Geomorphology Study of the Middle Mississippi River

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INTRODUCTION

A geomorphology study of the Middle Mississippi River, from St. Louis, Missouri to Cairo, Illinois, was conducted by the U.S. Army Corps of Engineers, St. Louis District. The study was conducted between the period of 2000 and 2005 at the Applied River Engineering Center by Mr. Edward J. Brauer, Mr. Robert D. Davinroy, Mr. David Busse, Mr. David C. Gordon, Mr. Jasen L. Brown, Mr. Jared E. Myers, Mr. Aron M. Rhoads and Mrs. Dawn Lamm. The study was originally initiated as an investigative study for the Mississippi River Channel Improvement Project and later supported by the Biological Opinion. Several people provided important input and resources for this effort including Mr. Mike Flowers, Land Surveyor for the State of Missouri, Missouri Geological Survey and his staff; Mr. Lou Gilbert, Registered Land Surveyor, Rolla, Missouri; Mr. Chuck Calli, Illinois State Archives, Springfield, Illinois; Mr. Claude N. Strauser, Retired Chief, Hydrologic and Hydraulic Branch, St. Louis District; Dr. Jerome Westphall, retired professor, University of Missouri-Rolla; Dr. Daryl Simons, retired professor and consultant, Fort Collins, Colorado; Dr. Stanley Schum, retired professor and consultant, Fort Collins, Colorado; and Dr. Terry Norris, Archaeologist, St. Louis District.

The primary goals of this report were to give a qualitatively and quantitatively chronology of the historical planform changes of the Middle Mississippi River and to develop conclusions and formulate ideas for future environmental initiatives.

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STUDY REACH

The geomorphology of approximately 180 miles of the Middle Mississippi River (MMR) was analyzed in this study, from St. Louis, Missouri, Mile 180.0, to the confluence of the Mississippi and Ohio Rivers, Mile 0.0. Figure 1 is a vicinity and location map of the area. Primary tributaries between the mouth of the Ohio River and St. Louis, Missouri include the Meramec, Kaskaskia and Big Muddy Rivers. The drainage area covers part or all of twelve states including Montana, Wyoming, Colorado, North Dakota, South Dakota, Nebraska, Kansas, Wisconsin, Iowa, Missouri, Michigan and Illinois.

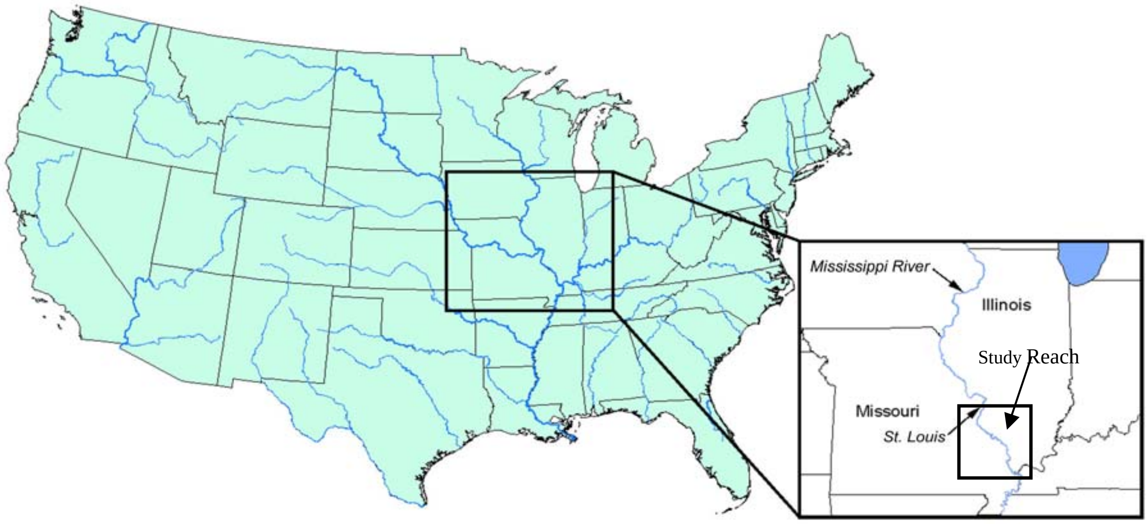


Figure 1: Location of Study Reach

BASIN GEOLOGY

Most scientists believe the geology of the Mississippi River basin was formed by the advance and retreat of the continental glaciers. The glaciers were approximately 5,000 to 10,000 feet thick and covered hundreds of thousands of square miles. The advance and retreat of the glaciers scoured the earth and created many lakes, most of which can be found in the northern part of the basin (Davinroy, 2005).

The retreat of the glaciers produced enormous flows along with massive chunks of ice that worked to carve out the valleys. During the retreat of the glaciers, over five hundred feet of glacial till were deposited in some areas of the basin. The glacial till consisted of silts, clays, sands and gravels.

GENERAL RIVER CHARASTERISTICS

The study reach was divided into two distinct geomorphic sub-reaches. Sub-reach 1 included the river between St. Louis, Missouri (Mile 180.0) and the lower end of Thebes Gap (Mile 40.0). Sub-reach 2 encompassed the lower end of Thebes Gap and the mouth of the Ohio River (Mile 0.0). The majority of the study reach encompassed sub-reach 1. Figure 2 shows the location of the two sub-reaches.

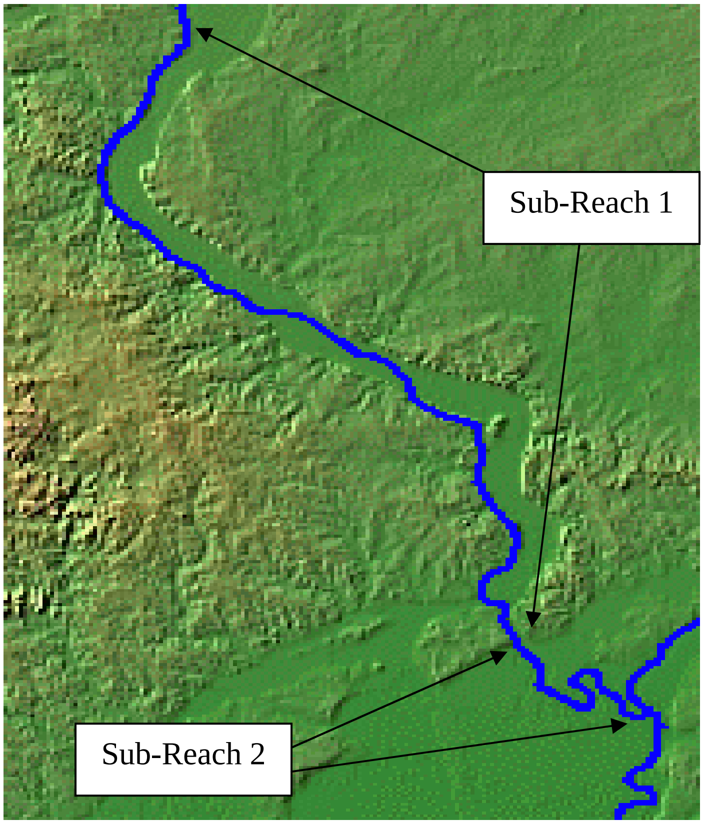


Figure 2: Sub-reach Location

In sub-reach 1 the floodplain width varies between 10,000 feet and 40,000 feet with an average floodplain width of approximately 31,000 feet. The channel (bank to bank) in this reach varies between 1400 feet and 3800 feet wide. The corresponding floodplain width to channel width ratio varies between 7 and 10. The river in this reach may be classified as a mildly sinuous canaliform, characterized by narrow crescent-shaped point bars, a notably uniform width, a lack of braiding, and low to moderate sinuosity. The material found in the floodplain is predominantly alluvium in the form of fine sands, silts and clays. Rock outcroppings and clay plugs are also abundant.

The floodplain width in sub-reach 2 varies between 10,300 feet to over 500,000 feet with an average floodplain width of approximately 333,000 feet. The channel (bank to bank) in this reach varies between 1000 feet and 7000 feet wide with an average channel (bank to bank) width of approximately 5,000 feet. The ratio of floodplain width to channel width ranges between approximately 5 and 200. The river in this reach can be classified as a highly sinuous point bar canaliform, characterized by prominent point bars and lower bank erosion resistance as compared to the characteristics found in sub-reach 1. The average slope of the river along both reaches is approximately 0.5 ft per mile.

CLIMATE

The surrounding bi-state region of Missouri and Illinois which is adjacent to the MMR has a temperate, semi-humid climate characterized by a mean annual precipitation and temperature of 37.5 inches and 56.2 degrees Fahrenheit, respectively (Degenhardt, 1973)

HISTORY

Most early settlements were located along a body of water. The water was a source of food, transportation and fertile soil. The MMR Basin was no exception. Just south of the confluence of the Missouri and Mississippi Rivers, was the home to one of the largest prehistoric sites in North America. At its peak, Cahokia, Illinois covered nearly six square miles and had a population of up to 20,000. "The discovery of prehistoric river craft, such as the Ringler dugout, a wooden canoe, is evidence that Native Americans used the river systems as highways of transportation and trade at least three thousand years prior to the arrival of Europeans in North America"(Norris, 1997).

Beginning in the sixteenth century European empires sent explorers to America to stake claims to the new land. The first European to discover the Mississippi River was the Spanish explorer Hernando De Soto. De Soto and his expedition discovered the Mississippi River in 1541 at a site near present day Memphis, Tennessee. Over one hundred years later in 1673, French missionary Jaques Marquette lead the first European exploration of the Upper Mississippi River.

Two of the most famous early river travelers were Captain Meriwether Lewis and William Clark. Following the Louisiana Purchase in 1803, Thomas Jefferson selected Lewis and Clark to find “the most direct and practicable water communication across this continent for the purpose of commerce.” Prior to their famous Corps of Discovery Expedition, Lewis and Clark traveled up the Mississippi River from the Ohio River to Camp River Dubois where they began their westward journey. Along the journey up the Mississippi to Camp River Dubois, Lewis and Clark stopped at the Illinois town of Kaskaskia where they recruited twelve new soldiers, obtained a second pirogue and hired French boatmen to assist in their expedition.

During the seventeenth and early eighteenth centuries French explorers established settlements along the Mississippi River at the confluence of other large rivers such as the Missouri, Illinois, Ohio and Arkansas in quest of minerals and furs. Cahokia, Illinois founded in 1699, was the earliest French settlement still in existence. Next to be established was Kaskaskia, Illinois which was followed by a series of east bank towns at Prairie du Pont, Illinois Fort Chartres, Illinois, Fort Vincennes, Illinois on the Wabash. Settlements by the French on the west bank of the Mississippi included Ste. Genevieve, Missouri and New Madrid, Missouri, these were followed by St. Louis, Missouri, St. Charles, Missouri, Carondelet, Missouri in 1767, St. Ferdinand, Missouri (now Florissant) and Portage des Sioux (“Physical Growth”). Like their predecessors, the French explorers used the Mississippi River to transport passengers and goods.

St. Louis was founded in 1764 and quickly developed into the primary trading post on the Mississippi River Valley. By 1768, St. Louis had a population of over 500 inhabitants and rivaled Ste. Genevieve as the largest settlement on the Mississippi River north of New Orleans. The introduction of the steamboat would change St. Louis and the Mississippi River forever. "The first steamboat, the "Zebulon M. Pike," arrived in St. Louis from Louisville on July 27, 1817" (**"**Physical Growth"). Between 1817 and 1858 the annual steamboat arrivals grew from 3 to over 3600 and the population grew from 3000, in 1817, to over 160,000 by 1860. A chart of annual steamboat arrivals to the port of St. Louis is shown in Figure 3. Figure 4 is a graphic depicting the city of St. Louis in 1859.

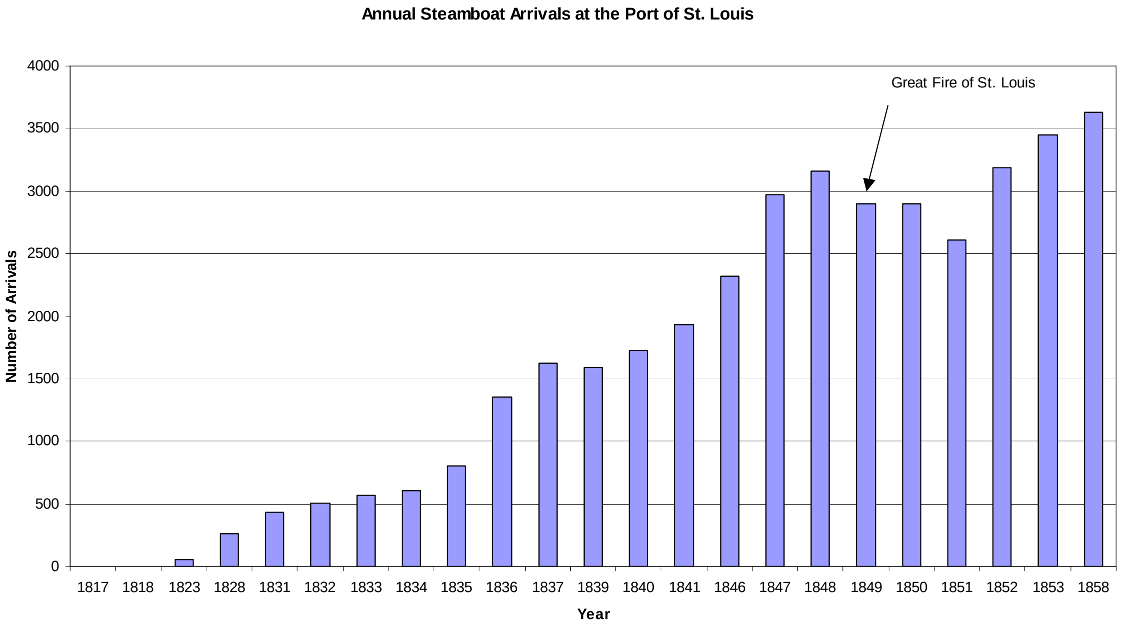


Figure 3: Annual Steamboat Arrivals in St. Louis

Figure 4: City of St. Louis, 1859

Between 1810 and 1850 over 4,000 people died in steamboat accidents. Mark Twain observed that "the Mississippi changes its channel so constantly that the pilots used to always find it necessary to run down to Cairo to take a fresh look, when their boats were to lie in port for a week; that is, when the water was at a low state." Snags also contributed to a large number of accidents on the river. Even if a snag did not penetrate the hull, they could still cause damage to the paddle wheels or other exterior parts of the boat. It is no surprise that the lifespan of a steamboat during the 1880's was only eighteen months considering the dangers they faced. In addition to the collisions and snags, many boats were destroyed by fire and explosions.

Figure 5: Sunken Steamboat

RIVER TRAINING STRUCTURES

The first river training structures constructed in the MMR were engineered by Lt. Robert E. Lee in 1838 to move the navigation channel from the Illinois bank to the Missouri bank. The structures were necessary because "the obvious tendency of the river is to open itself a channel on the Illinois side, eventually to fill with alluvium and to desert the Missouri channel, which constitutes the harbor," as stated in House Document Number 2, 1843. Lee used a system of dikes to move the main channel back towards the Missouri shore and incorporate Bloody Island, a large sandbar in St. Louis Harbor, into the Illinois shore line. Figure 6 is an 1837 Map of St. Louis Harbor showing the proposed dike and revetment locations.

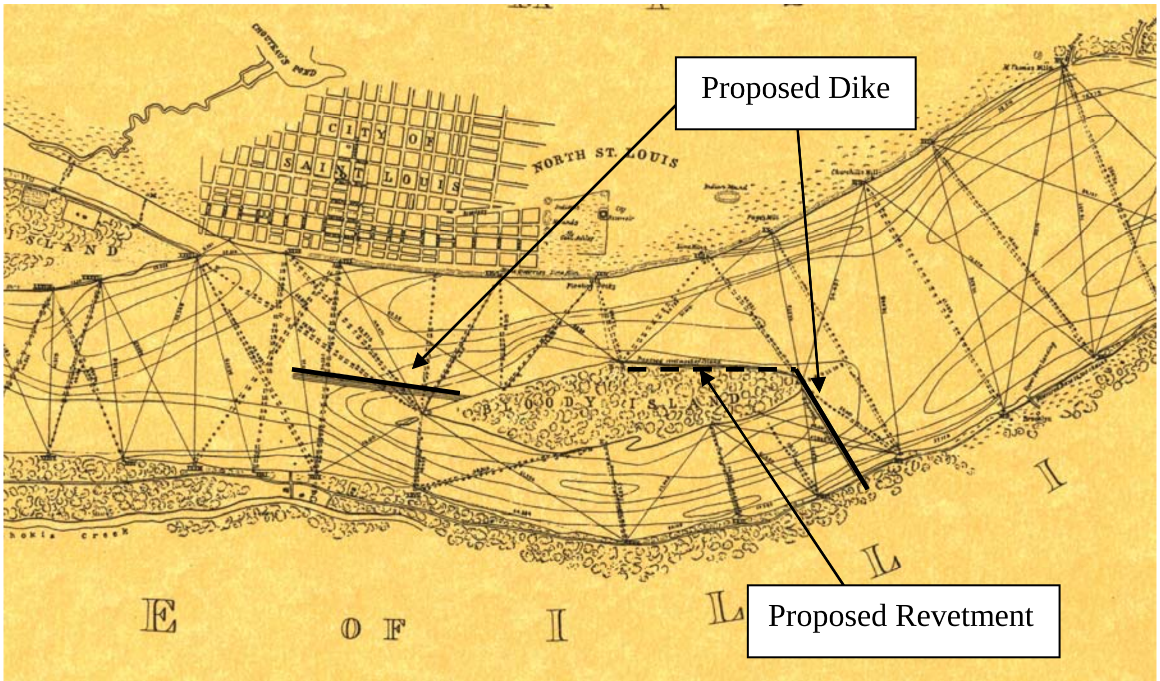


Figure 6: Map of the Harbor of St. Louis, 1837

After the construction of the dikes in St. Louis Harbor by Lt. Robert E. Lee, the Federal Government did not construct another river training structure in the river until 1872. The main focus of work shifted to snagboat operations.

In 1879, the Federal Government began developing a coordinated plan for the Mississippi River with the establishment of the Mississippi River Commission (MRC). The purpose of the MRC was to "improve and give safety and ease to navigation" and to "prevent destructive floods" on the Mississippi River. The MRC was a seven member advisory board that consisted of three representatives from the U.S. Army Corps of Engineers, one representative from the Coast and Geodetic Survey, and three civilians, at least two of whom were required to be engineers. All members of the MRC were appointed by the President of the United States and confirmed by the Senate. All MRC work was done through the U.S. Army Corps of Engineers, which was also responsible for supplying necessary plants and equipment ("Mississippi River").

The master plan for the channel stabilization works along the MMR was to "to make the improvement continuous, working downstream from St. Louis, by reclaiming land and building up new banks, thus reducing the width of the river to the uniform width of about 2500 feet" (Ernst, 1881). This plan was based on the idea, observed by Captain O.H. Ernst, that "The shoals in the Mississippi are constantly shifting their position, and there are very few spots now occupied by them where there has not been deep water within a recent period. It is pretty well established that there was in former years a depth of water throughout the navigable channel at the lowest stage at least equal to what we shall endeavor to obtain by our works" (Ernst, 1880). All of the construction was intended "simply to restore what once existed and to do it in such a way that the restoration shall be permanent" (Ernst, 1881).

The types of structures used starting in 1872 were wood pile dikes and willow weave mattress. Pile dikes were permeable structures made from timber hurdles and built at an elevation of the present day equivalent to twenty to twenty five feet on the St. Louis Gage. Figure 7 is a detail view of a timber hurdle. Figure 8 shows a detailed plan of a willow weave mattress. Figure 9 is an illustration showing workers constructing pile dikes. One of the problems with the pile structures was their durability. Pile structures would have to be periodically repaired after the ice season or after an accident with a vessel or floating debris. During the Great Depression the Corps of Engineers began using hand placed stone riprap along eroding banks. Figure 10 shows workers placing stone riprap. The construction of stone dikes began in the 1960's. Most of the dikes built after 1963 have been constructed of stone. Engineers presently are developing and building new river training structures to not only assist in maintaining a navigable channel but to restore and create biological habitat. Some examples of these types of structures are bendway weirs and chevrons. Figures 11 and 12 show the number and length of dikes constructed in each decade since 1880.

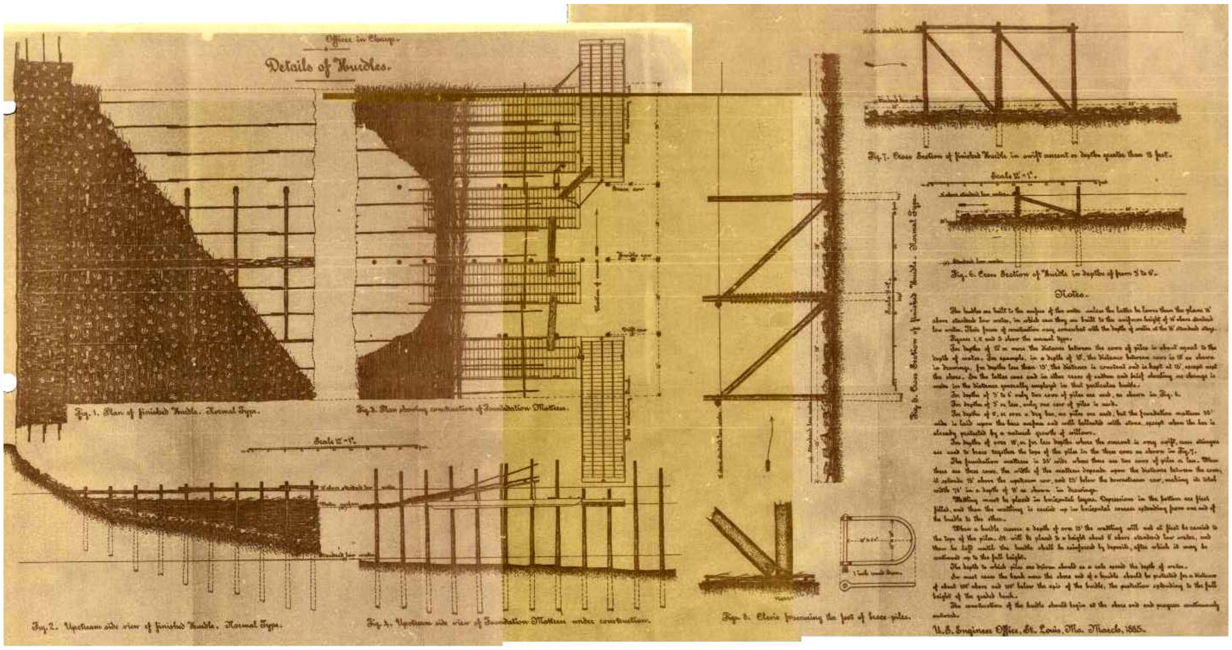


Figure 7: Detail view of a timber Hurdle

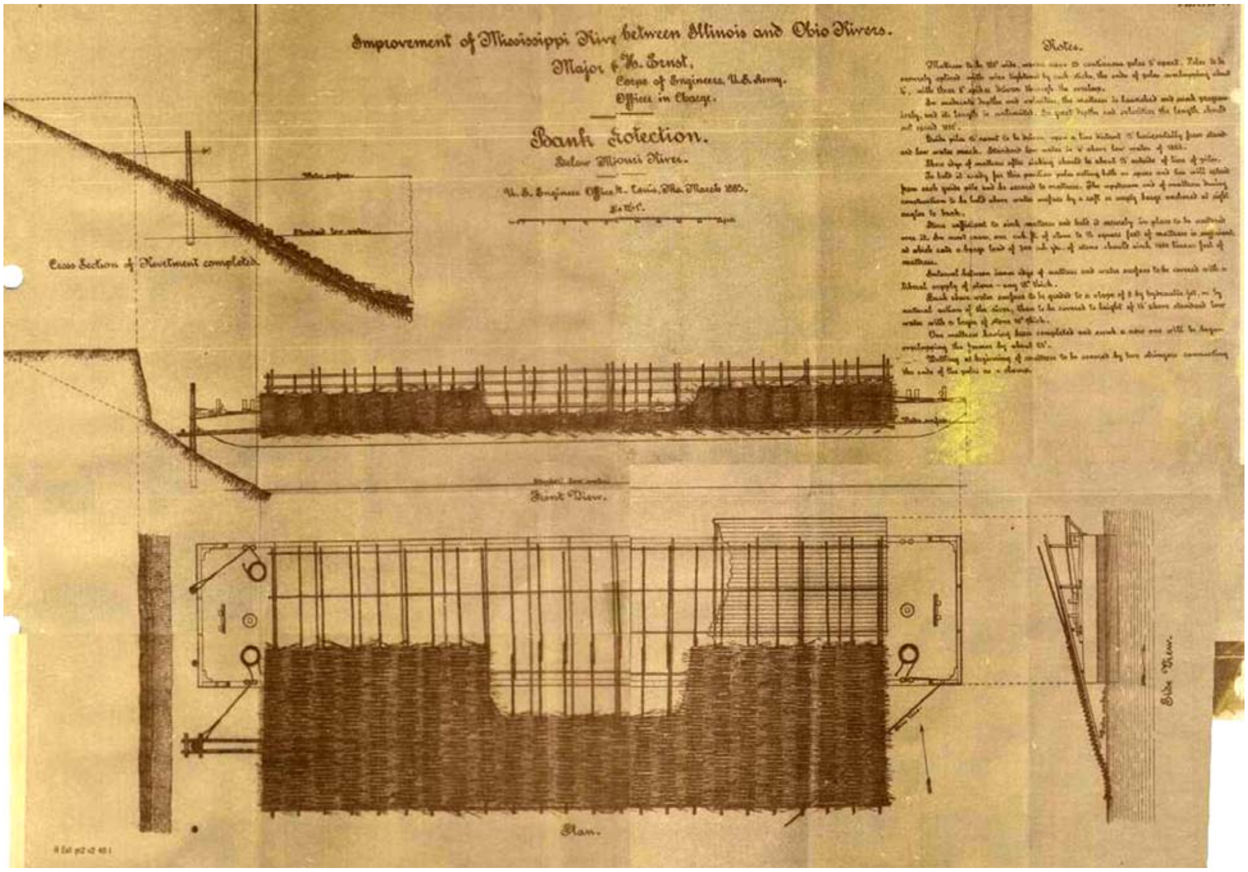


Figure 8: Detail view of a willow weave mattress

Figure 9: Workers Constructing a Pile Dike


MISSISSIPPI RIVER
Locality - Giboney Isl.-Devils Isl. (47-62)
Contractor - Morrison-Glasscock-Connor Co.
Cont. No. - W-1103-eng.-1920
PAVING BANK
Nov. 16, 1934 (Giboney Island, Ill.) 374

Figure 10: Workers placing stone revetment, 1934

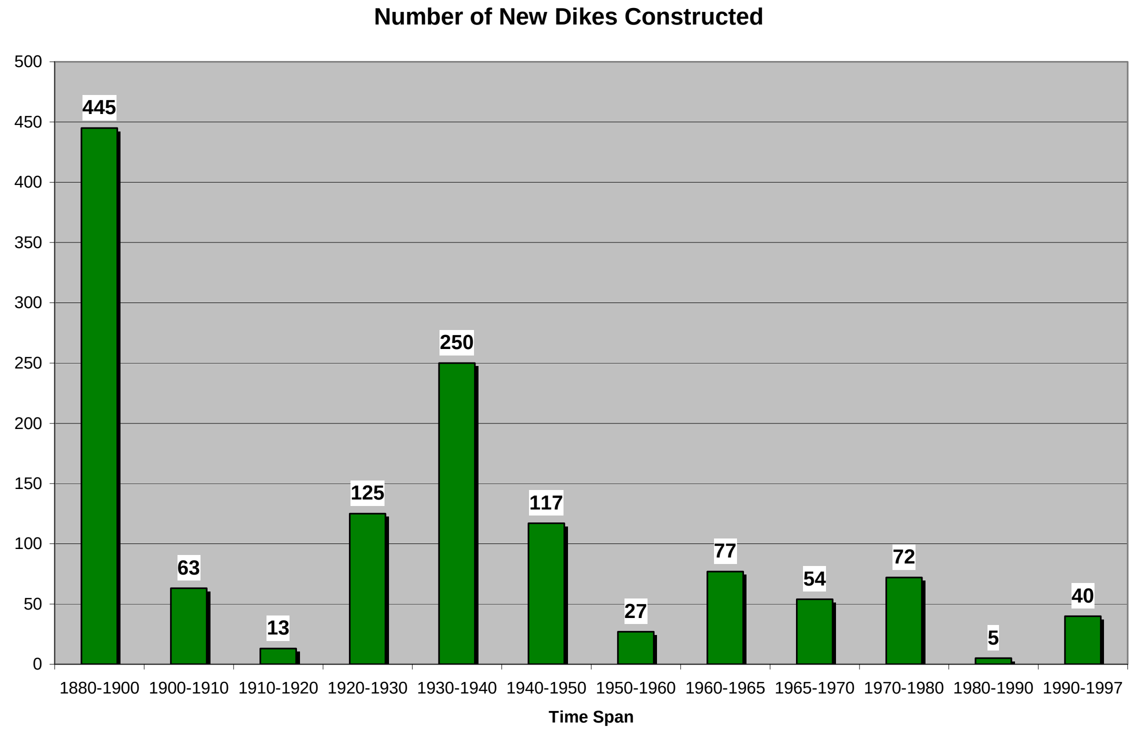


Figure 11: Number of Dikes Constructed

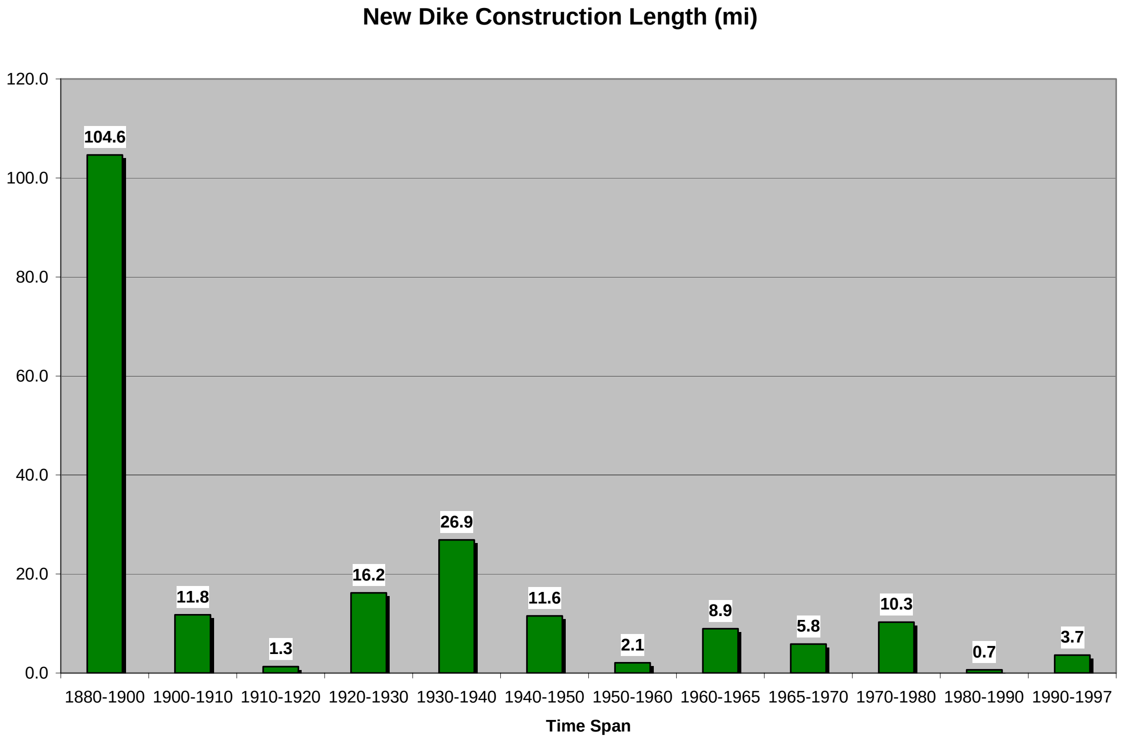


Figure 12: Length of Dikes Constructed

GEOMORPHOLOGY STUDY

The primary goals of this study were to define and develop a detailed historical baseline of the Mississippi River prior to the steamboat era to qualitatively and quantitatively compare the “undisturbed” river to the modern day river. The conclusions developed by this comparison were used to formulate ideas that may influence future environmental initiatives. This task was accomplished by researching all known available records and maps in order to find the most complete and accurate historical data of the Mississippi River. This data was then used to produce historic planforms used in this report. These planforms can be found in Appendix A.

AVAILABLE MAPS AND DATA

Many historic maps, surveys and journals exist of the Mississippi River dating back to the eighteenth century. Unfortunately many of these records were sketches and did not contain enough accurate geographic information to make historical planform comparisons. Furthermore many of the early maps and surveys covered only a small portion of the study area. The requirements of accuracy and completeness made obtaining early data difficult. The historical maps and surveys used in this report were the most accurate and complete maps and surveys that exist of the Mississippi River. These were the 1817-1820 Government Land Office (GLO) surveys, the 1866 Mississippi River Maps produced by the U.S. Army Corps of Engineers under the direction of Bvt. Major General G. K. Warren, the 1881 Mississippi River Commission (MRC) Surveys, and aerial photographs from the years 1928 and 2003.

The GLO surveys were detailed surveys created to divide and sell land in the central and western United States. The State of Missouri began surveying in 1817 whereas the State of Illinois began surveying in 1820. The field data was recorded in survey books and the data was later used to create the GLO survey maps. The GLO surveys established the original sections and townships still observed today on modern United States Geological Survey (USGS) Quadrangle Maps. Rivers that were potentially navigable were also surveyed by the deputy surveyors. This was accomplished by establishing a baseline parallel to the river and measuring perpendicular lines to strategic points or “meander lines”.

The GLO surveys were surprisingly accurate considering the rough terrain encountered by the surveyors and antiquated surveying equipment they used. With that said there was much room for error, especially when surveying the river. At the time the surveys were being conducted, the Government was in need of money and the surveyors were instructed to get the land surveyed quickly so the divided land could be sold. It should be noted that in some cases, features in the river such as islands too small to sell were not included on the maps or were not surveyed accurately depending on the surveyor.

The “Maps of the Mississippi River from the Junction of the Minnesota to the Junction of the Ohio River in 22 Sheets” produced under the direction of Bvt. Major General G. K. Warren, U.S. Army Corps of Engineers, St. Louis District, 1869 were used as the source of the 1866 planforms.

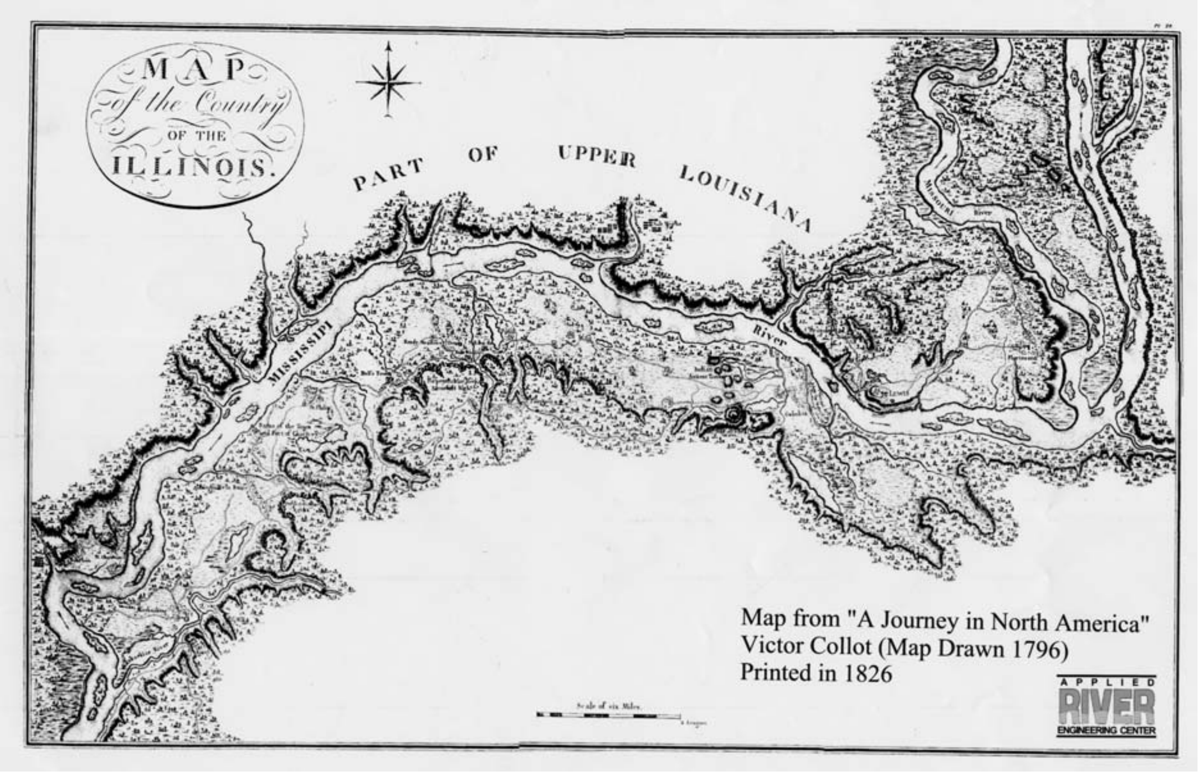
The source of the 1881 planform was detail maps of the Upper Mississippi River published by the Mississippi River Commission. The sheets were projected and drawn from actual surveys made under the direction of the MRC. The surveys were conduced in the years 1880 to 1882, 1884, 1888, 1889, and 1891 to 1899. These maps were made immediately following the creation of the MRC possibly as a baseline for the construction of training structures.

An attempt was made to use “The Map of the Mississippi River Between the Mouth of the Illinois and the Mouth of the Ohio Rivers” made from surveys under the direction of Lt. Col. W.F. Raynolds and Col. Jas. H. Simpson between 1870 and 1878. These surveys did not contain enough detailed control points to georeference to current land features and therefore could not be used.

VICTOR COLLET MAP OF 1796

One of the earliest known charts is the Victor Collet map of the Middle Mississippi River produced in 1796, shown in Figure 13. Some scientists consider this chart to be a good example of the “natural state” of the river. After calculations were performed on this chart, it was determined that the scale and features on the chart were distorted and could not be considered as an accurate reference. By taking known geological point locations that have remained constant over time some important observations were made of this map: The representative river length on the Collet map was on the average thirty percent shorter as compared to the actual river length. The representative lateral floodplain width on the Collet Map, bluff to bluff, was on the average twenty six percent too wide as compared to actual floodplain width. Furthermore, most of the river on the Missouri side was not drawn properly in relation to the bluffs. It is known from the 1817, 1880 and modern day maps that the planform of the river has been fixed mainly along the Missouri bluffs. Collet’s chart shows the river being as much as twenty five hundred feet from these bluffs. It is unlikely that the river could have moved twenty five hundred feet towards the Missouri bluffs in the twenty one years between 1796 and 1817, therefore the distance between the river and the Missouri Bluffs is a function of the distortion of the drawing.

These problems resulted in a distorted drawing of the river. The distorted river length and floodplain width make the river appear compressed on the map. These discrepancies are evidence that the Victor Collet map is an artist’s rendering of the MMR and can not be used for quantitative geomorphologic analysis.



Map from "A Journey in North America"
Victor Collot (Map Drawn 1796)
Printed in 1826

Figure 13: Victor Collet Map, 1796

CREATING THE 1817-2003 PLANFORMS

All of the raw data (maps, surveys, aerial photographs) were digitized using a flatbed scanner. The digital images were then georeferenced. Georeferencing is the process of putting digitized images into their correct place in space by matching known points from the digital images to the same points on previously georeferenced USGS quadrangle maps. These known points include but are not limited to survey lines, railroad tracks, road intersections and other permanent structures. The georeferencing was conducted using the computer program IRAS C by Bentley. The georeferenced images were then used to accurately digitize bank locations, river widths, dike locations, weir locations, and island locations.

All individual digital GLO maps were georeferenced whereby a mosaic was produced to develop the planform of the river. The 1817 planform was traced along the survey lines of the MMR as shown in the GLO surveys. The islands included on each planform were defined as the islands marked to contain vegetation. The 1866 planform was extracted from the river boundaries defined by the "Mississippi Maps" created by the U.S. Army Corps of Engineers under the direction of Bvt. Major General G. K. Warren. The 1880 planform was extracted from the river boundaries defined in the MRC hydrographic surveys. The 1928 and 2003 planforms were defined by the first line of permanent vegetation on the riverbanks in the aerial photographs. The 1928 aerial photographs were flown on October 5, 1928. The Mississippi River gage at St. Louis, MO when the aerial photographs were flown was 10.20.

CADASTRAL SURVEY-QUALITY CONTROL

In order to verify the accuracy of the georeferenced 1817 GLO maps, a cadastral survey analysis was performed by Lou Gilbert, private consultant. The cadastral survey was conducted using the University of Maine's Geographic Measurement Management (GMM) software. The GMM software performed a least squares adjustment on the bearings and distances derived from the field surveys and used the data to produce a planform. The planform obtained using the GMM software was then opened and viewed in Microstation and compared to the scanned and georeferenced 1817 maps to verify their location. Figure 14 shows a section of the cadastral survey.

The 1817 GLO maps georeferenced by the Applied River Engineering Center (AREC) aligned with the outline of the river created by the cadastral survey. An indicator of the accuracy of the 1817 AREC GLO was the way in which the major tributary in the section, the Meramec River, located at River Mile 161, was in exactly the same position in both surveys.

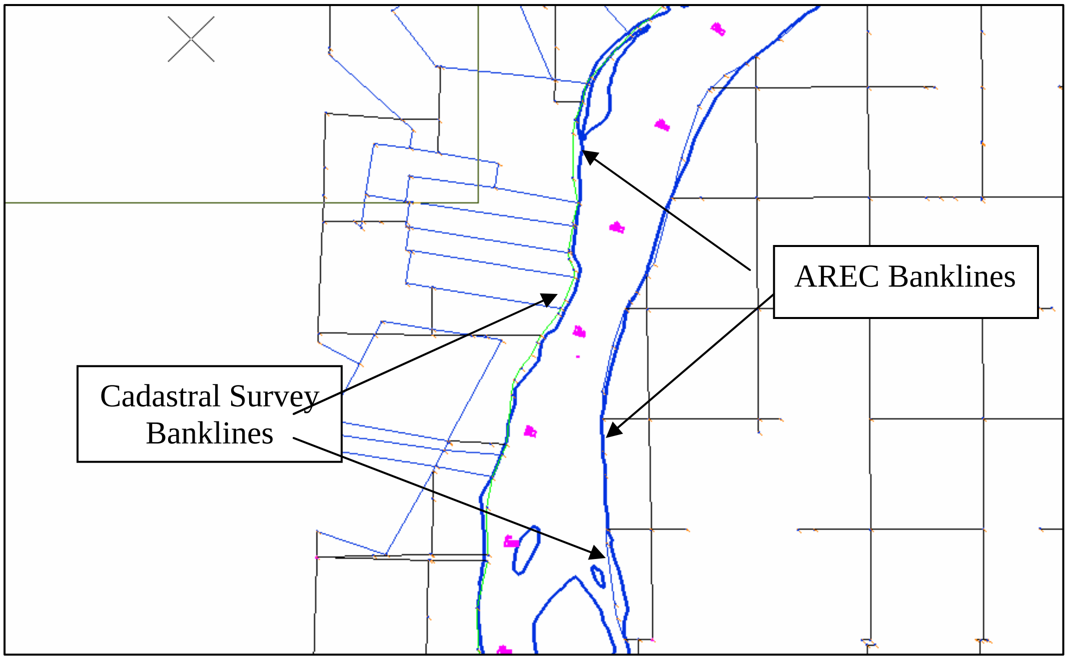


Figure 14: Cadasteral survey Planform

To statistically verify acceptable accuracy between the cadastral survey and the planform developed by AREC, an unpaired t-test was performed using the methods outlined in Biostatistical Analysis (Zar, 1999). The data used to test the accuracy was the planform width at one-half mile increments. Widths of the two planforms were taken along the same line normal to the general direction of flow in the river. Twenty nine data points were taken representing 14.5 miles of the planform. A box plot of the two data sets used in the analysis is shown in Figure 15. The null hypothesis used in the analysis was that the planform widths were the same. The analysis produced a t-value of 0.011907 and a p value of 0.99. A p-value of 0.99 demonstrates that the probability of this result assuming the null hypothesis (that the data is the same) is 99%, therefore the 1817 planform developed by AREC is in substantial agreement with the cadastral survey.

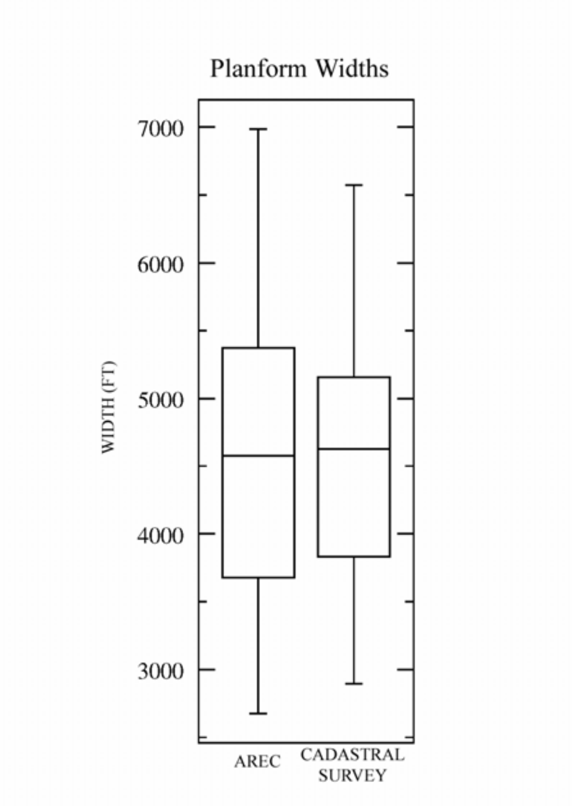


Figure 15: T-test Analysis Boxplot

DEFINITIONS

For this analysis, river width was defined as the distance between the vegetated banks observed on all maps taken normal to the general direction of flow in the river. River widths were measured at approximately half-mile increments along the centerline of the planform.

River length was defined as the length of the river along the thalweg. The location of the thalweg in the 1817 surveys required interpretation and judgment due to the insufficient amount of data.

An island was defined as a body of land surrounded by water that contained vegetation. Due to the insufficient amount of island data in the GLO, interpretation and judgment were used. Islands with vegetation were clearly labeled on the 1881 surveys.

Sinuosity was defined as the ratio of thalweg channel length to the length of floodplain.

Wetted bank, or wetted perimeter, was defined as the length of all wetted edges including banklines and island perimeters.

A side channel was defined as the smaller channel that resulted from a river being divided into two or more channels by an island. In order to be considered a side channel, the island must have vegetation.

Surface Area was defined as the total area submerged by the flow of the river at bankfull stage.

PHYSICAL CHANGES

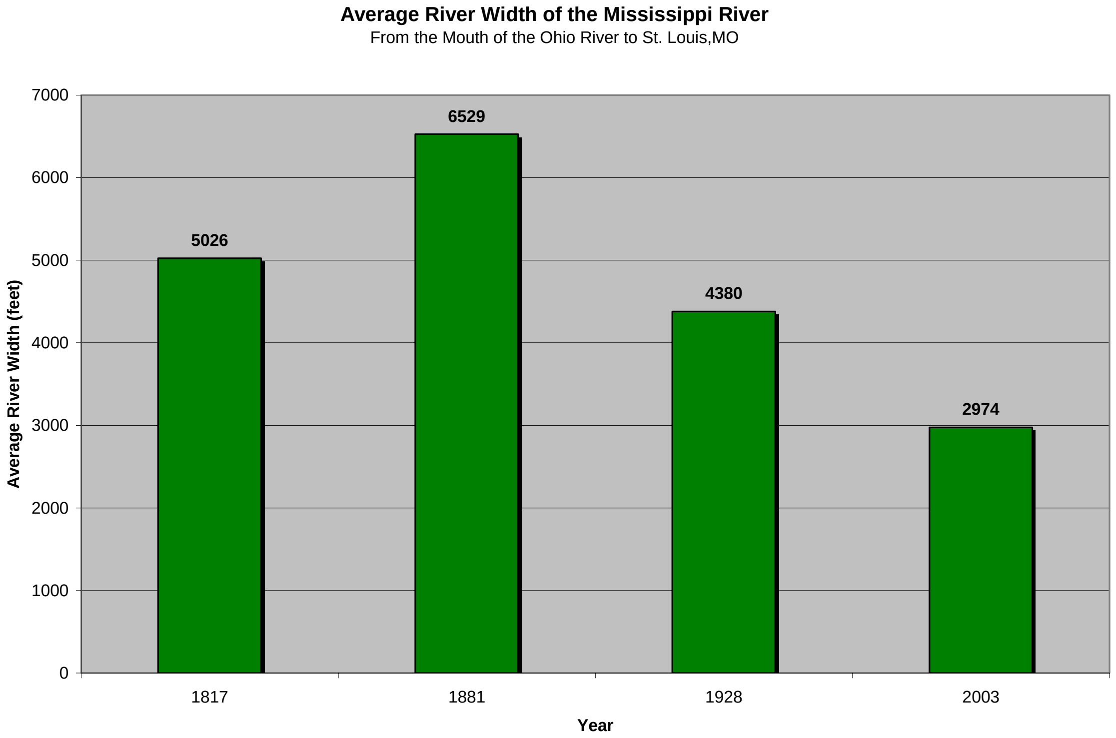


Figure 16: Average River Width

Planform widths for the years 1817, 1881, 1928 and 2003 are shown in Figure 16. The planform width of the Mississippi River increased by approximately 1500 feet on the average in the sixty four years between 1817 and 1881. The widespread construction of river training structures began in the1880's and lead to a decrease of over 2000 feet of average planform width in the 47 years between 1881 and 1928. Between 1928 and 2003, the Corps began constructing the rock structures we see today. In the seventy five years between 1928 and 2003, the planform width decreased by approximately 1400 feet.

The dramatic increase in planform width between 1817 and 1881, shown in Figure 16, was in part the result of the capture of the Kaskaskia River at River Mile 118 in April 1881. This is shown in a map by Capt O.H. Ernst in Figure 17. This change in planform created a large side channel between the new and old locations of the confluence of the Mississippi and Kaskaskia Rivers. Over time, the flow into the original Mississippi River channel decreased. With the construction of a levee, the north end of the original channel has been cut off from the present river channel.

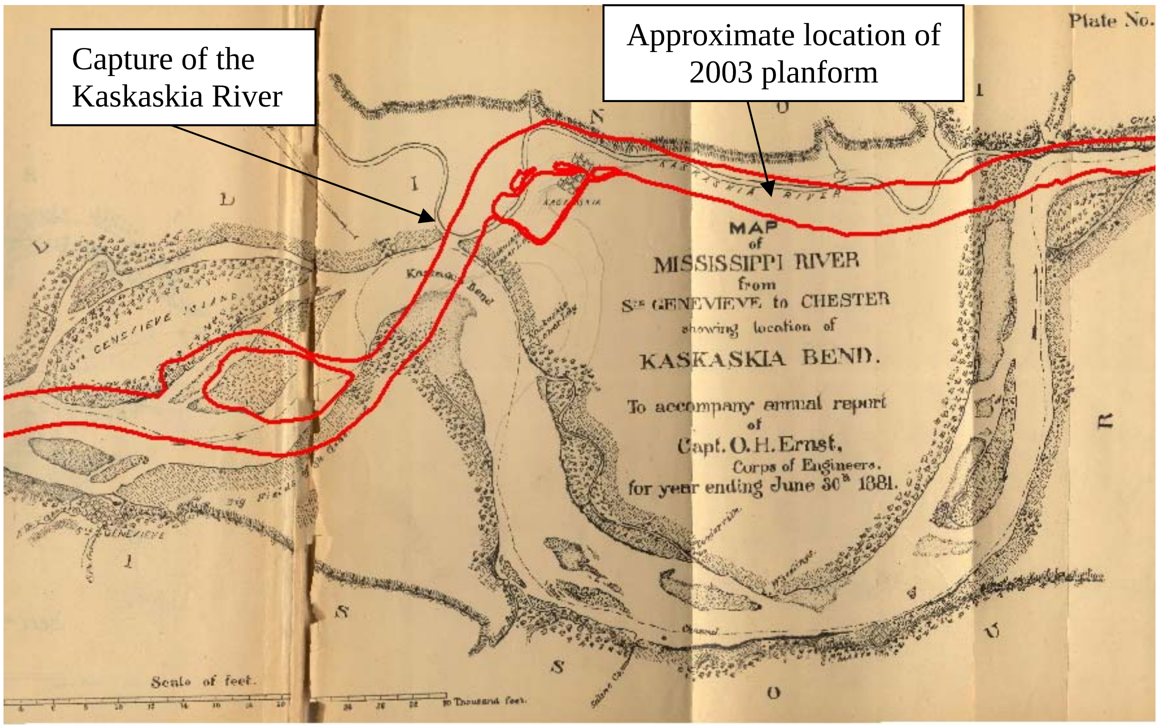


Figure 17: Map of the Mississippi River at Kaskaskia Bend Following the Capture of the Kaskaskia River

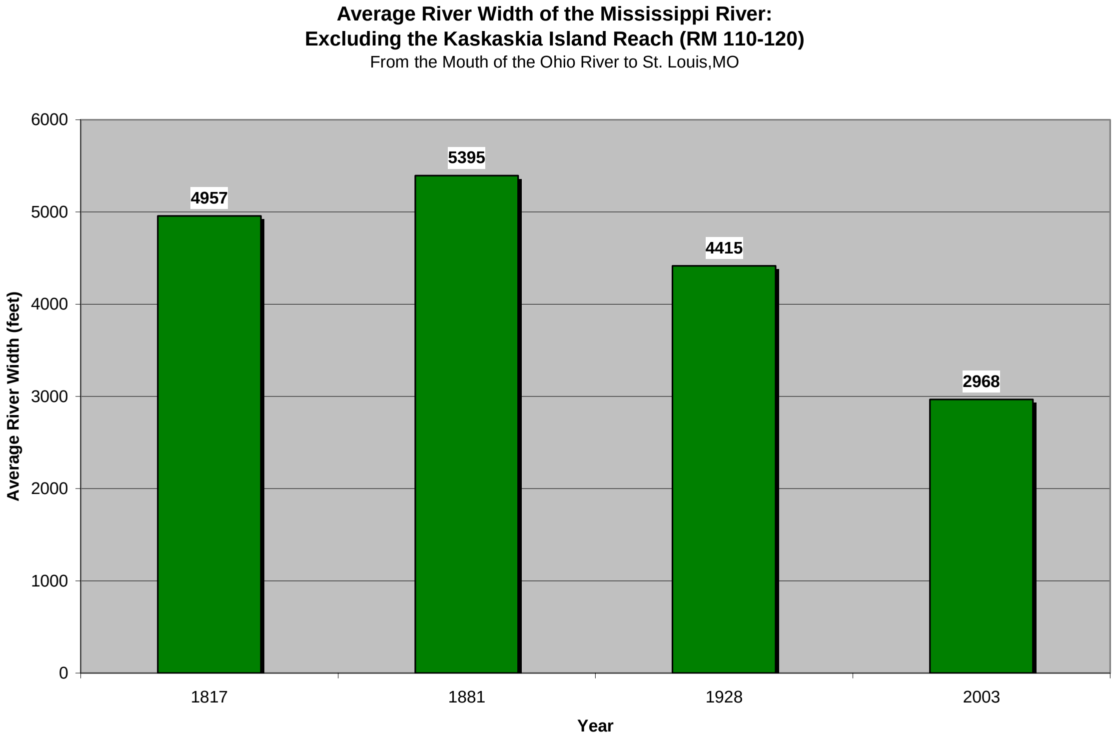


Figure 18: Average River Width excluding the Kaskaskia Island Reach

In an effort to better understand the trends throughout the entire study reach, the Kaskaskia Island reach was omitted in Figure 18. After omitting this reach, the planform widths for 1817, 1928 and 2003 remained almost the same. The average planform width decreased by 1134 feet between 1817 and 1881. As a result, Figure 18 provided a better understanding of the magnitude of the average changes in planform width on the Mississippi River between the confluence of the Ohio River and St. Louis, MO.

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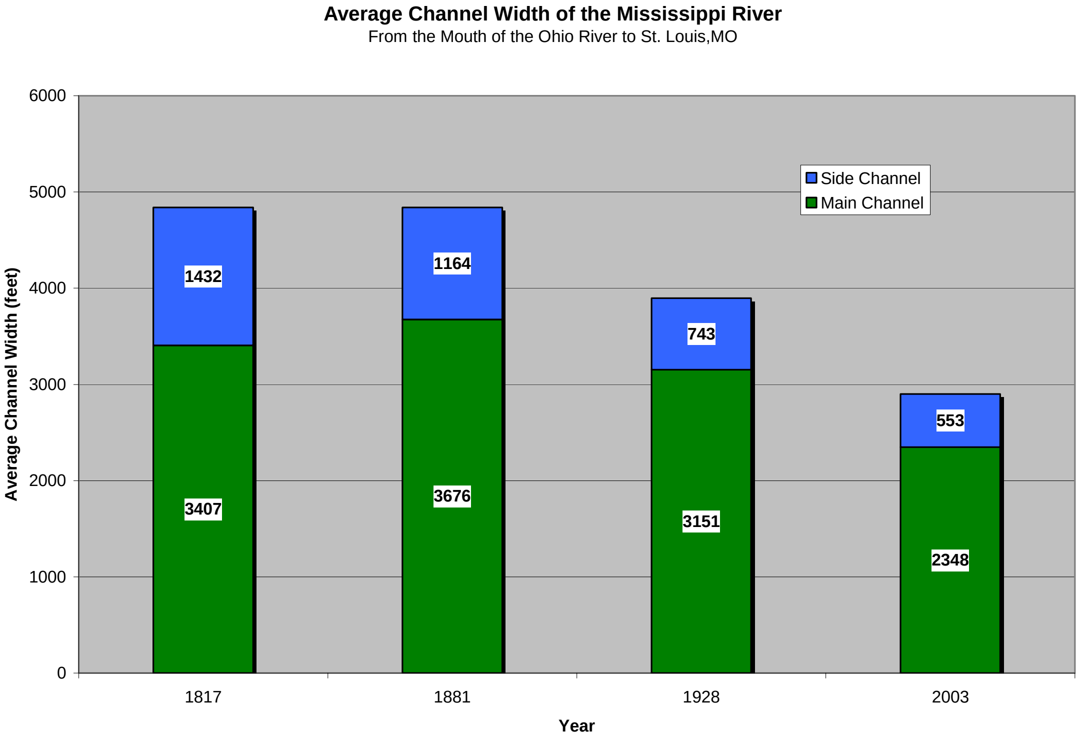

Figure 19: Average Channel Width

Figure 19 shows the average channel width. Although the planform width increased by 1500 feet between 1817 and 1881, the total average channel width remained the same. This is a result of the increased island area, which will be discussed later. After the construction of river training structures began in 1881, both the main channel width and side channel width began to decrease. The average side channel width also decreased due to the construction of closure structures built to help maintain an adequate low water navigation channel.

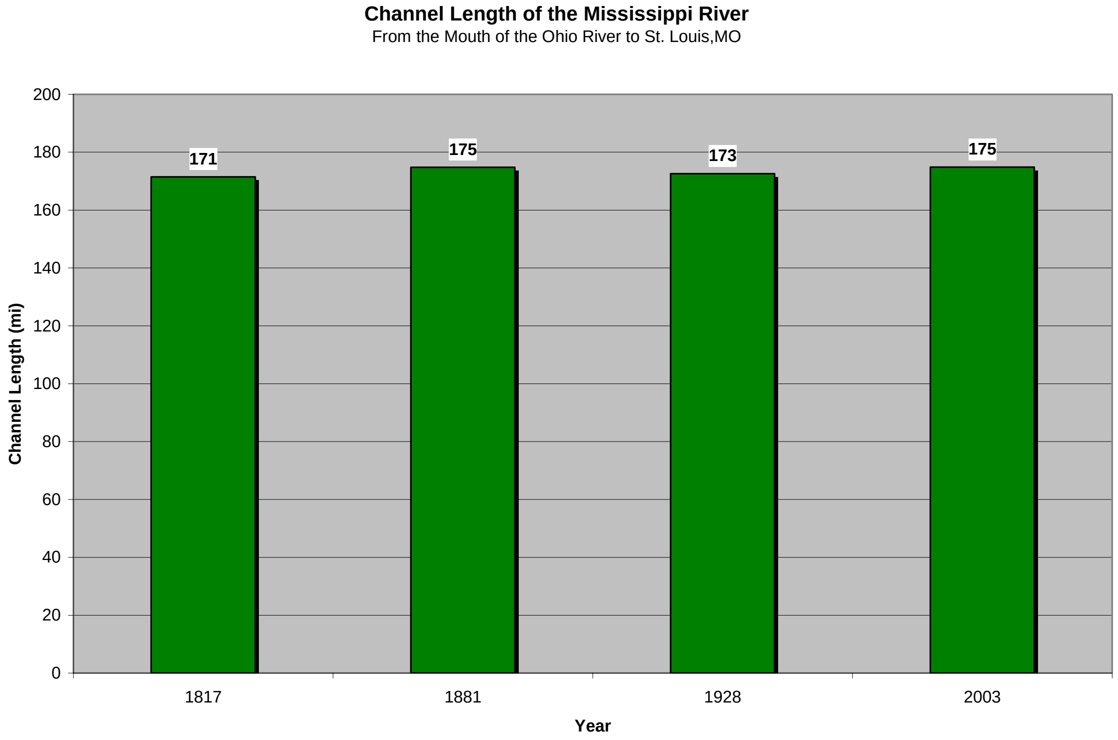

Figure 20: Channel Length

Channel length is shown in Figure 20. This does not show the same trends as the other graphs. The channel increased in length by 3 miles between 1817 and 1881. Most of this extra length was observed between the mouth of the Ohio River and Thebes Gap, due to the greater sinuosity in this reach.

The decrease in length between 1881 and 1928 is mostly the product of the capture of the Kaskaskia River. This event decreased the length of the Mississippi River by 5 miles in the Kaskaskia Island reach between 1881 and 1928. Similar to the change between 1817 and 1881, the 2003 channel was 1.5 miles longer than the 1928 channel in the reach between the mouth of the Ohio River and Thebes Gap. In general there has been very little change in length over the 186 years studied.

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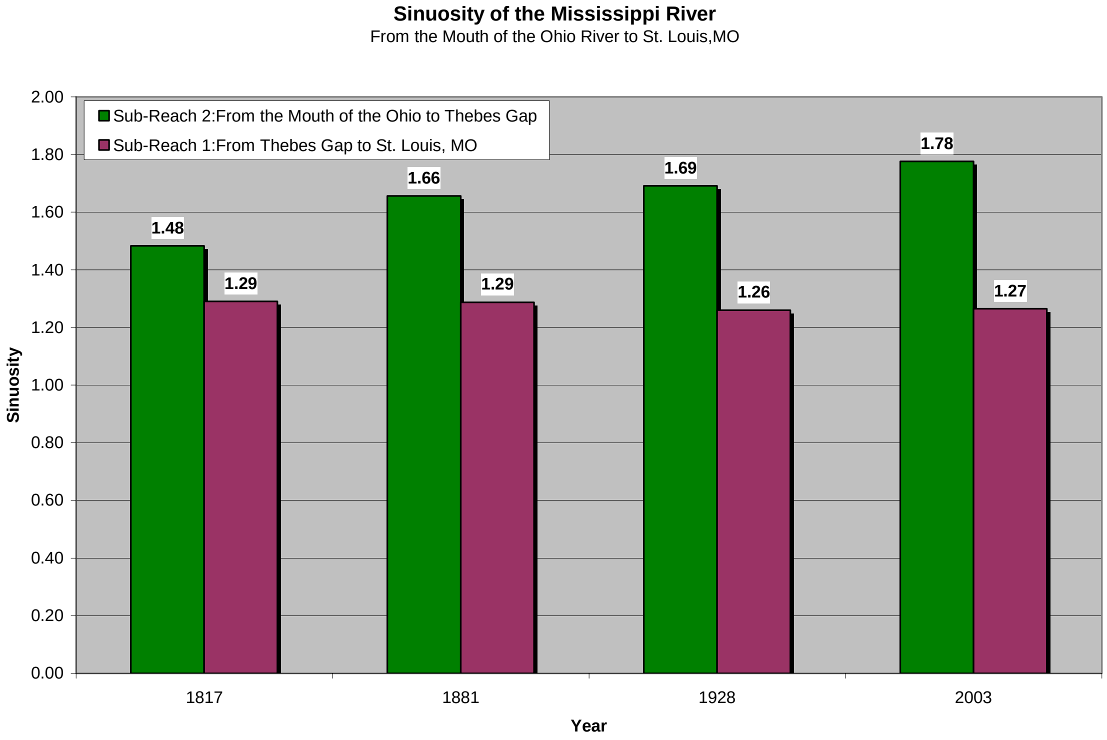


Figure 21: Sinuosity

The sinuosity of the Middle Mississippi River is shown in Figure 21. Since the study reach includes two distinct reaches, sinuosity was broken down into the two-sub reaches. From St. Louis, Missouri to Thebes Gap (sub-reach 1) the sinuosity has remained relatively the same. The slight decrease in sinuosity between 1881 and 1928 in sub-reach 1 was the result of the capture of Kaskaskia River in 1881. Apart from the capture, the overall length of sub-reach 1 has remained the same. The reach between Thebes Gap and the mouth of the Ohio River (sub-reach 2) has been historically the most active reach in the Middle Mississippi River. The sinuosity of sub-reach 2 has steadily increased over the 186 years studied do to increased meandering.

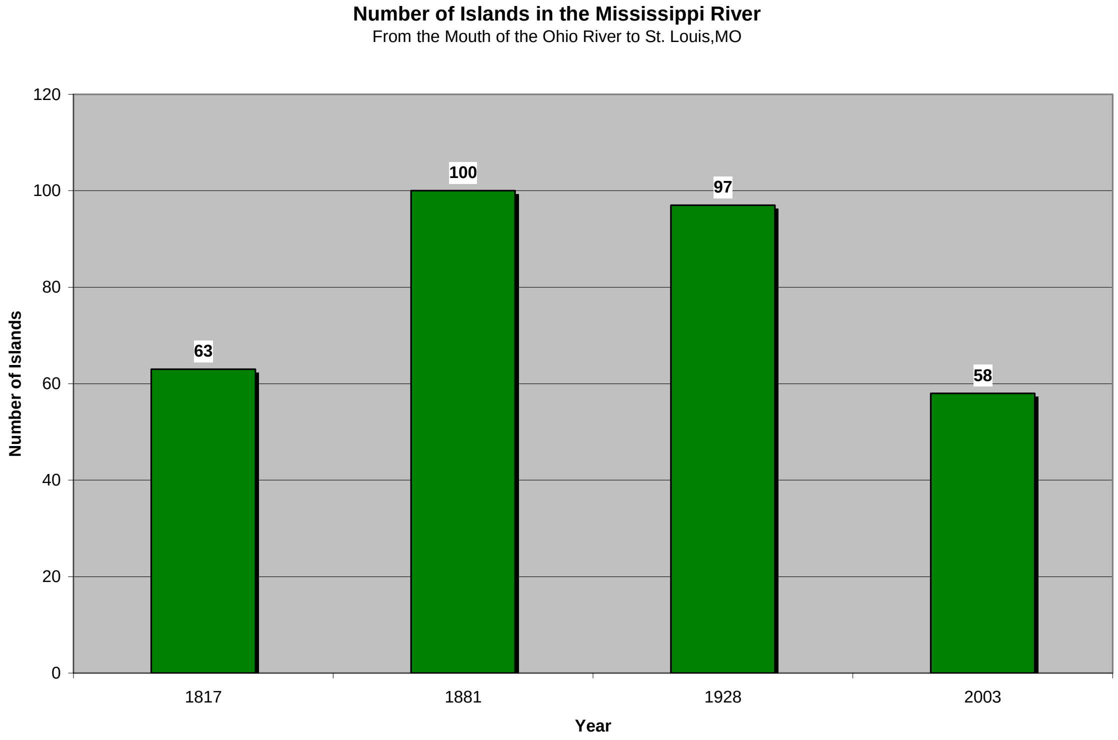


Figure 22: Number of Islands

The number of islands is shown in Figure 22. One of the products of all of the changes occurring along the MMR between 1817 and 1881 was an increase in the number of islands. Throughout the 64 years between 1817 and 1881, the Mississippi River channel became more braided. The closure of many of the side channels in the MMR lead to a decrease in number of islands between 1928 and 2003.

Since the island data for the years 1817 and 1881 were taken from surveys some error existed due to the difference in island definition. The definition used by each individual surveyor to describe an island is not known. Because of this discrepancy there was no way of knowing exactly how many islands existed and the condition of each island.

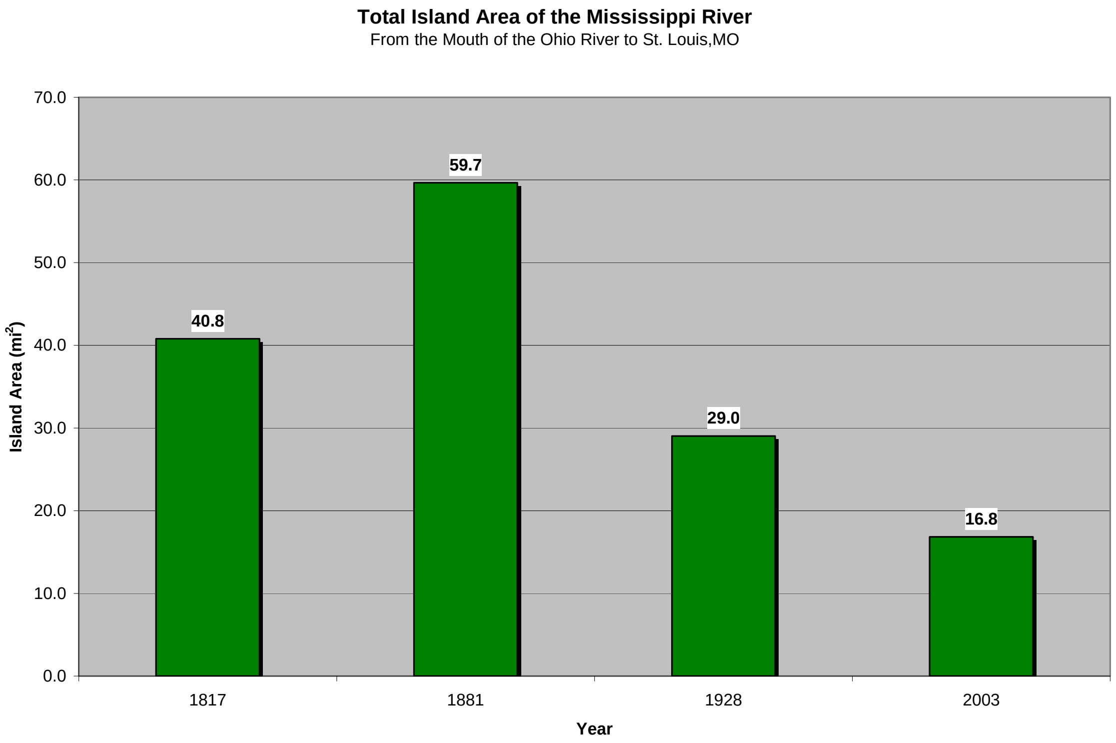


Figure 23: Total Island Area

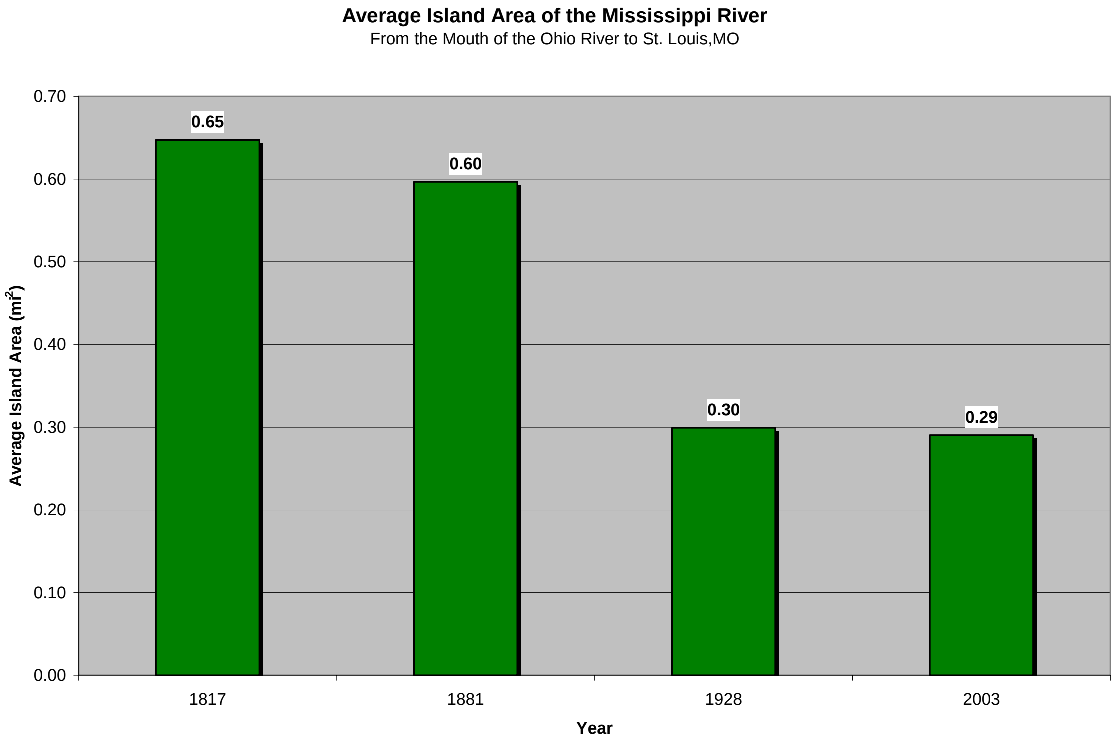


Figure 24: Average Island Area

Figure 23 shows the total island area. Total island area in conjunction with the number of islands is helpful in understanding the condition of the river. The dominant cause of the increase in islands between 1817 and 1881 was the increased braiding, a product of the conversion from a sinuous canaliform to a braided canaliform. A visual inspection of the planforms in APPENDIX A shows a change in island alignment. Prior to the construction of river training structures in 1881, large islands were scattered among the channel and surrounded by wide side channels. After the construction of river training structures, the islands were much smaller and were located away from the main channel and surrounded by much narrower side channels. This is shown by the average island area illustrated in Figure 24.

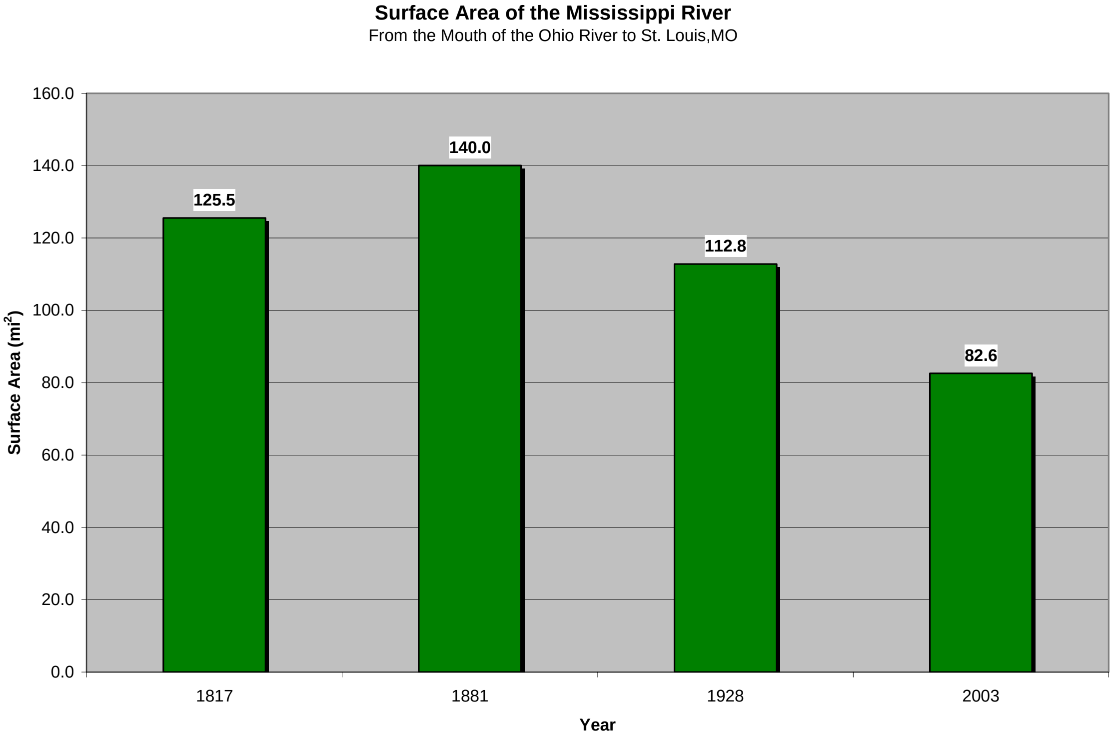


Figure 25: Surface Area

Surface area was measured by subtracting the total island area from the total area enclosed of the planform. The surface area of the MMR between the confluence of the Ohio River and St. Louis, Missouri roughly followed the same trend as the planform widths. This is shown in Figure 25. The surface area decreased uniformly between 1881 and 2003. The surface area is a function of both planform width and island area.

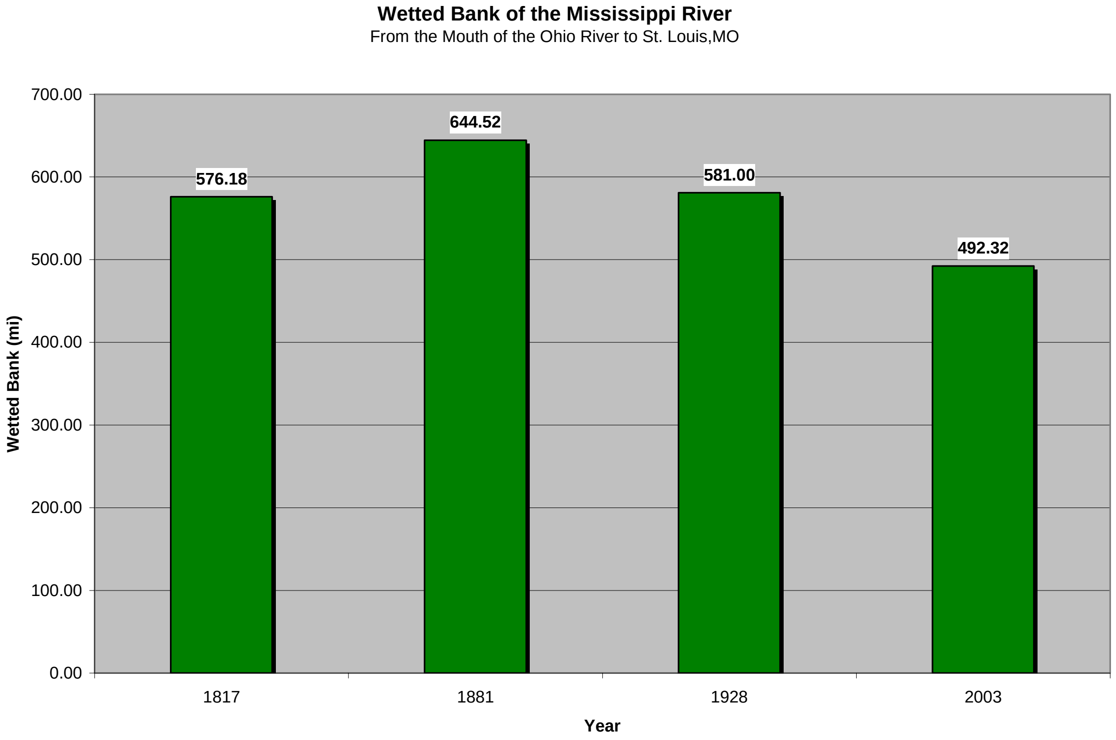


Figure 26: Wetted Bank

The wetted bank of the MMR from the mouth of the Ohio River to St. Louis, Missouri is shown in Figure 26. Wetted bank was measured by adding the perimeter of the islands and length of bankline. Wetted bank also followed the same trends as planform width.

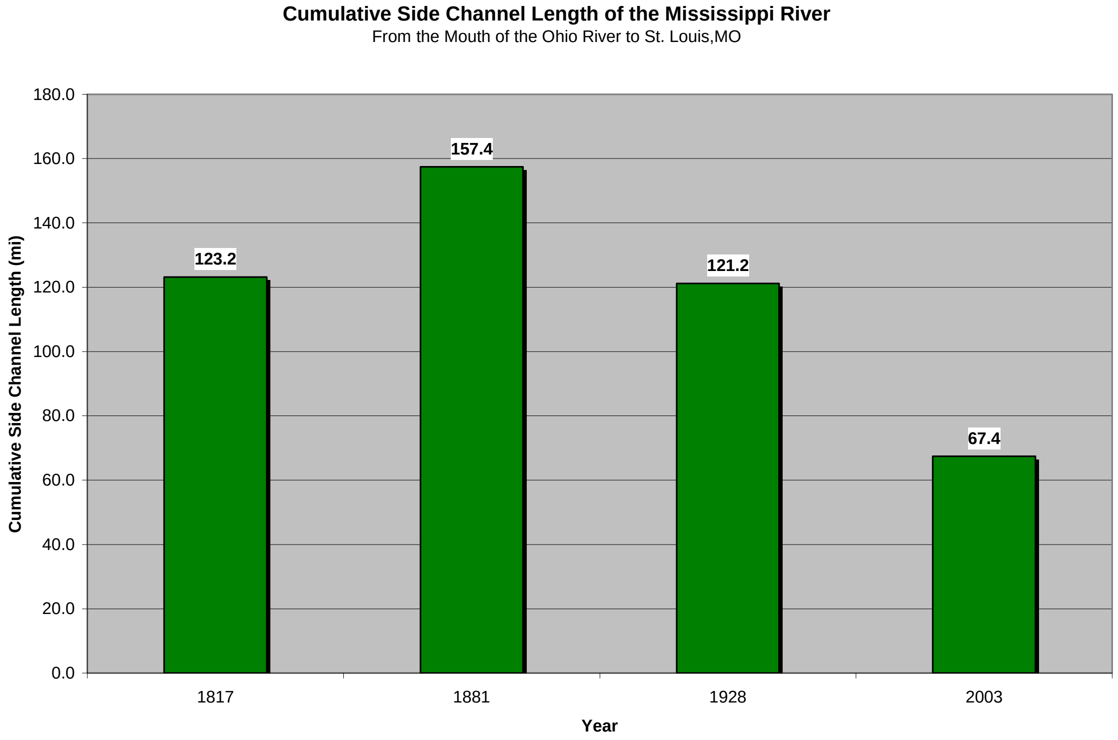


Figure 27: Cumulative Side Channel Length

The cumulative side channel length, shown in Figure 27, increased between 1817 and 1881 with the increase in the number of islands. The cumulative side channel length decreased between 1881 and 1928 with the decrease in the average size of the islands. The decrease in cumulative side channel length 1928 and 2003 was caused by a decrease in number of islands during the same time period.

In this study the MRC surveys were used to illustrate the extreme width of the Mississippi River prior to the construction of river training structures. Since the surveys were conduced in the years 1880 to 1882, 1884, 1888, 1889, and 1891 to 1899, some river training structure construction had already been completed which narrowed the planform width. When comparing the 1881 planform to the planforms of 1817 and 1866 some stretches along the banks showed an anomalous decrease in width as the result of this construction. An effort was made to find another set of maps, charts, or surveys that could be used to show the extreme width of the Mississippi River before any river training structures were constructed. No other data could be found.

There were many stretches where the 1866 planform was wider than the planform of 1881. These areas were located mostly around St. Louis where structures were constructed. Since the 1866 Bvt. Major General Warren maps start at Thebes Gap, a comparison could only be made between Thebes Gap and St. Louis. This area was isolated and the results are shown on Figure 28. The Kaskaskia Island reach was omitted in order to better understand the average planform width throughout the study area.

The planform width in 1866 followed the trend between 1817 and 1881; the average widening rate in the 49 years between 1817 and 1866 was 8.3 ft/yr whereas the average widening rate in the 15 years between 1866 and 1881 was 8.5 ft/year.

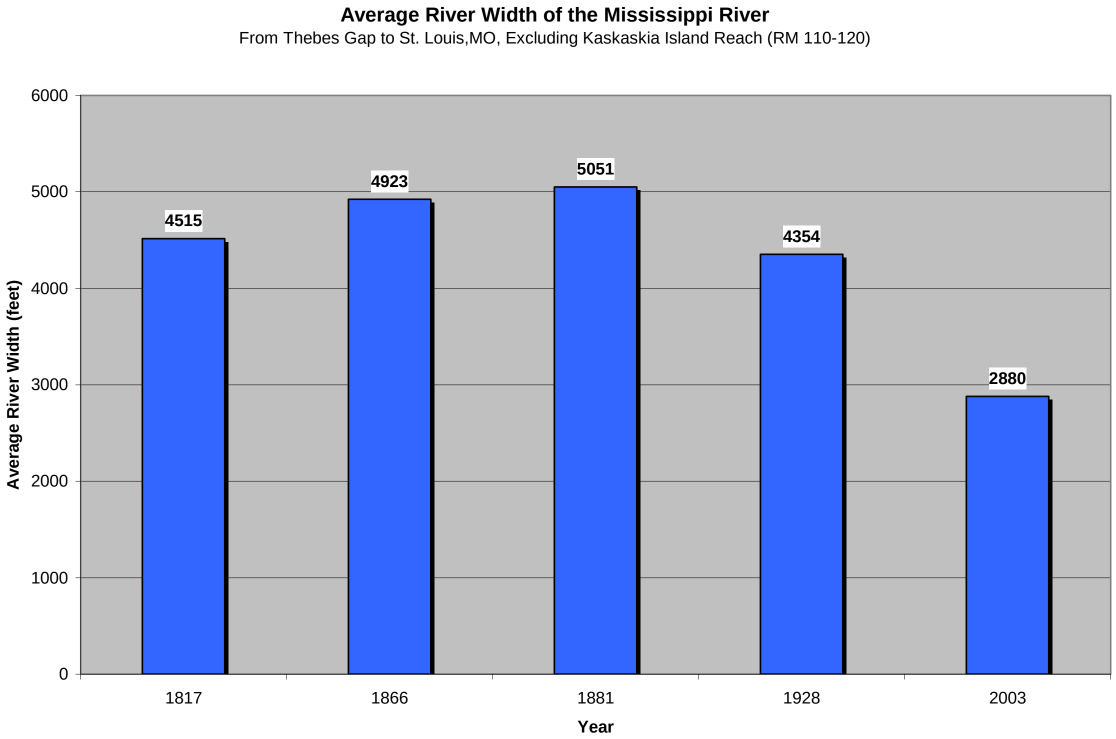


Figure 28: Average River Width, Thebes Gap to St. Louis

PAST GEOMORPHOLOGY STUDIES

This is the third of three major studies conducted on this topic for the U.S. Army Corps of Engineers. The others are:

1.) Geomorphology of the Middle Mississippi River prepared for the U.S. Army Engineer Waterways Experiment Station by the Engineering Research Center at Colorado State University in 1974. The primary authors of this study were Daryl B. Simons, Stanley A. Schumm and Michael A. Stevens.

2.) SLD Potamology Study (S-7) prepared for the U.S. Army Corps of Engineers- St. Louis District by the Institute of River Studies, Department of Civil Engineering, School of Engineering, University of Missouri-Rolla in 1976. The primary authors of this study were Jerome A. Westphal and Samuel P. Clemence.

The planforms for the Colorado State University report were created using a combination of land surveys and aerial photographs. The 1821 map was identified as "Reconnaissance of the Mississippi and Ohio Rivers" made in the months of October, November and December 1821 under the direction of the Board of Engineers. The 1888 map was a survey made under the direction of the Mississippi River Commission between 1876 and 1888. The planforms titled 1888 used by Colorado State University were extracted from the same data as the surveys titled 1881 used in this report. The 1968 map was prepared from aerial photograph mosaics taken in November 1967 and March 1968.

The definition used by Colorado State University when measuring river width was that "the river width was the distance from tree line to tree line irrespective of bank height taken normal to the general direction of flow in the river. River widths were measured at one-mile increments between Jefferson Barracks, Missouri and Cairo, Illinois." The results obtained in this study are summarized in Table 1.

Year	Average Width (ft)
1821	3600
1888	5300
1968	3200

Table 1: History of River Widths: Colorado State University

The planforms for the University of Missouri-Rolla were created using a combination of land surveys and hydrographic surveys. The 1821 maps were "based primarily on information from Government Land Office (GLO) maps and a reconnaissance survey made during October-December, 1821, by Corps personnel". The 1881, 1899, 1907 and 1919 maps were made from hydrographic surveys made during the period 1880 to 1881, 1896 to 1899, 1907 to 1908 and 1915 to 1919 respectively. This data was scaled to a ratio of 1:62,500 and matched to the United States Geological Survey Topographic Sheets. Top-bank widths shown for 1935 and subsequent years were taken from Munger, et.al. (1976) and scaled from aerial photographs

The definition used by the University of Missouri-Rolla when measuring river width was that the width was the "top-bank widths scaled from the hydrographic surveys at intervals of approximately 2 miles". The results obtained in this study are summarized in Table 2 below.

Year	Width (ft)	Year	Width (ft)
1821	3130	1935	2910
1881	3800	1947-8	2900
1899	4360	1965	2510
1907	3320	1970	2520
1919	3370	1974	2370

Table 2. Average top-bank widths in the Middle Mississippi River, University of Missouri-Rolla

DIFFERENCES IN STUDY RESULTS

A clear deviation in results exists between studies performed by Colorado State University, University of Missouri-Rolla and AREC. This deviation is illustrated in Table 3 and Figure 29. A large effort was made to understand the origin of the deviation between the three studies.

Since such a deviation in results existed between the AREC study and previous studies, quality control measures were used to assure the results obtained in the AREC study were correct. These measures include performing a cadastral survey on the 1817 GLO data, double checking the digital banklines for accuracy, and double checking the measurements for accuracy.

Average Planform Width (feet)			
	University of Missouri - Rolla	Colorado State University	Applied River Engineering Center
1821	3130	3600	5026
1881	3800		6529
1888		5300	
1899	4360		
1907	3320		
1919	3370		
1928			4380
1935	2910		
1947	2900		
1965	2510		
1968		3200	
1970	2520		
1974	2370		
2003			2974

Table 3: Average Planform Width in Each Study

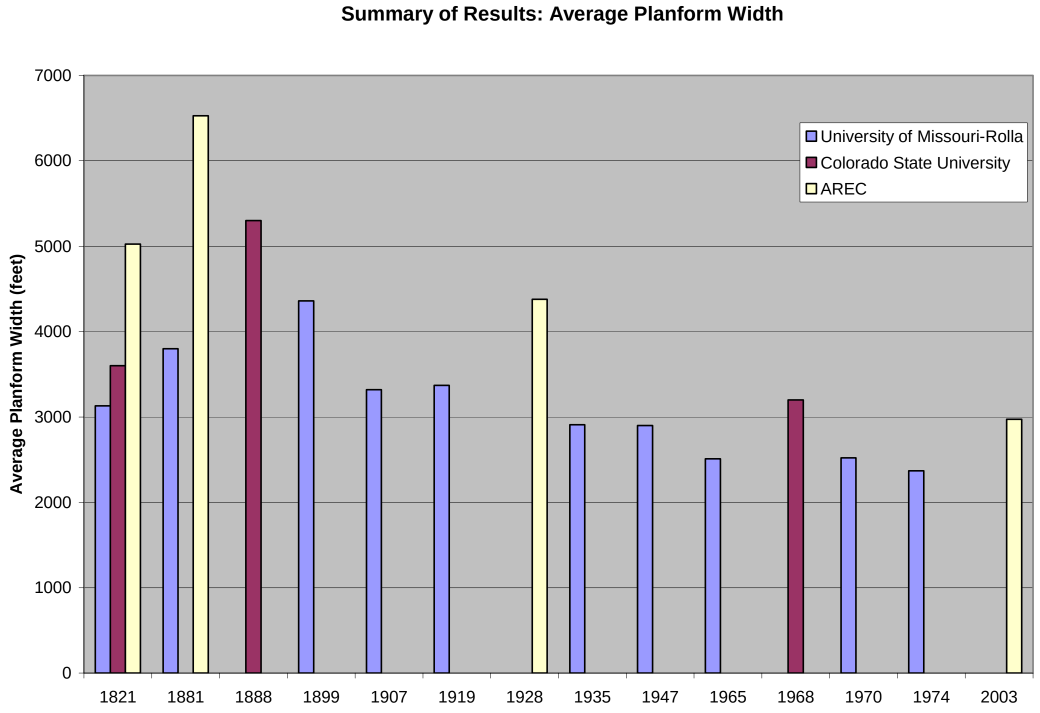
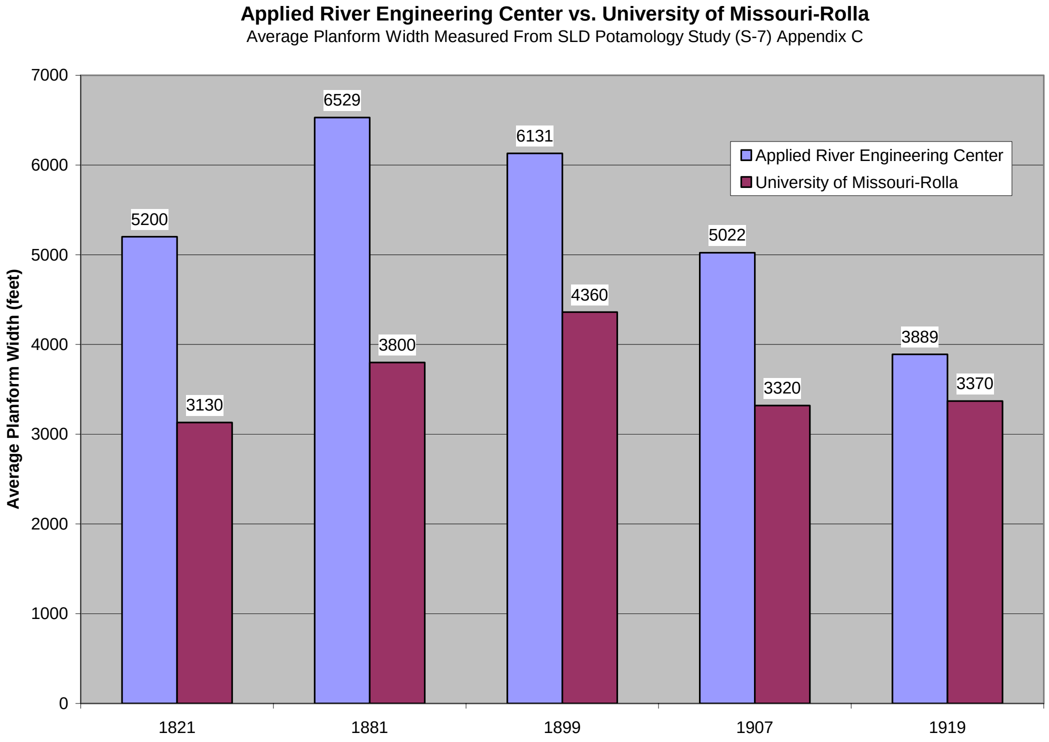


Figure 29: Average Planform Width from Each Study

Figure 30 is a comparison of average river width measurements using the morphology overlays from Appendix C of the Rolla Study. The banklines in the overlays were scanned into digital format, georeferenced and traced. The digital banklines were then measured and the results were compared to those published in Rolla Study. The purpose of this exercise was to show the variation in results between the two studies. The planforms measured by the Applied River Engineering Center was nearly the exact planform used by the University of Missouri-Rolla. Although there are no globally accepted results that can determine which study results are correct, an insight can be found in the “Bank Protection on Mississippi and Missouri Rivers” report prepared under the direction of the Chief of Engineers by Colonel T. H. Jackson in 1935. This report stated that the average width of the Mississippi River between the mouths of the Missouri and Ohio Rivers was 3500 feet. This width did not fit into the trend shown in the study by the University of Missouri-Rolla.



	1821	1881	1899	1907	1919
Applied River Engineering Center	5200	6529	6131	5022	3889
University of Missouri-Rolla	3130	3800	4360	3320	3370

Figure 30: Average Planform Width UMR Study vs AREC Study

The best explanation in the differences in results stems from a difference in technology. This study was conducted using state of the art computer technology that leaves very little room for error. The scaling of the raw data (surveys, aerials, GLO's) was done using a computer program that matches known points and scales, rotates, and adjusts the image into a correct position in space. The previous studies used manual methods such as light tables and overhead projectors to scale the data.

Eugene Degenhardt, who worked closely with Daryl Simons at Colorado State University, described the methods used to scale and reference the data. A USGS quadrangle map was placed on the wall with a known scale and used as a reference. Then, an overhead projection of the raw data was adjusted to match the scale of the USGS quadrangle map. This adjustment in scale was done by moving the projector close to and away from the wall.

The problems associated with this methodology are the obvious human error that is introduced along with the limitation of not being able to morph the data to fit to the USGS quadrangle map. Morphing is the process of stretching, rotating, and scaling a digital image so all known points fit into their correct position in space. A good example of this is the distortion found in all aerial photographs. Due to radial distortion the only part of the photograph that has the correct scale is the direct center. The farther an object is from the center of the picture the more distorted the scale. By using digitized images and computer processing this error can be accounted for by morphing the picture.

There is also the possibility that a math error was the cause of the discrepancy. All of the data collected in this study was stored and analyzed using a spreadsheet. In the previous two studies all of the data was tabulated and calculated by hand. Daryl Simons and Jerome Westphal, in phone conversations with Robert Davinroy agreed that a math error could be the cause of the discrepancy.

SUMMARY/CONCLUSIONS

The MMR went through a transformation from a sinuous canaliform to a braided canaliform in the 64 years between 1817 and 1881. Through the construction of river training structures, the U.S. Army Corps of Engineers transformed the river back into a sinuous channel over the past 122 years while maintaining a nine-foot low water channel for navigation. The average planform width in 2003 is 59% of the planform width in 1817. Although side channel closure structures have eliminated some of the larger islands, the Middle Mississippi River contains 82% of the number of islands and 81.7% of the wetted bank observed in 1817.

In order to better understand the changes made to the Mississippi River over the past 186 years we must look at the historical perception of the river. In the years prior to 1817, the Mississippi River was used primarily for protection from enemies, as a water supply, and transportation. The introduction of the steamboat changed the river into a major means of transporting goods and people. Since the major function of the Mississippi River at that time was as a highway for steamboats, the main objective was to maintain a navigable channel through the use of river training structures. This mindset existed for over 150 years. Not until the modern environmental movement of the last 30 years was the Mississippi River valued as a diverse and important ecosystem as well.

The modern environmental movement did not begin in this country until around 1962 with the publication of Silent Spring by Rachel Carson. Silent Spring, a book about the effects of pesticides on songbird populations, lead to the introduction of modern ecology and an increase in environmental awareness. Politicians took notice and passed the National Environmental Policy Act in 1969 and created the Environmental Protection Agency (EPA) in 1970. In 1972 the Clean Water Act was passed.

Since the introduction of the modern environmental movement the U.S. Army Corps of Engineers, along with environmental federal and state agencies, has focused not only on maintaining a safe and dependable navigation channel, but also on providing environmental habitat and diversity. Over the past thirty-five years many changes have been made to the navigation structures on the MMR to create and maintain aquatic habitat. Some examples are rootless dikes, notched dikes, chevrons, bendway weirs and the opening of previously closed side channels. These new structures along with innovative river engineering can concurrently develop the modern day river channel and achieve environmental restoration and sustainability.

FUTURE RESTORATION

The past study effort focused on establishing a better understanding of the historical planform changes that have occurred on the Middle Mississippi River during European settlement. This can be used to serve as reference for future restoration initiatives.

The desired future river does not necessarily have to resemble the river of 1817 to be considered restored or environmentally sustainable. In fact, unless navigation ceases and landowners evacuate the floodplain, this is a physical impossibility. However, with that being said, modern river engineering methods combined with the latest fisheries and waterfowl management strategies can develop a river that achieves all of the goals of a healthy ecosystem.

A tremendous opportunity for creating new habitat above and beyond the constraints of the planform rests on the fact that a substantial amount of land exists alongside most of the river between the riverbanks and the agricultural levees. This land is mostly in private ownership. A very small portion of it is actually farmed because most of the area is subject to periodic flooding. Hence, most of the land is forested. There also exists many small lakes formed by borrow areas created by the construction of the levees. Unlike many of the rivers in Europe where restoration has been limited because the levees have been constructed along or near the riverbanks, a far greater potential for additional river restoration exists on the Middle Mississippi River.

Within this land exist old remnant channels, sloughs, oxbows, and wetlands. Over time many of these features have become filled with sediment, making them barely discernable or in many cases non-existent. Using ground based excavation, dredging, and/or a combination of river engineering structures, these features can be restored and connected to the modern day river, producing a new river planform never before seen or realized.

Examining a variety of data including the historical planforms, aerial photography, and conducting field reconnaissance, a blueprint for restoration was developed. This blueprint utilized many of the historical remnant features while at the same time considering the preservation of the navigation channel and ensuring the integrity of the levees. Any of these conceptual additions to the existing planform are possible, but collaboration among the stakeholders is paramount for these efforts to become a reality.

The blueprint serves as a reference for what the river may look like in the future, but may easily be modified according to specific needs, constraints, or other considerations. Blueprint for restoration can be found in Appendix A.

The proposed restoration shown in the blueprint for restoration reclaims 965 feet of average planform width. This is approximately 50% of the difference in average planform width between 2003 and 1817. Two hundred and twenty six miles of additional wetted bank have been reclaimed in the proposed blueprint for restoration. The virtual planform has twenty-five percent more wetted bank than the 1817 planform. The proposed restoration adds an additional 9.53 square miles of area to the 2003 planform.

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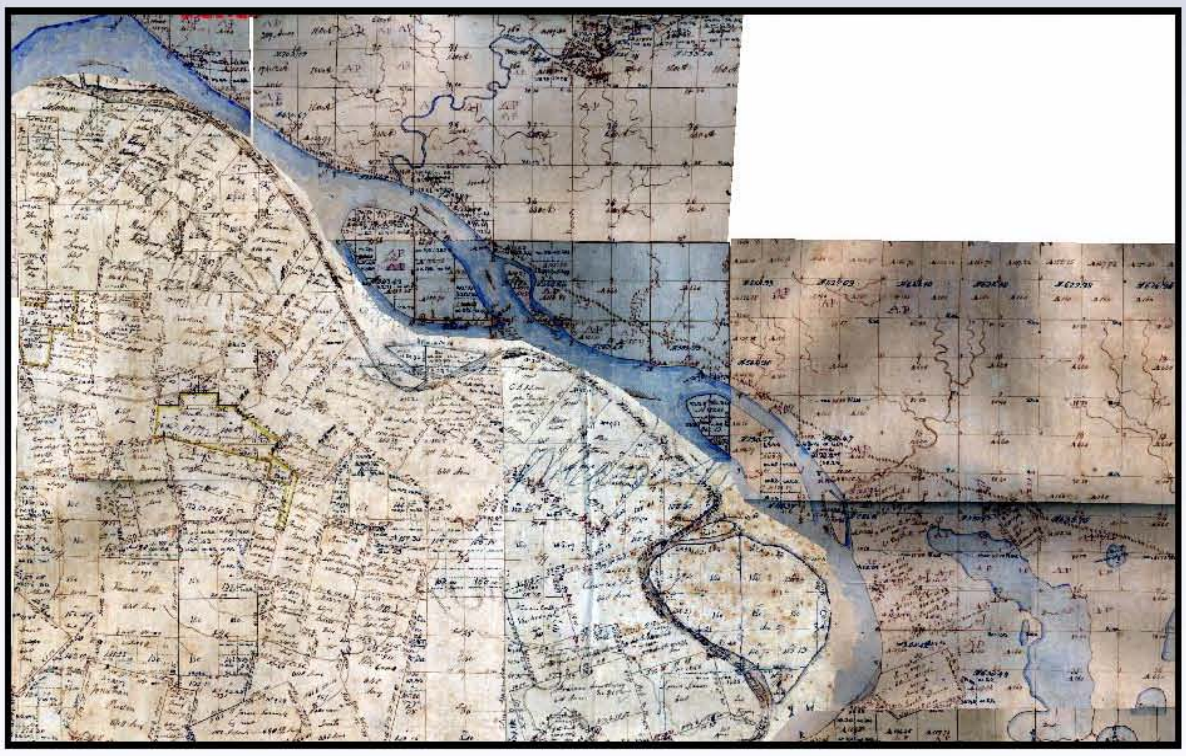
Geomorphology Study of the Middle Mississippi River

Appendix A



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December
2005

US Army Corps
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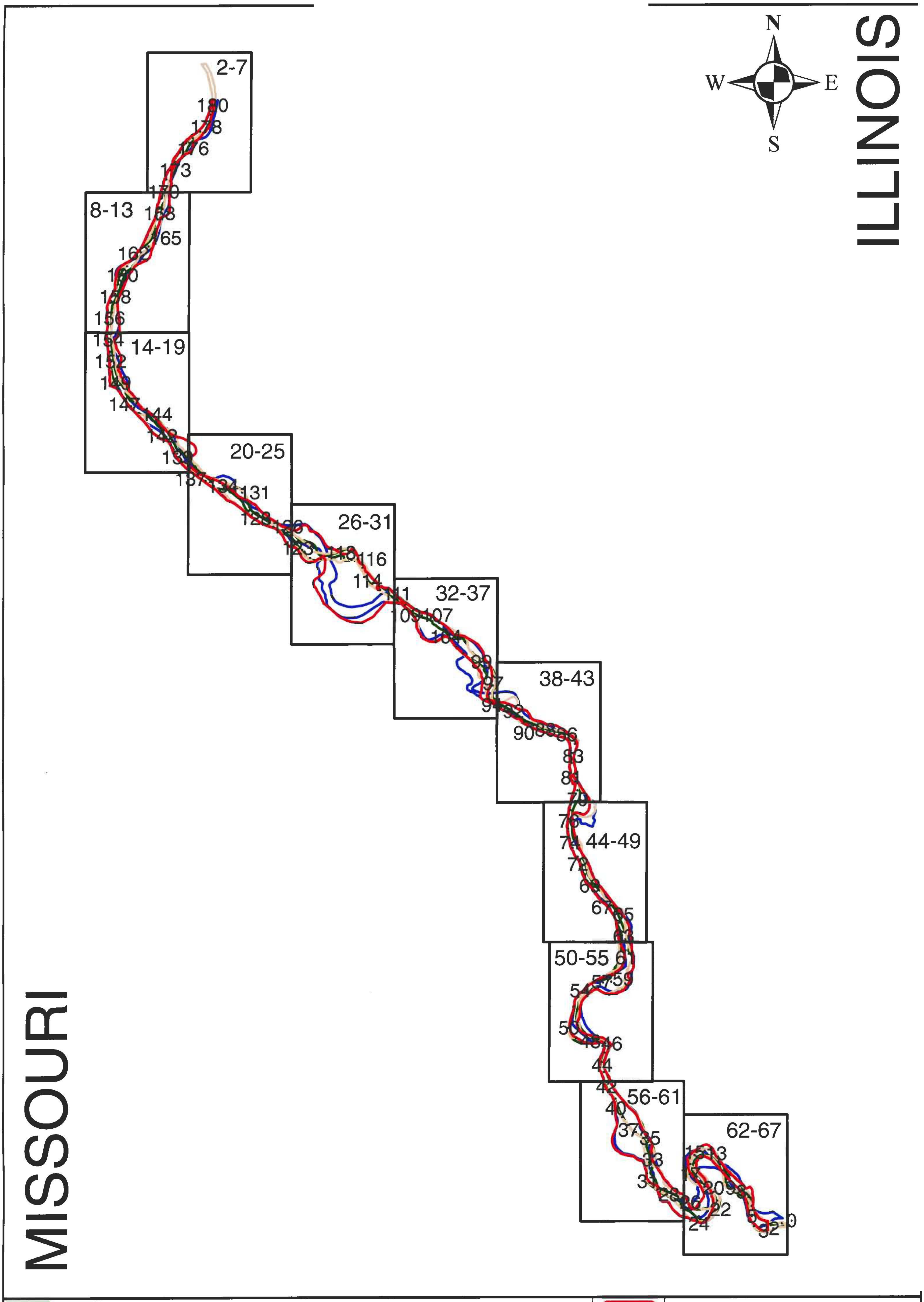
St. Louis District



🟩	2003
🟧	1928
🟥	1881
⬛	1866
🟦	1817

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DRAWN BY: Edward J. Brauer
CHECKED BY: Robert D. Davinroy

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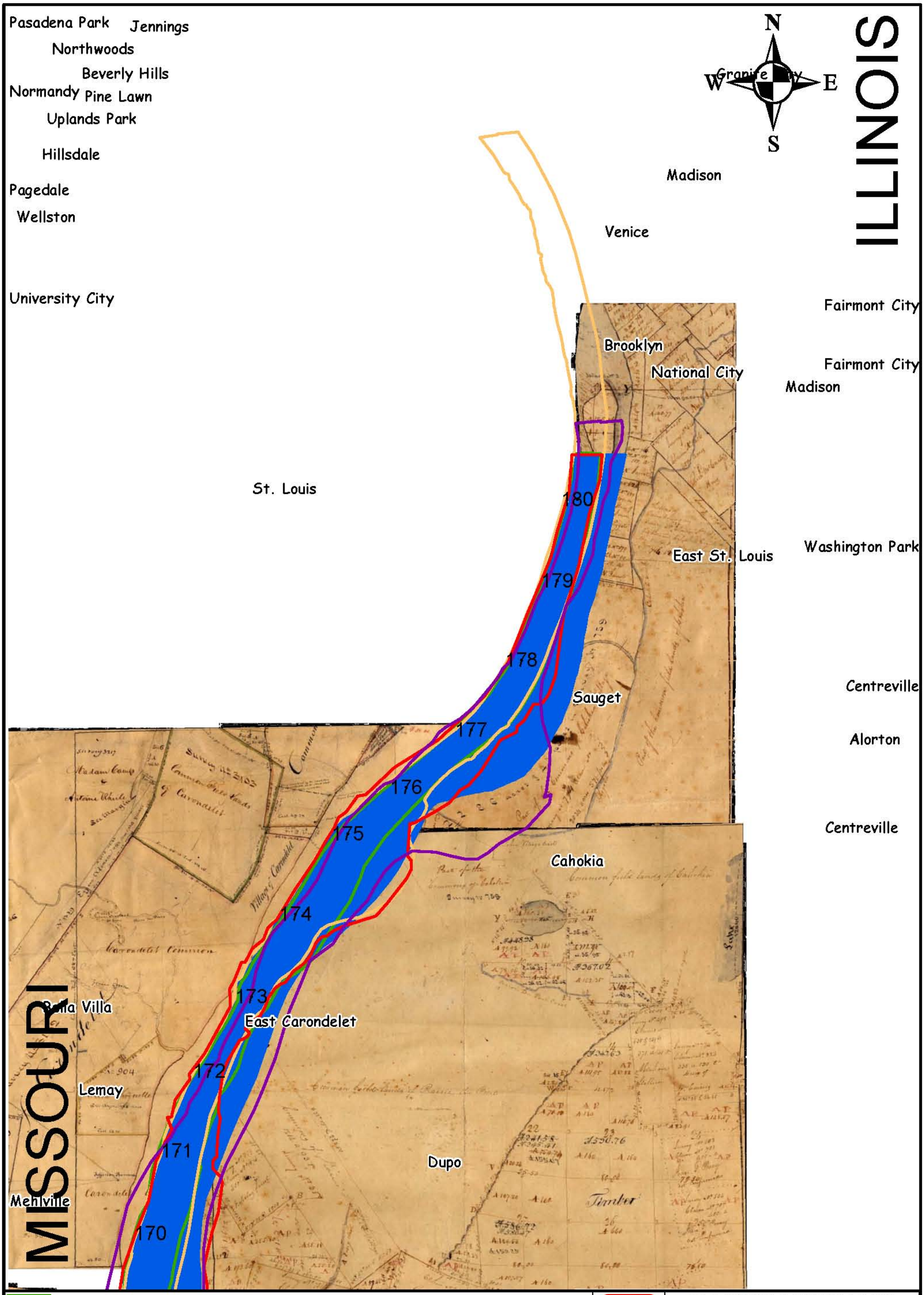
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

INDEX

RIVER MILES 180-0

PLATE NO. 1



🟩 2003

🟧 1928

🟥 1881

🟪 1866

🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: 1817-1820 Government Land Office Surveys

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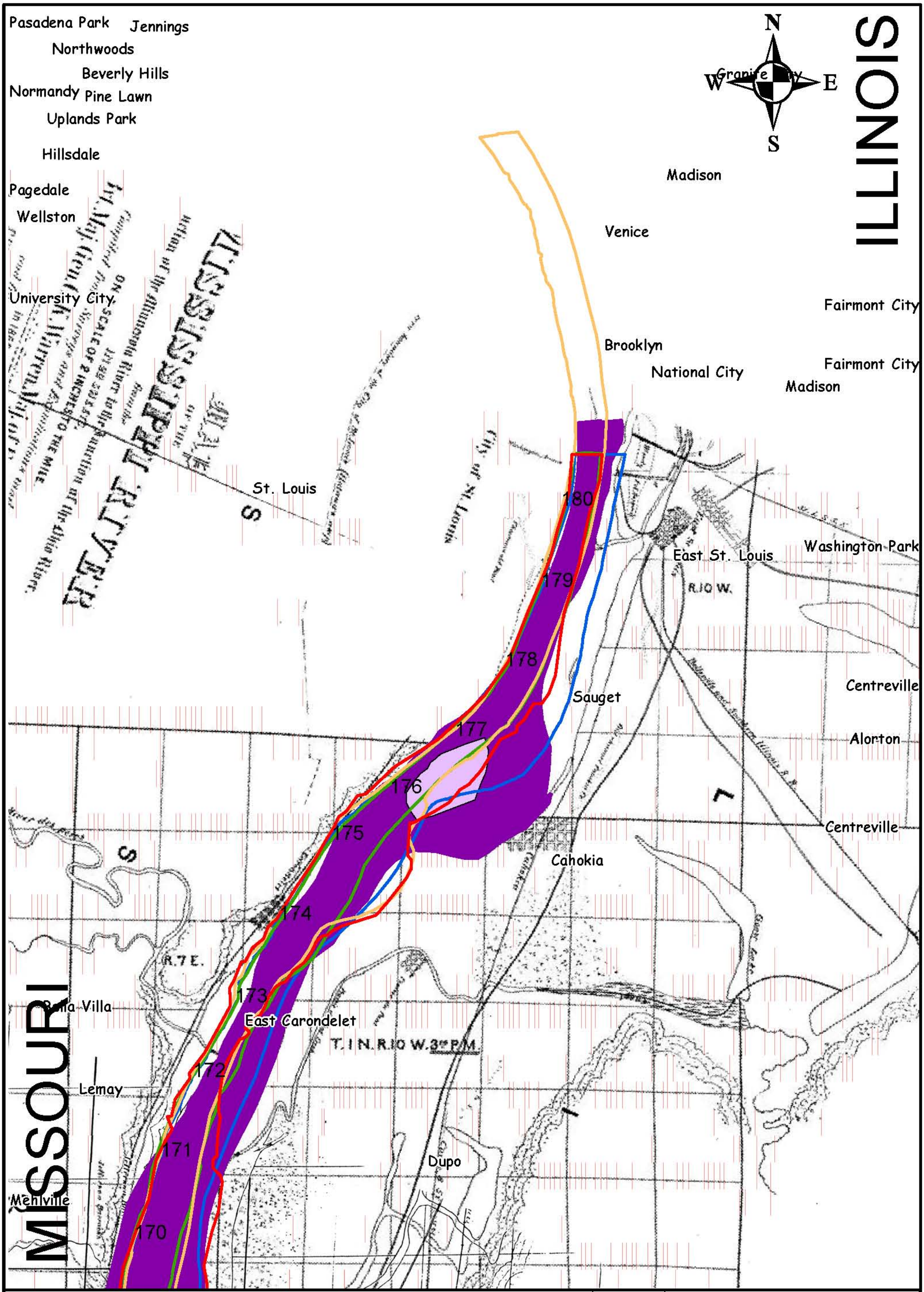
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1817 Planform

RIVER MILES 180-170

PLATE NO.: 2



🟩 2003

🟨 1928

🟥 1881

🟪 1866

🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Warren, Bvt. Major General G. K.

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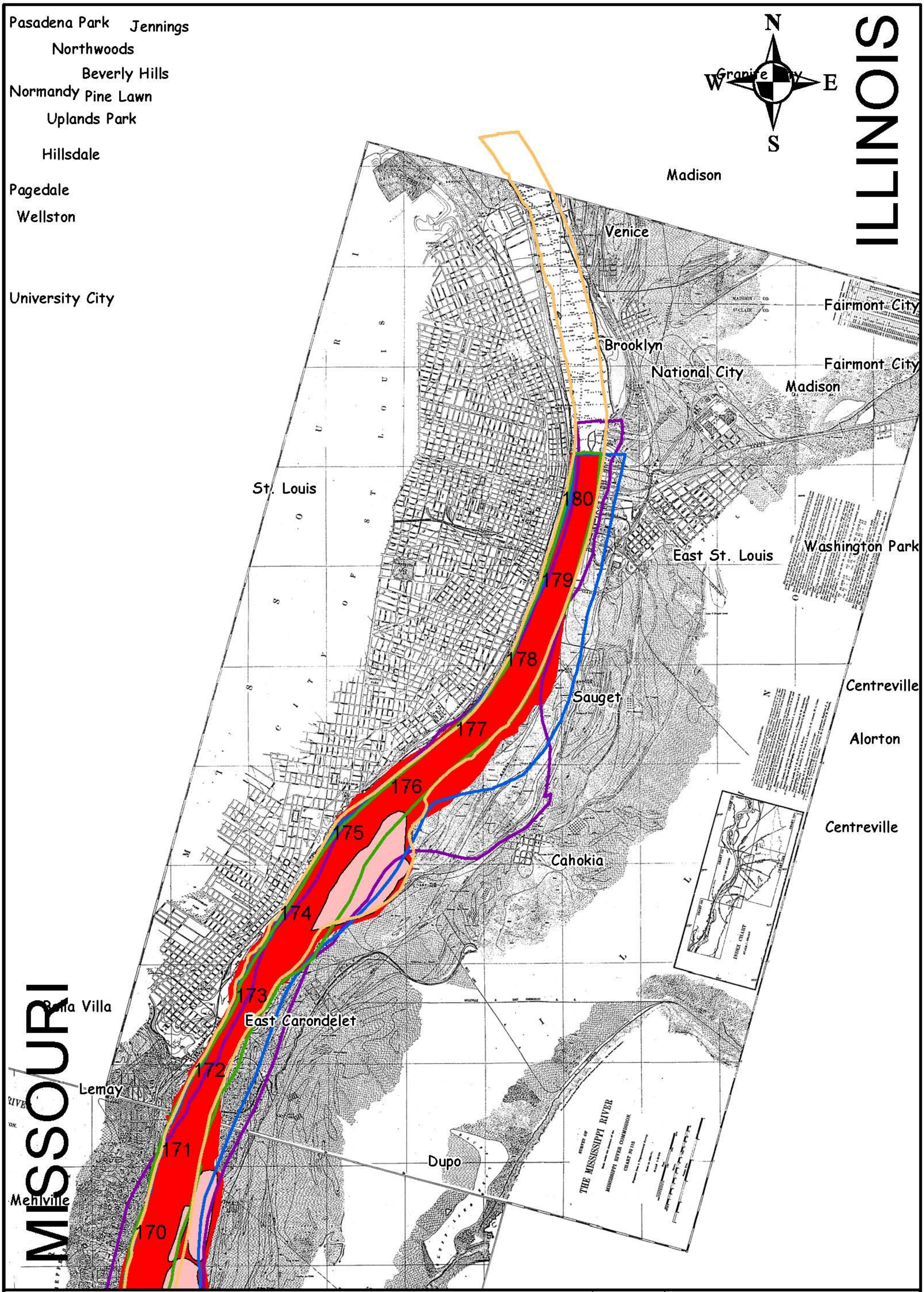
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1866 Planform

RIVER MILES 180-170

PLATE NO.: 3



🟩 2003

🟧 1928

🟥 1881

🟪 1866

🟦 1817

SOURCE: Mississippi River Commission, 1880-1882, 1884, 1888, 1889, 1891-1899

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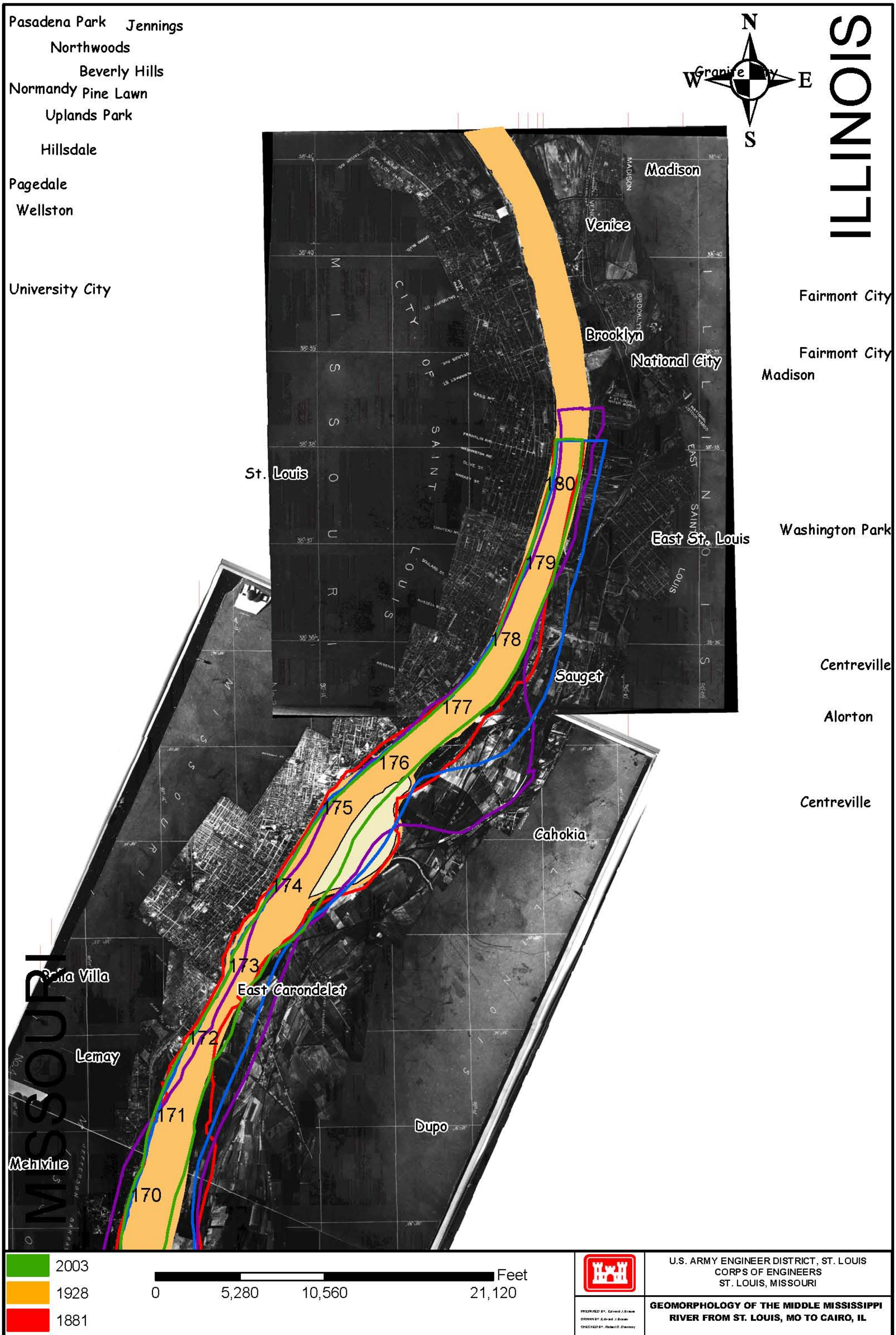
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1881 Planform

RIVER MILES 180-170

PLATE NO.: 4



🟩	2003
🟧	1928
🟥	1881
🟪	1866
🟦	1817

SOURCE: Aerial Photographs
Flown 5 OCT 1928

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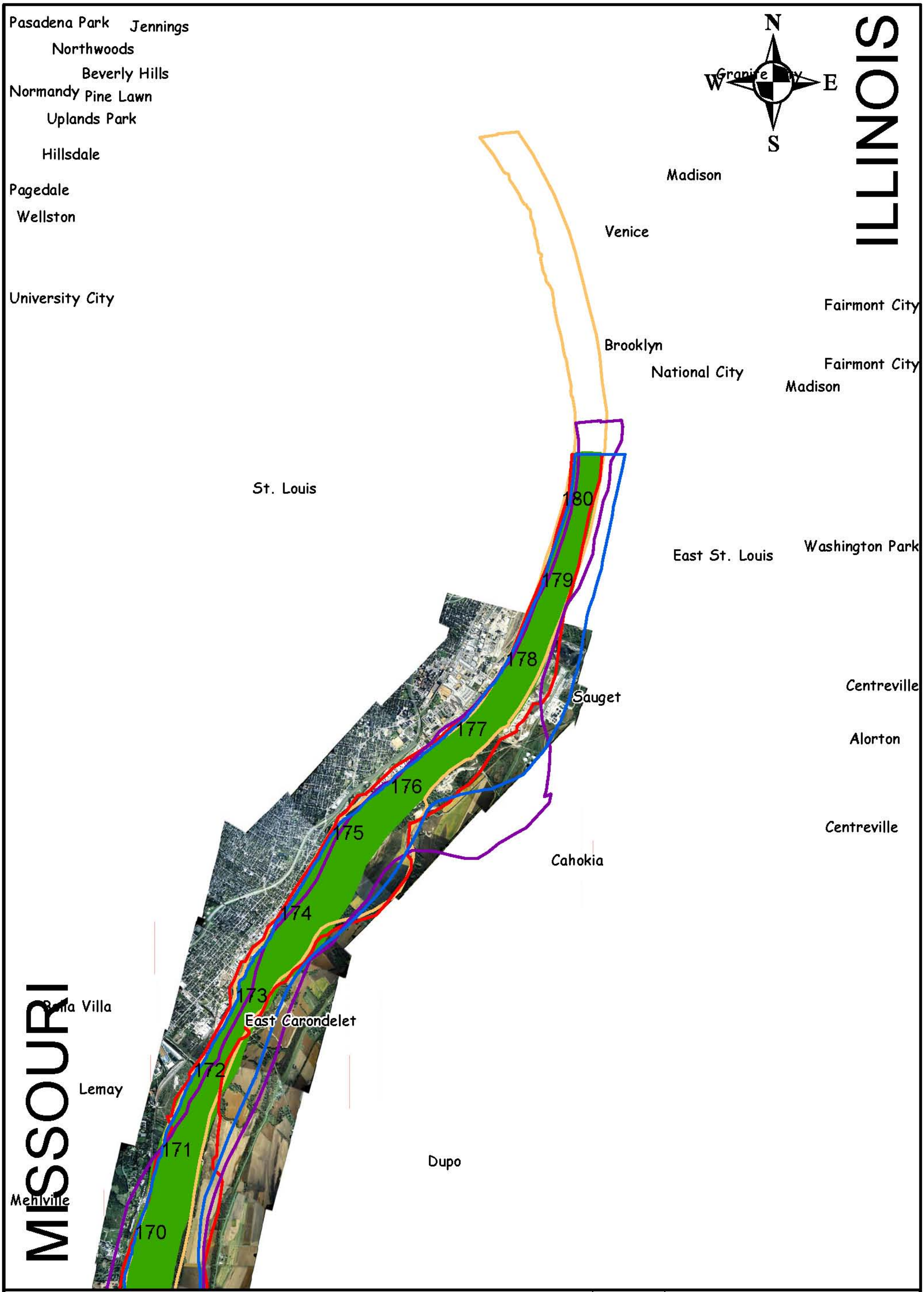
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1928 Planform

RIVER MILES 180-170

PLATE NO.: 5



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Aerial Photographs

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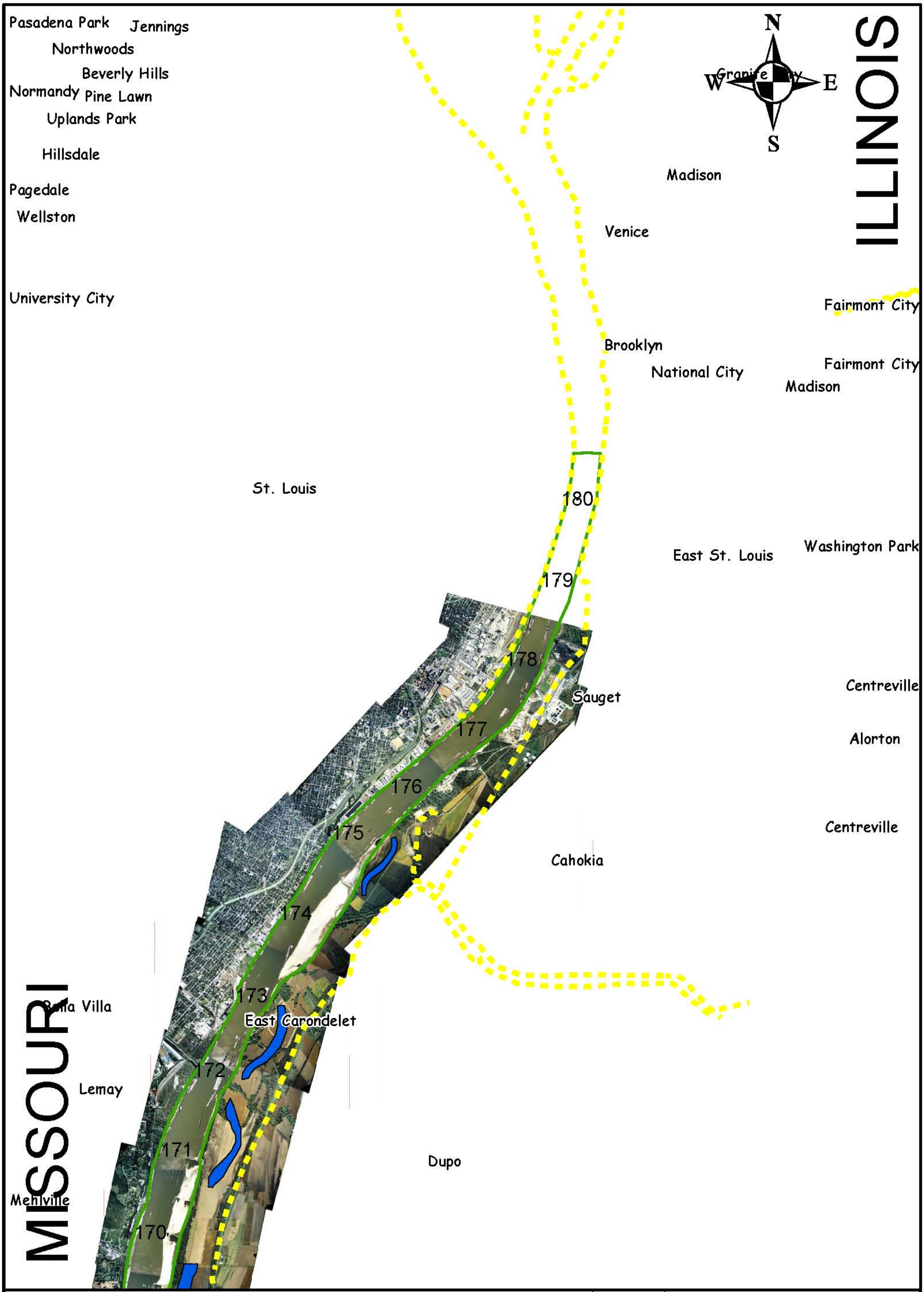
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

2003 Planform

RIVER MILES 180-170

PLATE NO.: 6



LEGEND

0 5,280 10,560 21,120 Feet

- ⁃ ⁃ Levee
- ▭ 2003 Planform
- 🟦 Isolated, Deep Oxbow
- ▭ Side Channel, Sloughs or Backwater

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ST. LOUIS, MISSOURI

PREPARED BY: Edward J.Brauer
DRAWN BY: Edward J.Brauer
CHECKED BY: Robert D.Davinroy

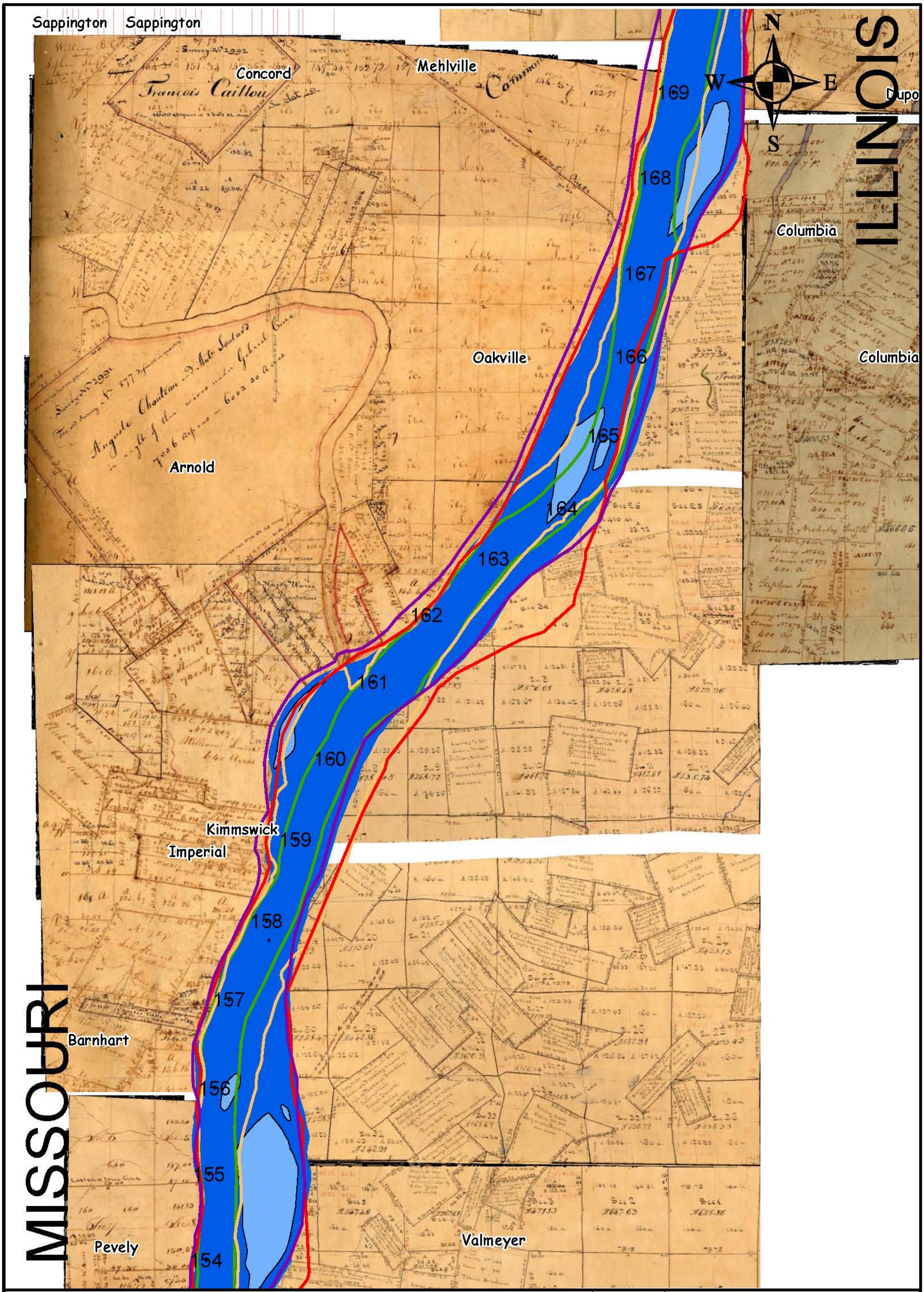
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

BLUEPRINT FOR RESTORATION

RIVER MILES 180-170

PLATE NO.: 7



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: 1817-1820 Government Land Office Surveys

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

PREPARED BY: Edward J. Brauer
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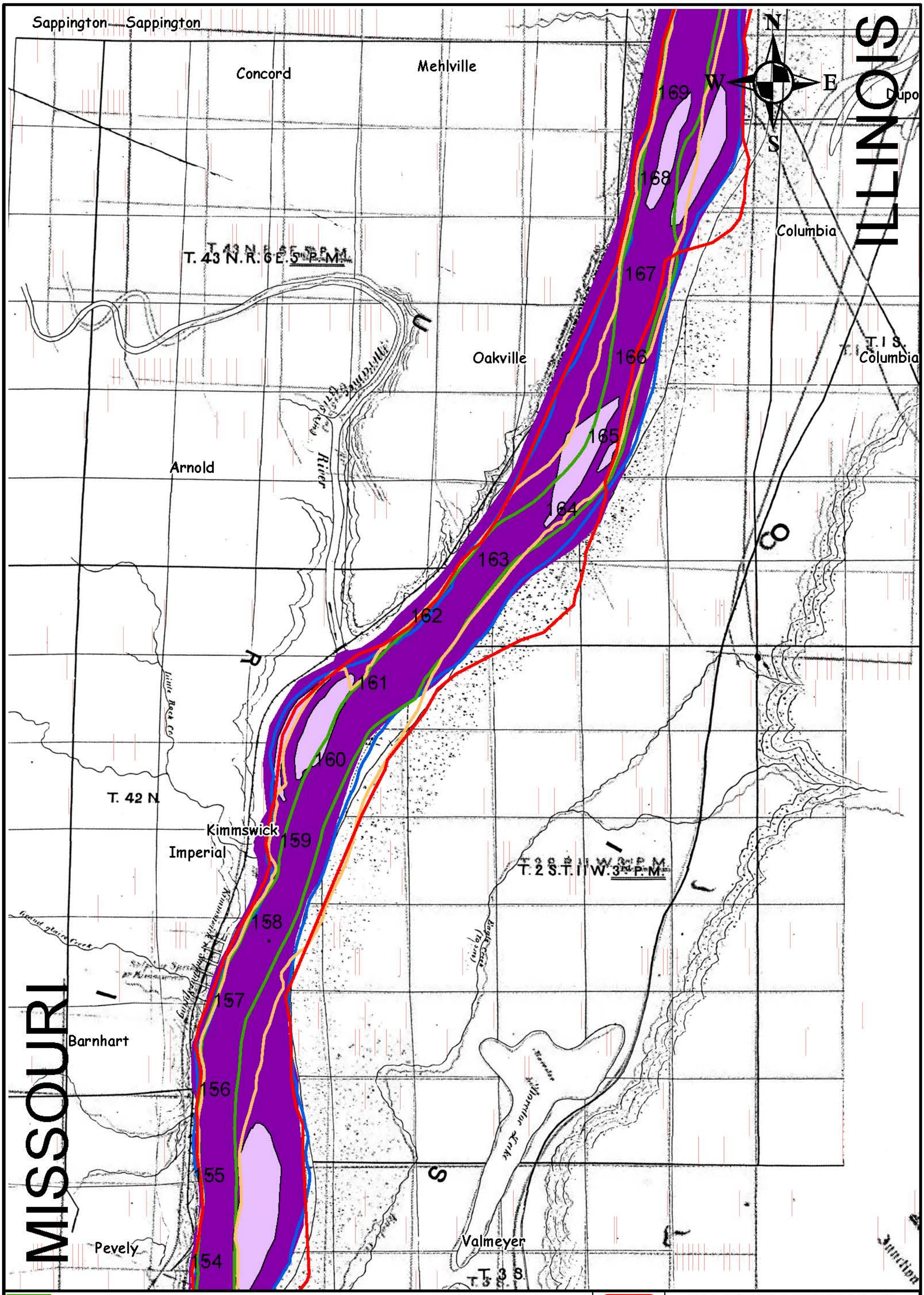
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1817 Planform

RIVER MILES 170-154

PLATE NO.: 8



🟩	2003
🟧	1928
🟥	1881
🟪	1866
🟦	1817

0 5,280 10,560 21,120 Feet

SOURCE: Warren, Bvt. Major General G. K.

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

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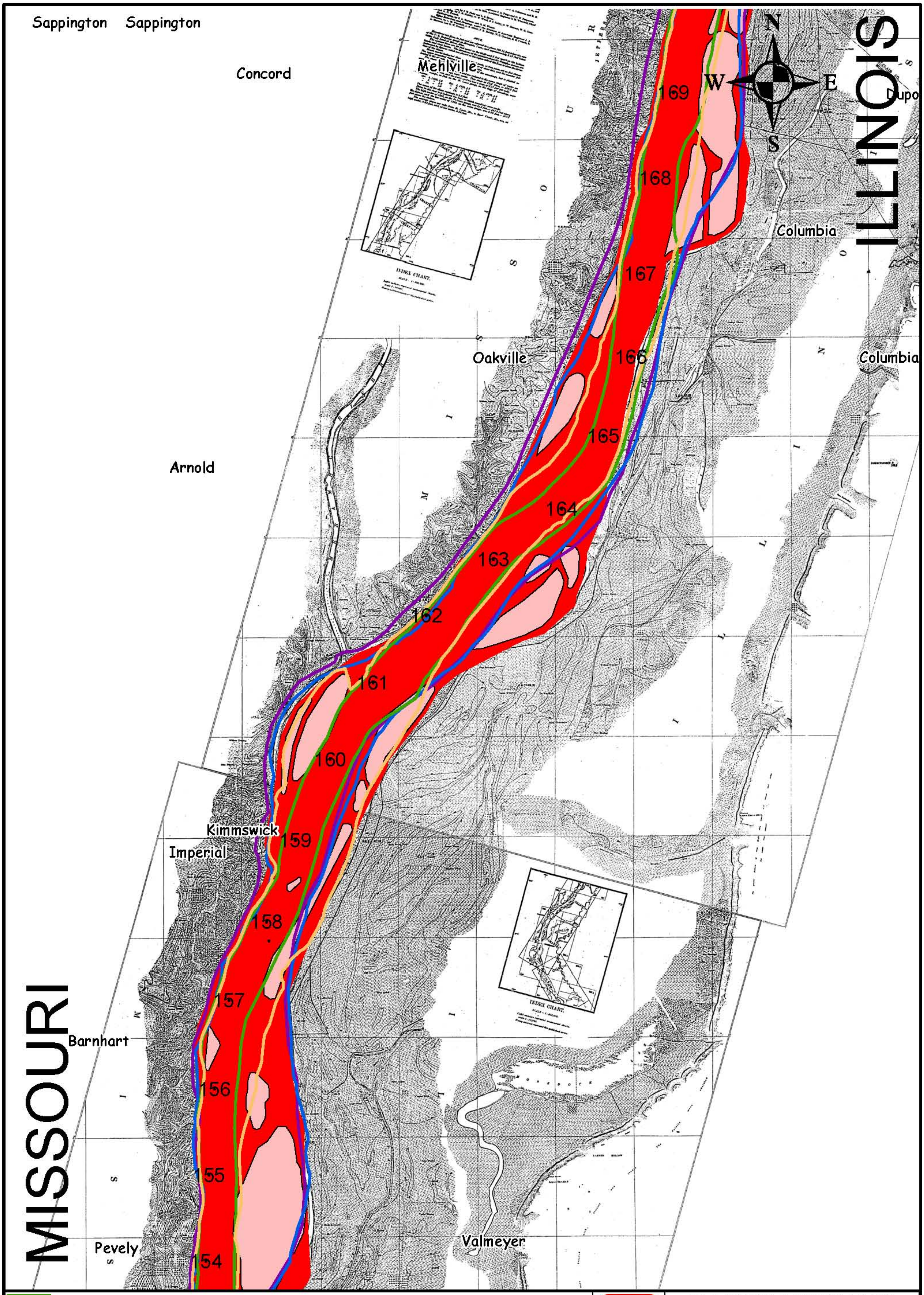
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1866 Planform

RIVER MILES 170-154

PLATE NO. 9



🟩 2003

🟧 1928

🟥 1881

🟪 1866

🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Mississippi River Commission, 1880-1882, 1884, 1888, 1889, 1891-1899

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

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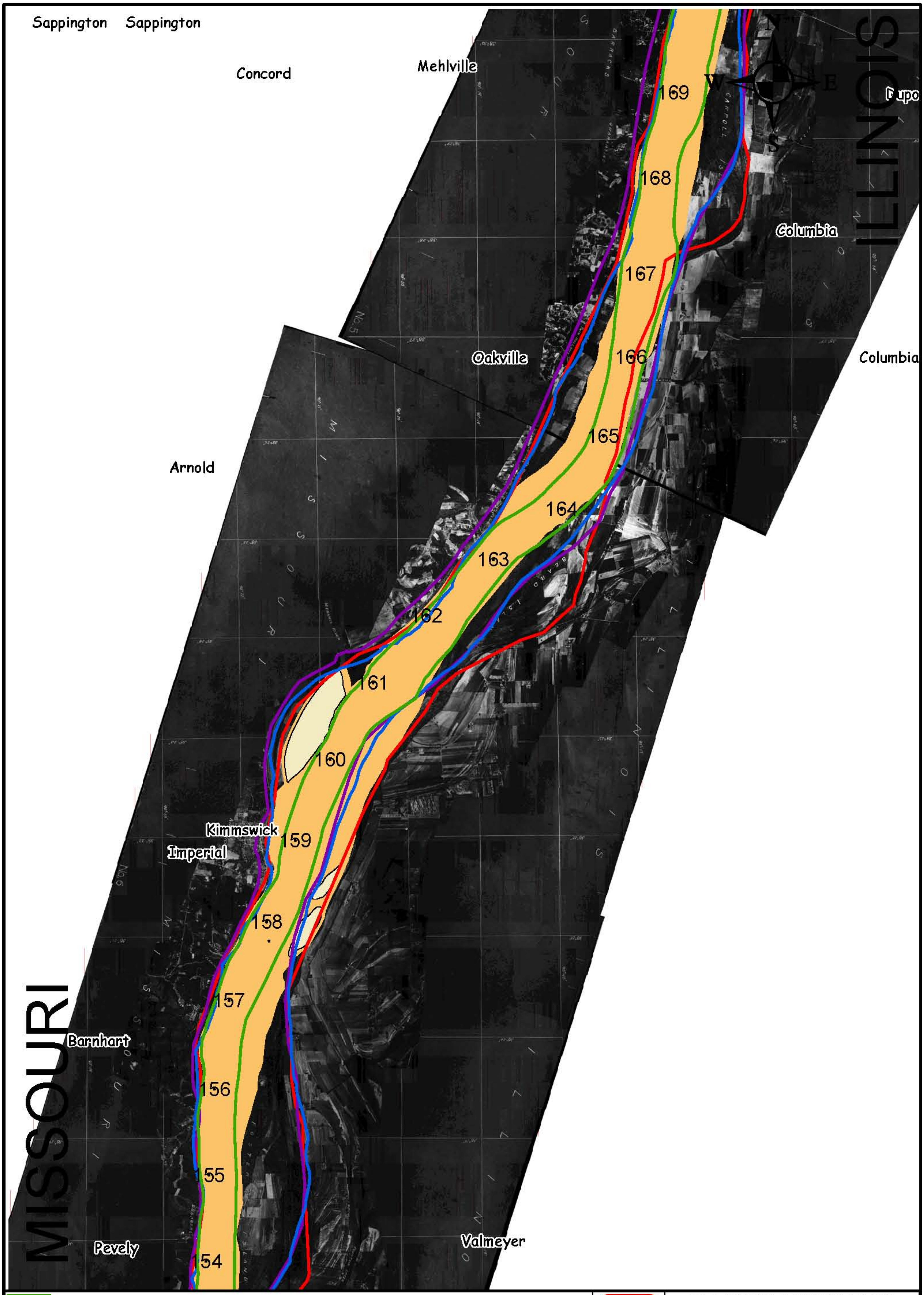
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1881 Planform

RIVER MILES 170-154

PLATE NO.: 10



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

Feet
0 5,280 10,560 21,120

SOURCE: Aerial Photographs
Flown 5 OCT 1928

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

PREPARED BY: Edward J.Brauer
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APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1928 Planform

RIVER MILES 170-154

PLATE NO.: 11

🟩	2003
🟧	1928
🟥	1881
🟪	1866
🟦	1817

0 5,280 10,560 21,120 Feet

SOURCE: Aerial Photographs

PREPARED BY: Edward J. Brauer
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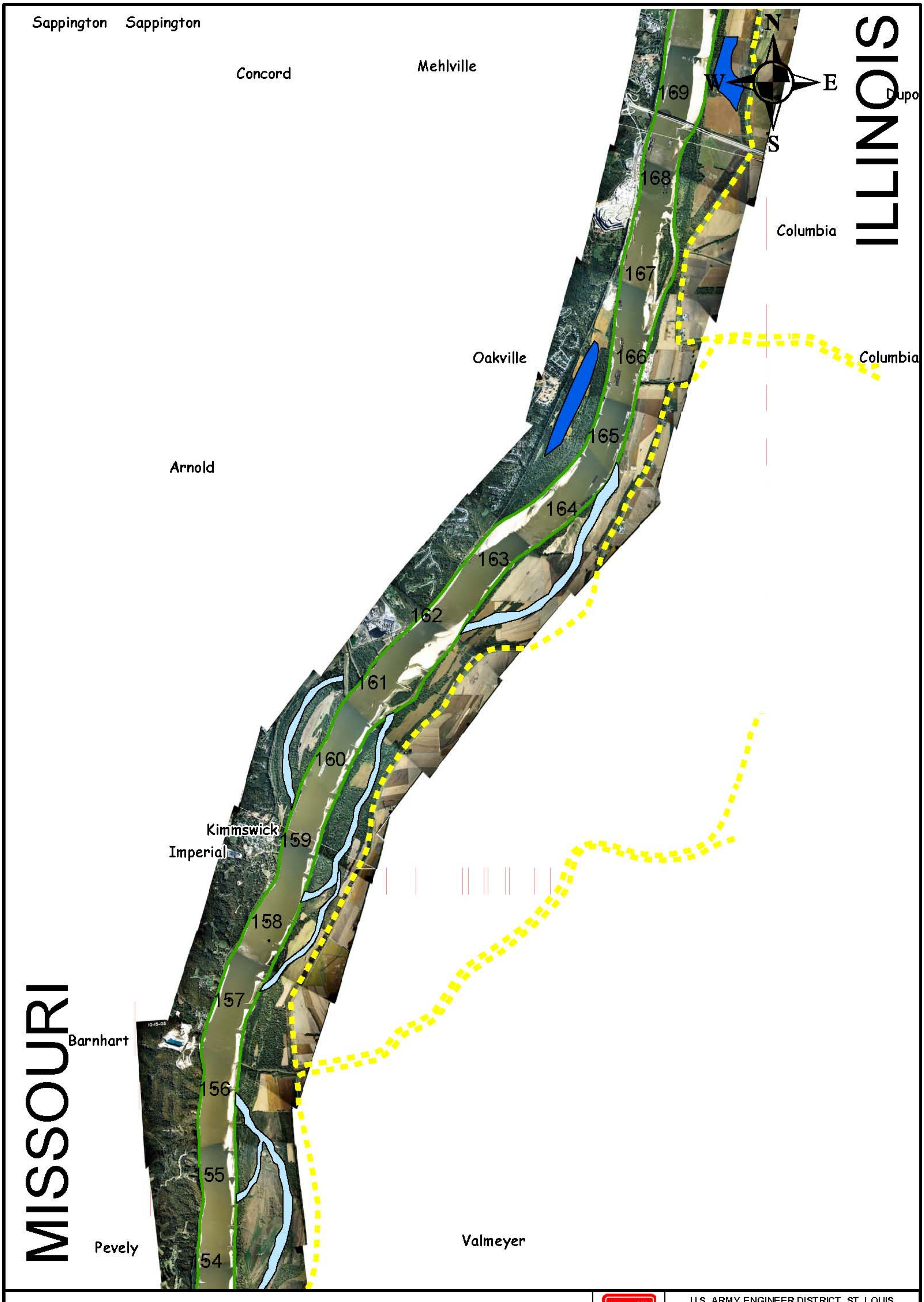
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

2003 Planform

RIVER MILES 170-154

PLATE NO. 12



LEGEND

0 5,280 10,560 21,120 Feet

- 🟨 Levee
- 🟩 2003 Planform
- 🟦 Isolated, Deep Oxbow
- 🟦 Side Channel, Sloughs or Backwater

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

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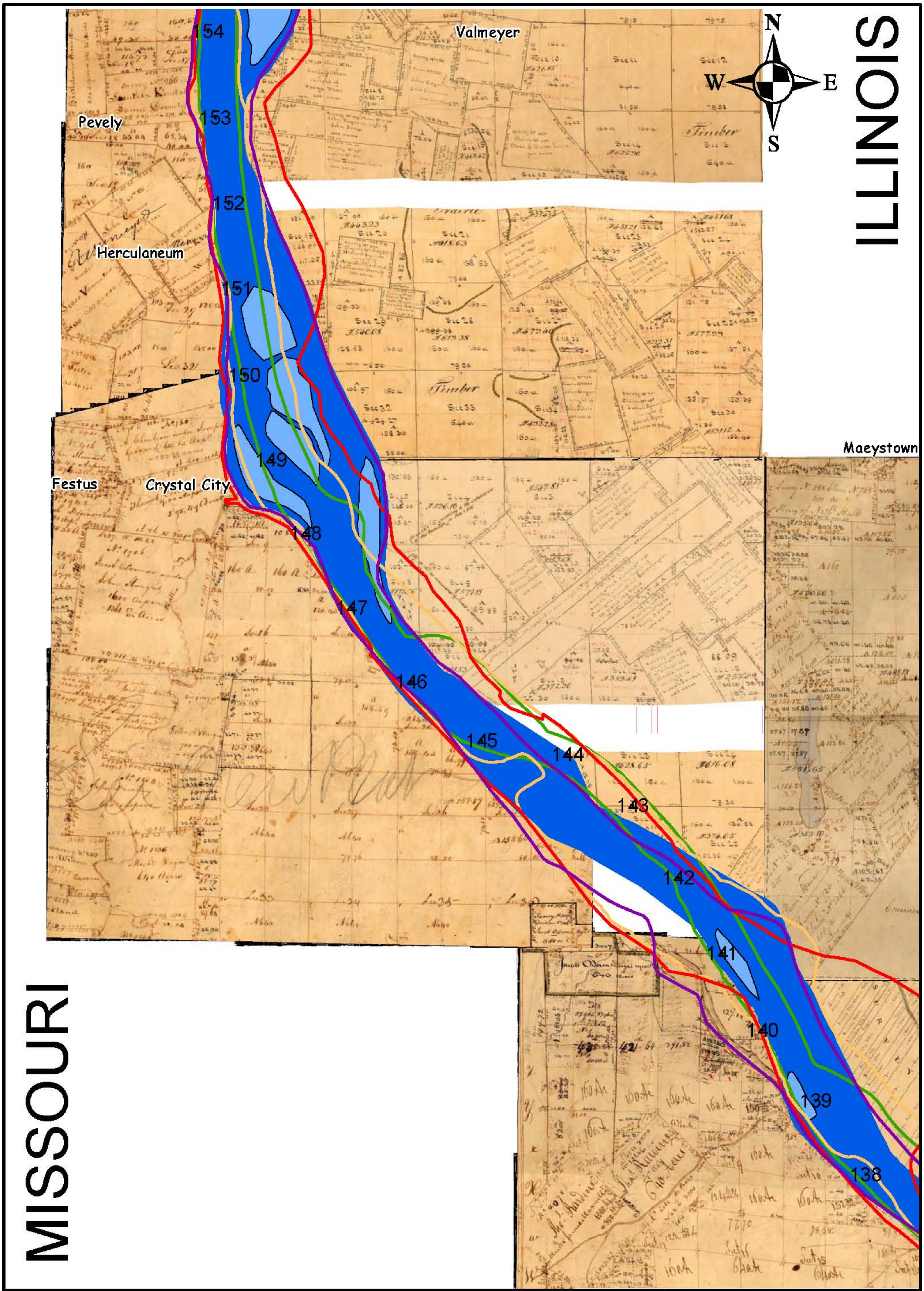
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

BLUEPRINT FOR RESTORATION

RIVER MILES 170-154

PLATE NO.: 13



🟩 2003
🟨 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: 1817-1820 Government Land Office Surveys

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
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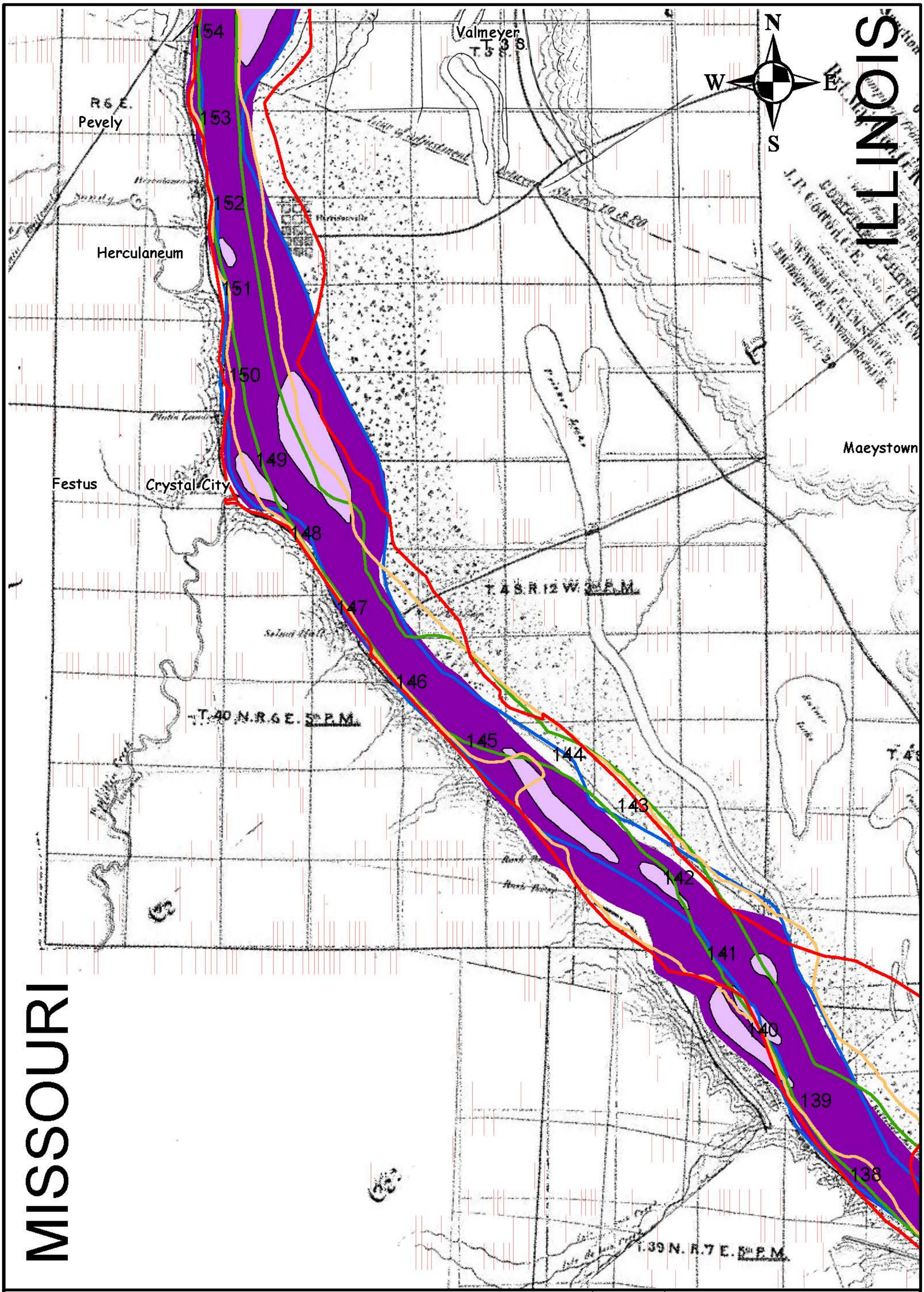
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1817 Planform

RIVER MILES 154-137

PLATE NO.: 14



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Warren, Bvt. Major General G. K.

PREPARED BY: Edward J. Brauer
DRAWN BY: Edward J. Brauer
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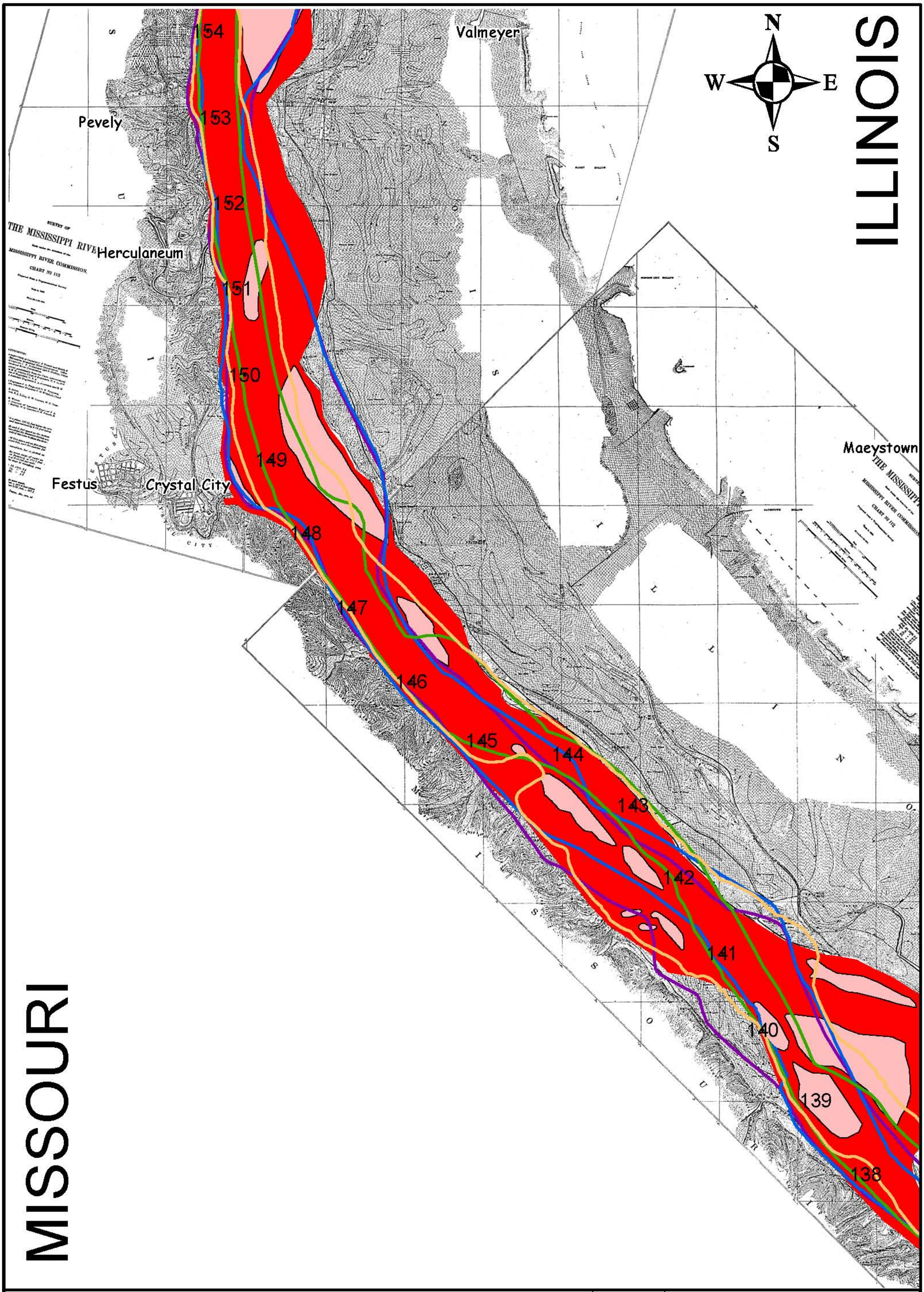
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1866 Planform

RIVER MILES 154-137

PLATE NO. 15



🟩	2003
🟧	1928
🟥	1881
🟪	1866
🟦	1817

0 5,280 10,560 21,120 Feet

SOURCE: Mississippi River Commission, 1880-1882, 1884, 1888, 1889, 1891-1899

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

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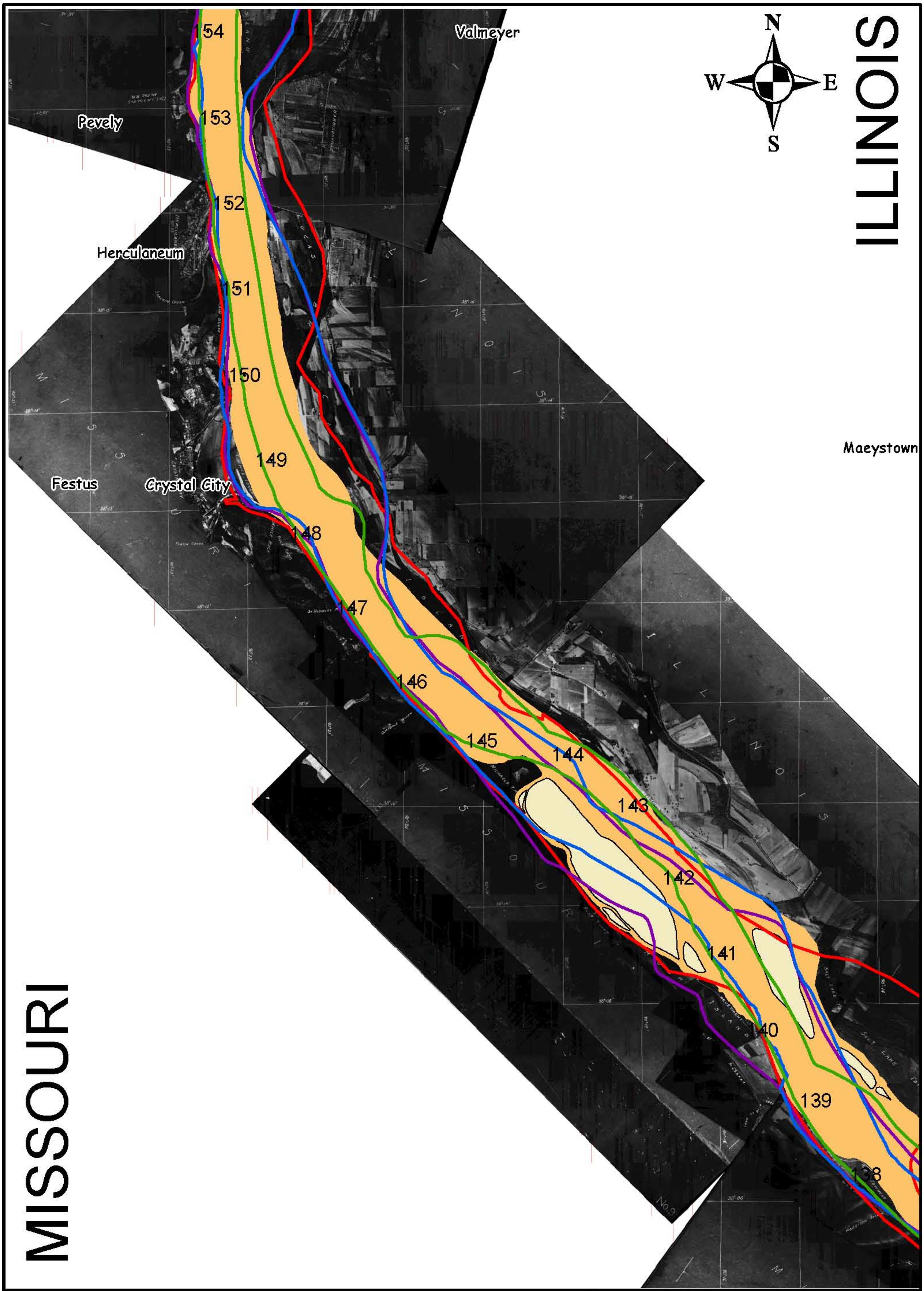
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1881 Planform

RIVER MILES 154-137

PLATE NO. 16



🟩	2003
🟧	1928
🟥	1881
🟪	1866
🟦	1817

0 5,280 10,560 21,120 Feet

SOURCE: Aerial Photographs
Flown 5 OCT 1928

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

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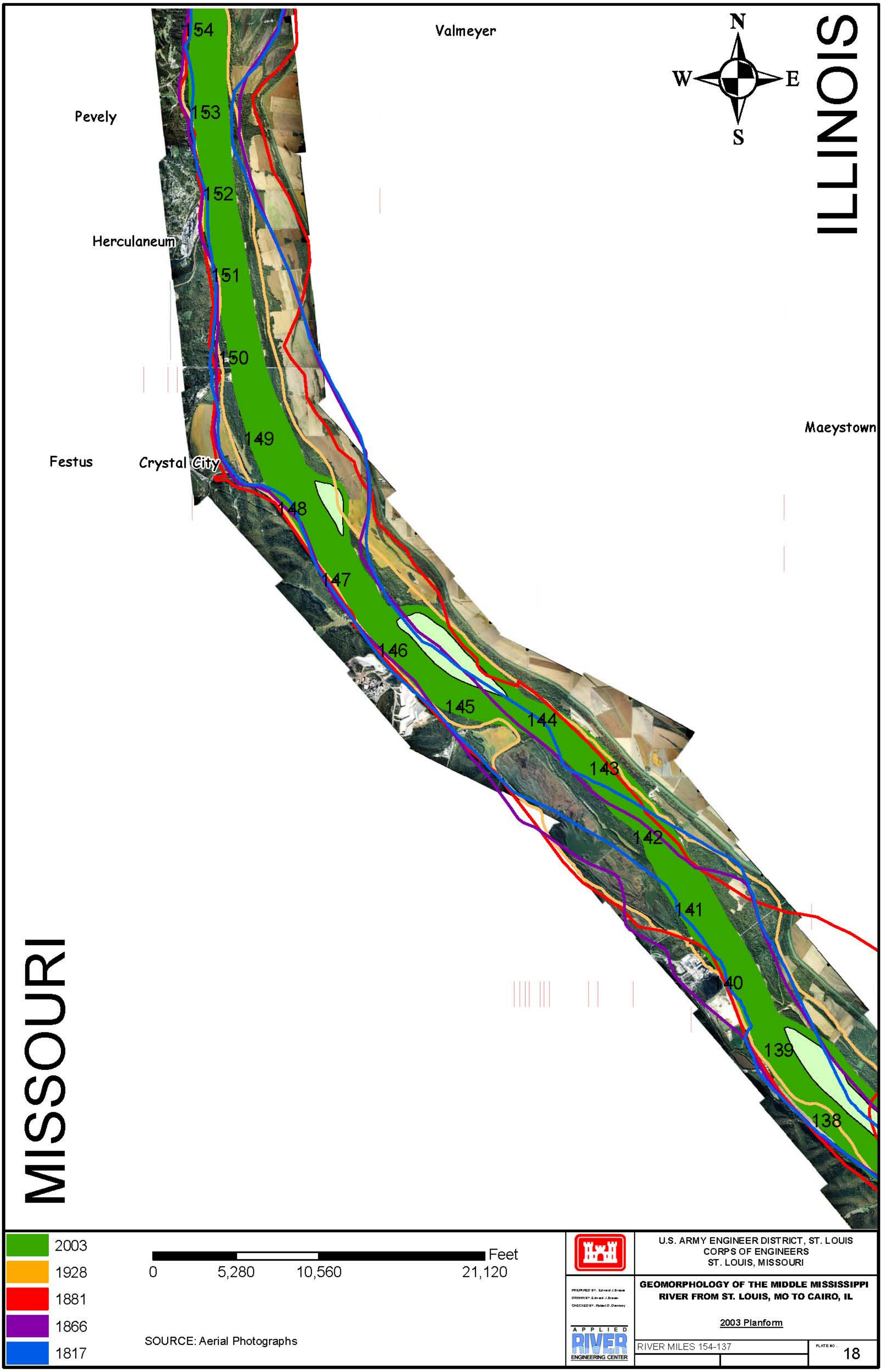
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1928 Planform

RIVER MILES 154-137

PLATE NO.: 17



SOURCE: Aerial Photographs

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

PREPARED BY: Edward J.Brauer
DRAWN BY: Edward J.Brauer
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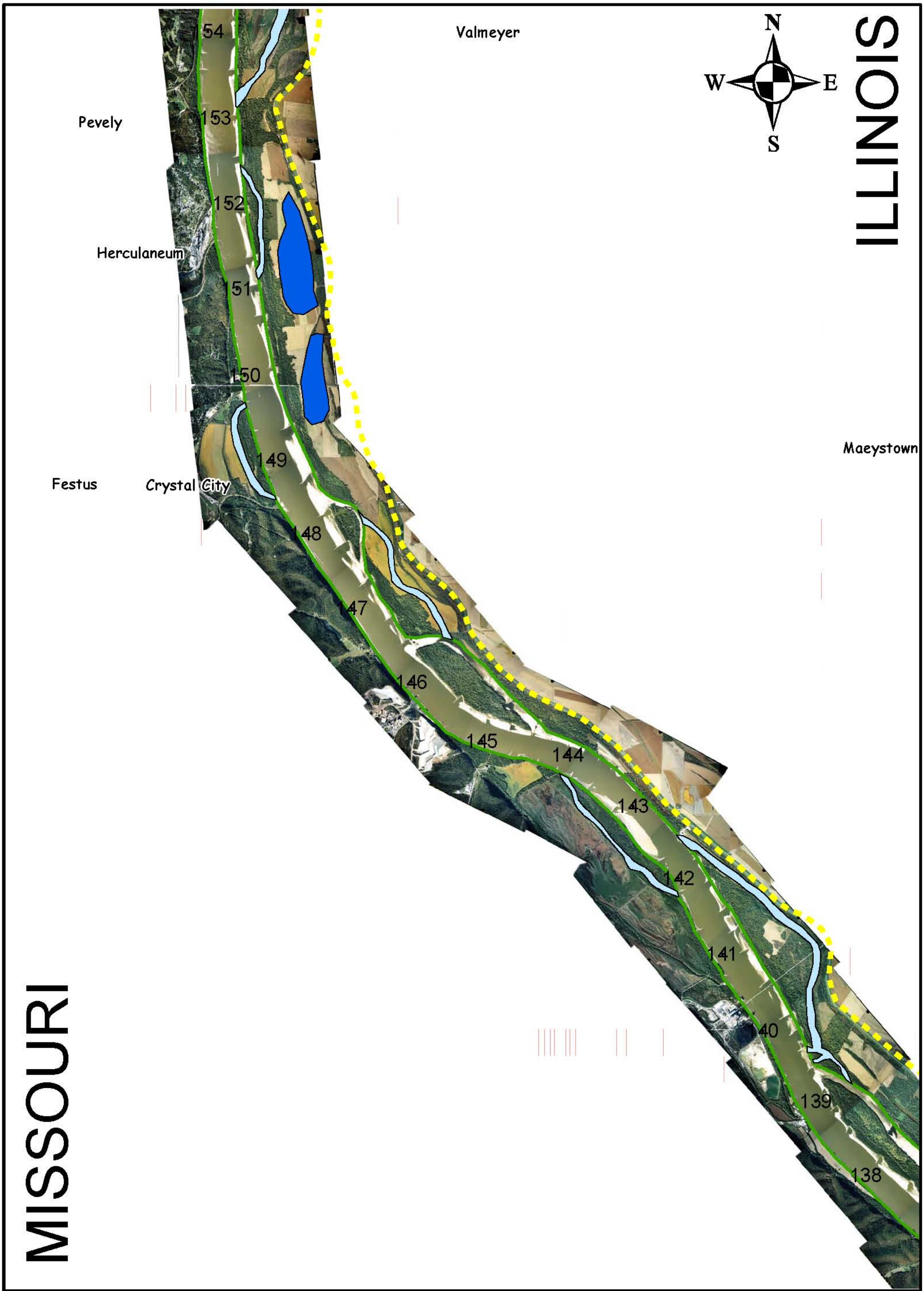
ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

2003 Planform

RIVER MILES 154-137

PLATE NO. 18



LEGEND

- 🟨 Levee
- ▭ 2003 Planform
- 🟦 Isolated, Deep Oxbow
- ▭ Side Channel, Sloughs or Backwater

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

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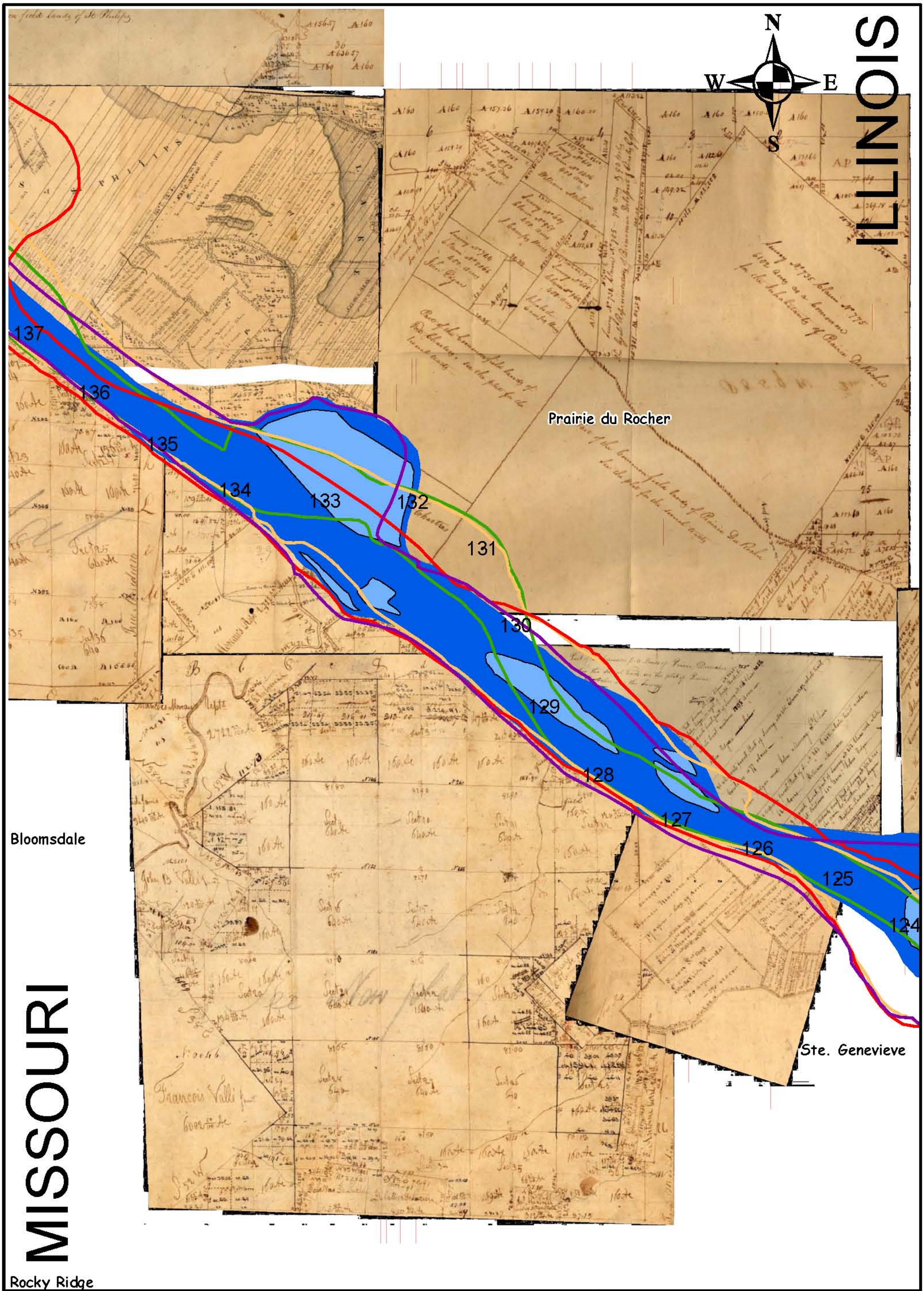
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

BLUEPRINT FOR RESTORATION

RIVER MILES 154-137

PLATE NO. 19



SOURCE: 1817-1820 Government Land Office Surveys

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

PREPARED BY: Edward J.Brauer
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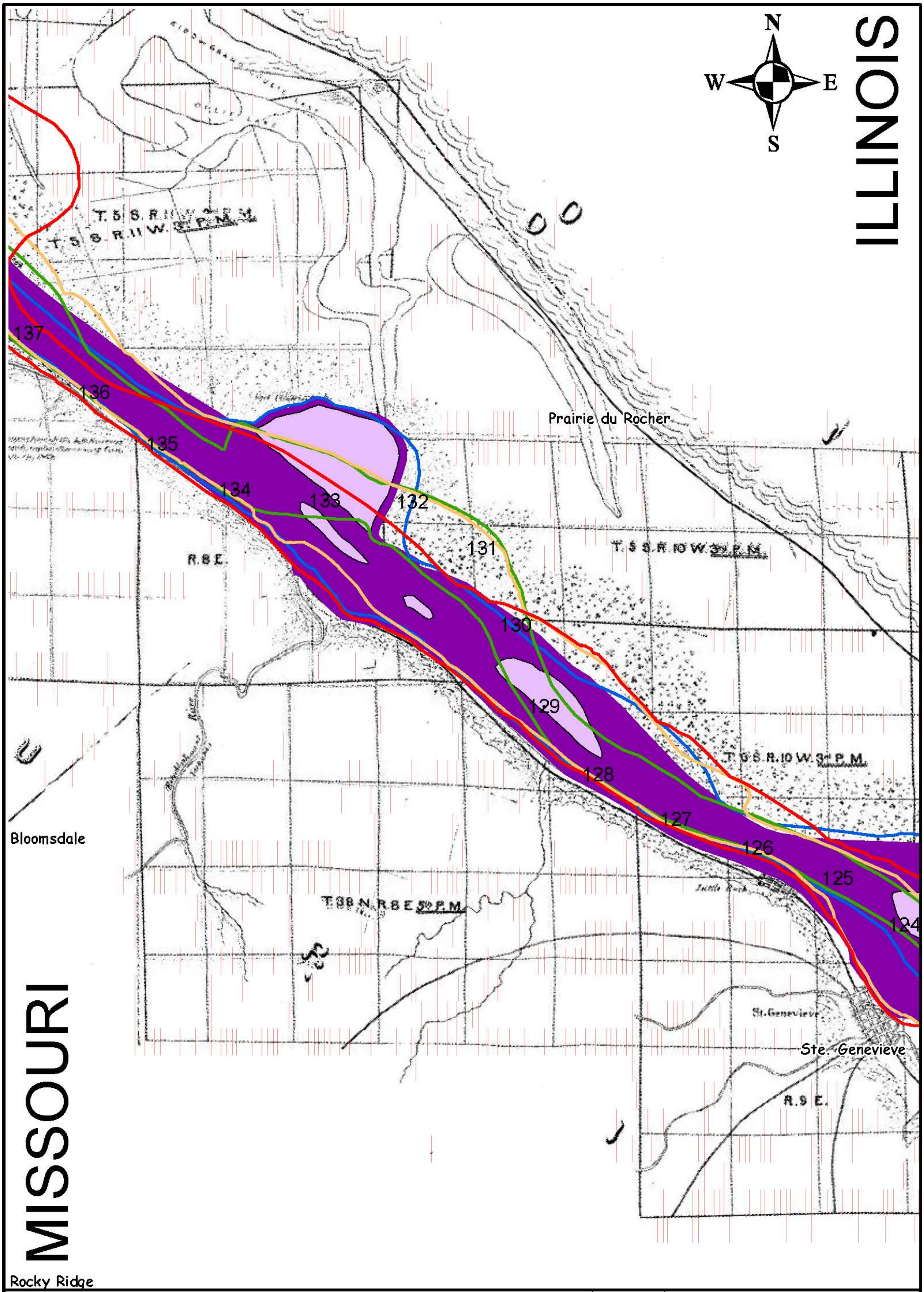
CHECKED BY: Robert D.Davinroy

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1817 Planform

RIVER MILES 137-124

PLATE NO. 20



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Warren, Bvt. Major General G. K.

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

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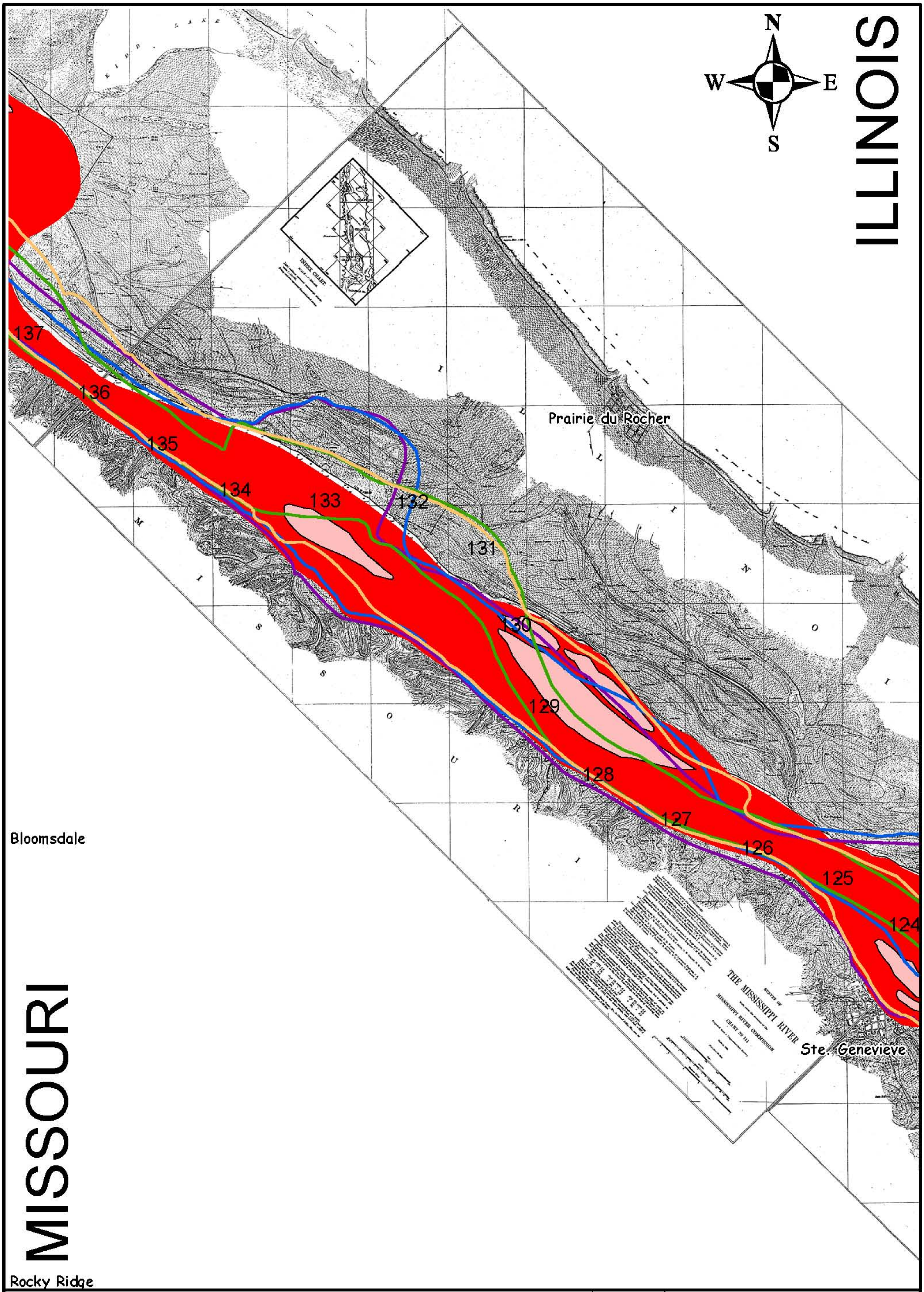
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1866 Planform

RIVER MILES 137-124

PLATE NO.: 21



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Mississippi River Commission, 1880-1882, 1884, 1888, 1889, 1891-1899

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

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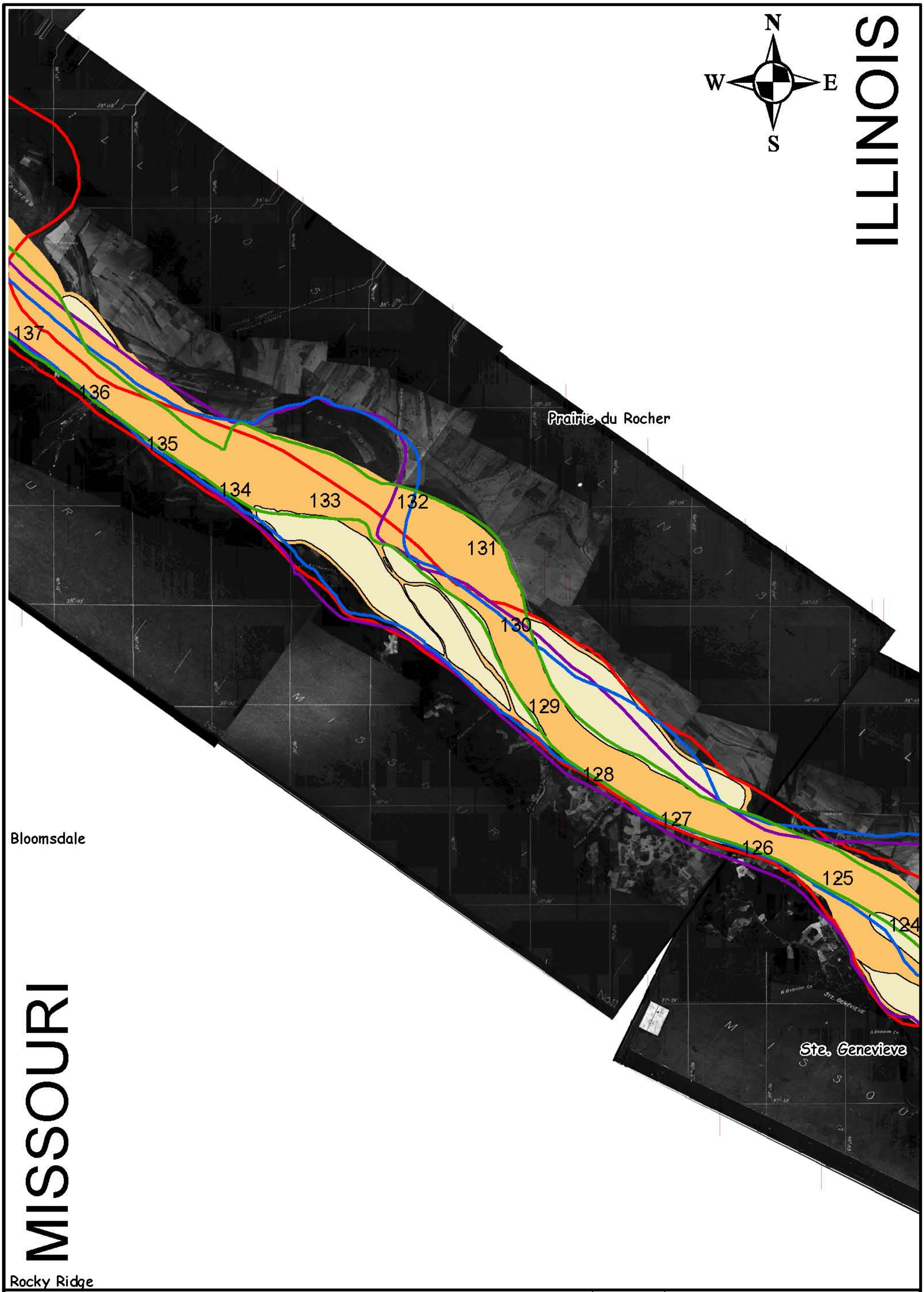
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1881 Planform

RIVER MILES 137-124

PLATE NO.: 22



🟩 2003

🟧 1928

🟥 1881

🟪 1866

🟦 1817

Feet
0 5,280 10,560 21,120

SOURCE: Aerial Photographs
Flown 5 OCT 1928

PREPARED BY: Edward J.Brauer
DRAWN BY: Edward J.Brauer
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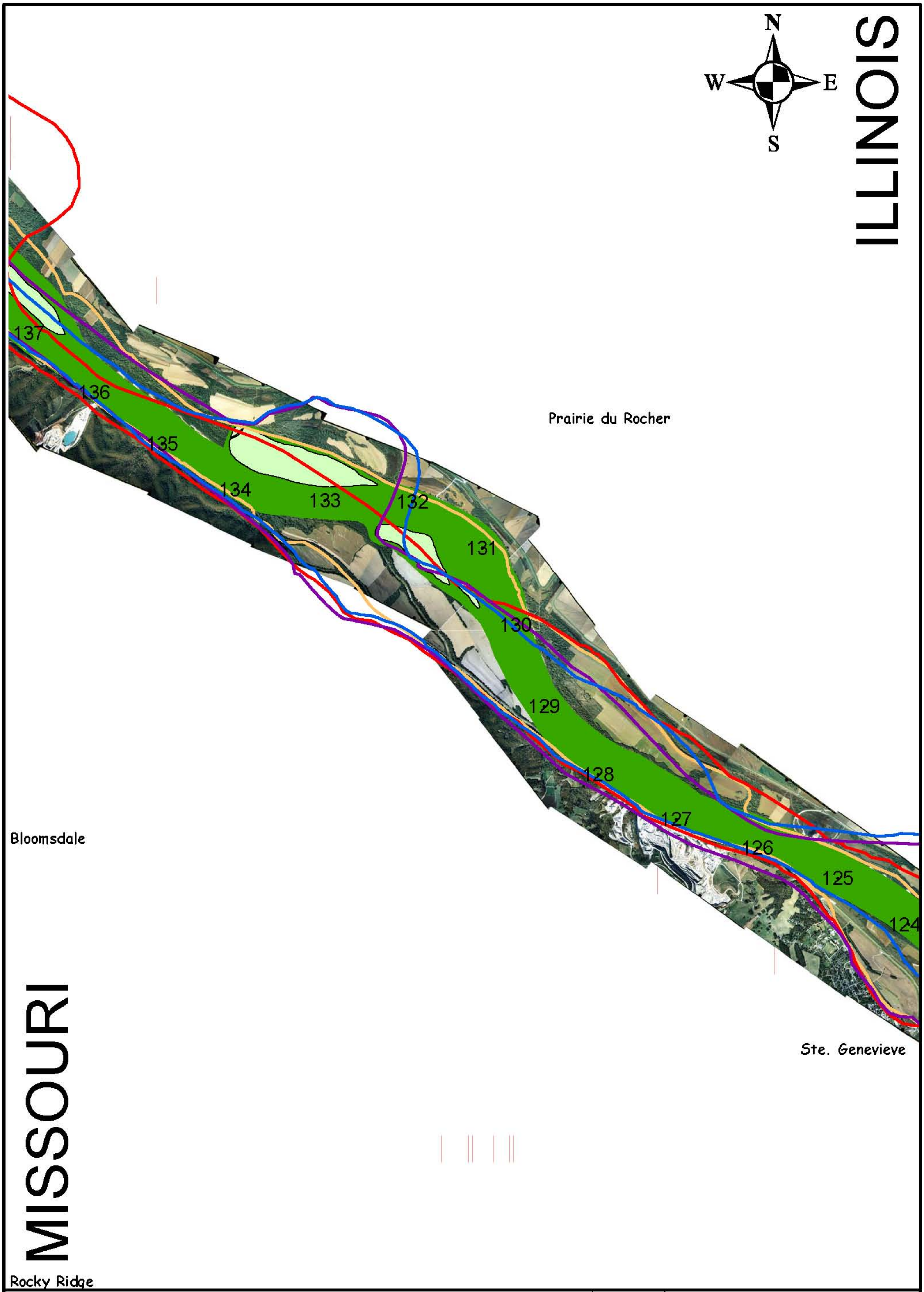
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1928 Planform

RIVER MILES 137-124

PLATE NO.: 23



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

SOURCE: Aerial Photographs

PREPARED BY: Edward J. Brauer
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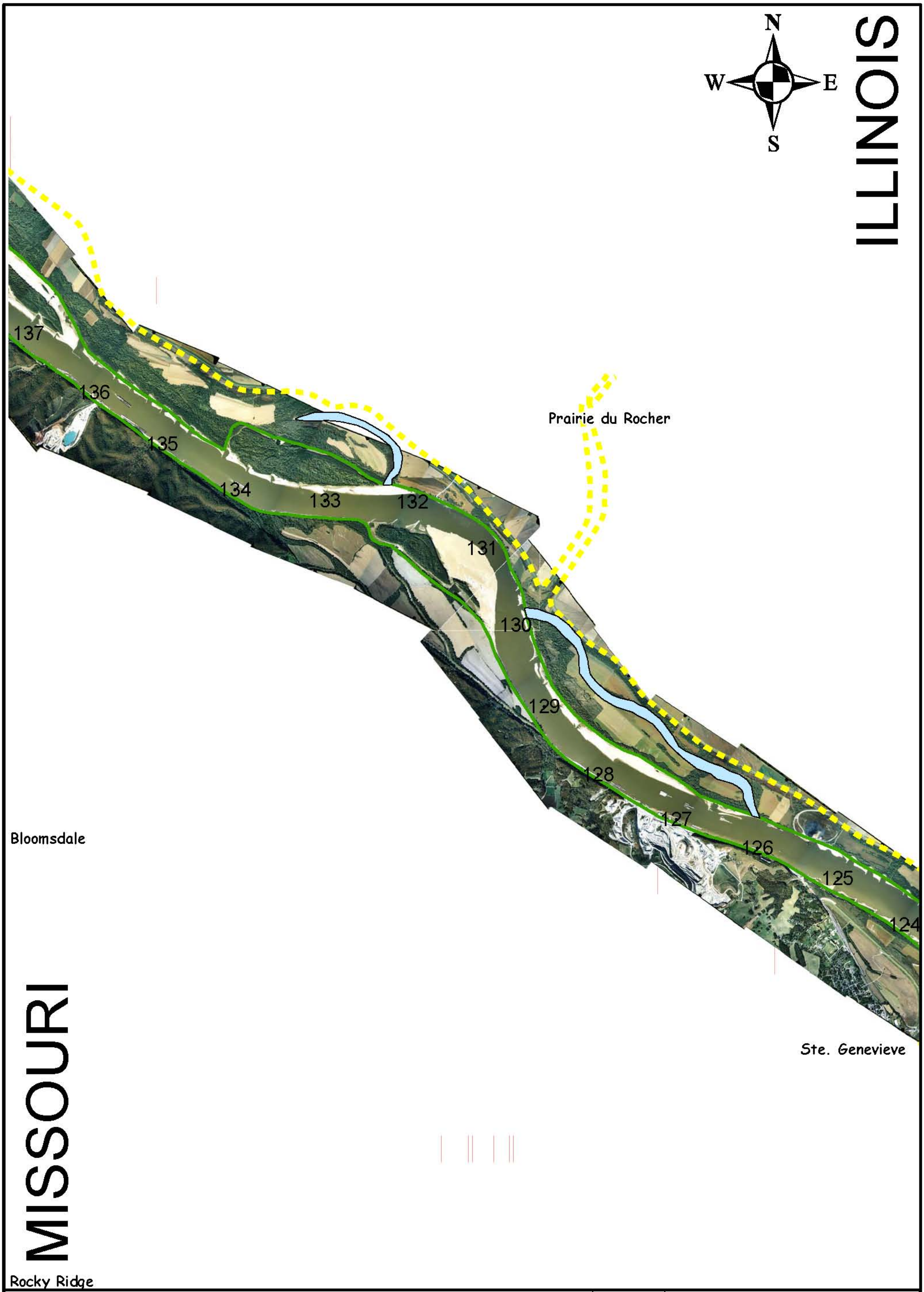
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

2003 Planform

RIVER MILES 137-124

PLATE NO.: 24



LEGEND

- 🟨 Levee
- ▭ 2003 Planform
- 🟦 Isolated, Deep Oxbow
- ▭ Side Channel, Sloughs or Backwater

Feet
0 5,280 10,560 21,120

PREPARED BY: Edward J.Brauer
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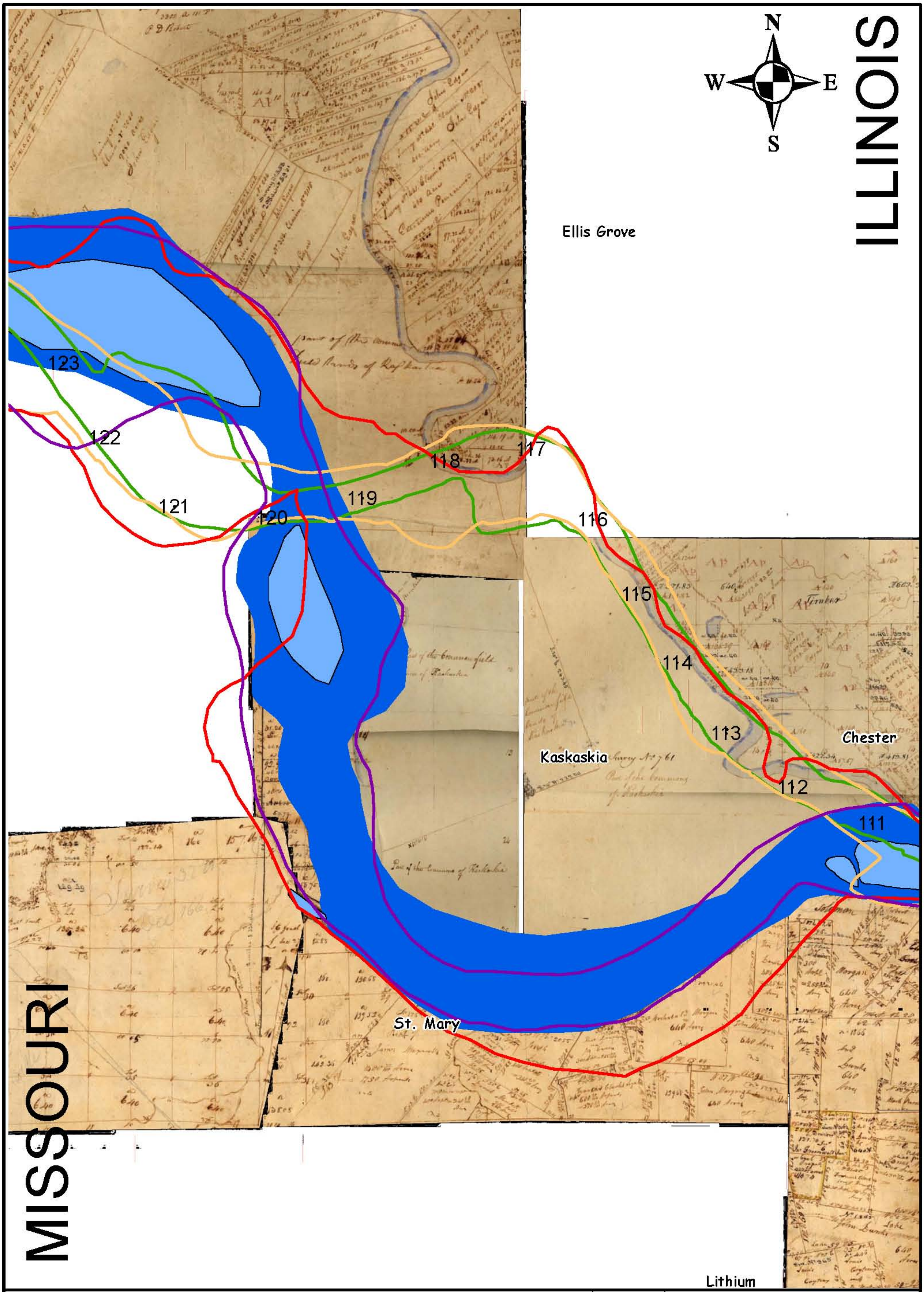
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

BLUEPRINT FOR RESTORATION

RIVER MILES 137-124

PLATE NO.: 25



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

SOURCE: 1817-1820 Government Land Office Surveys

PREPARED BY: Edward J. Brauer
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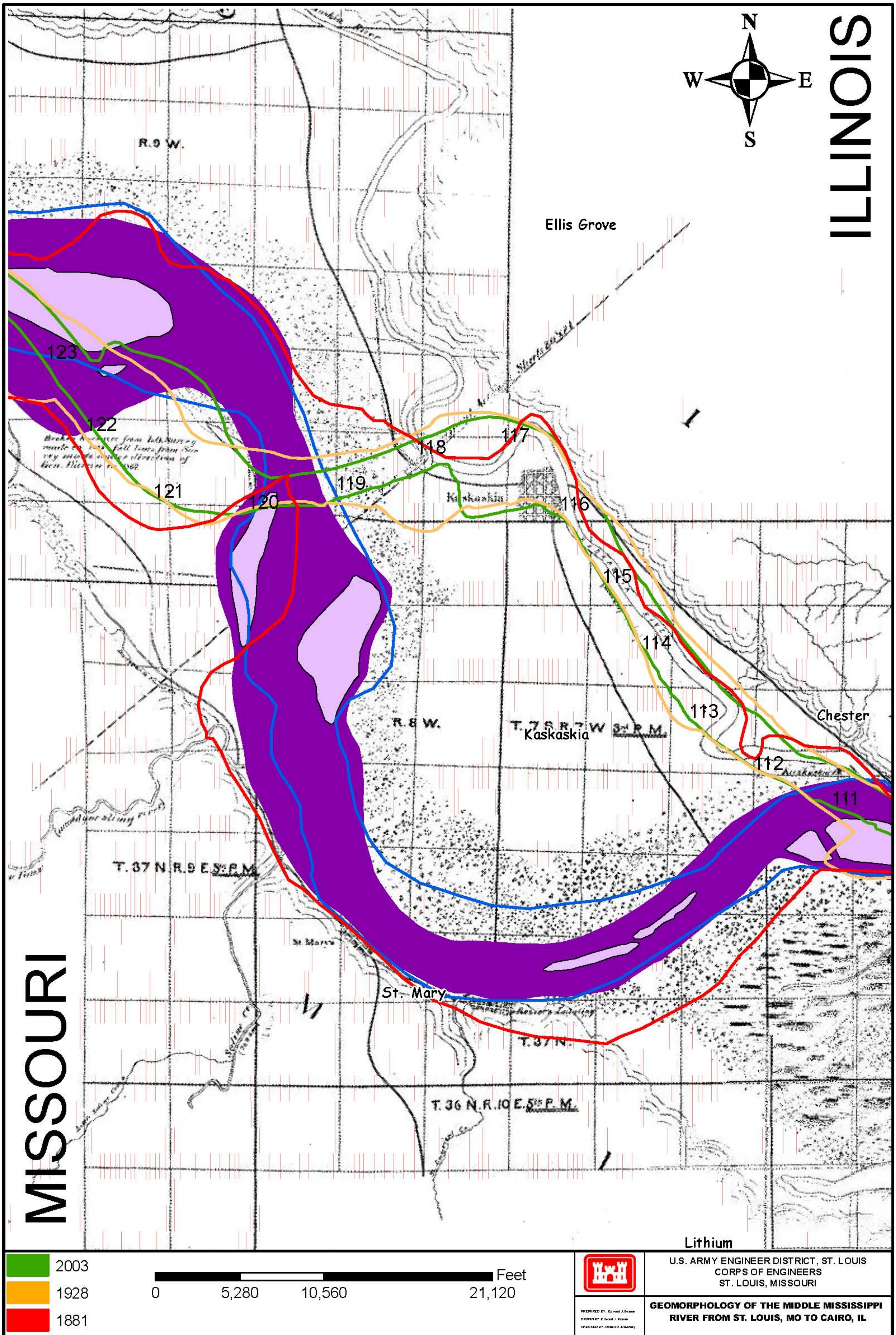
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1817 Planform

RIVER MILES 124-110

PLATE NO. 26



🟩 2003

🟧 1928

🟥 1881

🟪 1866

🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Warren, Bvt. Major General G. K.

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

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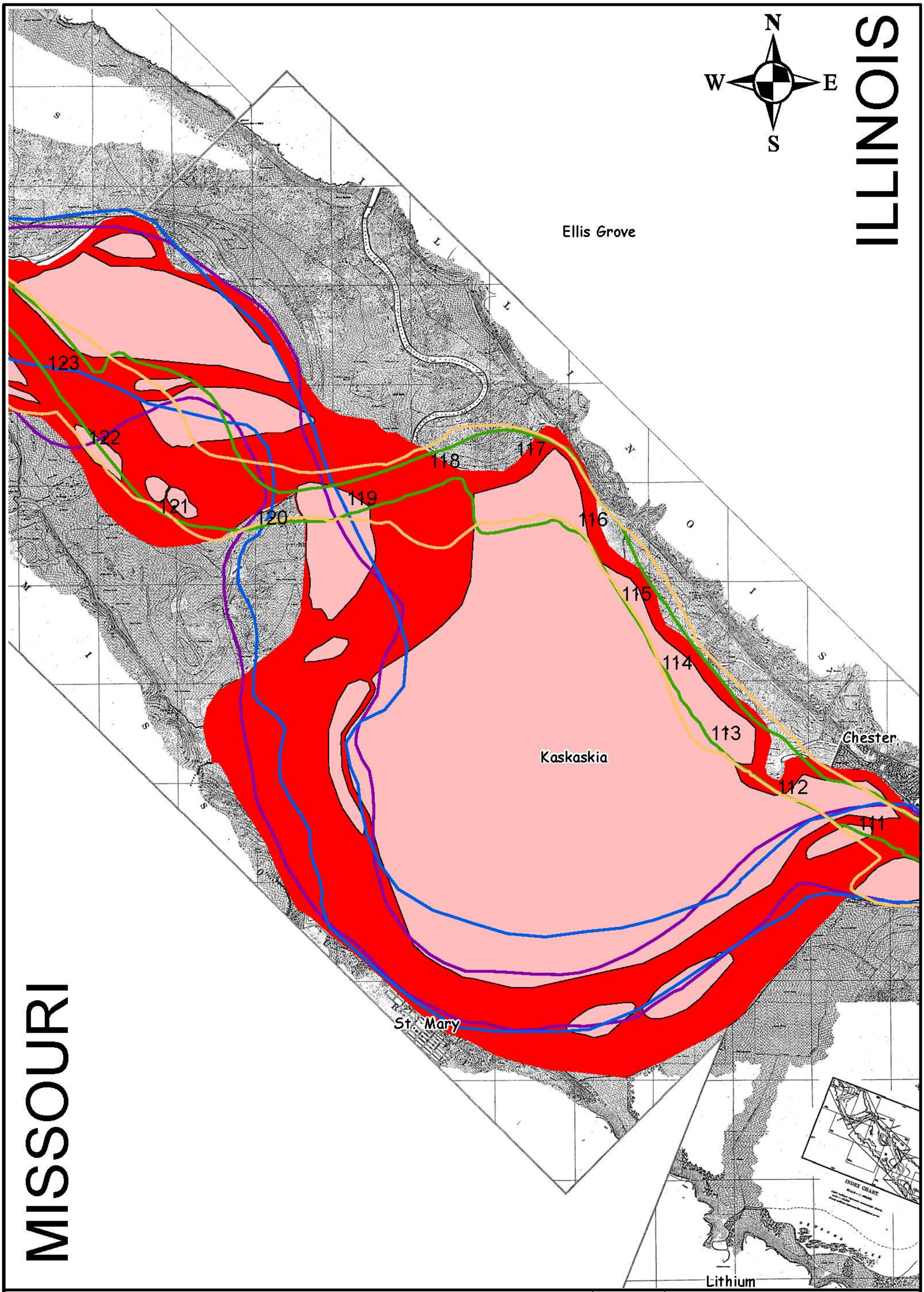
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1866 Planform

RIVER MILES 124-110

PLATE NO.: 27



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Mississippi River Commission, 1880-1882,
1884, 1888, 1889, 1891-1899

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

PREPARED BY: Edward J. Brauer
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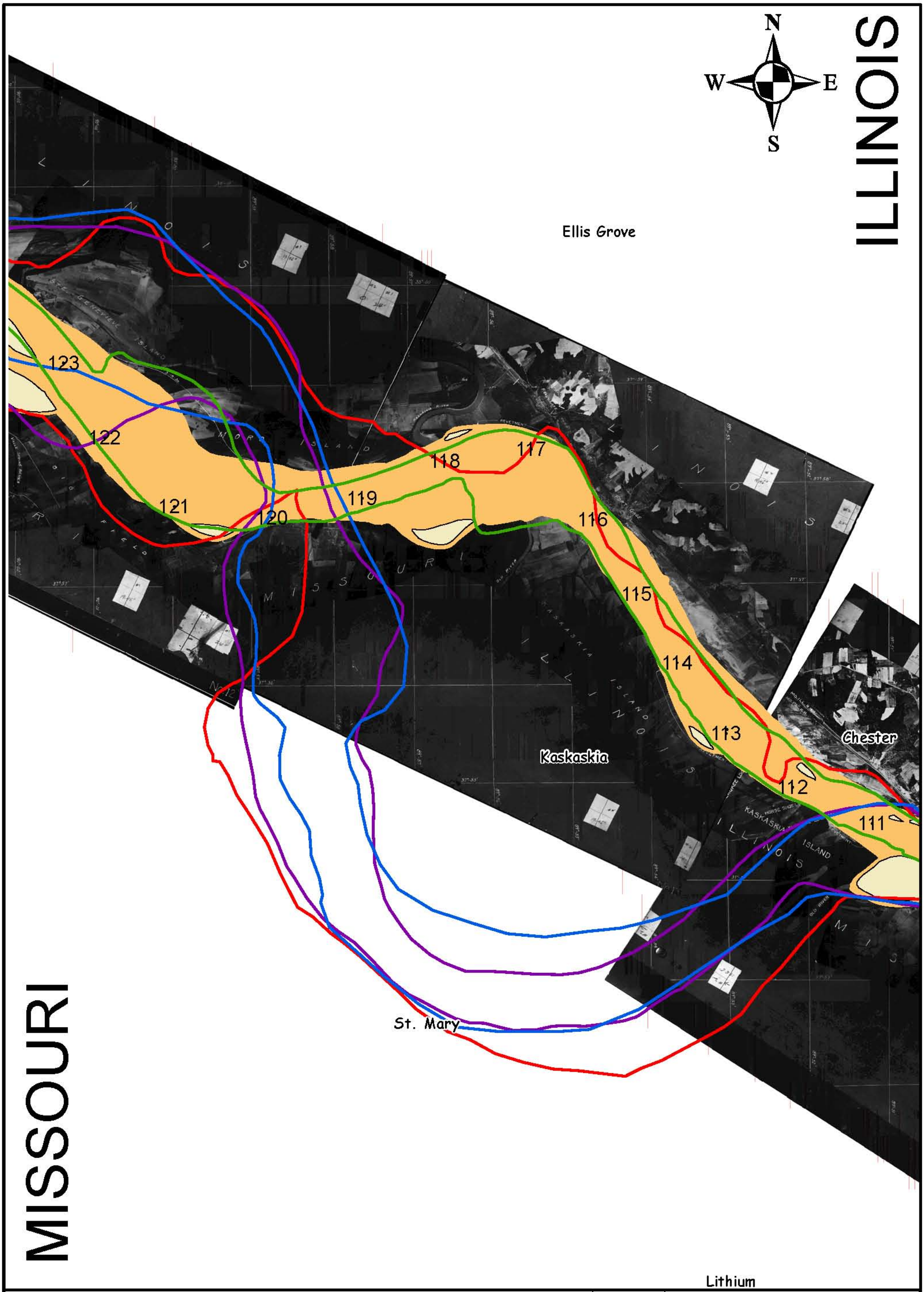
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1881 Planform

RIVER MILES 124-110

PLATE NO.: 28



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Aerial Photographs
Flown 5 OCT 1928

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

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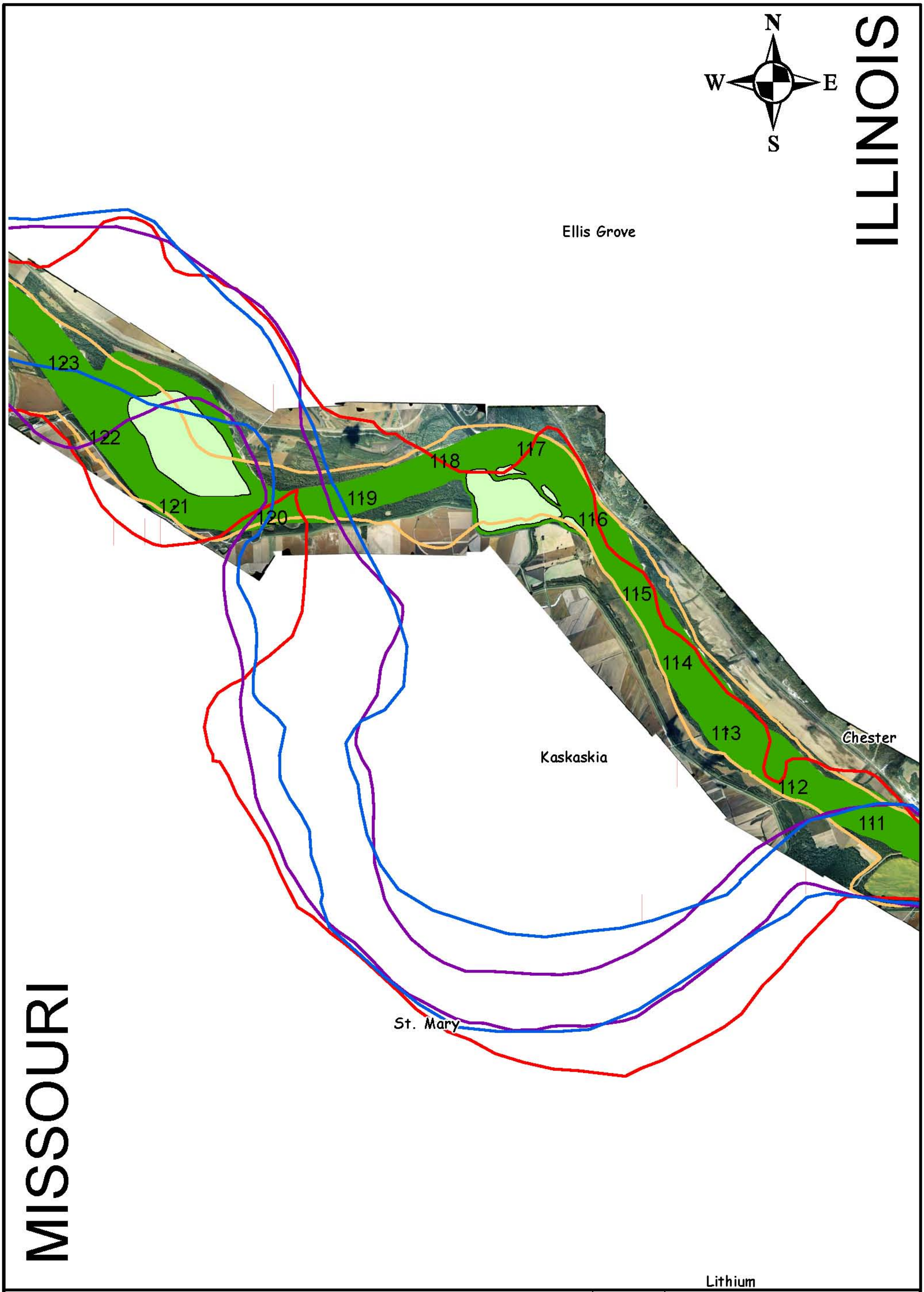
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1928 Planform

RIVER MILES 124-110

PLATE NO.: 29



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

Feet
0 5,280 10,560 21,120

SOURCE: Aerial Photographs

PREPARED BY: Edward J. Brauer
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CHECKED BY: Robert D. Davinroy

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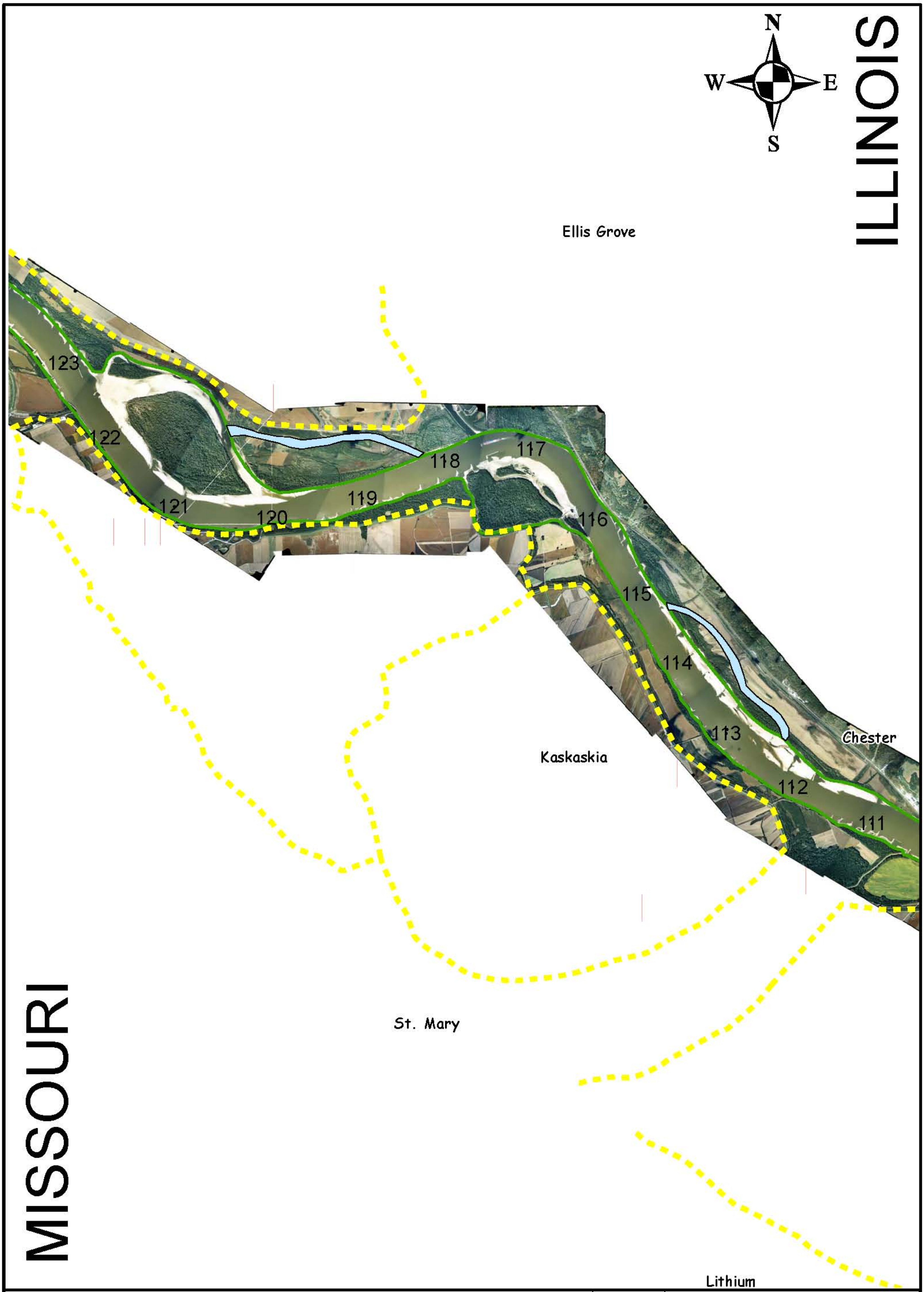
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

2003 Planform

RIVER MILES 124-110

PLATE NO.: 30



LEGEND

- ▬ ▬ Levee
- ▭ 2003 Planform
- 🟦 Isolated, Deep Oxbow
- ▭ Side Channel, Sloughs or Backwater

0 5,280 10,560 21,120 Feet

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

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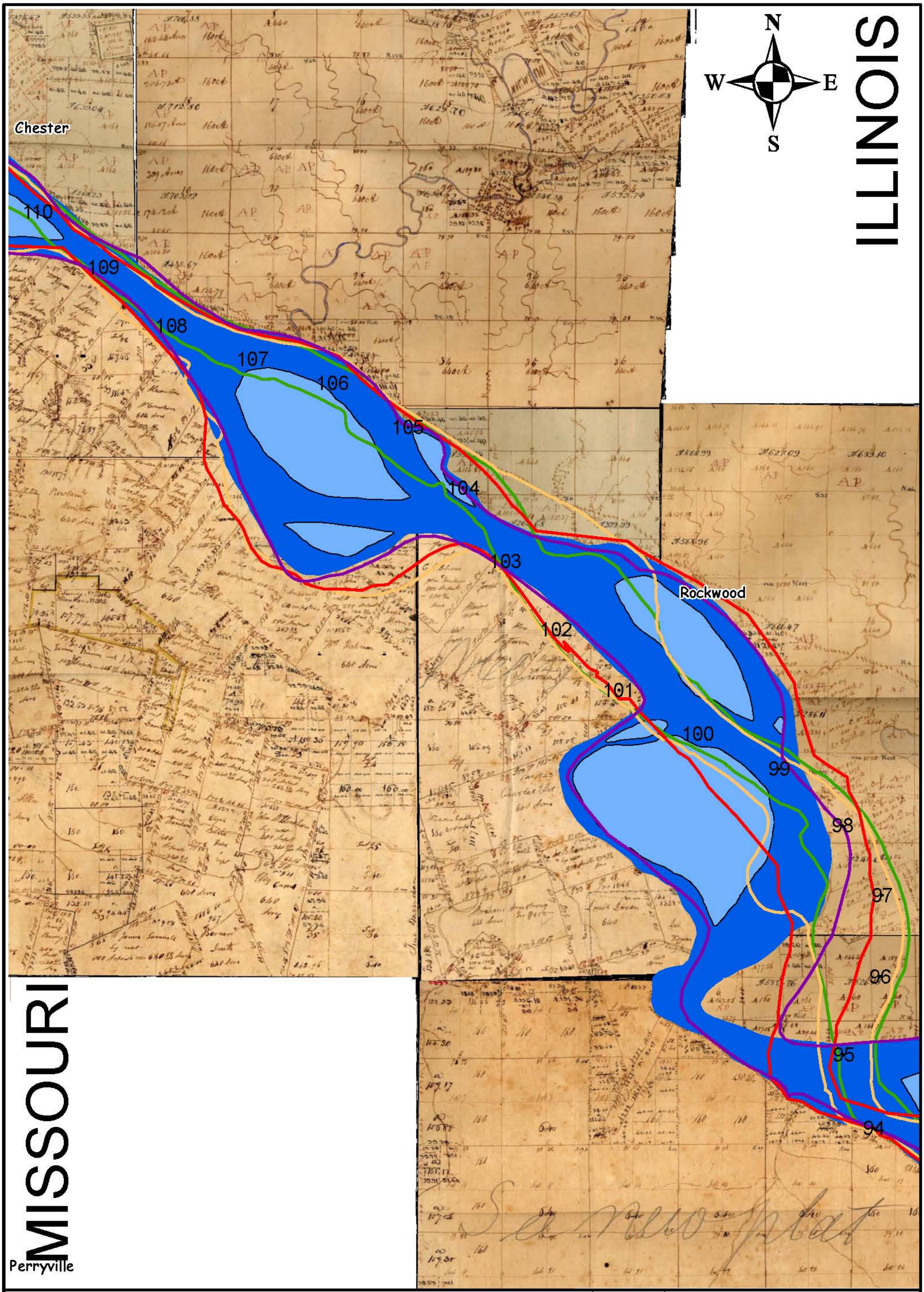
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

BLUEPRINT FOR RESTORATION

RIVER MILES 124-110

PLATE NO.: 31



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: 1817-1820 Government Land Office Surveys

PREPARED BY: Edward J.Brauer
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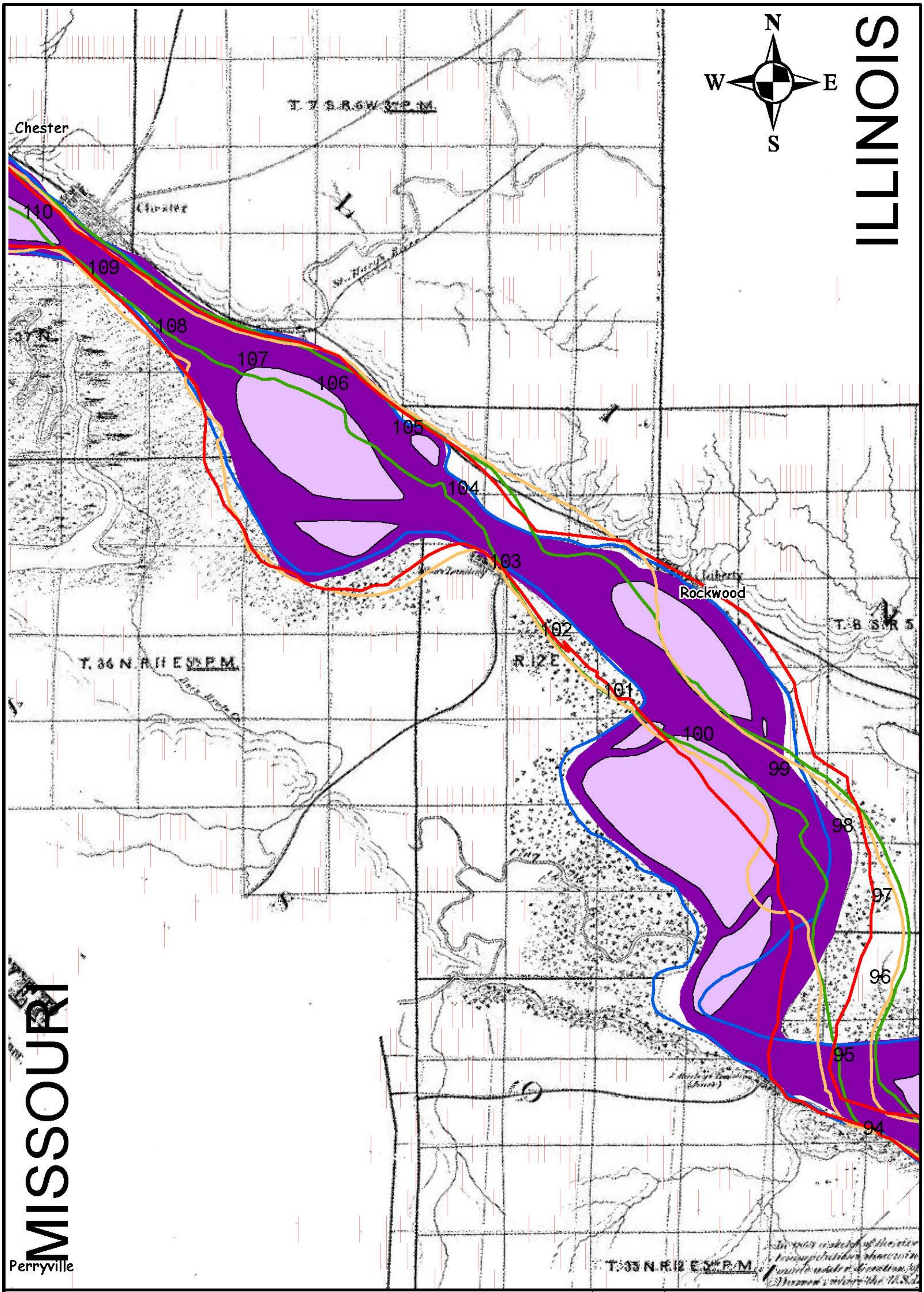
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1817 Planform

RIVER MILES 110-94

PLATE NO.: 32



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Warren, Bvt. Major General G. K.

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

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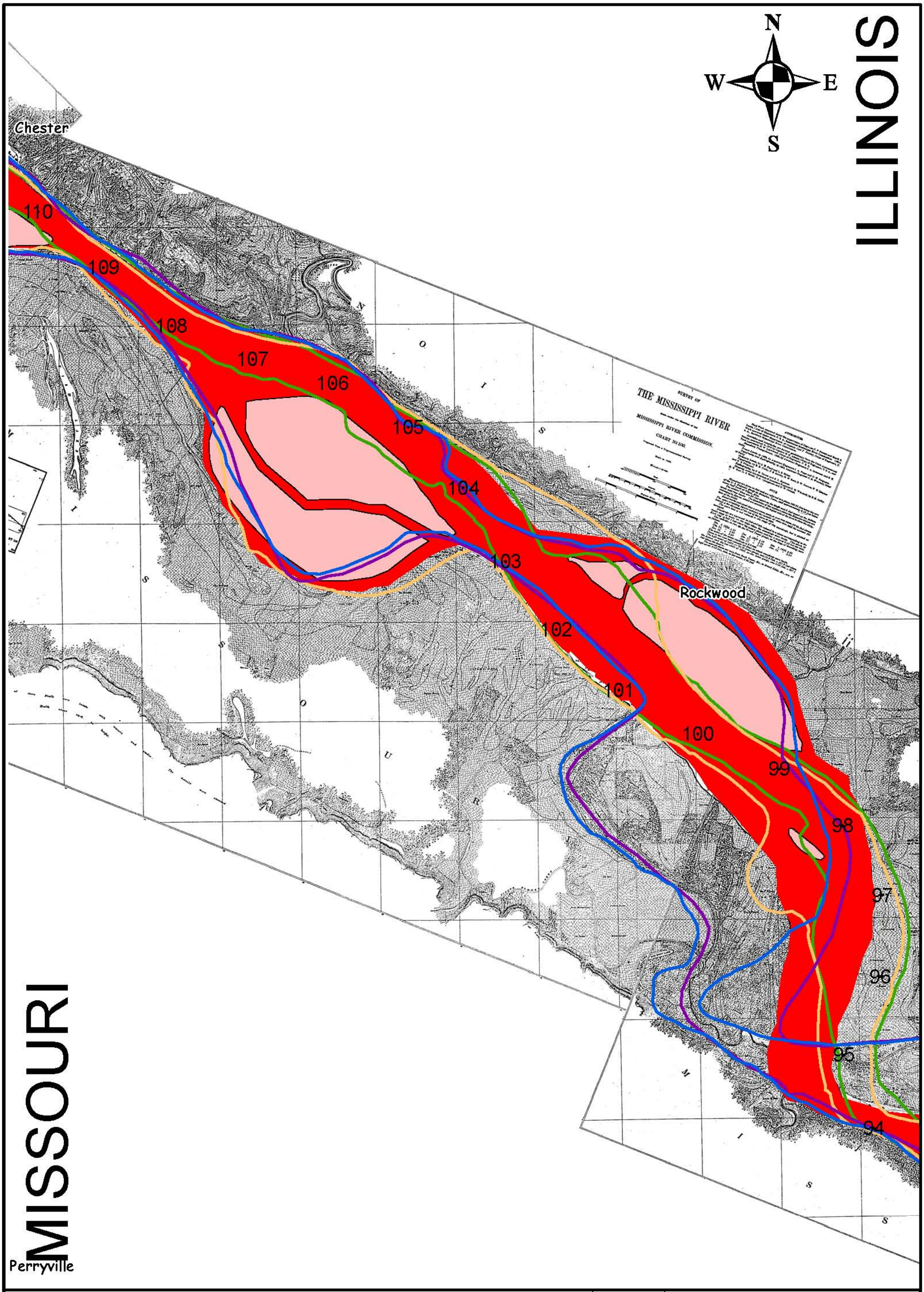
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1866 Planform

RIVER MILES 110-94

PLATE NO.: 33



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Mississippi River Commission, 1880-1882,
1884, 1888, 1889, 1891-1899

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
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ST. LOUIS, MISSOURI

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CHECKED BY: Robert D.Davinroy

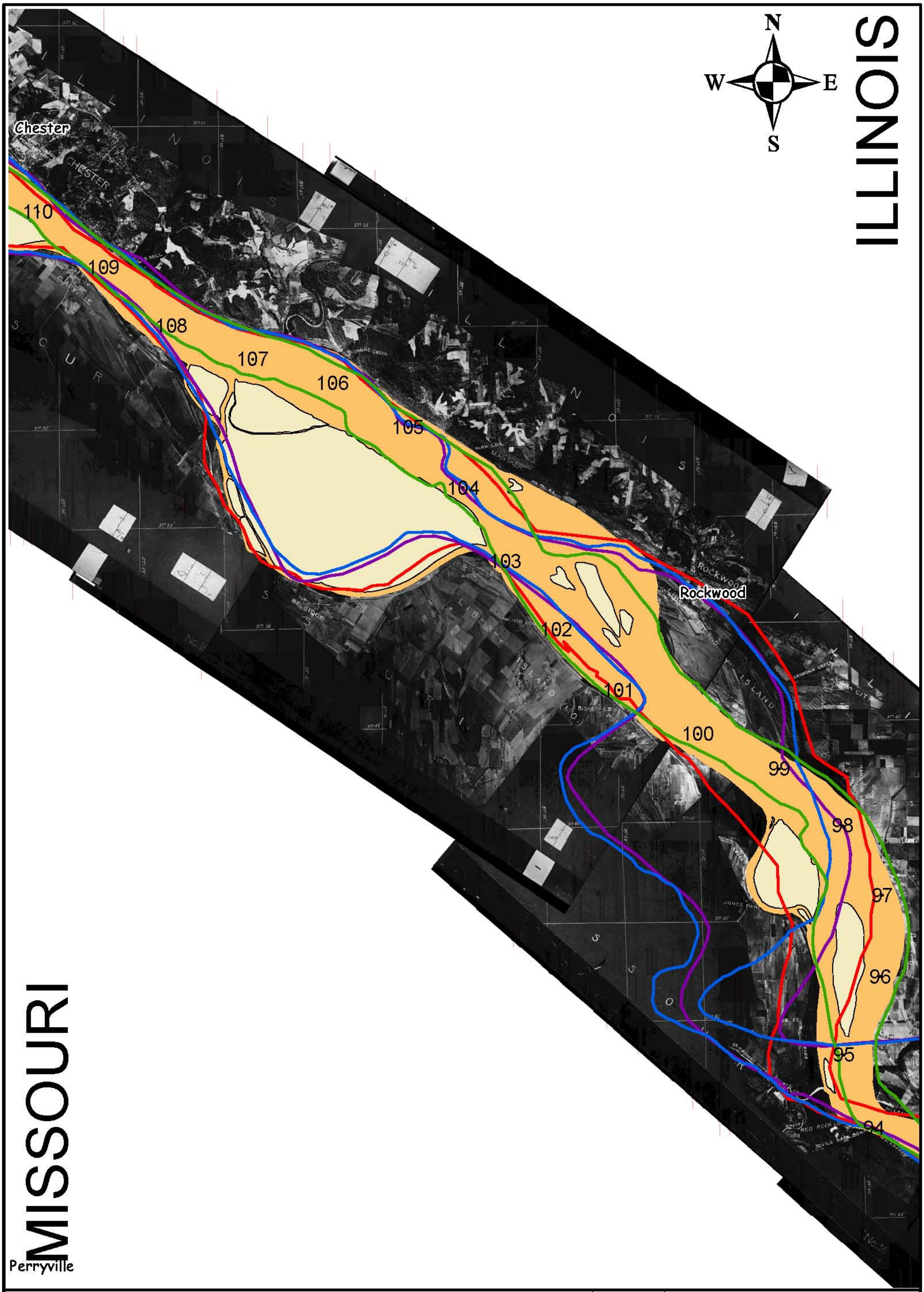
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1881 Planform

RIVER MILES 110-94

PLATE NO.: 34



🟩	2003
🟧	1928
🟥	1881
🟪	1866
🟦	1817

0 5,280 10,560 21,120 Feet

SOURCE: Aerial Photographs
Flown 5 OCT 1928

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

PREPARED BY: Edward J. Brauer
DRAWN BY: Edward J. Brauer
CHECKED BY: Robert D. Davinroy

APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1928 Planform

RIVER MILES 110-94

PLATE NO.: 35

🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Aerial Photographs

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

PREPARED BY: Edward J. Brauer
DRAWN BY: Edward J. Brauer
CHECKED BY: Robert D. Davinroy

APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

2003 Planform

RIVER MILES 110-94

PLATE NO.: 36

LEGEND

- - - Levee

▭ 2003 Planform

■ Isolated, Deep Oxbow

▭ Side Channel, Sloughs or Backwater

0 5,280 10,560 21,120 Feet

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

PREPARED BY: Edward J.Brauer
DRAWN BY: Edward J.Brauer
CHECKED BY: Robert D.Davinroy

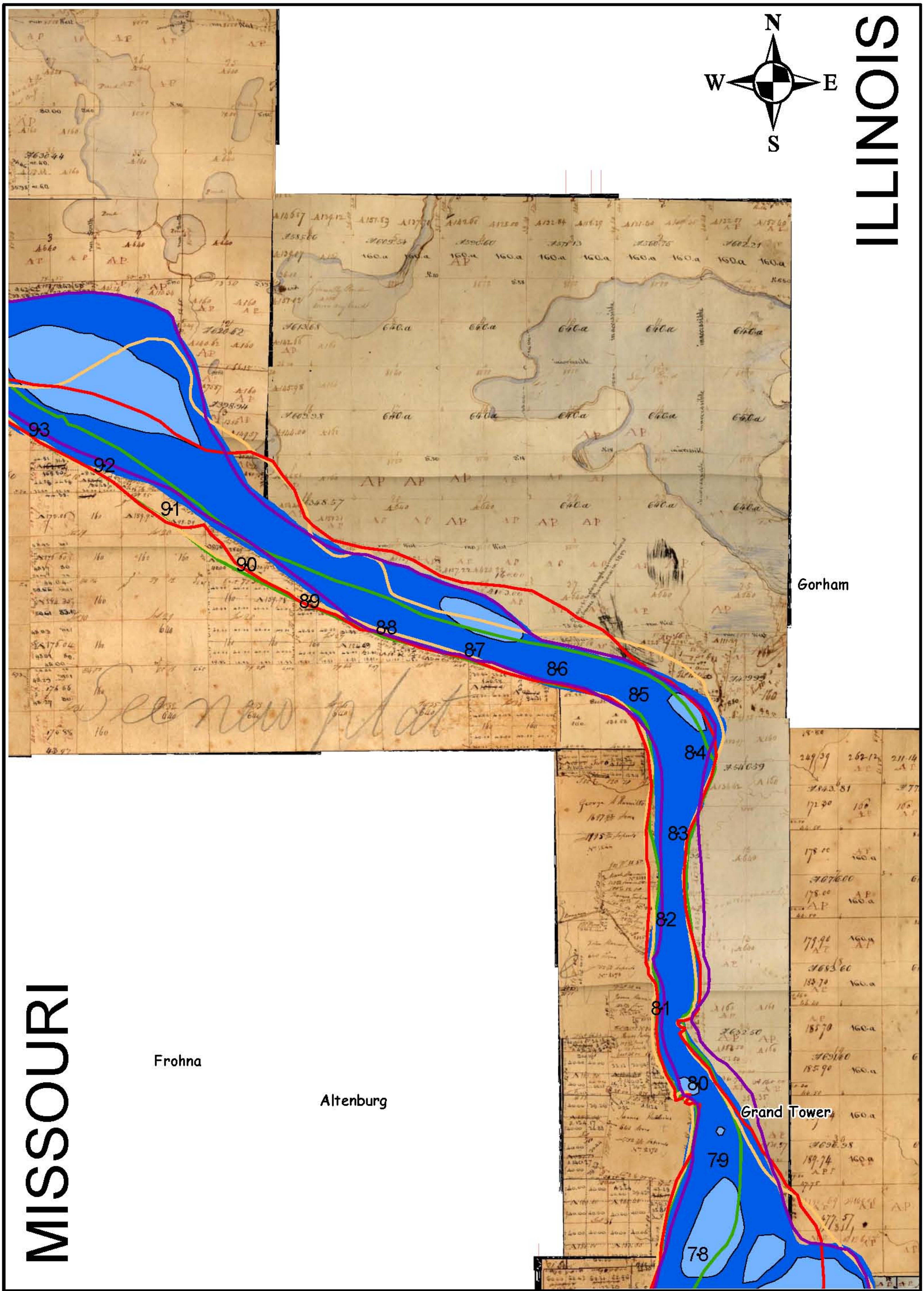
APPLIED
RIVER
ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

BLUEPRINT FOR RESTORATION

RIVER MILES 110-94

PLATE NO.: 37



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: 1817-1820 Government Land Office Surveys

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

PREPARED BY: Edward J. Brauer
DRAWN BY: Edward J. Brauer
CHECKED BY: Robert D. Davinroy

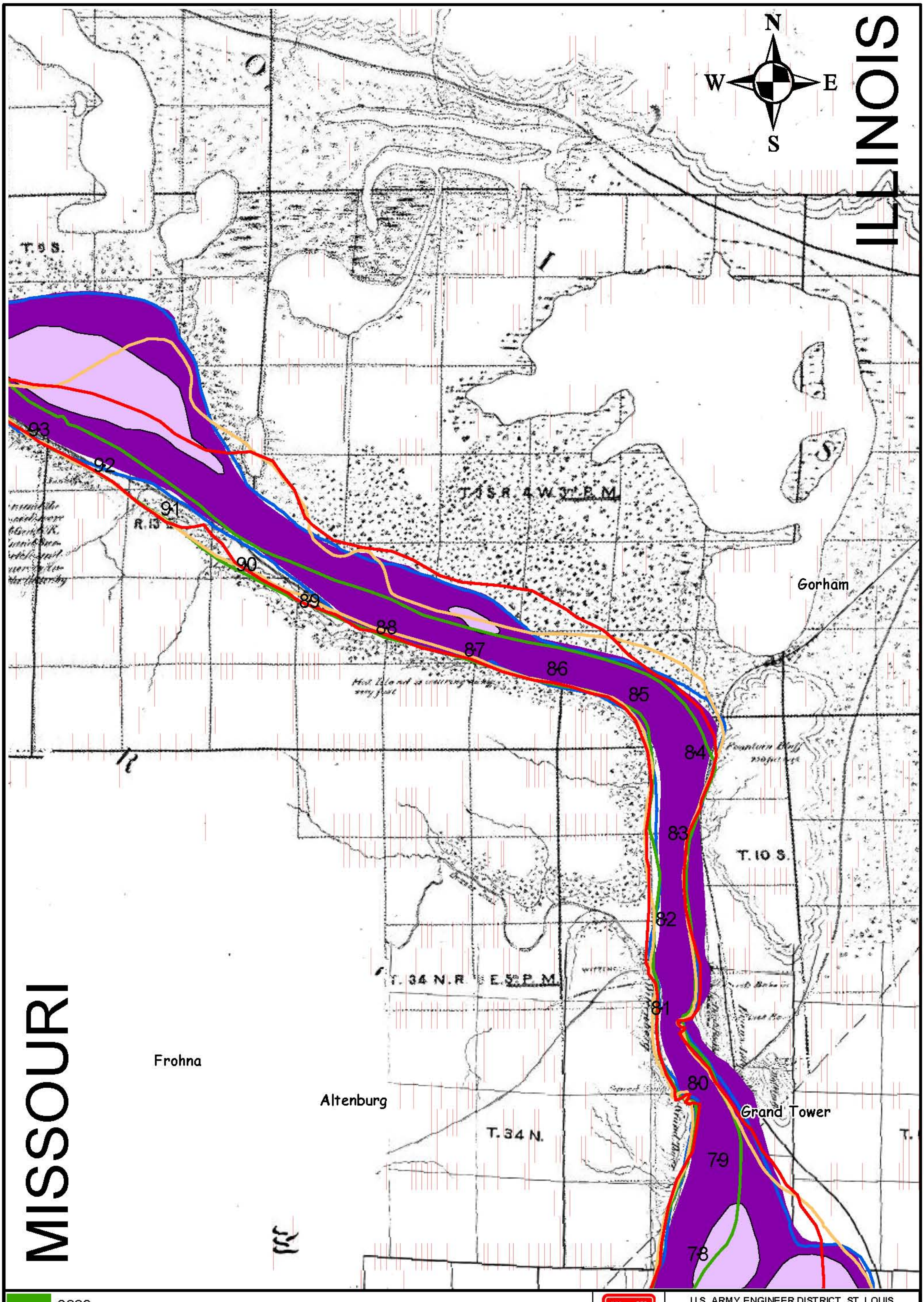
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1817 Planform

RIVER MILES 94-78

PLATE NO.: 38



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

SOURCE: Warren, Bvt. Major General G. K.

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

PREPARED BY: Edward J. Brauer
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CHECKED BY: Robert D. Davinroy

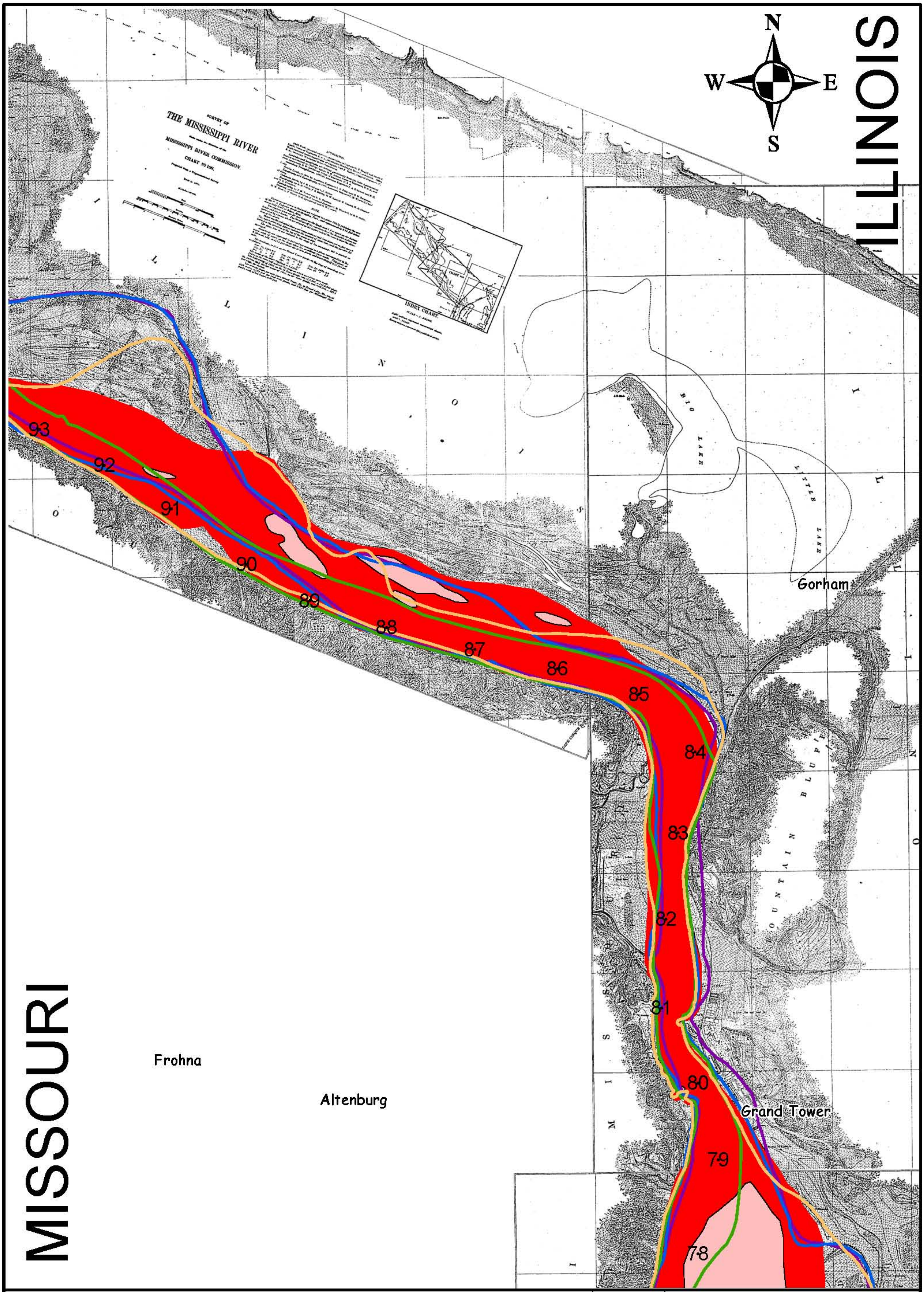
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1866 Planform

RIVER MILES 94-78

PLATE NO.: 39



🟩 2003

🟧 1928

🟥 1881

🟪 1866

🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Mississippi River Commission, 1880-1882, 1884, 1888, 1889, 1891-1899

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

PREPARED BY: Edward J.Brauer
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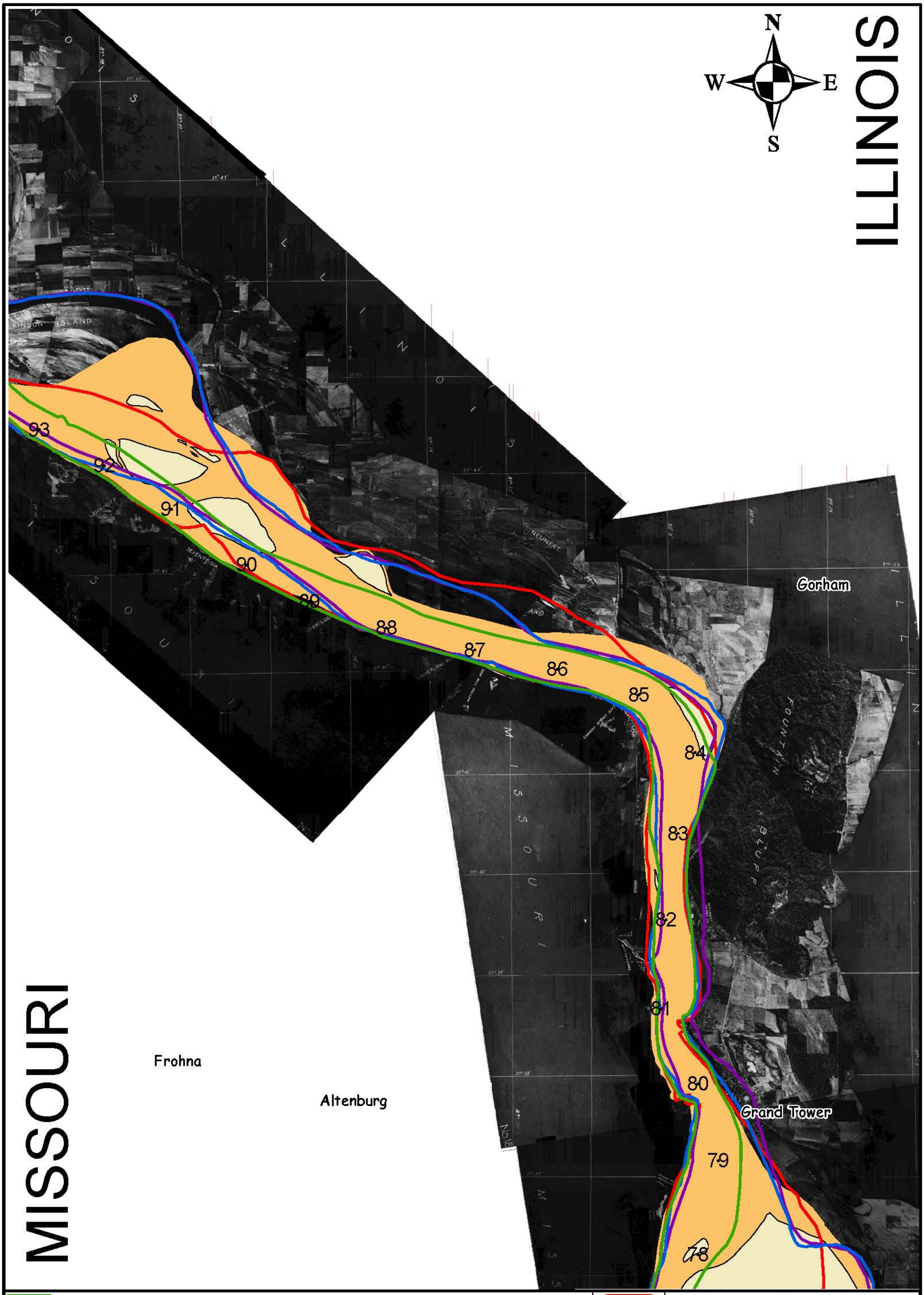
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1881 Planform

RIVER MILES 94-78

PLATE NO.: 40



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Aerial Photographs
Flown 5 OCT 1928

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

PREPARED BY: Edward J. Brauer
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CHECKED BY: Robert D. Davinroy

APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1928 Planform

RIVER MILES 94-78

PLATE NO.
41

🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Aerial Photographs

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

PREPARED BY: Edward J. Brauer
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CHECKED BY: Robert D. Davinroy

APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

2003 Planform

RIVER MILES 94-78

PLATE NO.: 42

LEGEND

0 5,280 10,560 21,120 Feet

- 🟨 Levee
- ▢ 2003 Planform
- 🟦 Isolated, Deep Oxbow
- ▨ Side Channel, Sloughs or Backwater

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

PREPARED BY: Edward J.Brauer
DRAWN BY: Edward J.Brauer
CHECKED BY: Robert D.Davinroy

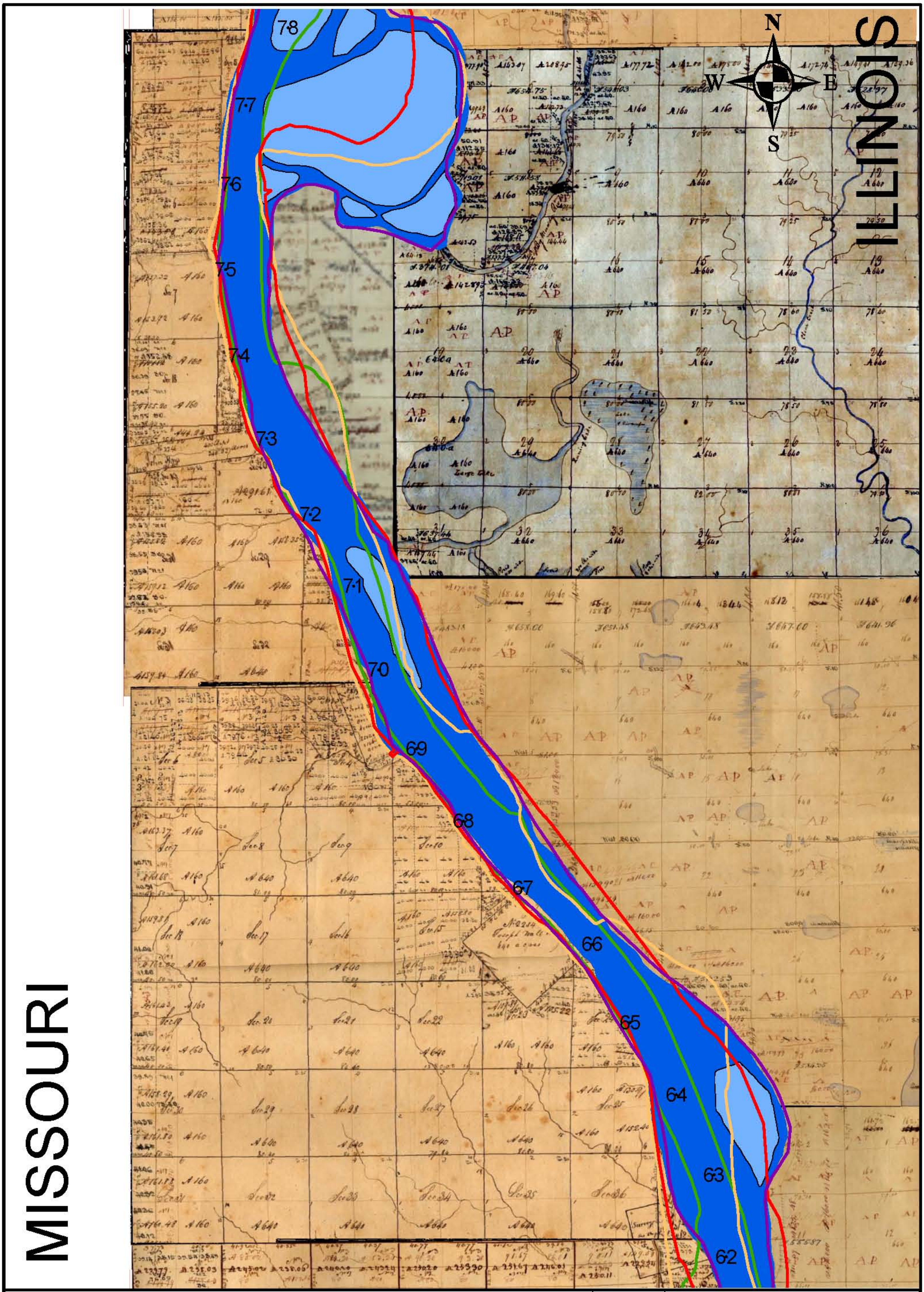
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

BLUEPRINT FOR RESTORATION

RIVER MILES 94-78

PLATE NO.: 43



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

Feet
0 5,280 10,560 21,120

SOURCE: 1817-1820 Government Land Office Surveys

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

PREPARED BY: Edward J. Brauer
DRAWN BY: Edward J. Brauer
CHECKED BY: Robert D. Davinroy

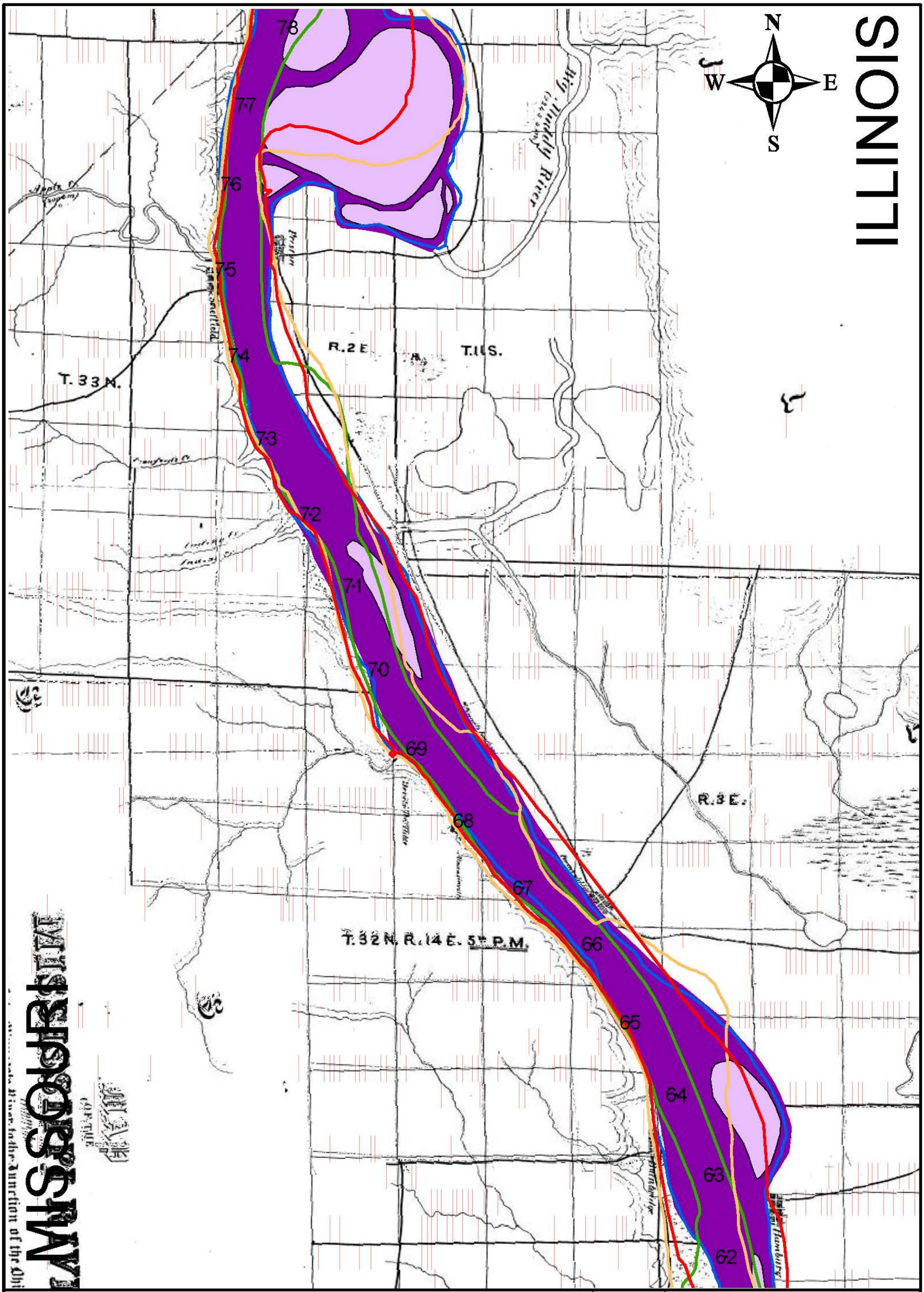
APPLIED
RIVER
ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1817 Planform

RIVER MILES 78-62

PLATE NO.: 44



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

SOURCE: Warren, Bvt. Major General G. K.

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

PREPARED BY: Edward J. Brauer
DRAWN BY: Edward J. Brauer
CHECKED BY: Robert D. Davinroy

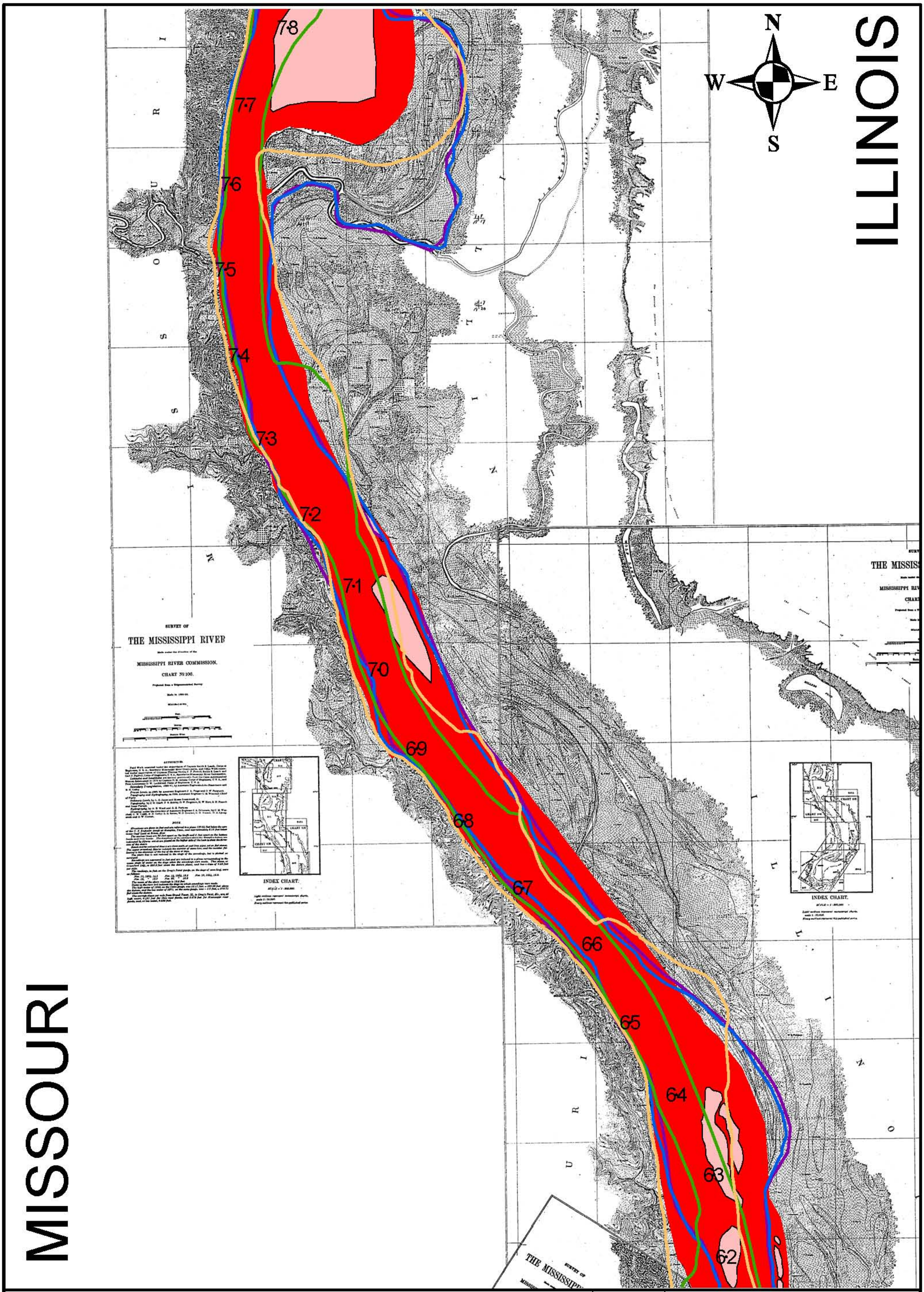
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1866 Planform

RIVER MILES 78-62

PLATE NO.: 45



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

Feet
0 5,280 10,560 21,120

SOURCE: Mississippi River Commission, 1880-1882, 1884, 1888, 1889, 1891-1899

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

PREPARED BY: Edward J.Brauer
DRAWN BY: Edward J.Brauer
CHECKED BY: Robert D.Davinroy

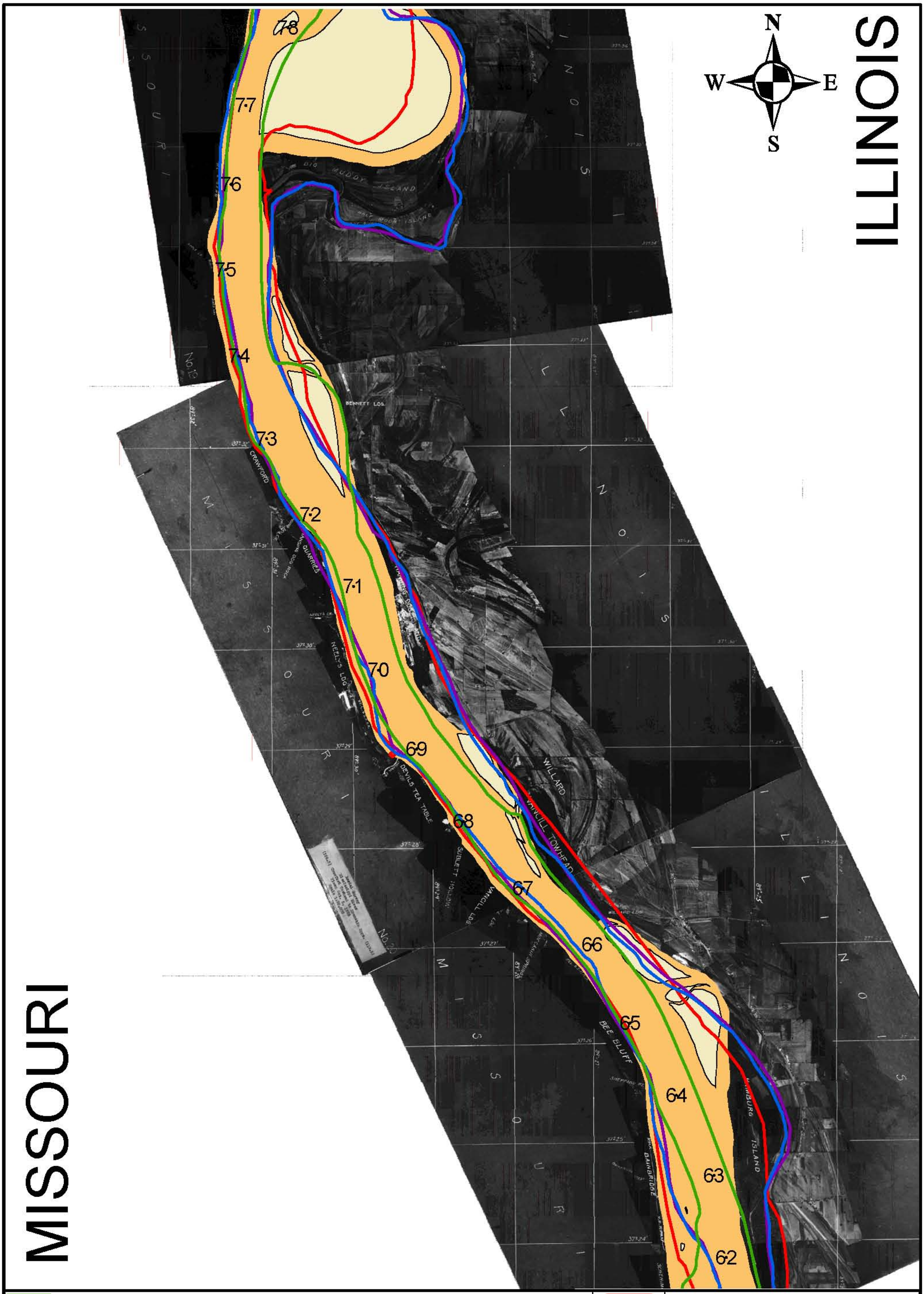
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1881 Planform

RIVER MILES 78-62

PLATE NO.: 46



🟩 2003

🟧 1928

🟥 1881

🟪 1866

🟦 1817

Feet

0 5,280 10,560 21,120

SOURCE: Aerial Photographs
Flown 5 OCT 1928

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

PREPARED BY: Edward J. Brauer
DRAWN BY: Edward J. Brauer
CHECKED BY: Robert D. Davinroy

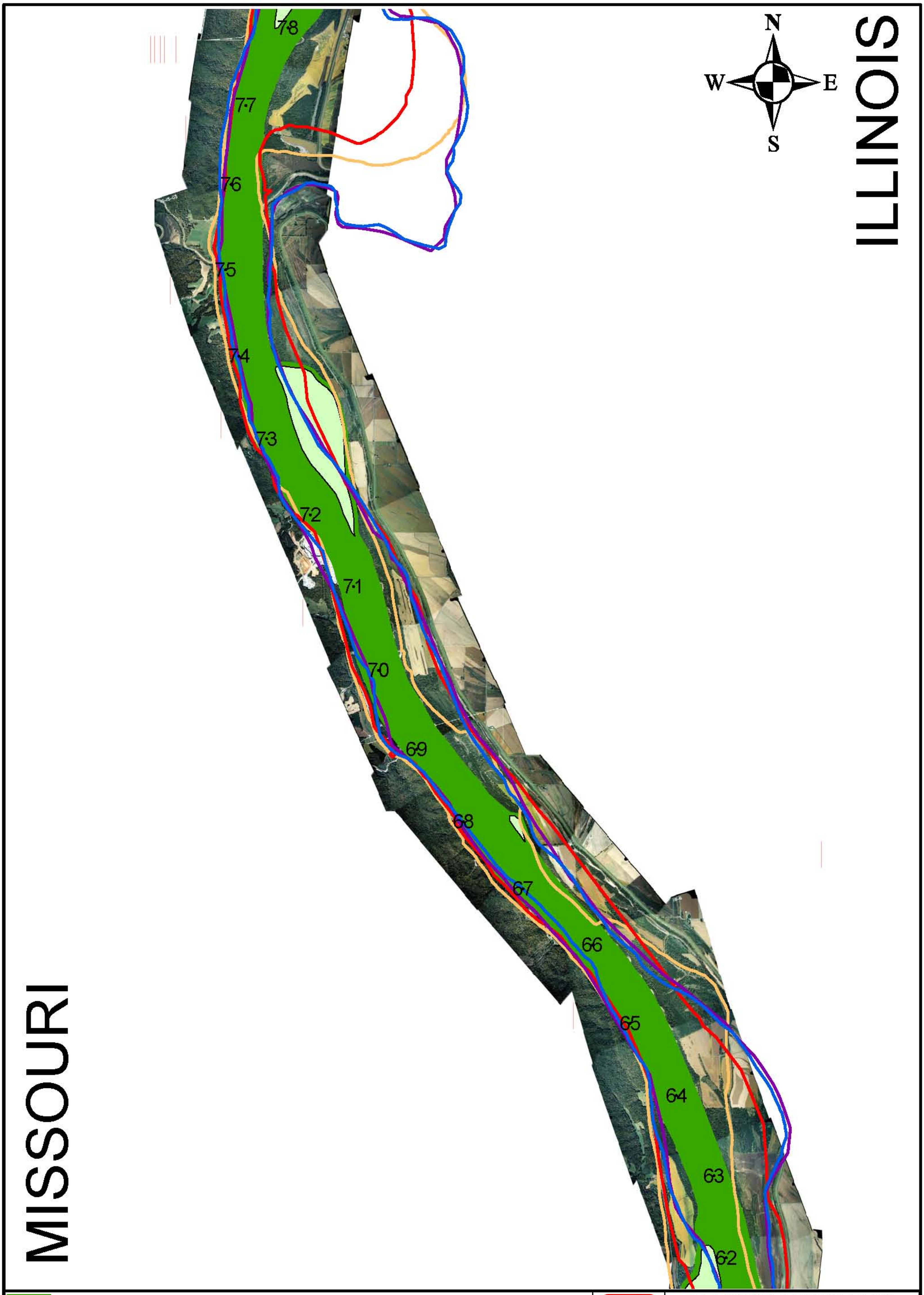
APPLIED
RIVER
ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1928 Planform

RIVER MILES 78-62

PLATE NO.: 47



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Aerial Photographs

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

PREPARED BY: Edward J. Brauer
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CHECKED BY: Robert D. Davinroy

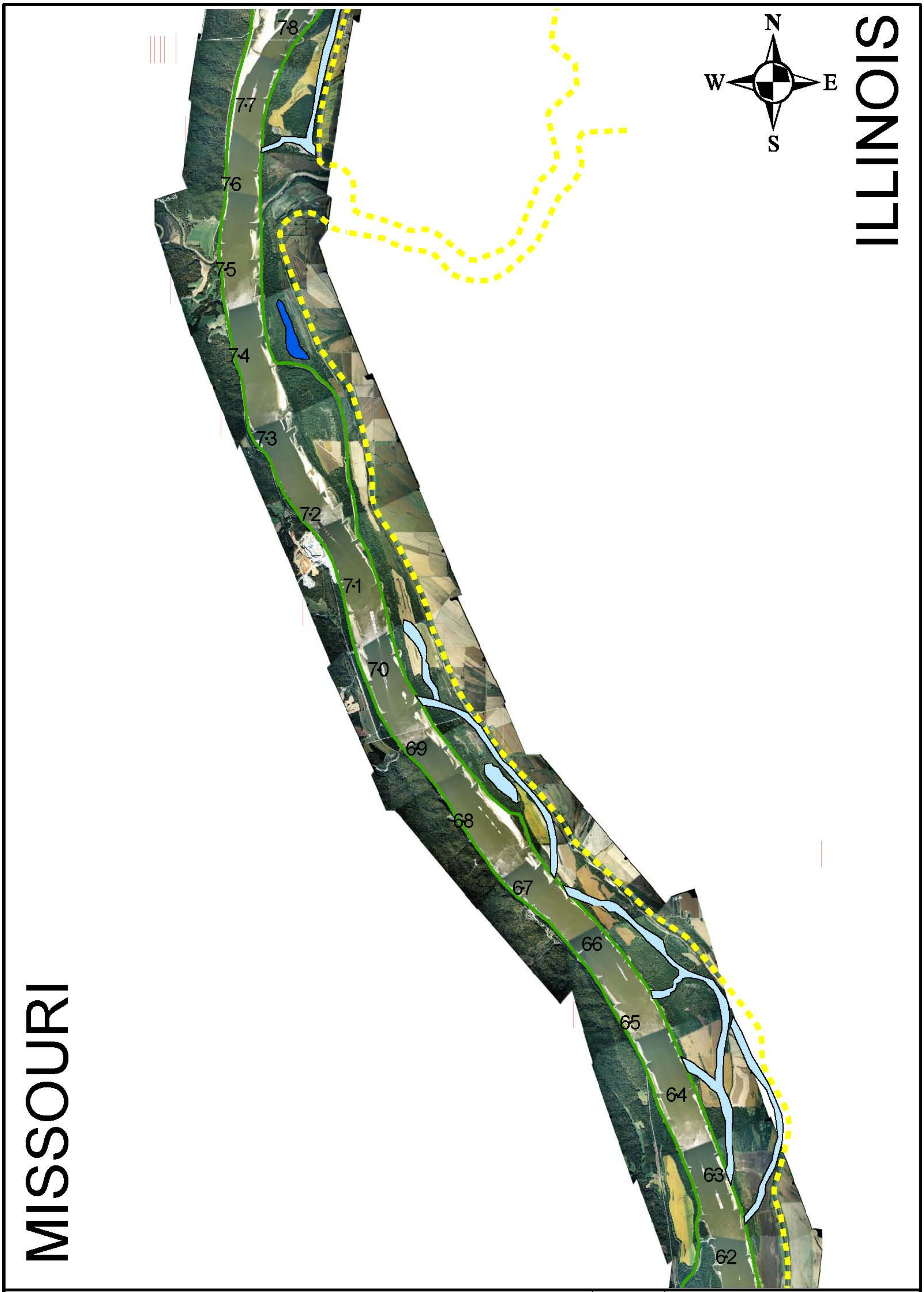
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

2003 Planform

RIVER MILES 78-62

PLATE NO. 48



LEGEND

- - - Levee

▭ 2003 Planform

■ Isolated, Deep Oxbow

▭ Side Channel, Sloughs or Backwater

0 5,280 10,560 21,120 Feet

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

PREPARED BY: Edward J. Brauer
DRAWN BY: Edward J. Brauer
CHECKED BY: Robert D. Davinroy

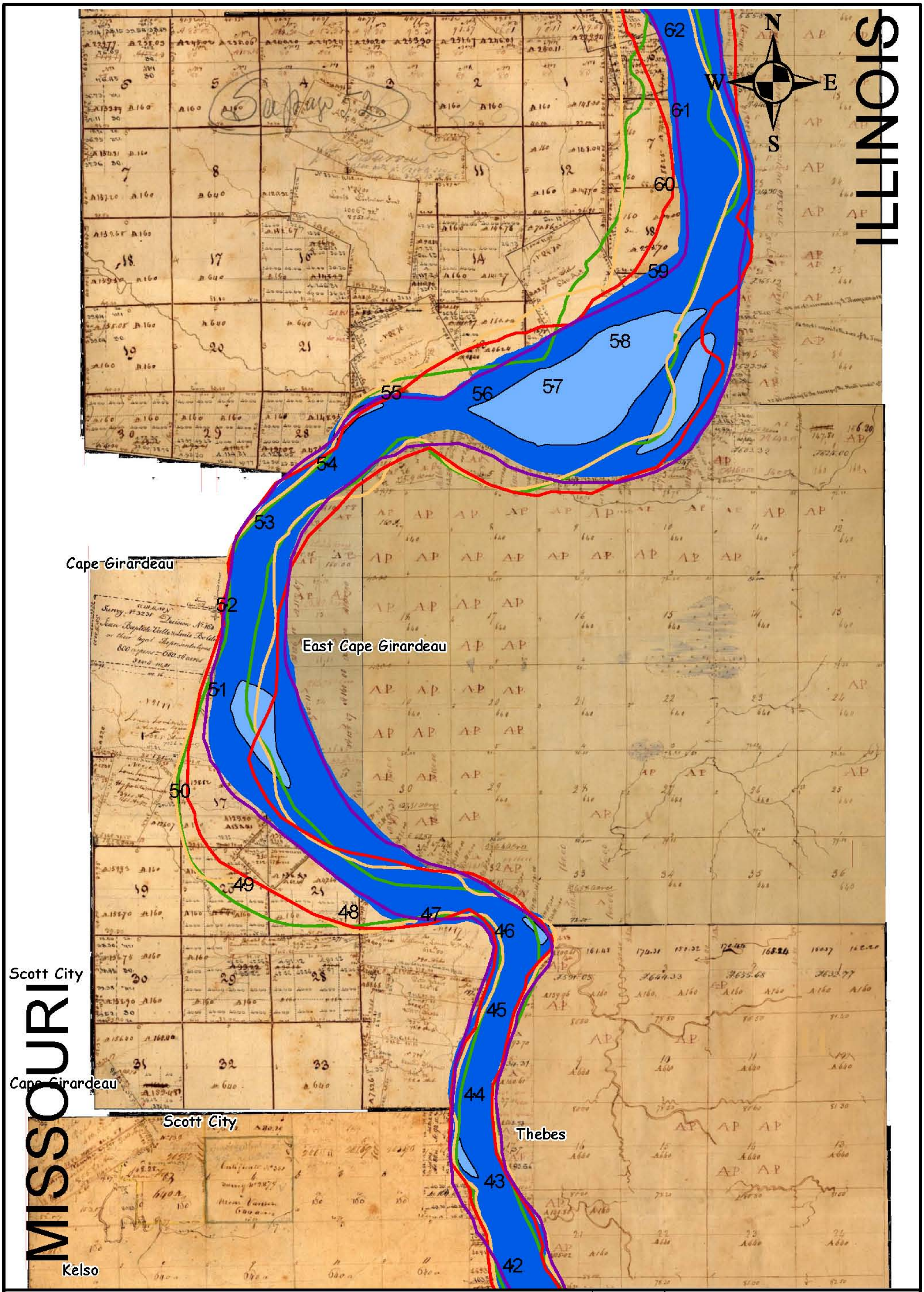
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

BLUEPRINT FOR RESTORATION

RIVER MILES 78-62

PLATE NO.: 49



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: 1817-1820 Government Land Office Surveys

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

PREPARED BY: Edward J. Brauer
DRAWN BY: Edward J. Brauer
CHECKED BY: Robert D. Davinroy

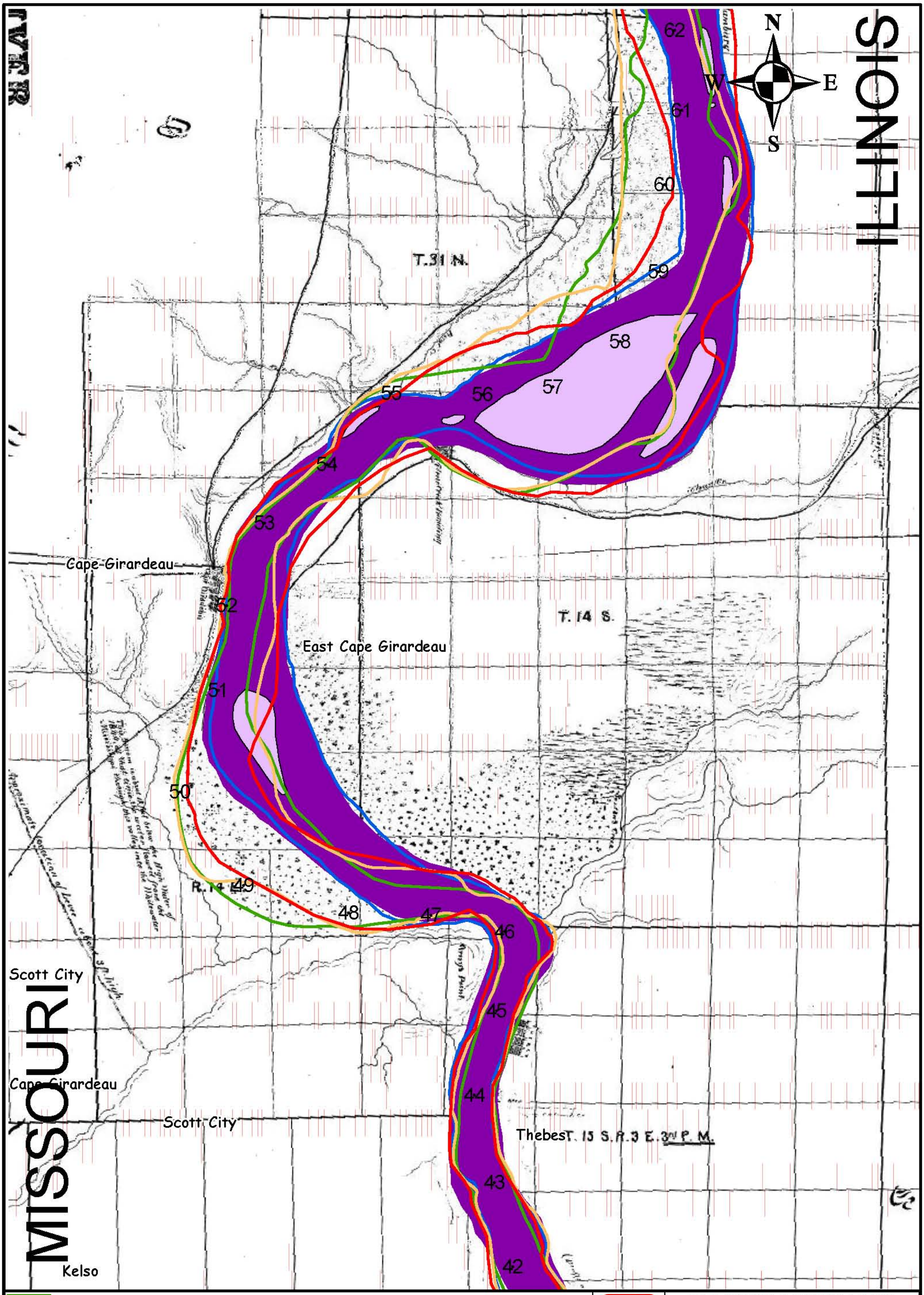
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1817 Planform

RIVER MILES 62-42

PLATE NO.: 50



SOURCE: Warren, Bvt. Major General G. K.

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

PREPARED BY: Edward J.Brauer
DRAWN BY: Edward J.Brauer
CHECKED BY: Robert D.Davinroy

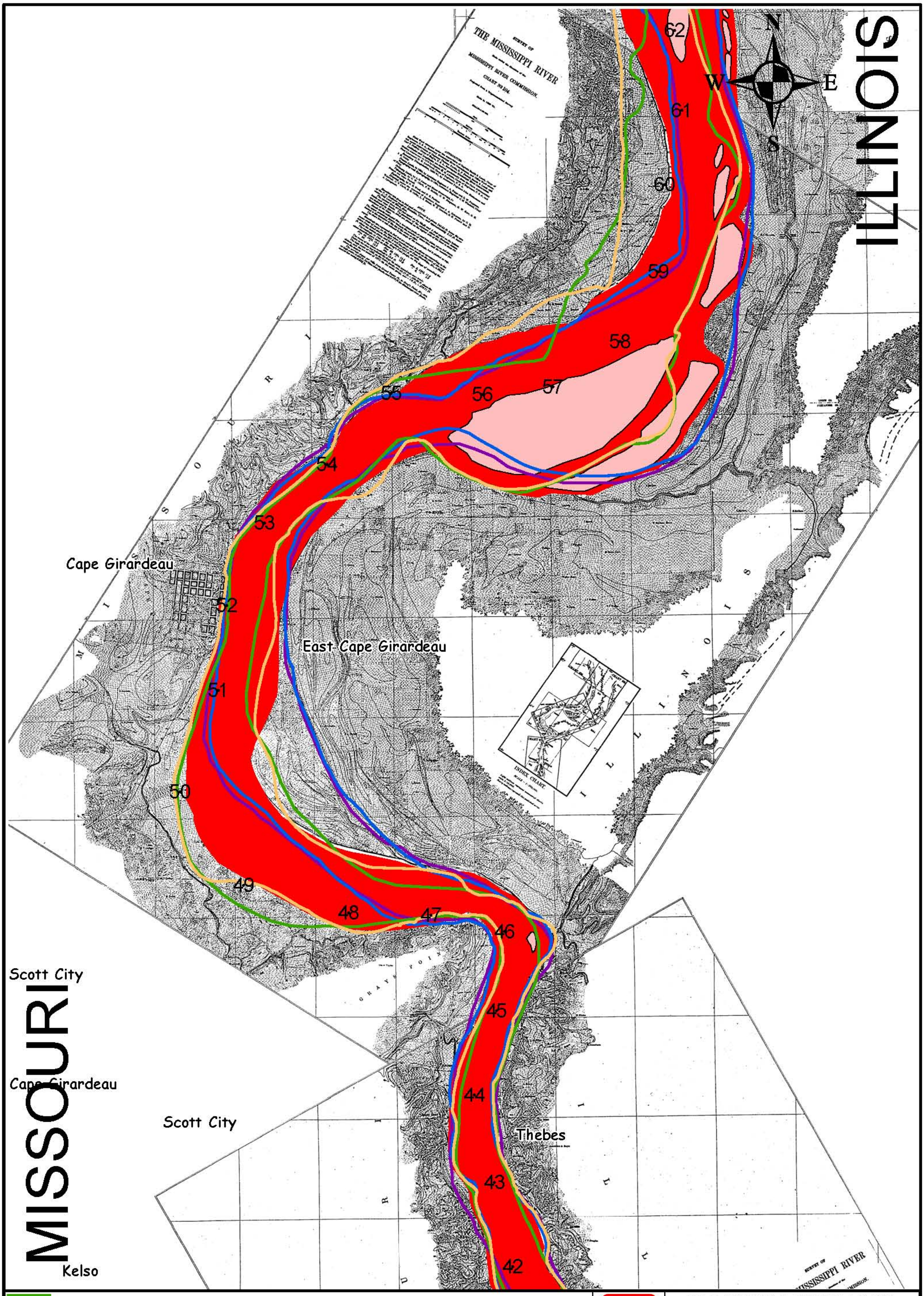
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1866 Planform

RIVER MILES 62-42

PLATE NO.: 51



🟩	2003
🟧	1928
🟥	1881
🟪	1866
🟦	1817

0 5,280 10,560 21,120 Feet

SOURCE: Mississippi River Commission, 1880-1882,
1884, 1888, 1889, 1891-1899

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

PREPARED BY: Edward J. Brauer
DRAWN BY: Edward J. Brauer
CHECKED BY: Robert D. Davinroy

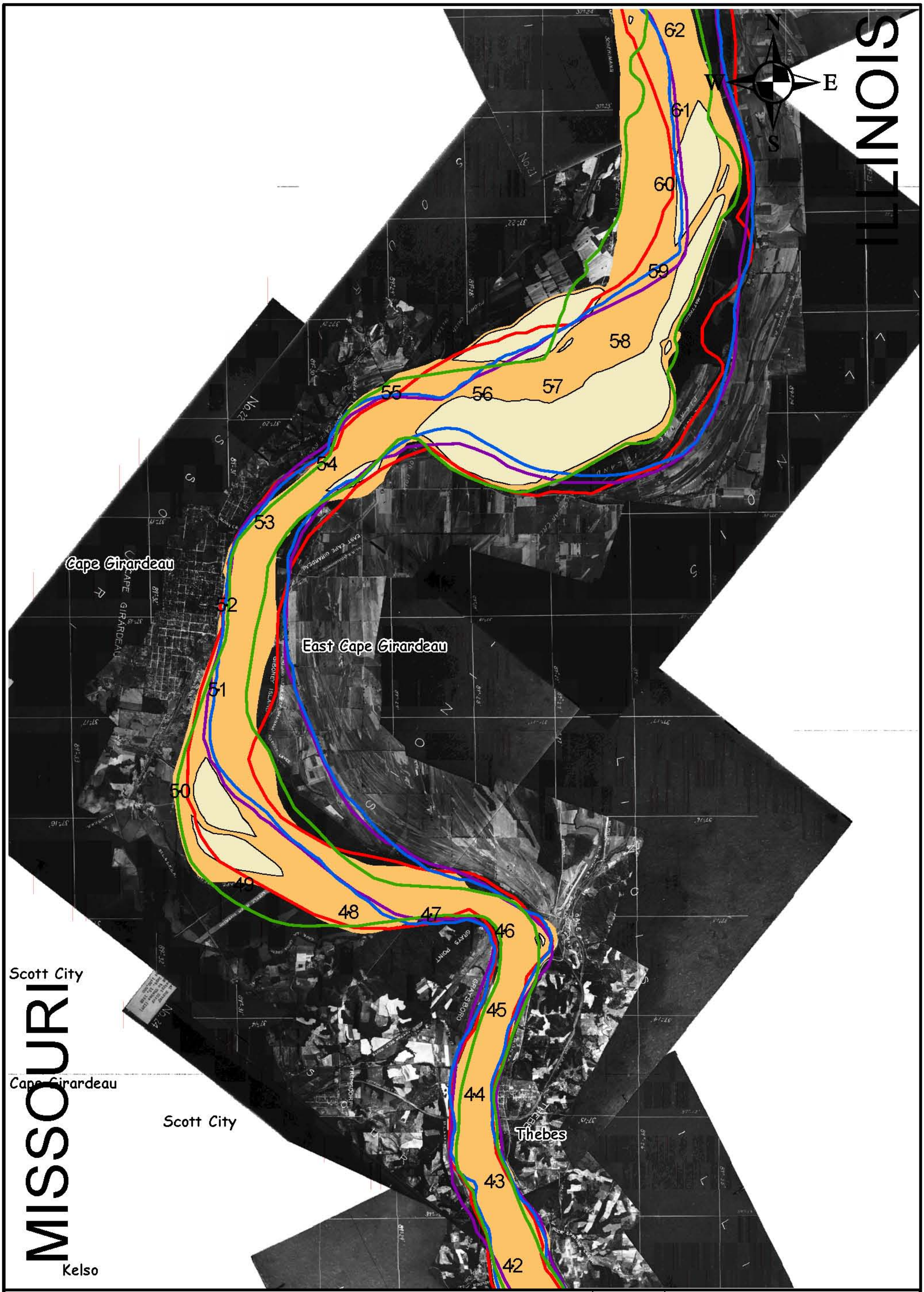
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1881 Planform

RIVER MILES 62-42

PLATE NO.: 52



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

Feet
0 5,280 10,560 21,120

SOURCE: Aerial Photographs
Flown 5 OCT 1928

PREPARED BY: Edward J.Brauer
DRAWN BY: Edward J.Brauer
CHECKED BY: Robert D.Davinroy

APPLIED RIVER ENGINEERING CENTER

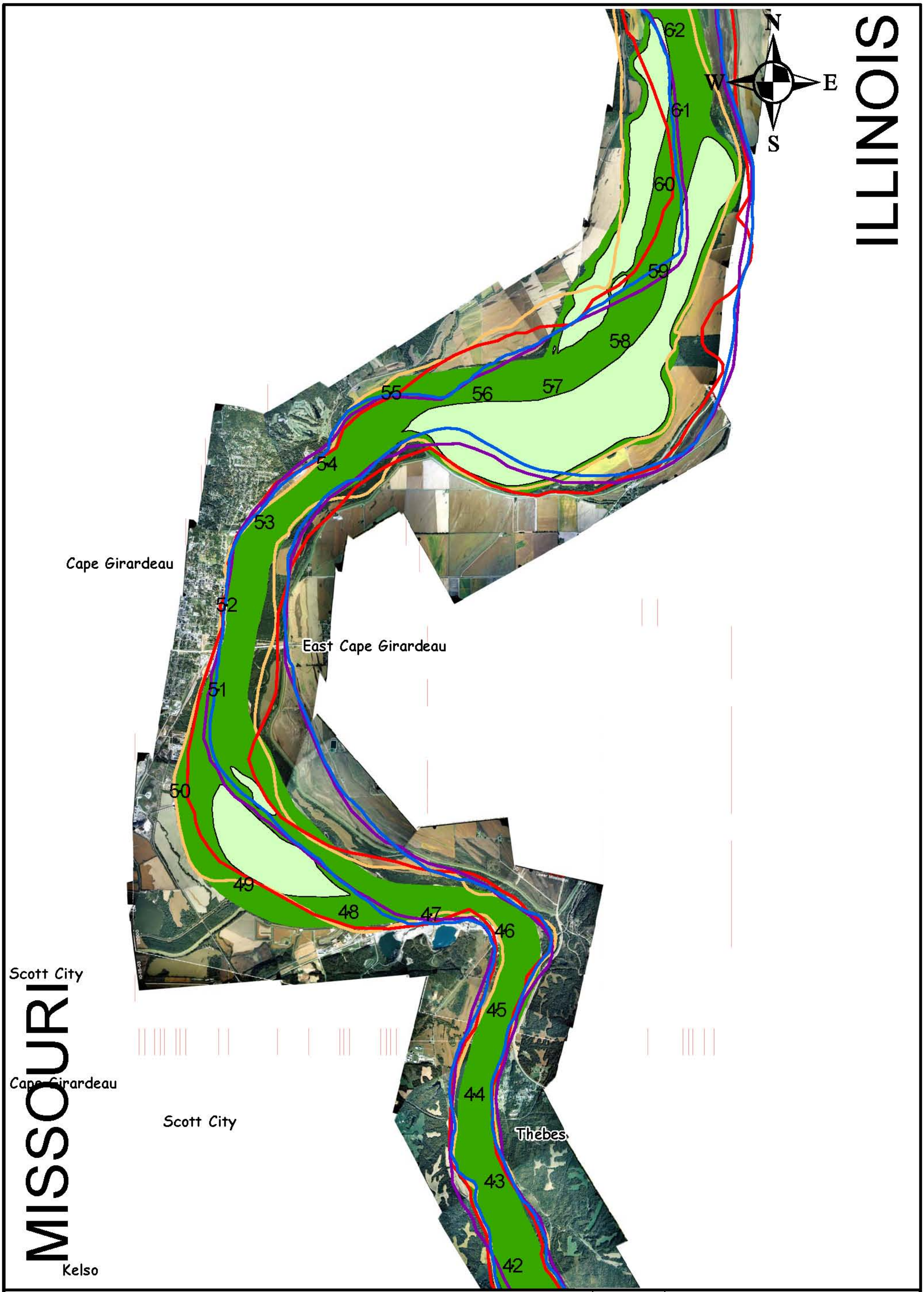
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1928 Planform

RIVER MILES 62-42

PLATE NO.: 53



🟩	2003
🟧	1928
🟥	1881
🟪	1866
🟦	1817

0 5,280 10,560 21,120 Feet

SOURCE: Aerial Photographs

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

PREPARED BY: Edward J. Brauer
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APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

2003 Planform

RIVER MILES 62-42

PLATE NO.: 54

LEGEND

Feet
0 5,280 10,560 21,120

▪ ▪ ▪	Levee
☐	2003 Planform
■	Isolated, Deep Oxbow
■	Side Channel, Sloughs or Backwater

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

PREPARED BY: Edward J. Brauer
DRAWN BY: Edward J. Brauer
CHECKED BY: Robert D. Davinroy

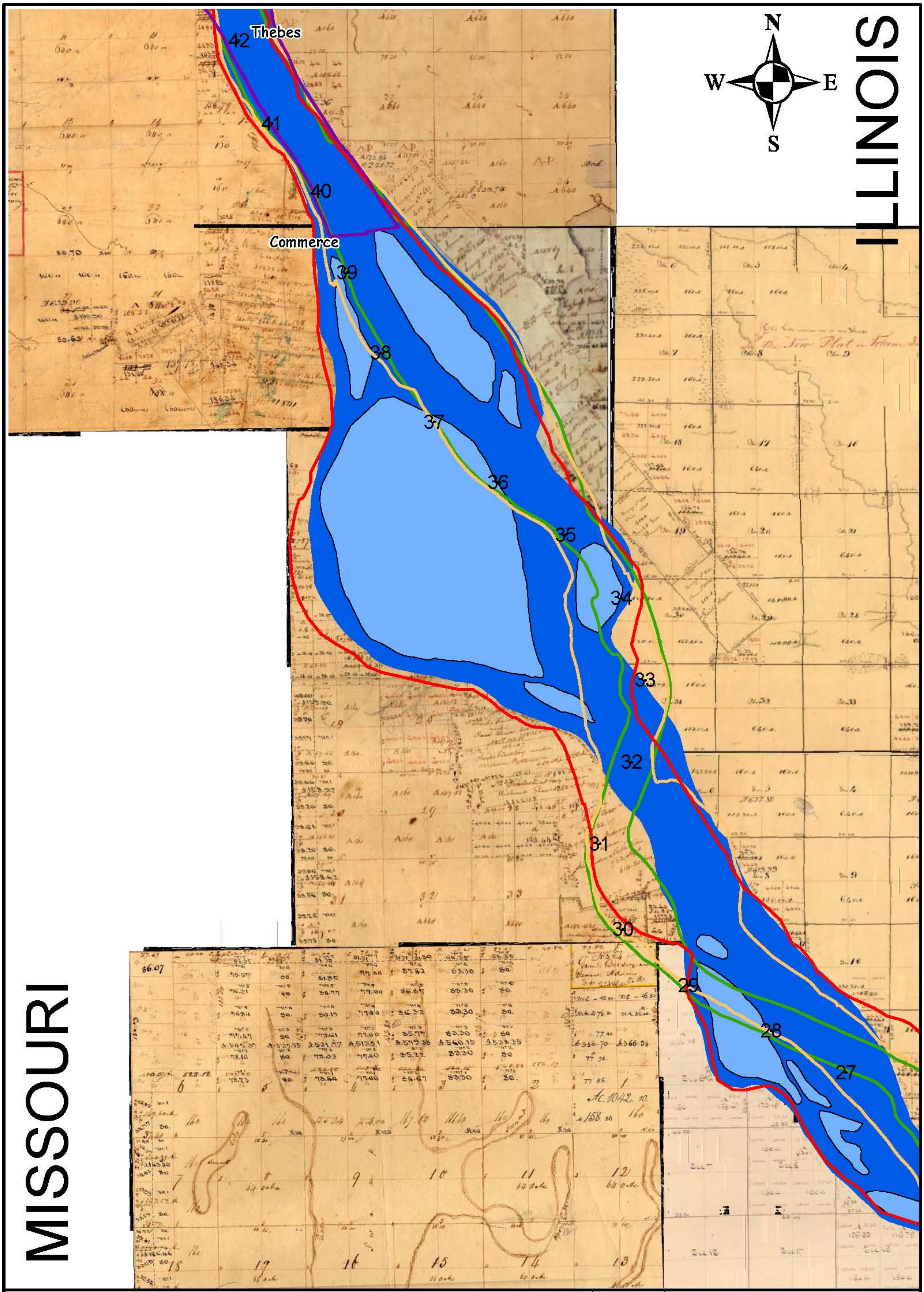
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

BLUEPRINT FOR RESTORATION

RIVER MILES 62-42

PLATE NO.: 55



🟩	2003
🟧	1928
🟥	1881
🟪	1866
🟦	1817

0 5,280 10,560 21,120 Feet

SOURCE: 1817-1820 Government Land Office Surveys

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

PREPARED BY: Edward J.Brauer
DRAWN BY: Edward J.Brauer
CHECKED BY: Robert D.Davinroy

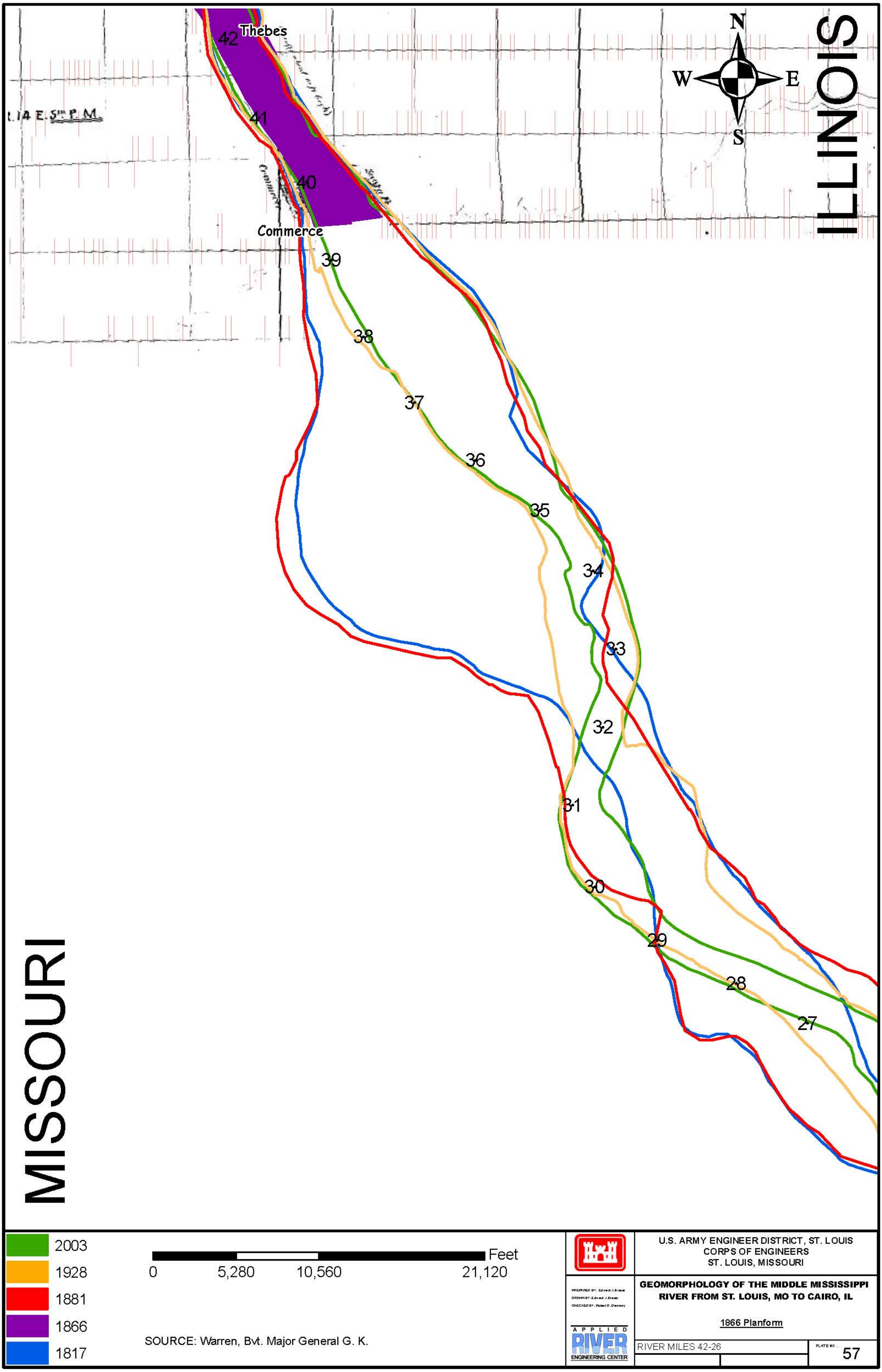
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1817 Planform

RIVER MILES 42-26

PLATE NO.: 56



SOURCE: Warren, Bvt. Major General G. K.

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

PREPARED BY: Edward J.Brauer
DRAWN BY: Edward J.Brauer
CHECKED BY: Robert D.Davinroy

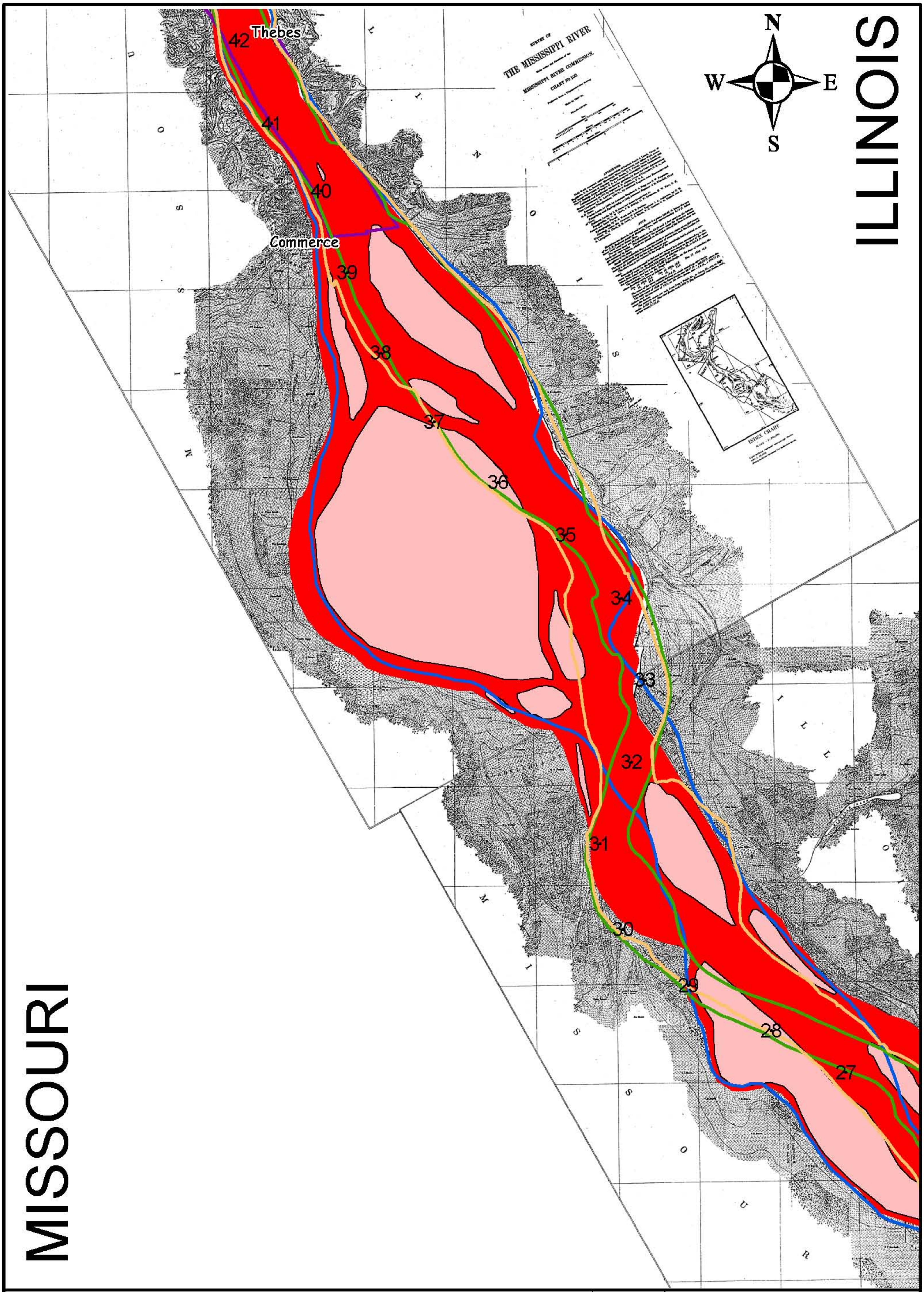
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1866 Planform

RIVER MILES 42-26

PLATE NO.: 57



🟩	2003
🟧	1928
🟥	1881
🟪	1866
🟦	1817

Feet
0 5,280 10,560 21,120

SOURCE: Mississippi River Commission, 1880-1882, 1884, 1888, 1889, 1891-1899

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

PREPARED BY: Edward J.Brauer
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CHECKED BY: Robert D.Davinroy

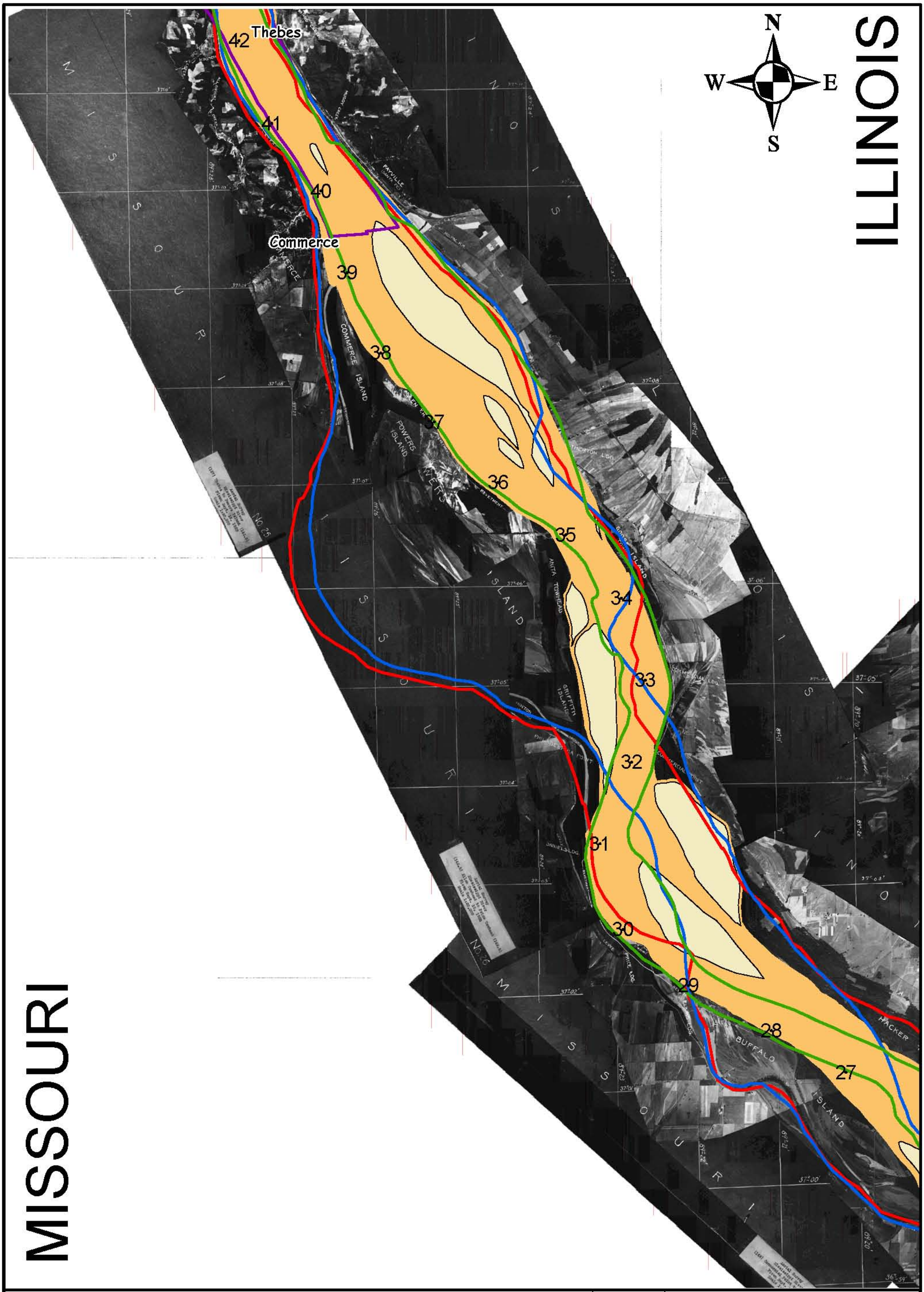
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1881 Planform

RIVER MILES 42-26

PLATE NO.: 58



🟩	2003
🟧	1928
🟥	1881
🟪	1866
🟦	1817

0 5,280 10,560 21,120 Feet

SOURCE: Aerial Photographs
Flown 5 OCT 1928

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

PREPARED BY: Edward J. Brauer
DRAWN BY: Edward J. Brauer
CHECKED BY: Robert D. Davinroy

APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1928 Planform

RIVER MILES 42-26

PLATE NO.: 59

🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Aerial Photographs

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

PREPARED BY: Edward J.Brauer
DRAWN BY: Edward J.Brauer
CHECKED BY: Robert D.Davinroy

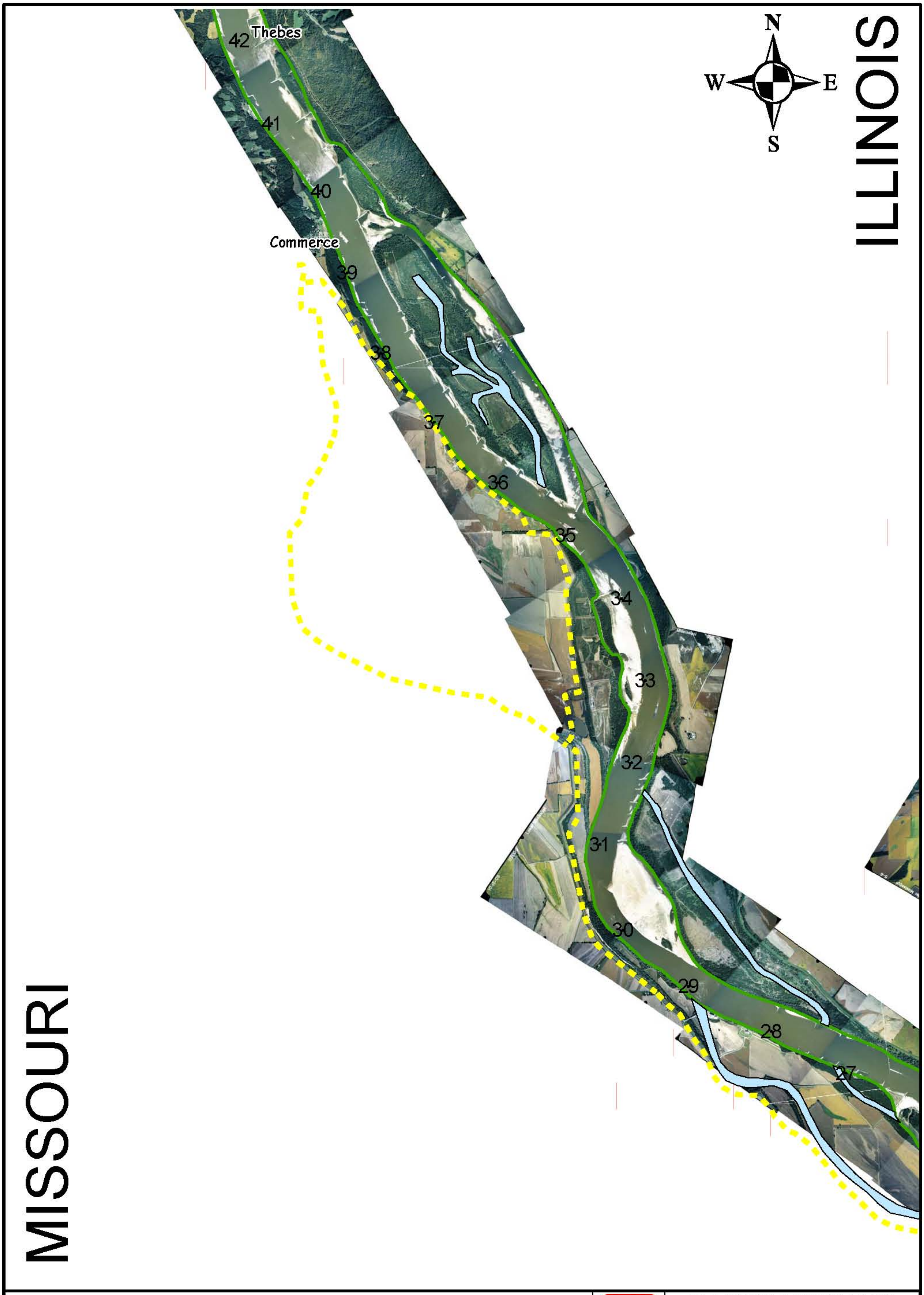
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

2003 Planform

RIVER MILES 42-26

PLATE NO.: 60



LEGEND

- 🟨 Levee
- 🟩 2003 Planform
- 🟦 Isolated, Deep Oxbow
- 🟦 Side Channel, Sloughs or Backwater

0 5,280 10,560 21,120 Feet

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

PREPARED BY: Edward J. Brauer
DRAWN BY: Edward J. Brauer
CHECKED BY: Robert D. Davinroy

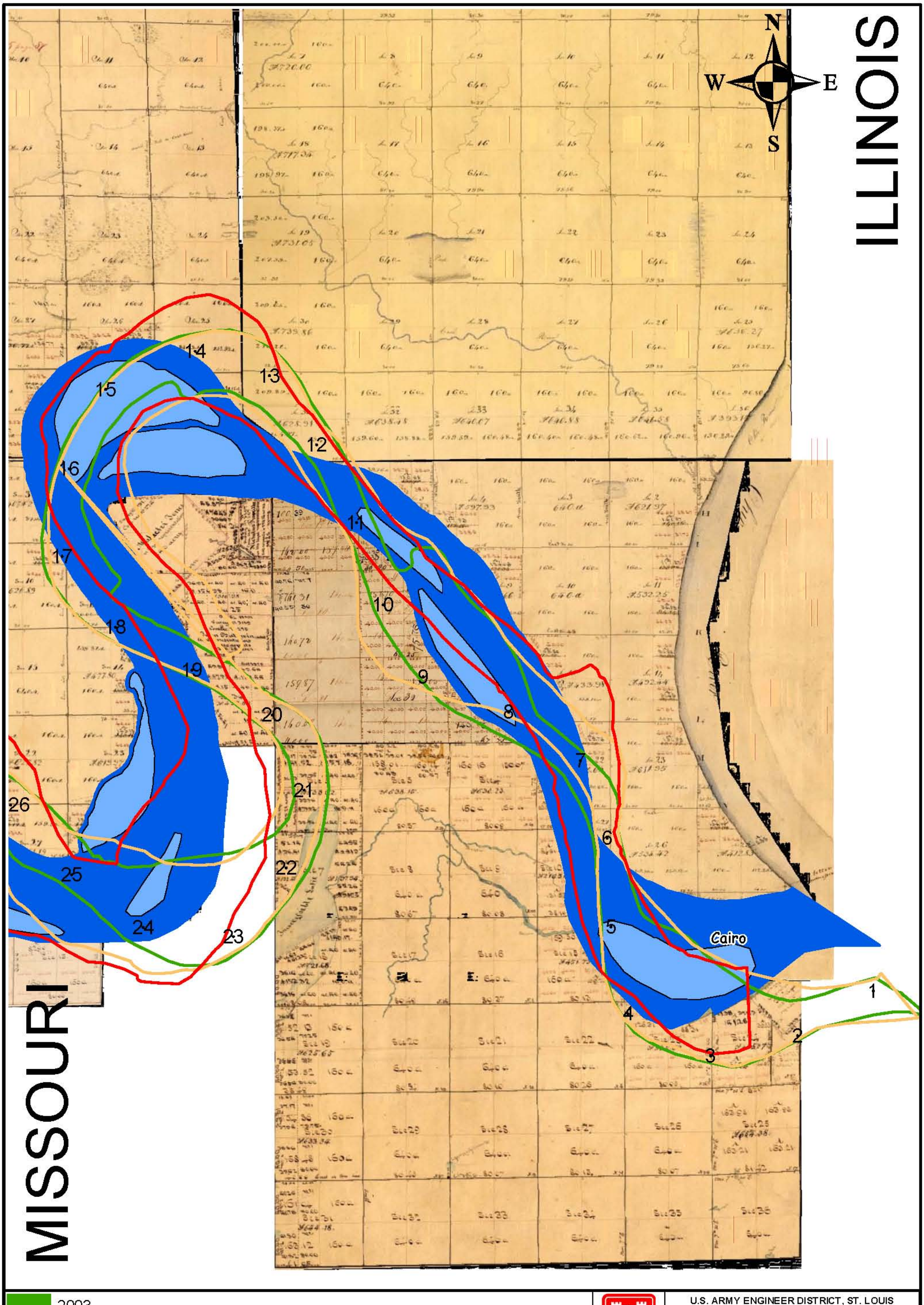
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

BLUEPRINT FOR RESTORATION

RIVER MILES 42-26

PLATE NO.: 61



🟩 2003

🟧 1928

🟥 1881

🟪 1866

🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: 1817-1820 Government Land Office Surveys

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

PREPARED BY: Edward J.Brauer
DRAWN BY: Edward J.Brauer
CHECKED BY: Robert D.Davinroy

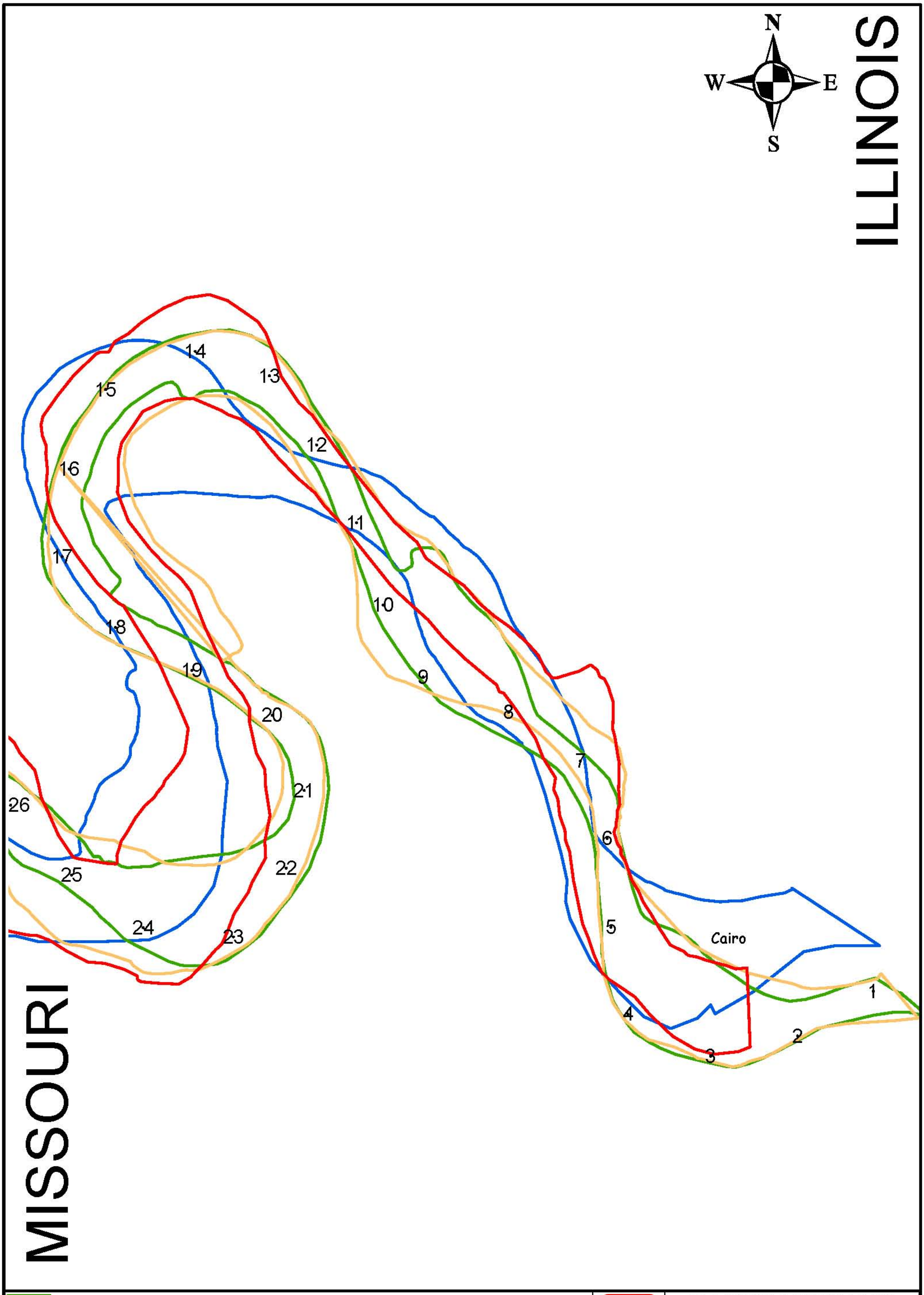
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1817 Planform

RIVER MILES 26-0

PLATE NO.: 62



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

Feet
0 5,280 10,560 21,120

SOURCE: Warren, Bvt. Major General G. K.

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

PREPARED BY: Edward J. Brauer
DRAWN BY: Edward J. Brauer
CHECKED BY: Robert D. Davinroy

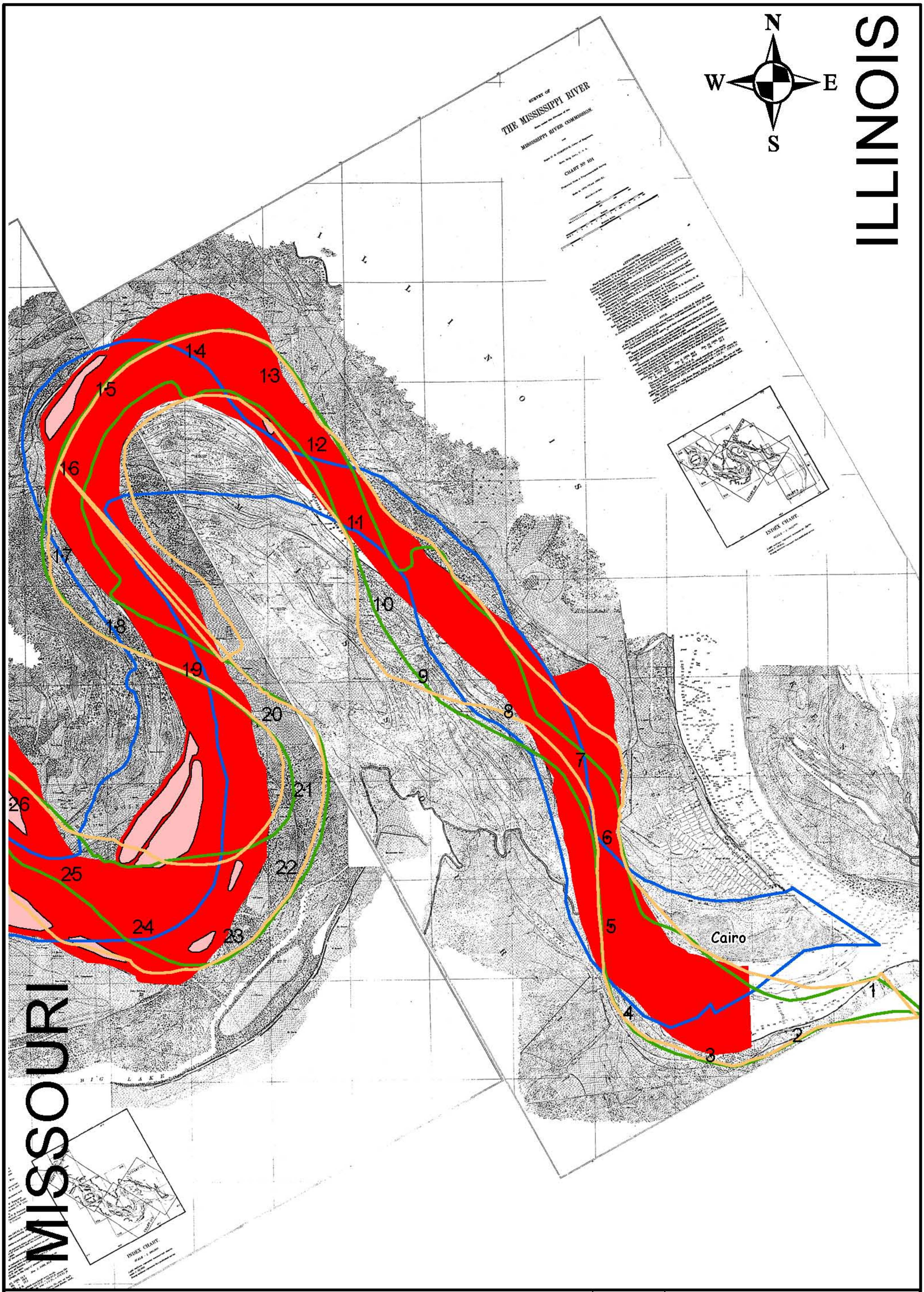
APPLIED RIVER ENGINEERING CENTER

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1866 Planform

RIVER MILES 26-0

PLATE NO.: 63



🟩 2003

🟧 1928

🟥 1881

🟪 1866

🟦 1817

Feet
0 5,280 10,560 21,120

SOURCE: Mississippi River Commission, 1880-1882, 1884, 1888, 1889, 1891-1899

PREPARED BY: Edward J.Brauer
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CHECKED BY: Robert D.Davinroy

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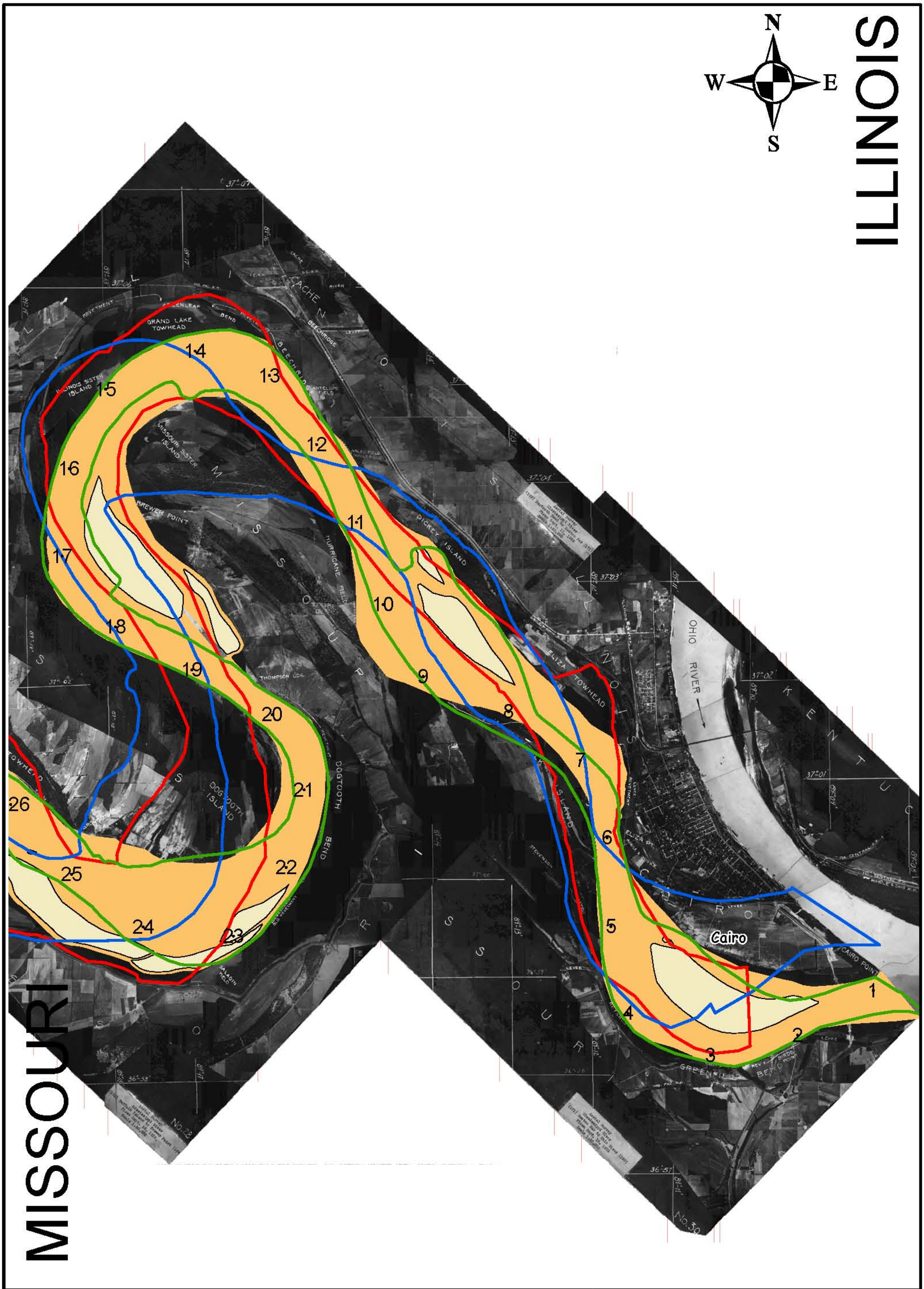
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1881 Planform

RIVER MILES 26-0

PLATE NO. 64



🟩 2003

🟧 1928

🟥 1881

🟪 1866

🟦 1817

SOURCE: Aerial Photographs
Flown 5 OCT 1928

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ST. LOUIS, MISSOURI

PREPARED BY: Edward J.Brauer
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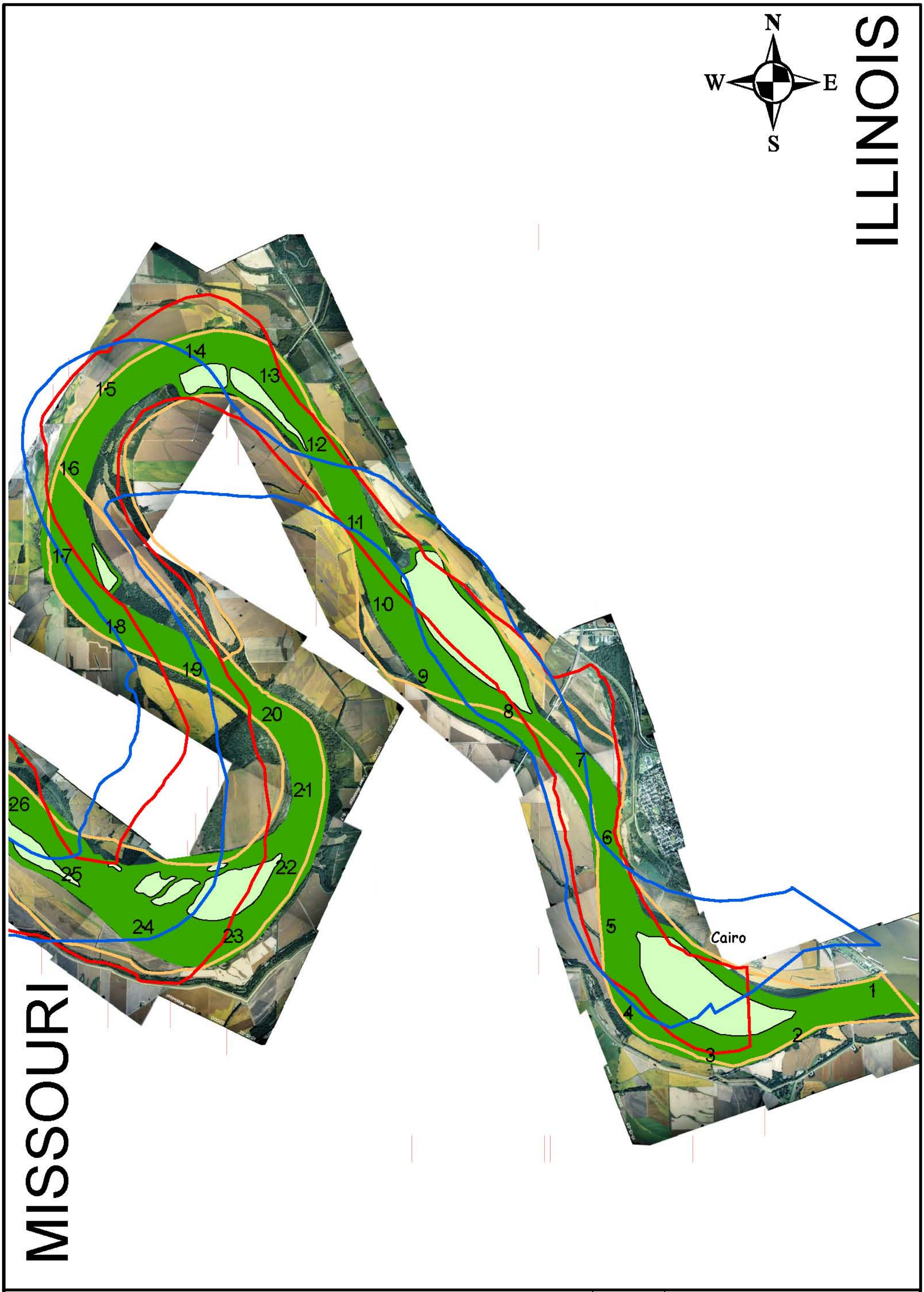
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

1928 Planform

RIVER MILES 26-0

PLATE NO.: 65



🟩 2003
🟧 1928
🟥 1881
🟪 1866
🟦 1817

0 5,280 10,560 21,120 Feet

SOURCE: Aerial Photographs

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
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PREPARED BY: Edward J.Brauer
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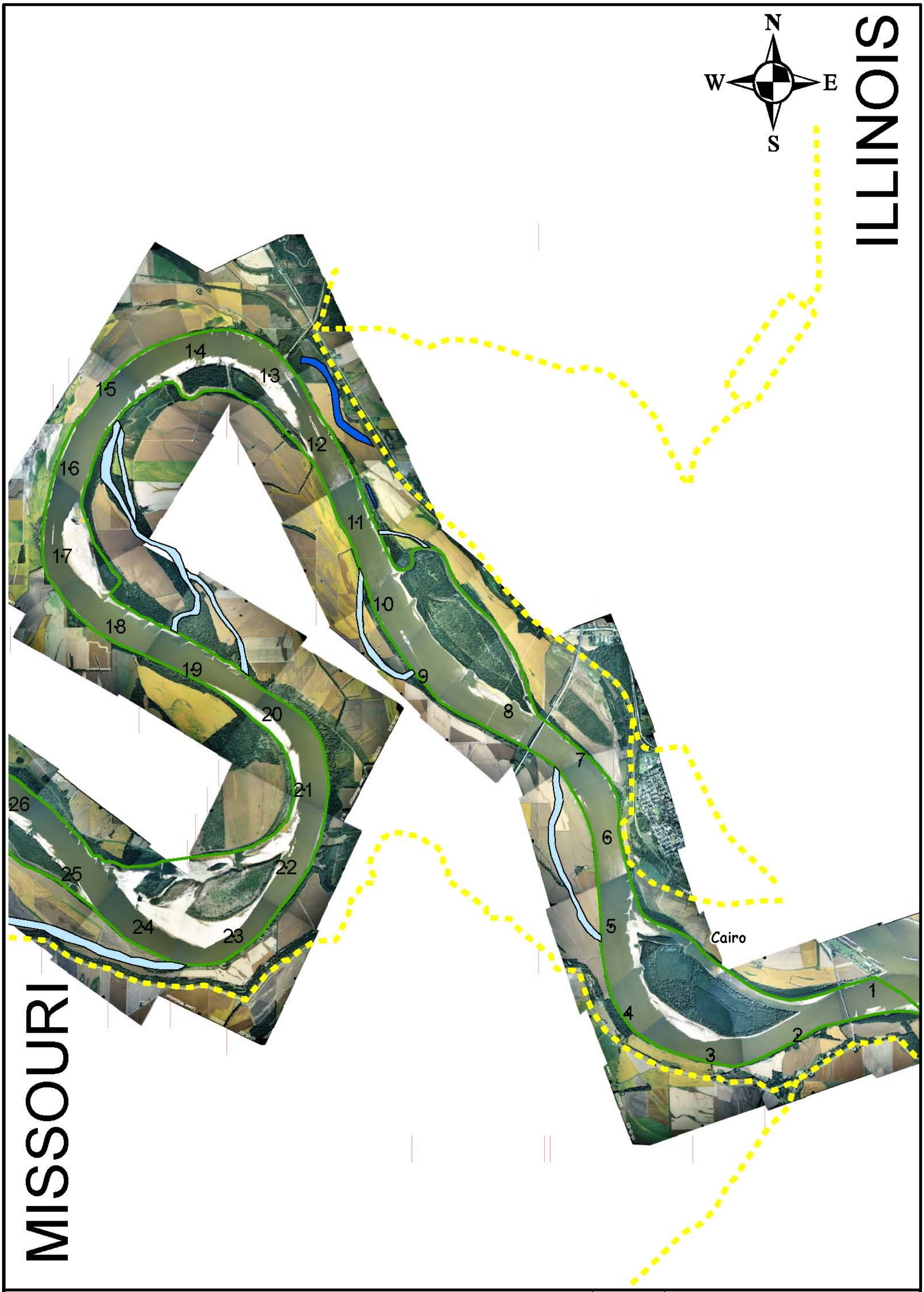
GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

2003 Planform

RIVER MILES 26-0

PLATE NO.: 66



LEGEND

Feet
0 5,280 10,560 21,120

- ▬ ▬ Levee
- ☐ 2003 Planform
- ■ Isolated, Deep Oxbow
- ■ Side Channel, Sloughs or Backwater

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
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ST. LOUIS, MISSOURI

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GEOMORPHOLOGY OF THE MIDDLE MISSISSIPPI RIVER FROM ST. LOUIS, MO TO CAIRO, IL

BLUEPRINT FOR RESTORATION

RIVER MILES 26-0

PLATE NO. 67

morphology Appendix_A