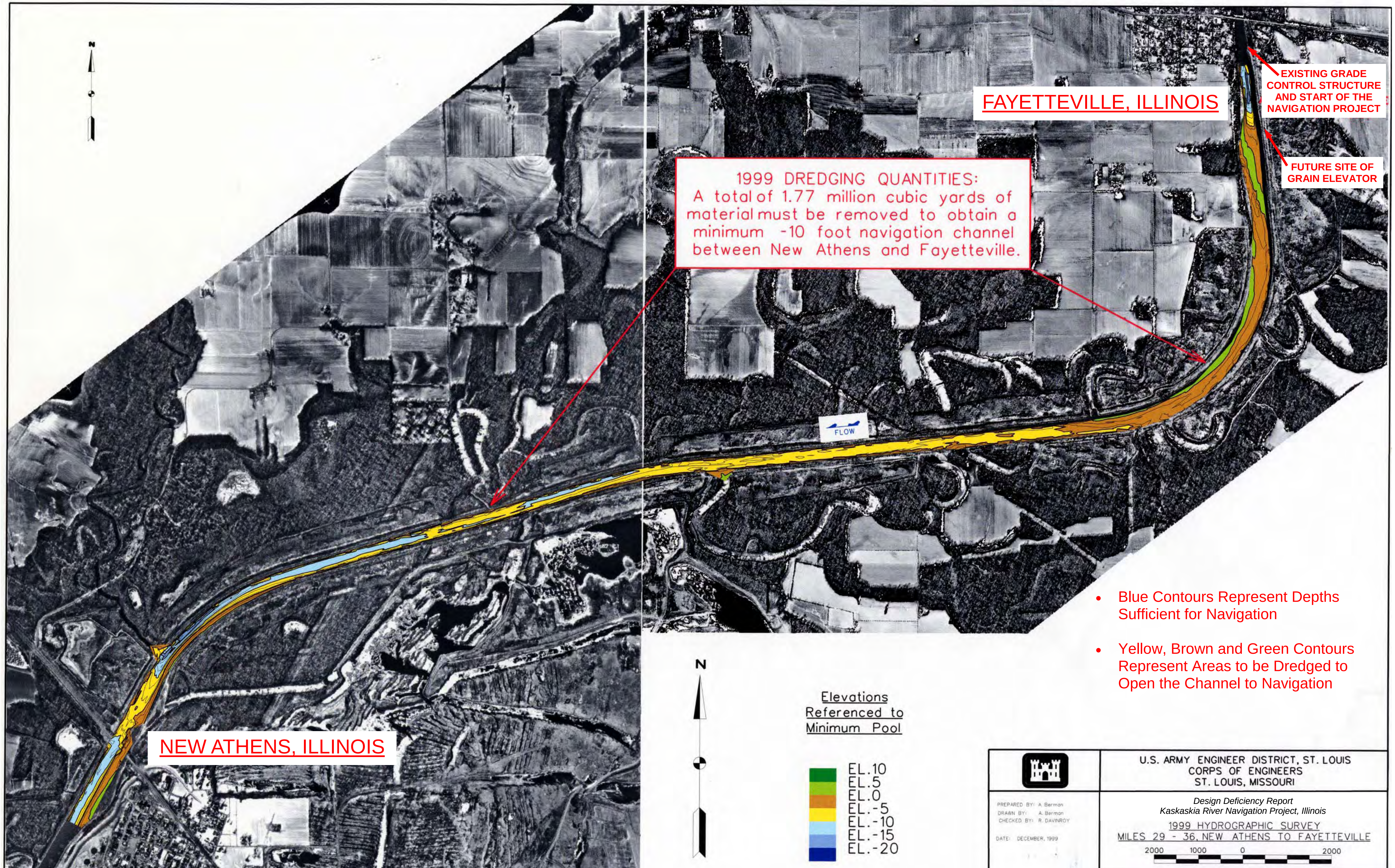
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

PREPARED BY: A. Rhoads
CHECKED BY: R. Davinroy

KASKASKIA RIVER
BANK EROSION STUDY

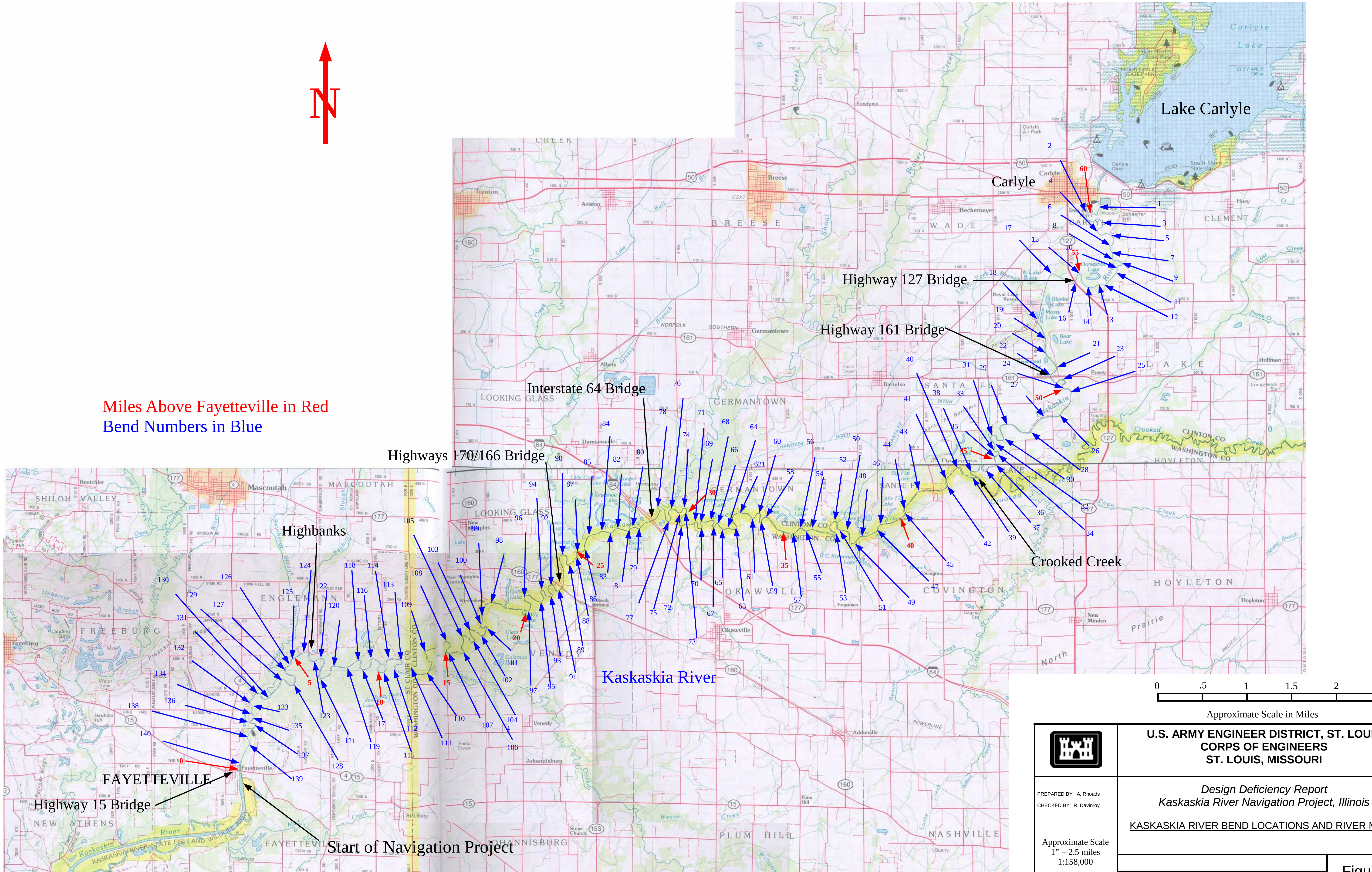
SPECIFICATIONS OF THE ORIGINAL GRADE-CONTROL STRUCTURE AT FAYETTEVILLE, ILLINOIS

PLATE NO.
2



FAYETTEVILLE, ILLINOIS
EXISTING GRADE CONTROL STRUCTURE AND START OF THE NAVIGATION PROJECT
FUTURE SITE OF GRAIN ELEVATOR
1999 DREDGING QUANTITIES: A total of 1.77 million cubic yards of material must be removed to obtain a minimum -10 foot navigation channel between New Athens and Fayetteville.
FLOW
NEW ATHENS, ILLINOIS
N
Elevations Referenced to Minimum Pool
EL.10
EL.5
EL.0
EL.-5
EL.-10
EL.-15
EL.-20
• Blue Contours Represent Depths Sufficient for Navigation
• Yellow, Brown and Green Contours Represent Areas to be Dredged to Open the Channel to Navigation
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: A. Bermon
DRAWN BY: A. Bermon
CHECKED BY: R. DAVINROY
DATE: DECEMBER, 1999
Design Deficiency Report
Kaskaskia River Navigation Project, Illinois
1999 HYDROGRAPHIC SURVEY
MILES 29 - 36, NEW ATHENS TO FAYETTEVILLE
2000 1000 0 2000
DESIGN FILE: PROJECT\KASKY\DGN\KASK2936.DGN
PLOT SCALE: 2000
PLOT DATE: JAN 18, 2000

Figure 6



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ST. LOUIS, MISSOURI

PREPARED BY: A. Rhoads
CHECKED BY: R. Davinroy

Design Deficiency Report
Kaskaskia River Navigation Project, Illinois

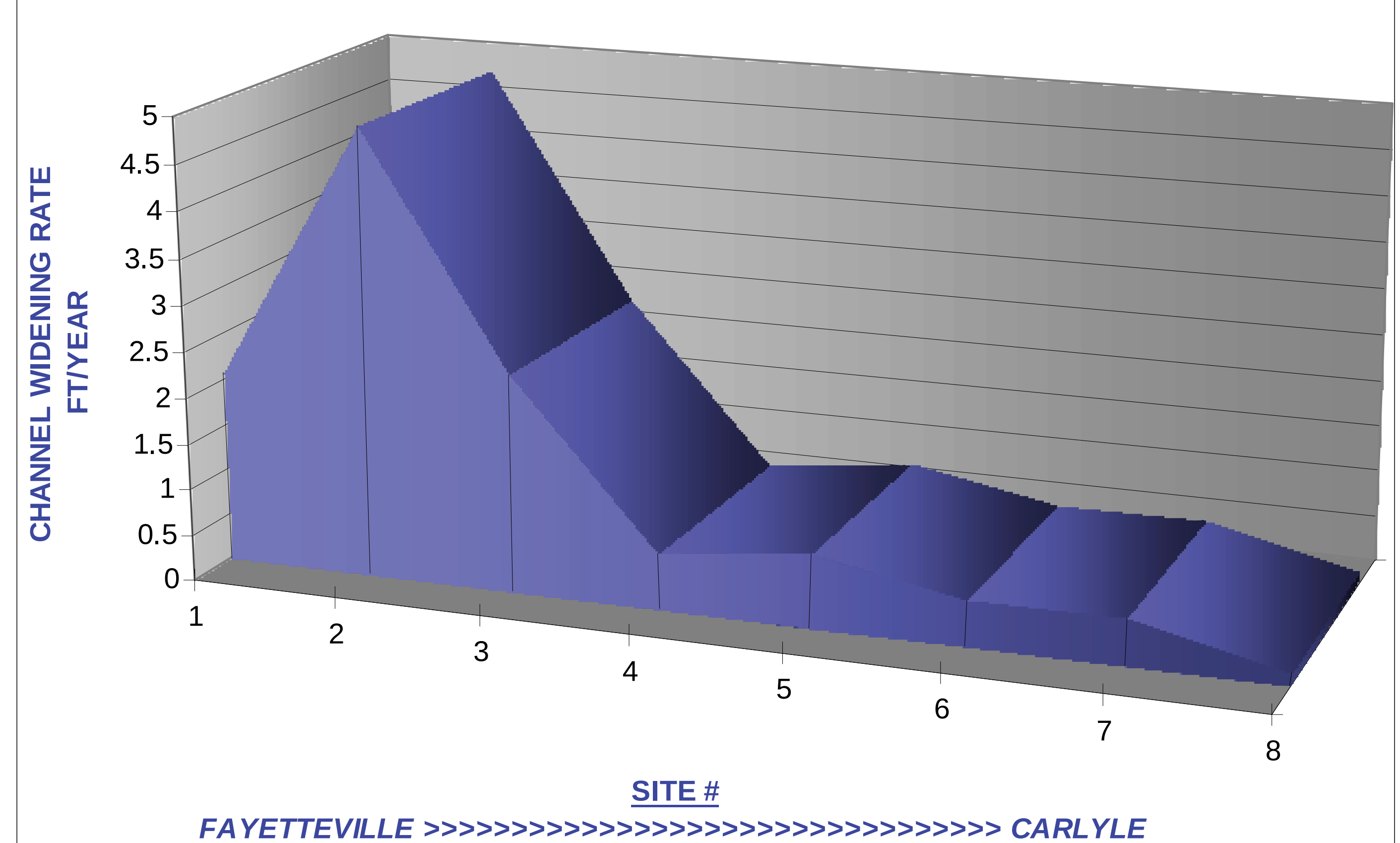
KASKASKIA RIVER BEND LOCATIONS AND RIVER MILES

Approximate Scale
1" = 2.5 miles
1:158,000

Figure 7

CHANNEL WIDENING RATES FROM 1962 THRU 1998
(FROM AERIAL PHOTO INTERPRETATION)

LOCATION	YEAR	WIDTH (FT)	TOTAL CHANGE In 36 years (FT)	RATE PER YEAR
Site 1 600 Feet Above Rte. 15 Bridge at Fayetteville	1962 1978 1988 1998	125 155 185 200	75	2.08
Site 2 5500 Feet Above Rte. 15 Bridge at Fayetteville	1962 1978 1988 1998	125 180 260 300	175	4.86
Site 3 1700 Feet Below "High Banks"	1962 1978 1988 1998	125 170 175 210	85	2.36
Site 4 500 Feet Below Confluence of Elkhorn Creek	1962 1978 1988 1998	138 138 154 160	22	0.6
Site 5 1000 Feet Above Rte. 177	1962 1978 1988 1998	125 125 138 154	29	0.8
Site 6 500 Feet Above Hoyleton Bridge	1962 1978 1988 1998	125 125 138 145	20	0.5
Site 7 2000 Feet Below Rte. 127	1962 1978 1988 1998	125 125 138 145	20	0.5
Site 8 Opposite of Carlyle Lagoon	1962 1978 1988 1998	125 125 125 130	5	0.14



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CHECKED BY: R. Davinroy

KASKASKIA RIVER
BANK EROSION STUDY

CHANNEL WIDENING RATES FROM 1962 THRU 1998

PLATE NO. 5

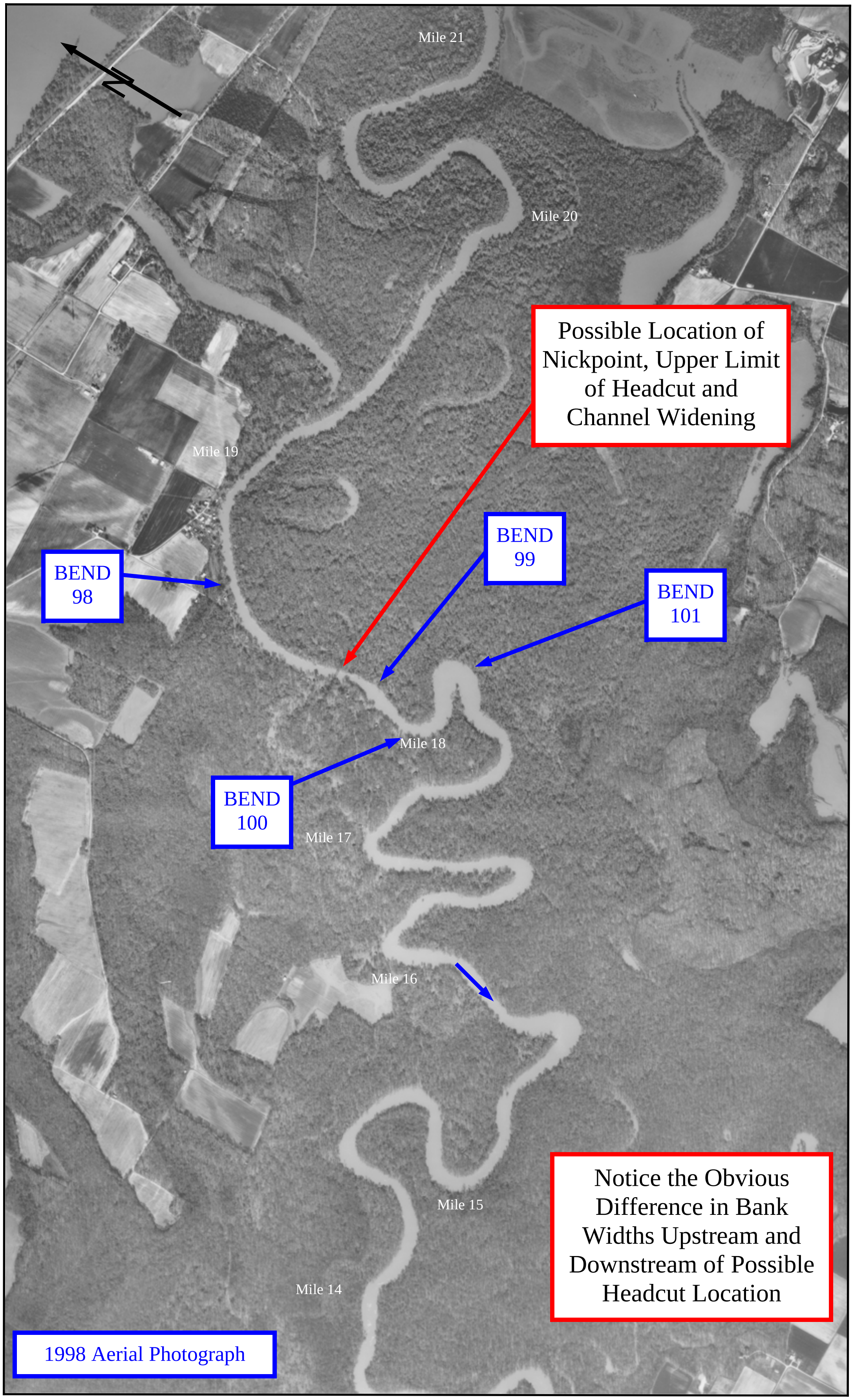
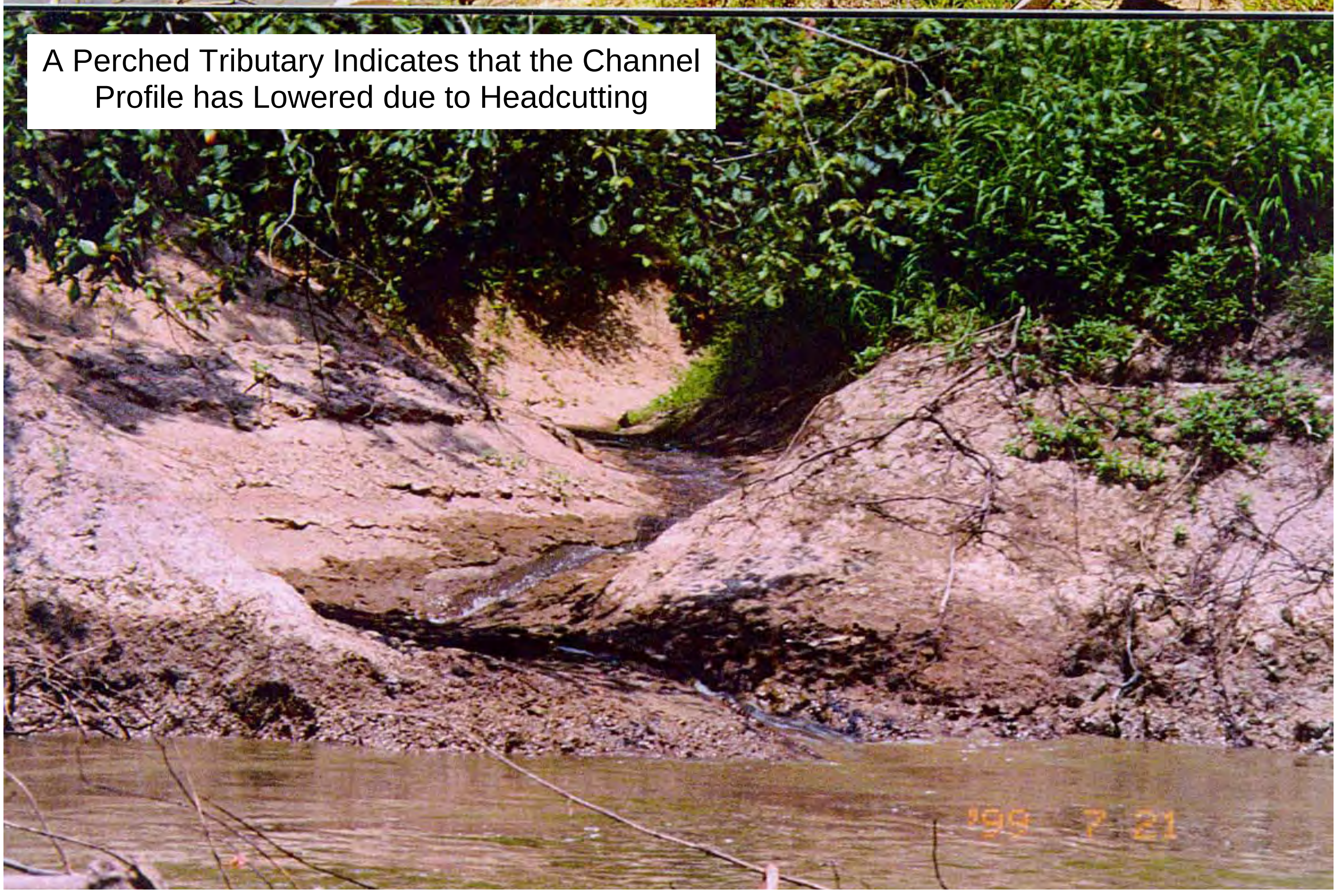


Figure 8: Possible Location of Nickpoint as Observed During the 1999 Field Reconnaissance

River Channel is Clogged with Vegetative Debris from Excessive Bankline Erosion

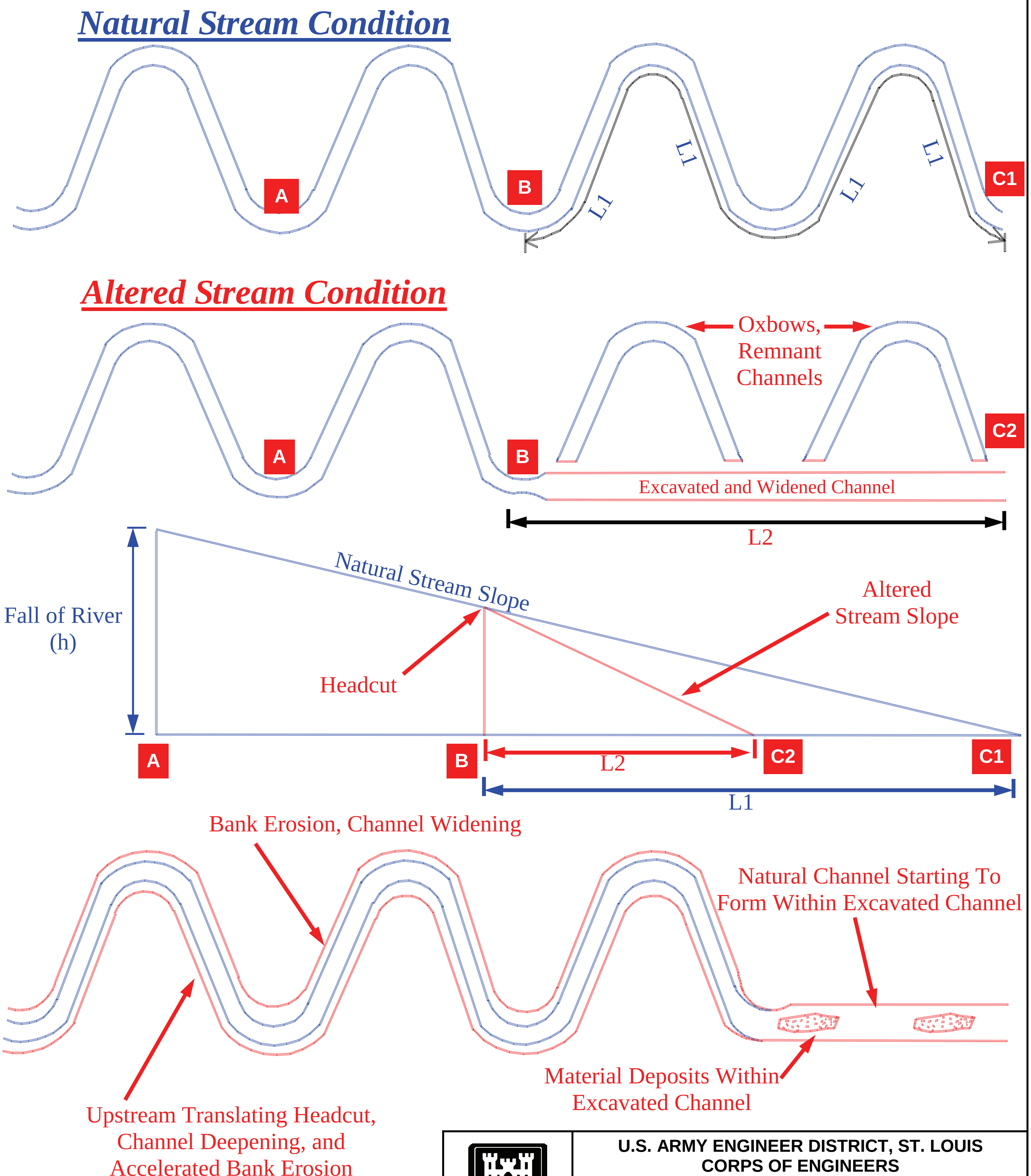


A Perched Tributary Indicates that the Channel Profile has Lowered due to Headcutting

Figure 9


The Channel Profile has Lowered due to Headcutting which has Induced Excessive Bankline Erosion
TRACKER
Excessive Bankline Erosion has Destroyed Private Property

Figure 10



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KASKASKIA RIVER
BANK EROSION STUDY

EFFECTS OF CHANNELIZATION

PLATE NO.
9

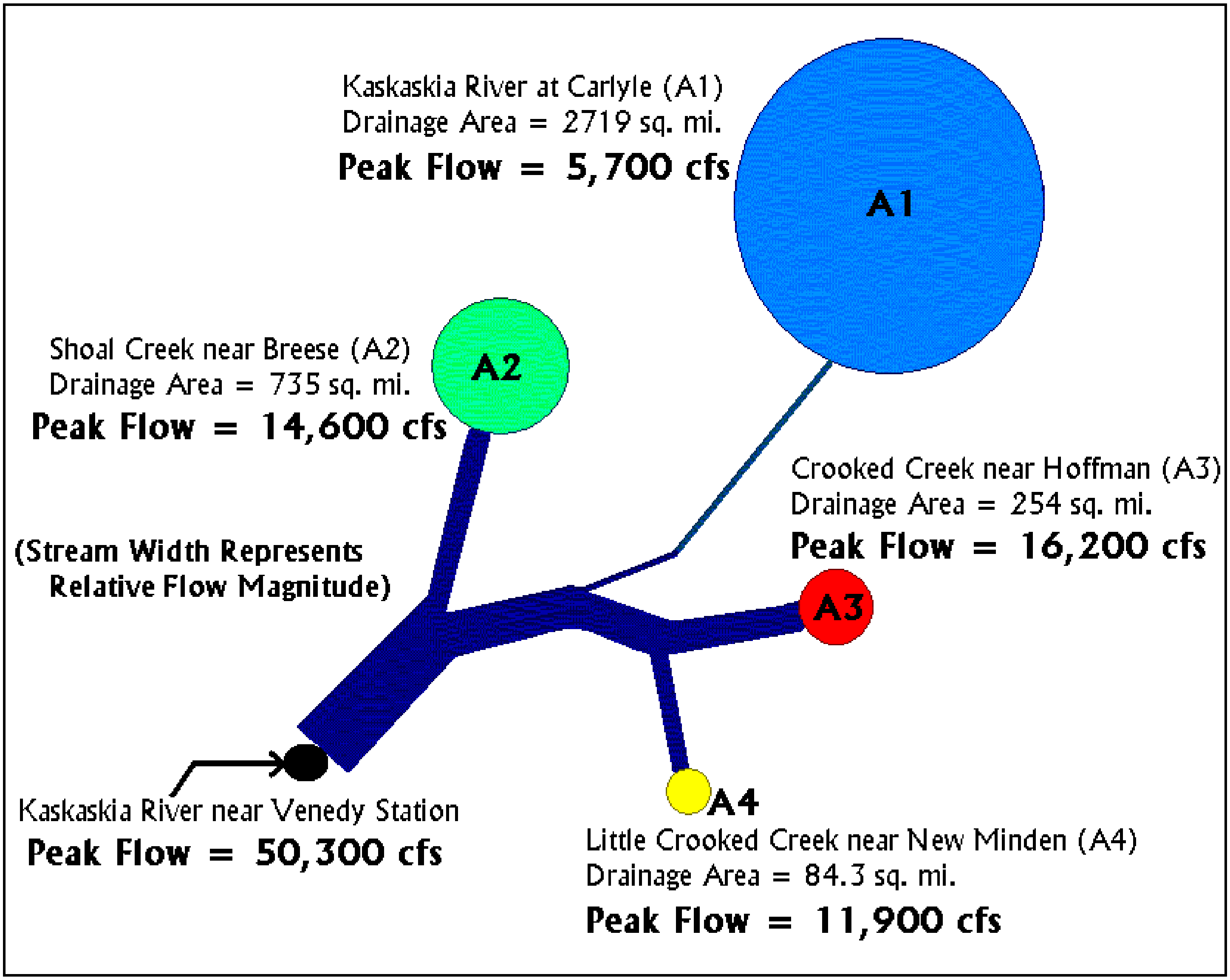
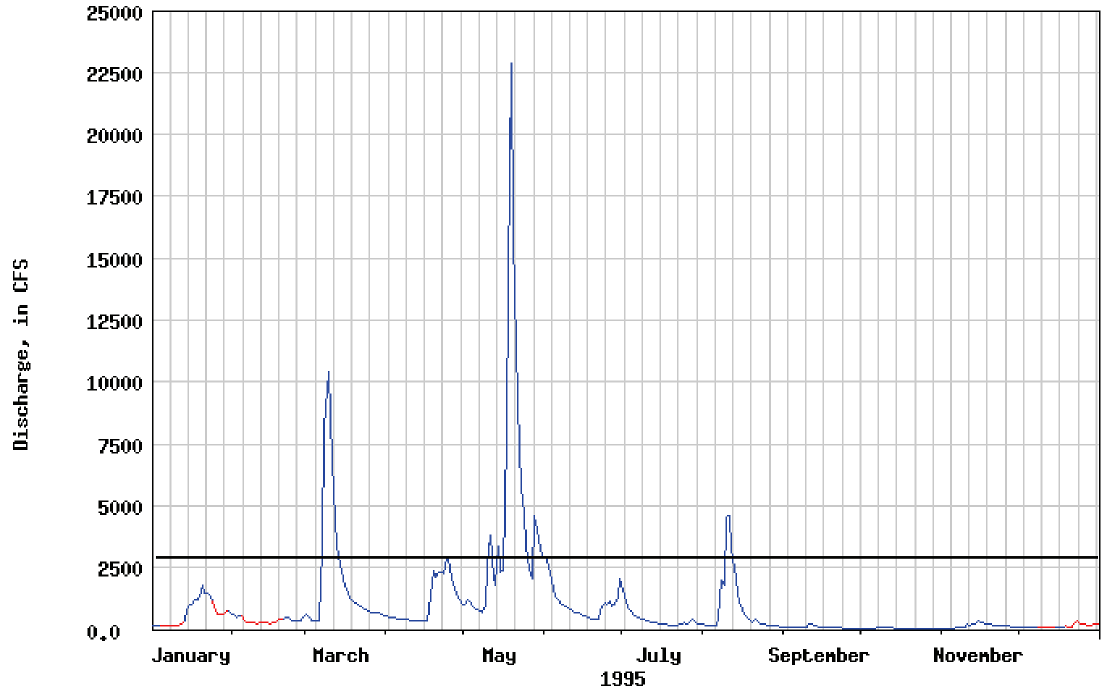


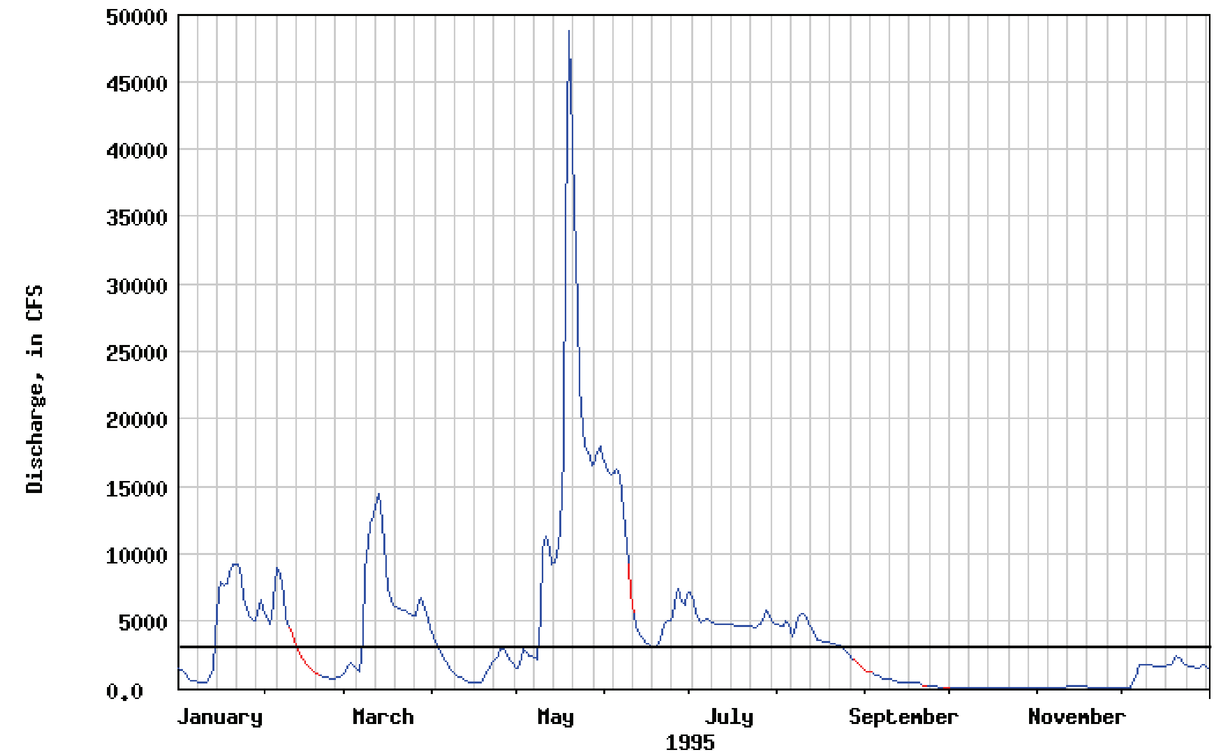
Figure 17: 1995 Flow Comparison, Kaskaskia River Basin

Embarras River At Ste. Marie, Il
Station Number: 03345500



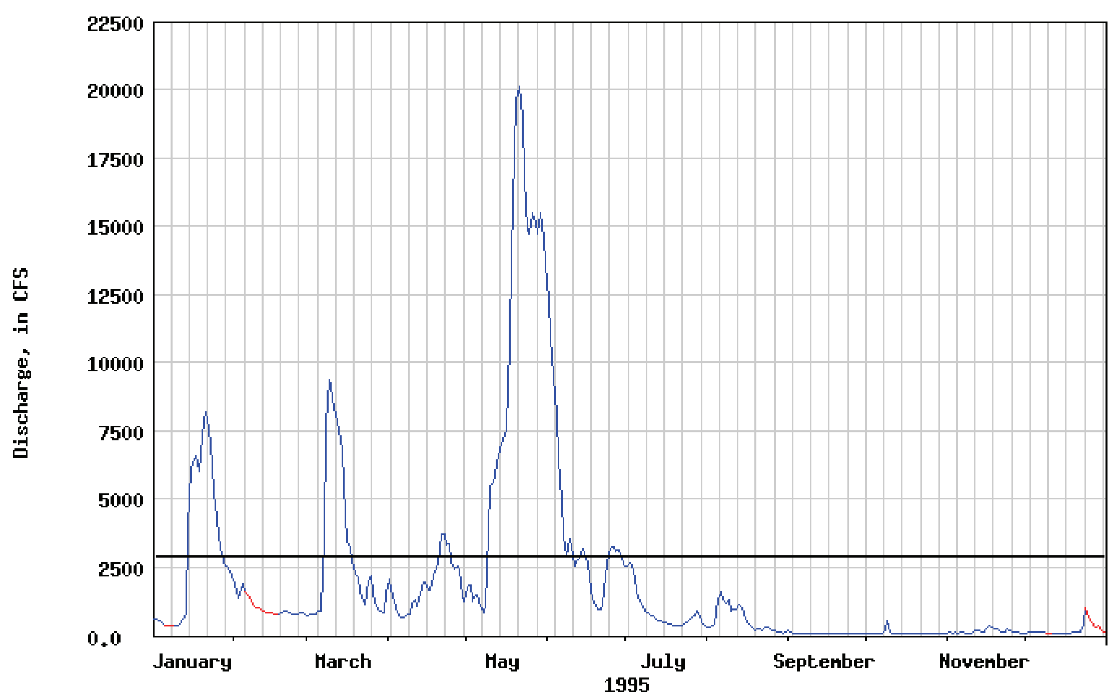
Legend: Discharge, in CFS
Estimated Discharge, in CFS

Kaskaskia River Near Venedy Station, Il
Station Number: 05594100



Legend: Discharge, in CFS
Estimated Discharge, in CFS

Sangamon River At Riverton, Il
Station Number: 05576500



Legend: Discharge, in CFS
Estimated Discharge, in CFS

Duration above 3,000 cfs discharge:

Embarras River = 69 days
Sangamon River = 76 days
Kaskaskia River = 175 days

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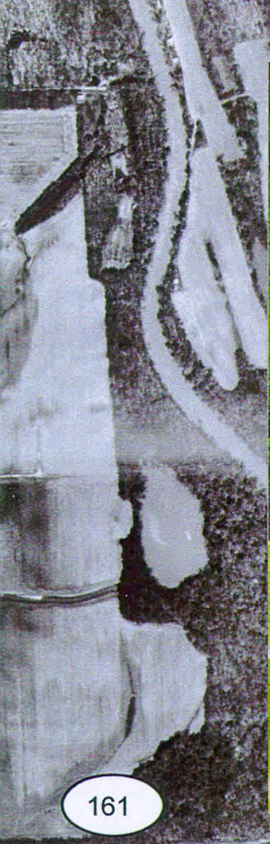
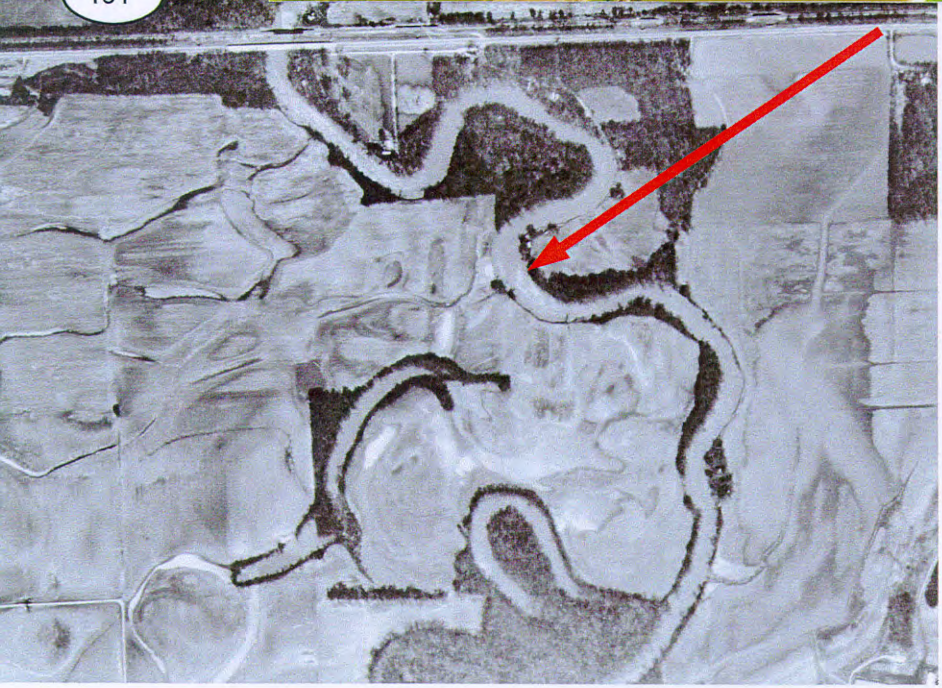
CHECKED BY: R. Davinroy

KASKASKIA RIVER
BANK EROSION STUDY

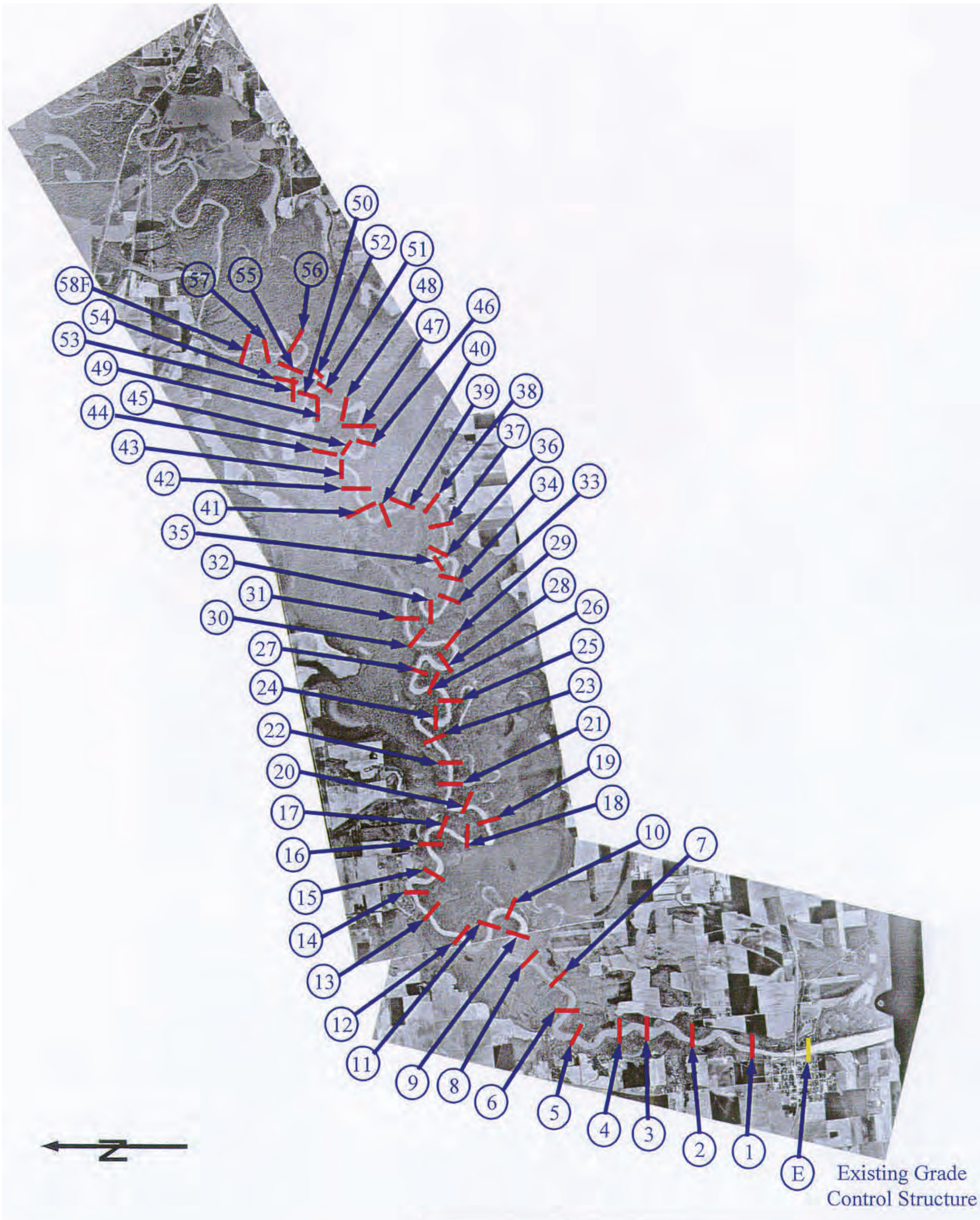
1995 FLOW DURATIONS

PLATE NO.
11





Land Clearing and Tree Removal



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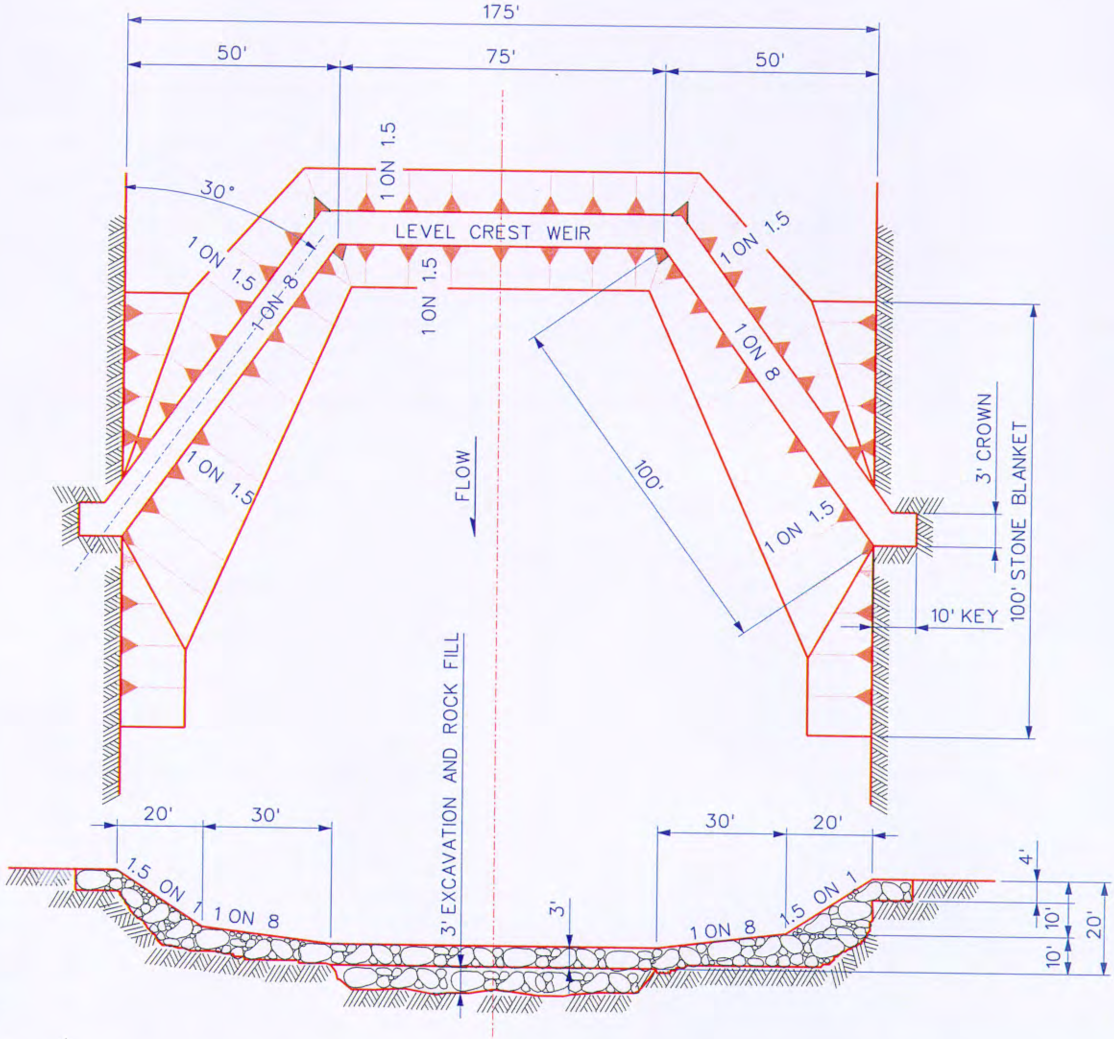
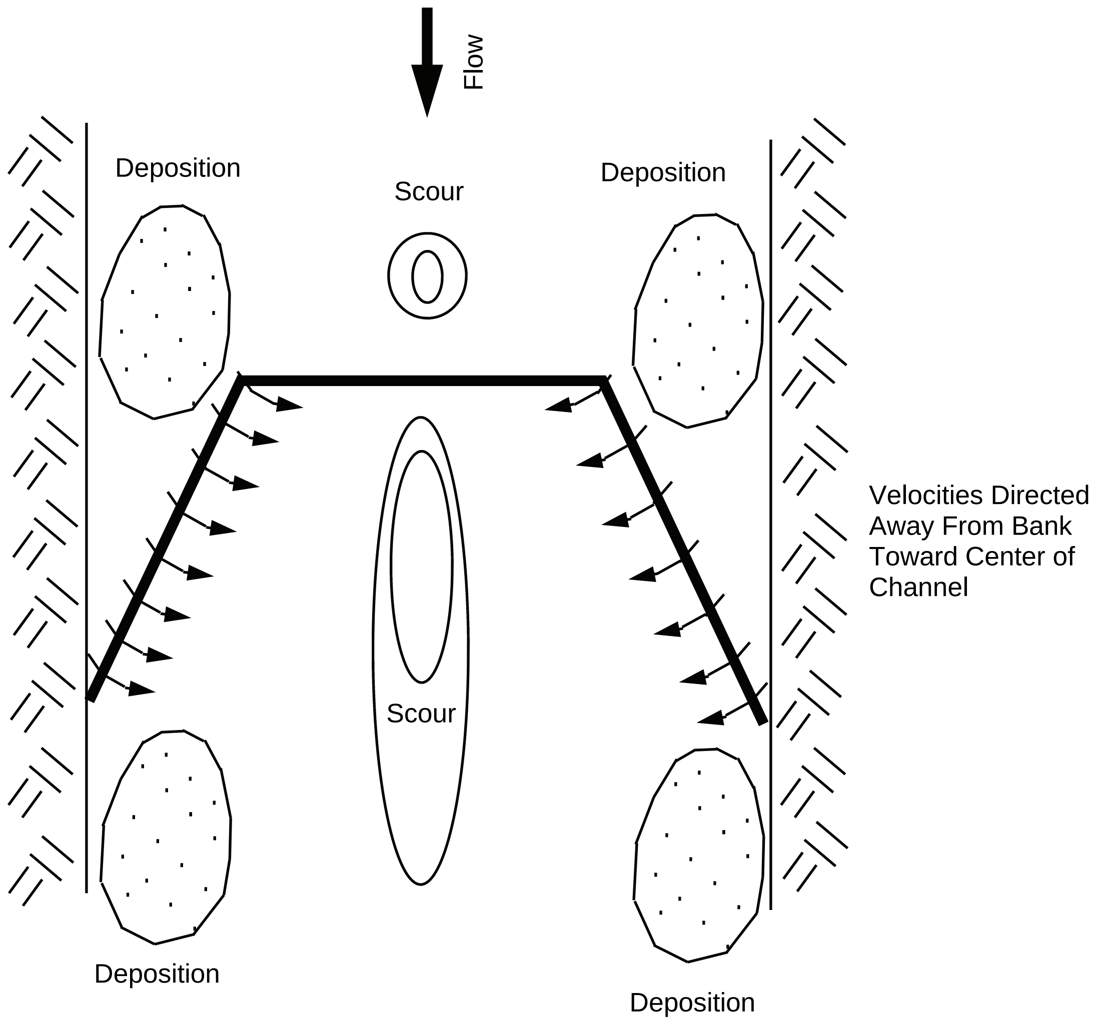
KASKASKIA RIVER
BANK EROSION STUDY

LOCATION OF PROPOSED STRUCTURES

PLATE NO.
13



TYPICAL ROCK WEIR GRADE CONTROL STRUCTURE



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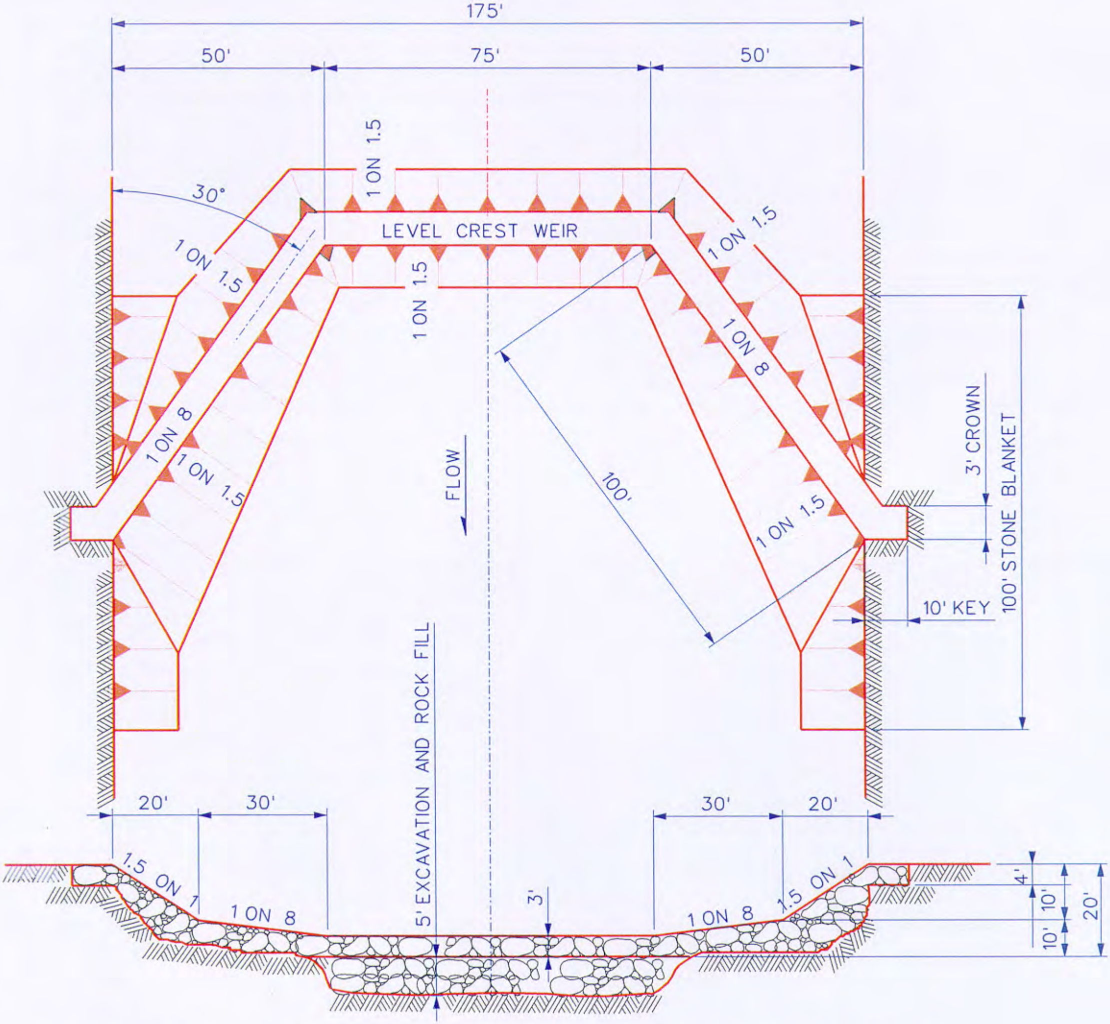
Not to Scale

KASKASKIA RIVER
BANK EROSION STUDY

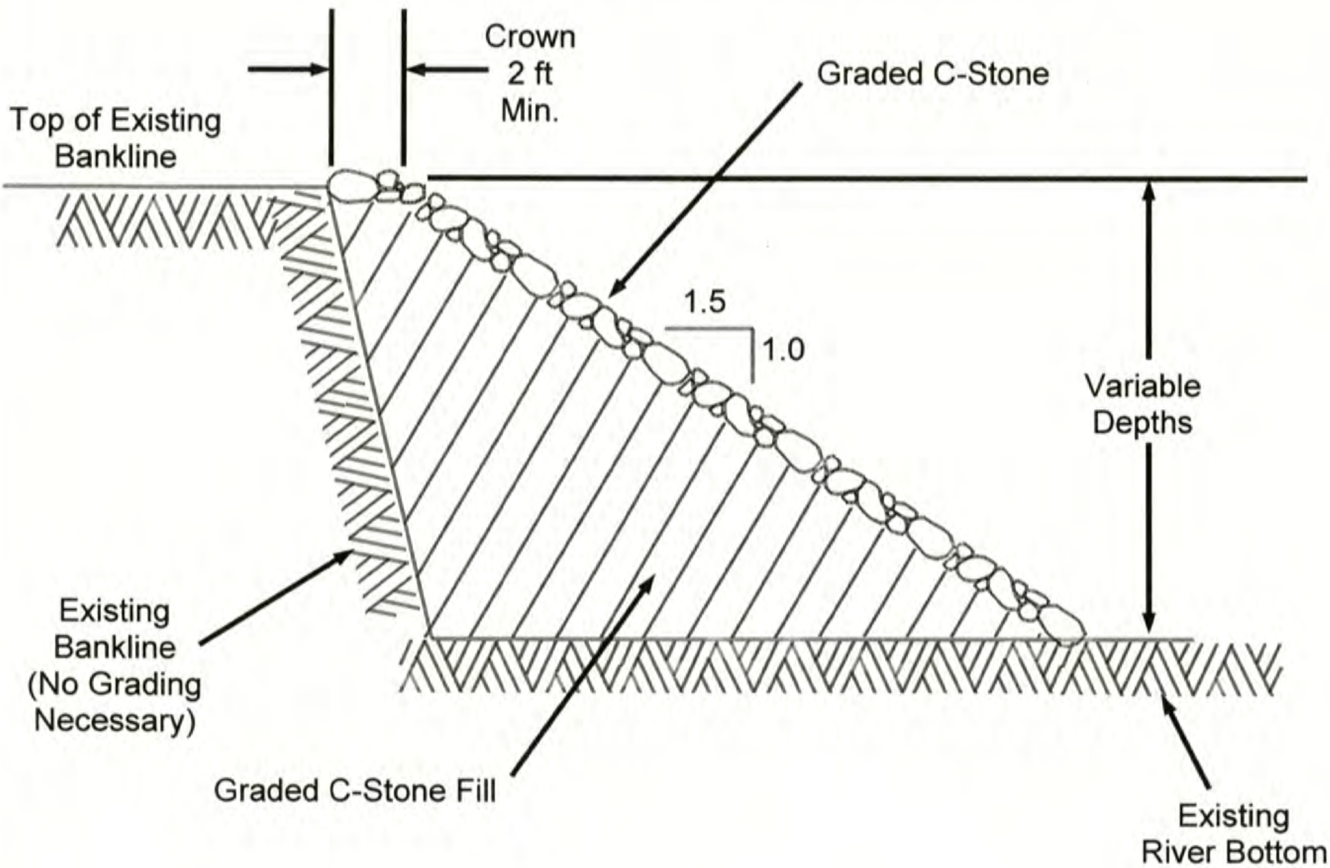
SCOUR AND DEPOSITION EFFECTS FROM CHEVRON DESIGN

PLATE NO. 15



TYPICAL HEADCUT ABATEMENT STRUCTURE

TYPICAL BANKLINE STABILIZATION



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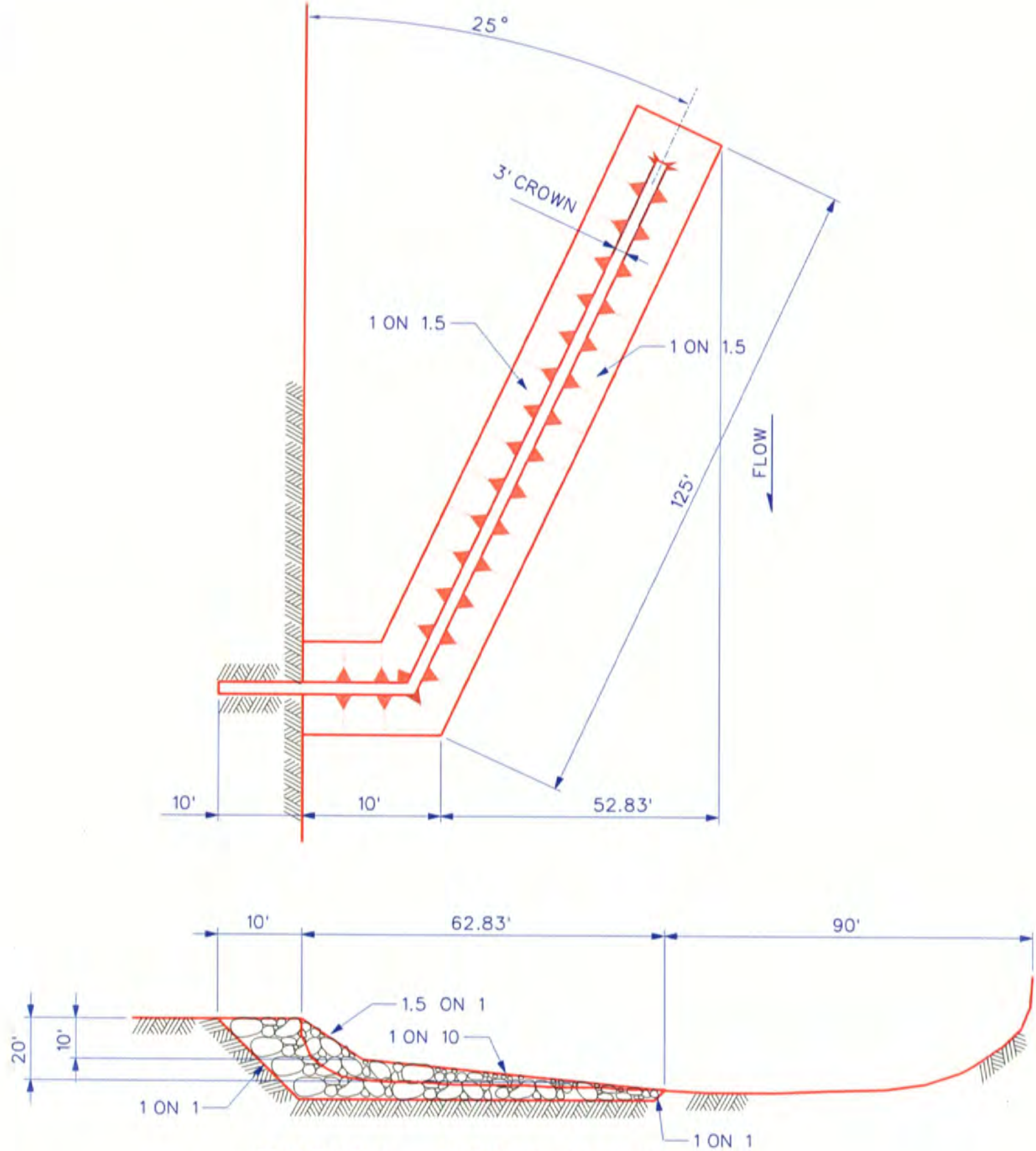
BANK EROSION STUDY

TYPICAL BANKLINE STABILIZATION

PLATE NO.
17



TYPICAL ROCK VANE

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PREPARED BY: E. RIIFF CHECKED BY: R. Davinroy	KASKASKIA RIVER BANK EROSION STUDY TYPICAL ROCK VANE
	PLATE NO. 18