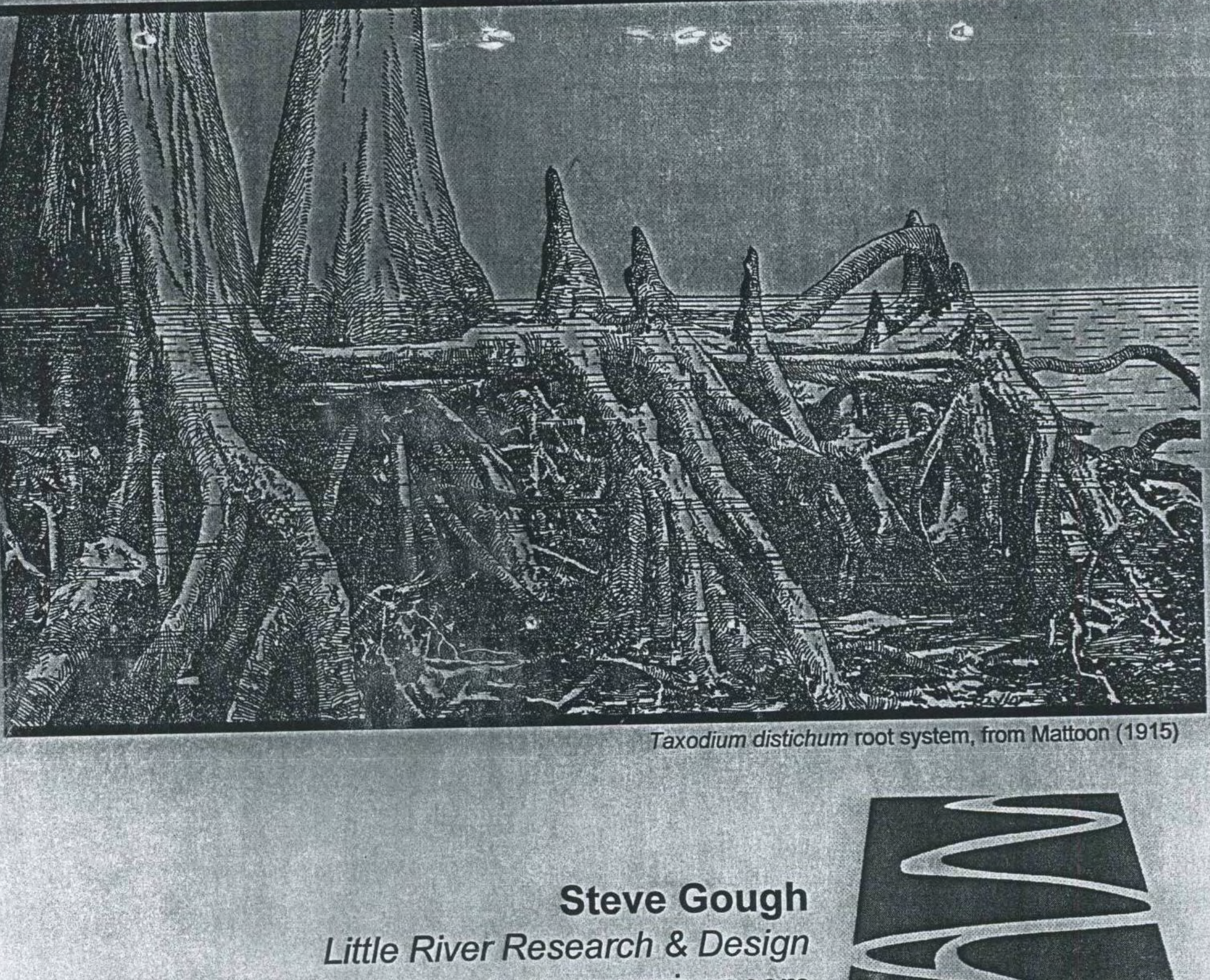
05-L27W

Historic and prehistoric hydrology of the Cache River, Illinois



Taxodium distichum root system, from Mattoon (1915)

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Abstract

The work described here is a synthesis of existing literature and information on the hydrology of the Cache River aimed at these questions: Did the Middle Cache Valley (MCV) hold permanent water prior to European settlement, and, if so, at what average elevation? The Cache River Watershed has an exceedingly complex natural history greatly influenced by glaciation, perhaps tectonic events in the past 1,000 years, and certainly by radical alteration after European settlement. We have two powerful and objective sources of historical evidence: The 1807 Public Land Survey (PLS) records, and the 1903 Bell survey. The PLS clearly shows that the MCV was flooded to an elevation of at least 330 ft. NGVD29 at the time of the survey. The MCV is subject to floods of long duration, but the PLS surveyors described flooded areas in the MCV using terms such as "lake," and "pond." It seems unlikely that these experienced geographers, would have described temporarily flooded timber using such terms.

In 1903 Bell (1904) surveyed bank and bed elevations, along with planform, or 93 miles (150 km) of the Cache River. This survey shows that an eight mile (13 km) section of the MCV is sunken, and clearly not in fluvial equilibrium with the rest of the Cache River. Over a period of thousands of years of Cache River flows and Ohio River overflows since the Pleistocene, this sunken section should have reached an equilibrium form with reaches upstream and downstream. This lack of equilibrium begs explanation and may have resulted from earthquakes. Recent work in the Cache Valley has dated at least one strong shock to about 900 years ago (Guccione 2002).

Regardless of the genesis of the sunken parts of the MCV, it is clear that they held permanent water before alteration by European settlers. The Upper Cache River holds several wetland areas, remnants of glacial lakes, that also were poorly drained swamplands. These areas held water at higher elevations and with much smaller drainage areas, strongly suggests that the MCV was well supplied with water and tended to hold it. Bell (1905) and others described the numerous dense logjams in the area, specifically noting that some of them barely let a trickle of water through. Considering this evidence in light of the depressed nature of the MCV as shown by Bell's long profile survey, it seems likely that these dams acted to keep permanent water in the MCV.

Citation

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A note on printing from an Adobe PDF file: This document may be printed in black and white, except for Figures 2 and 4 through10, which should be printed in color.

Introduction and scope

Early in 2005, I was given the task of investigating the historic hydrology of the Cache River Basin. More specifically, the Joint Venture Partnership (JVP) was interested in better understanding the hydrologic regime and, specifically, water elevations in the Cache River prior to alteration by European settlers in the late nineteenth and early twentieth centuries. I have spent considerable effort analyzing the geomorphology of the Cache River Basin because water surface elevations in a wetland, especially a complex riverine system like the Cache's, are a function not just of water flows, but of the morphology of the wetland as well. Without understanding the processes that formed and now maintain that morphology, we cannot fully understand the interaction between the landforms, hydrology, and biota that make up the Cache River's ecosystem.

Because the Cache Basin, shown in Figure 1, is large and resources were limited, I focused my attention on the Cache River Valley roughly between Belknap and Ullin. This area contains Eagle Pond, Long Reach, and Buttonland Swamp, and is the subject of interest in management of water surface elevations to protect and preserve the Valley's environmental values. Geographic names in this part of the Cache Valley are used rather loosely. For this reason, I will use a designation of my own: The Middle Cache Valley (MCV). This section of the Valley, shown in Figure 2, runs from Belknap (and the Post Creek Cutoff) west to the mouth of Big Creek, about two miles (3.2 km) east of Ullin. This section of the Cache is mapped on the Karnak, Cypress, and Dongola USGS 7.5' quads, and, as the crow flies, is about 10 miles (16 km) long.

As I approached the end of my work on this study and struggled to explain the unusual character of the Cache Valley, I wondered whether shallow subsidence had perhaps formed the MCV's extensive presettlement wetlands. My inquiries led to seismologists, including Martitia Tuttle and W. John Nelson, who confirmed that there appears to be a good possibility, as yet unexplored, that the MCV is a "sunkland," i.e. a swamp formed by subsidence or faulting during an earthquake. Sunklands are common in lowland river systems south of this region that were strongly influenced by the New Madrid earthquakes of 1811 and 1812. Aside from the MCV's unusual long profile, in which the MCV appears vertically depressed and out of equilibrium with the rest of the Cache

River's long profile, there appear to be numerous circular craters in the Cache's floodplain, including many concentrated along the Cache River just south and east of Perks in sections 11 and 12. These features may be sand blows that form in alluvial plains during strong earthquakes.

I was unable to determine whether the MCV has been influenced by seismic events, but we hope ongoing investigation will answer that question. Though this answer would be important in understanding the Cache River's natural history, it does not influence the conclusions in this report with regard to presettlement hydrology.

Acknowledgments

This project was commissioned by The Nature Conservancy and funded by a grant from the Illinois Department of Natural Resources' Wildlife Preservation Fund. Mike Baltz of The Nature Conservancy oversaw my work. Sam Indorante, Matt McCauley, Brian Fitch of the NRCS kindly advised and assisted me with coring in the Cache Valley. John Nelson of the Illinois State Geological Survey and Martitia Tuttle of Tuttle and Associates gave advice on geology and seismic investigations. Roy Frank of the University of Illinois-Carbondale Department of Civil Engineering, Bill Abbernath of Shawnee Surveying in Vienna, Illinois, David Webber of the NRCS, and Marty Merrill advised me on the Public Land Survey (PLS), its relation to modern surveying techniques, and availability of benchmarks in the MCV. My wife Katherine Poulos gave volunteer assistance with field work. Max Hutchison spent much time talking with me about the Cache Valley and providing invaluable data and research material.

Overview of the Cache River Basin

The Cache River Watershed, shown in Figure 1, drains much of the southern tip of Illinois. Today the river has been drastically altered, but was once about 110 miles long. Its watershed once included all or parts of six counties.

The Basin contains important natural communities, and is one of only sixteen United States wetlands listed by the United Nations' UNESCO division as a wetlands of "international importance, " and is listed as a U.S. National Natural Landmark. Before logging and conversion to agriculture, over 240,000 acres (97,124 ha) of the Cache River's watershed were covered with cypress-tupelo *(Taxodium distichum, Nyssa aquatica L.)* swamps. Today, the area holds two of the largest cypress trees in the United States, twelve state champion trees, and some of the oldest living cypress trees known (Demissie et al. 1990). Excellent descriptions of the Cache River and its natural and cultural history are given by Graham (1985), Hughes (1987), Hutchison (1979, 1984, 2000 et al.), Reinersten et al. (1994), and the authors, usually including J.W. Nelson, of the Illinois Geological Survey's (ISGS) Geologic Quadrangle Map Series. Demissie et al (1990) give a thorough description of the basin's hydrology, including a chronology of its alteration. Corzine (2005) gives a detailed analysis of historic conditions in the MCV. The USCOE (1992) gives a detailed description of alterations to drainage within the Cache River Watershed.

The Cache River Basin is geomorphically complex. I would argue that its complexity makes it unique on a global scale. The Cache Valley, which includes the present day Bay Creek drainage, is a low-lying area running west from the Ohio and then south to the Ohio near Cairo and the Ohio-Mississippi confluence, was the course of the Ohio River until about 8,200 years ago (Graham 1985). During the Cretaceous period, its present junction with the Ohio was likely once a confluence of the Cumberland and Tennessee River Valleys, and which then flowed in an easterly direction. The basin lies within and at the junction of three physiographic provinces: The Coastal Plain, Interior Low Plateaus and Ozark Plateaus Provinces, and at the edge of the Central Lowland Province (Masters and Reinersten 1987).

During the 19th century, settlers of European ancestry began to farm the basin, and the first large scale alterations began. Hutchison (1984) reports that by the time of the Civil War, many of the upland farms in the Basin had been worn out and abandoned.

Both the broad alluvial Cache Valley left behind by the Ohio River and the Pleistocene (1.8 million to 10,000 years ago) lake deposits in tributary valleys are geologically young, full of wetlands, and poorly drained. During the latter part of the 1800's and beginning in earnest in the early 1900's, the Cache Valley was ditched and drained. Drainage, levee construction, logging and intensive agriculture in the valley brought profound changes. Figure 3, from the 1919 USGS Dongola 15' quad, shows that parts of the Lower Cache were being channelized, and had probably been extensively cleared of logjams by 1919. The Post Creek Cut Off and Cache River Levee, completed in 1915, diverted the Upper Cache River south to the Ohio, disconnecting it from the lower Cache. Extensive ditching, mostly using floating dredges, took place in the wide Cache Valley from the Post Creek Cutoff east to the Ohio River, thr`ough the Bay Creek drainage. A levee across the Valley in the Reevesville area was built to prevent Ohio River overflows through the Cache Valley. After the 1937 flood overtopped this levee, the Army Corps of Engineers (USCOE) built a higher structure that has since prevented such flows.

Definitions and technical problems

Study of historic and prehistoric conditions in the Cache River watershed involves many technical problems. Different vertical datum have been used for surveys, including work done by railroads, drainage districts, and the US Geological Survey. Maps of the region may or may not be reliable. The Appendix contains notes, definitions, and analyses regarding some of these problems, including definitions and comparisons of vertical datum.

In this paper I will use these geographical definitions:

Cache River. The Cache River's pre-alteration channel as it is indicated on modern USGS maps, and shown in Figure 1, running from near Cobden in northern Union County south to the the *Cache Valley* and then west to near Ullin before turning south to join the Ohio River. This description does not include the Post Creek Cut Off, which now carries flow from the *Upper Cache River* south to the Ohio River.

Cache Watershed and Cache Basin. The area draining into the Cache River as defined above, and shown on Figure 1; the pre-European settlement watershed.

Cache Valley. The former course of the Ohio River, running from the Ohio south of Golconda east to near Ullin and then south to the Ohio River. The Upper Cache River becomes the Lower Cache River as it enters the Cache Valley near Belknap.

Upper Cache. The Cache River and its watershed that drains into the much flatter Cache Valley. The Post Creek Cut Off sends runoff from the Upper Cache south to the Ohio River, bypassing the Lower Cache.

Lower Cache. That part of the Cache River that is within the Cache Valley, which is a former course of the Ohio River.

Middle Cache Valley, or MCV. As defined previously, this section of the Cache Valley, shown in Figure 2, runs from Belknap (and the Post Creek Cutoff) west to the mouth of Big Creek, about two miles (3.2 km) east of Ullin. This section of the Cache is mapped on the Karnak, Cypress, and Dongola USGS 7.5' quads, and, as the crow flies, is about 10 miles (16 km) long.

Geology of the Cache River Basin

The valley walls of the Cache are cut into resistant Paleozoic rocks in the eastern one quarter of its length, and along the entire north side of the valley, sometimes following fault zones (Masters and Reinersten 1987). Recent work has located numerous faults crossing the valley, including the recently active Commerce Fault zone, which has moved as recently as 15,000 to 75,000 years ago (Nelson 1998).

The geology of the Cache Valley has been well-mapped by the ISGS and published through its Illinois Geologic Quadrangle Map series.

Nelson, Follmer, and Masters (1999) believe the Cache Valley may initially formed in the Tertiary (over 2 million years ago) at the boundary between the bedrock-cored Shawnee Hills of the north and the softer sediments of the Mississippi Embayment to the south. During the Illinoisan glacial period, the Ohio at roughly its present course became a major river, and the Cache Valley was deeply scoured by very high sediment and water discharges at the end of this glacial period (Nelson, Follmer, and Masters 1999). The high flows were further effective because Pleistocene lowering of sea level (Reinersten et al. 1994).

Seismology

Small to moderate earthquakes are common in the Cache Valley region (Chester and Tuttle 2000). Several major fault systems run through or are very near the Cache River Valley, including the Flourospar Area fault complex to the east, Commerce fault system to the west (Chester and Tuttle 2000, Nelson 1998). Figure 4 shows these. Chester and Tuttle (2000) found and explored several sand dikes (liquefaction features indicating strong earthquakes) in the region, dating one to 1,025 years ago or less, indicating recent major seismic activity in the valley. The well-known New Madrid earthquakes of 1811 - 1812 were also strongly felt in the Cache River Valley, though no one has, as yet, identified specific liquefaction features that may correlate with these events.

Winkley (1994) who looked at the geomorphology of the Mississippi River south from its confluence with the Ohio, noted evidence of many periods of bank caving and meander growth that were likely caused by tectonic activity, especially after the New Madrid events of 1811 - 1812.

Guccione et al. (2002), using sedimentary evidence in the Mississippi River floodplain, have dated three major earthquakes in the Reelfoot Lake area, ca. A.D. 900, 1470, and 1812. She notes that the two earthquakes produced large local coseismic deformation, and that both events caused stream responses such as shifting depocenters, modification of Mississippi River channel geometry, and "derangement" of small streams. Her study area lies only 65 miles (71 km) south of the Cache River Valley, so there is certainly a possibility that these events could have influenced river geomorphology there. She notes also that the Mississippi River, despite its size, has not yet attained equilibrium since the 1812 uplift 190 years ago. In the area of uplift, small channels unable to downcut through the uplift were filled, locally reversed flow direction, or formed lakes where they were dammed (Guccione 2002). Nelson et al. (1997) have recently found Pleistocene sediments displaced by faulting, and believe that major fault displacement may have taken place in southern Illinois as recently as 15,000 years ago.

In 1910 and 1911, Fuller (1912) made a detailed field study of the effects of the 1811-1812 New Madrid earthquakes. From his study:

> No other feature of the New Madrid region is so conspicuous and striking or so widely known as the so-called "sunk lands," resulting from the local settling or warping of alluvial deposits os western Tennessee, southeastern Missouri, and northeastern Arkansas by the action of the earthquake of 1811.

Fuller (1912) divides these sunk lands into three types: sand sloughs, river swamps, and lakes. He notes that the river swamps "include the depressed areas along certain of the streams, the level of which is such that water stands over them for considerable periods, but does not cover them so deep as to prevent the growth of timber."

Fuller (1912) noted and mapped the drainage features still extant in the bed of Reelfoot Lake, which was formed by subsidence and left both the channel and floodplain of the Bayou de Chien under several feet of water. This description fits the MCV's morphology quite well, and it appears that some of the wetlands in the MCV may indeed be sunklands. Further work will be needed to verify this.

Again we should note that a seismic genesis for the wetlands of the MCV does not influence the conclusions about presettlement hydrology given here. Regardless of the means by which the MCV's geomorphology came to be, my conclusions regarding hydrology, dominant water surface elevations, and resultant ecosystems would remain unchanged.

Geomorphology

The geomorphology of the Cache Valley is exceedingly complex, and I believe unique on a global scale. The valley lies at the junction of four physiographic provinces, and has a complex genesis that includes shifts of continental river systems. The valley has been formed and influenced by repeated ice advances in the Pleistocene Age (1.8 million to 10,000 years ago). These episodes caused repeated scouring to bedrock and filling with glaciofluvial sediments. Though now more isolated by navigation and flood control structures, the valley was strongly affected by the Ohio, Mississippi, and Tennessee River drainages.

Nelson, Follmer, and Masters (1999) believe the Cache Valley may have initially formed in the Tertiary (over 2 million years ago) at the boundary between the bedrock-cored Shawnee Hills of the north and the softer sediments of the Mississippi Embayment to the south. During the Illinoisan glacial period, the Ohio River at roughly its present course became a major river, and the Cache Valley was deeply scoured by very high sediment and water discharges at the end of this period (Nelson, Follmer, and Masters 1999).

Graham (1985) notes that the Cache River Watershed shows two very distinct valleys. The Upper Cache shows steep Mesozoic escarpments and narrow floodplains and joins the Lower Cache near Foreman. The Lower Cache Valley is a wide, relatively flat former course of the Ohio River. The Lower Cache Valley is underlain by the Henry Formation, which includes sands, gravels, and finer outwash materials from the Wisconsin advance. These sediments are overlain by the more modern Cahokia alluvium. Much of the watershed is blanketed by loess.

At the end of the Pleistocene and beginning of the Holocene (about 10,000 years ago), the valley was the course of the Ohio River, which completed a shift south to its present location about 8,200 years ago (Graham 1985). This shift left a wide, flat alluvial valley fed by several relatively small, steep watersheds to the north, as shown in Figure 1. Figure 5, from Demissie et al. (1990) shows how the long profiles of these relatively steep tributaries contrast with the much flatter Cache Valley.

During the last ice advance (the Wisconsinan, 75,000 - 10,000 years ago), both the Ohio and Mississippi Rivers carried huge sediment and water loads from melting glaciers. Rapid glaciofluvial deposition in the Cache Valley blocked tributary mouths with sediment, or valley trains, and glacial lakes formed. At least two slackwater lake systems formed during this time and partially filled with silt and clays eroded from the surrounding watersheds (Graham 1985). The second series reached an elevation of about 375 ft National Geodetic Vertical Datum of 1929 (NGVD29) (Graham 1985). These deposits formed the silts and clays of the Equality Formation (Esling et al. 1989).

The lakes are gone now, but sediment deposited in them left many of the flat landscapes, both in the Cache Valley and those of its tributaries, that later became swamps. Some of these are shown in Figure 6. This process is discussed in detail by Graham (1985) and Hughes (1987), who did graduate research on the geomorphology of the Cache Valley. All the Cache River's current tributaries hold lacustrine deposits from these lakes.

Hughes (1987) identified two main surfaces in the Lower Cache Valley. The first is the Brownsfield terrace, which lies at about 340-350 ft NGVD29, or 5-10 ft above the modern floodplain, which is at about 335 ft in the main valley. The ISGS Geologic maps of the Mermet and Reevesville 7.5' quads (Devera and Nelson 1997, Nelson 1996), for example, show these terrace deposits.

A divide of sorts exists near Reevesville, near the Cache Valley's eastern confluence with the Ohio River. This has been attributed to sediment accumulation from the Cache's headwaters (Hutchison 1984) but it may also be a sediment deposit that is typically seen in the upstream mouths of side channels. In this case the Cache Valley is a side channel, or chute, of the Ohio River. Although it appears that this divide has long directed local rainfall either to the east or west, the Ohio River, after its shift south, continued to flow through the Cache Valley when it was high. Silty sediments left behind by these events and sand and rock debris reworked from the Henry Formation, make up the Cahokia Formation that fills the present Cache Valley (Nelson, Follmer, and Masters 1999).

At Reevesville, the Cache Valley is only about 4,000 feet wide. Downstream, where the Valley makes a large sweep and turns toward the northwest, it is nearly 8,000 feet wide, and relatively unconstrained by rock bluffs. At a cross section encompassing the town of Mermet (see the Mermet 7.5' Quad), the Valley is roughly 10,000 feet wide, though some "lost hills" occur in the valley flat here. The valley again narrows to about 8,000 feet as it turns from northwest to southwest at the Indian Point Bluffs near Foreman. This part of the valley is shown in Figure 7. Moving to the west past Belknap, the valley again widens to about 10,000 feet and maintains this width through the middle Cache and the Long Reach area. These changes in valley width are likely due to changes in bedrock resistance, structural control, and faulting. The New Columbia Bluffs, for example, are clearly formed, at least in part, by the Lusk Creek fault, which displaced Mississippian age strata downward over 200 feet in this part of the Cache Valley. Figure 4 shows a cross-section through this bluff, showing how it and a nearby creek valley were formed by faulting.

Megachute morphology and the Pleistocene-Holocene

Since the shift of the Ohio River's course south about 8,200 years ago (Graham 1985), the Cache Valley, i.e. that part of it that is the wide, alluvial plain left by the Ohio, remained a route for Ohio River floods. In essence, this valley became a megachute, or very large chute. Chutes are common in large alluvial rivers, but it is rare for them to be so large relative to the parent river. To my knowledge, it is also rare for them to be separated from the parent river by a non-alluvial divide–in this case the low hills that separate the Cache Valley from the lower Ohio. It is through this divide that the Post Creek Cutoff was dug.

Chutes are always subdominant to the parent channel, i.e. they carry less sediment and water discharge. Their bed elevations tend to be higher than the parent channel's. Although chutes or side channels can carry flow even during times of low flow in the parent river, they tend to be active when the parent channel is carrying moderate to high flows. This was certainly the case for the historic Cache River Valley. The USCOE recorded significant Ohio River flows through the valley in 1883,1884,1898,1907, and 1937. The last event caused massive damage to structures in the valley, and is considered to be one of the worst disasters ever to strike southern Illinois (Hutchison 2000).

Very large fluvial landforms appear through much of the Cache River Valley from the mouth of Bay Creek west to the MCV. These forms include both raised ridges, locally known as whalebacks (because the resemble a partially surfaced whale), and depressions. Both forms tend to be elongate in a downvalley direction, with rounded ends. Their length tends to be five to ten or more times width, and the ends of these features are almost invariably rounded. Figure 7 shows a group of these features lying between Karnak and Belknap on the Karnak 7.5' quad.

These features are often a mile or more in length. Their size, and orientation with respect to the valley, strongly suggest they were formed by very high discharges that filled the entire Cache Valley to a depth of several feet at least. For example, these bars and sloughs (as I'll call the depressed features) suggest flows impinging on the Stafford Bluff three miles (4.8 km) east of Reevesville on the Reevesville 7.5' quad, excerpted in Figure 8. Further down the valley at Indian Point, where the valley is less than 1.5 miles (2.4 km) wide and has resistant bluffs on both sides, the features disappear, only to reappear again as the valley widens. Figures 7 and 8 show these two valley sections.

The tops of the whalebacks or bars are very consistent with respect to elevation, sitting about 350 ft NGVD29 east of Reevesville and dropping to 340 ft NGVD29 between Belknap and Karnak. Moving downvalley past the MCV, past the towns of Ullin, and Tamms (and on the Tamms 7.5' quad), the whaleback tops become less strongly expressed, their direction is less consistent, and their tops remain at roughly 340 ft NGVD29.

These features probably hold important clues to the genesis of the Cache River Valley's morphology. We can be fairly sure that many of these features were formed by very high flows, and not by historic flows (i.e. the 1884 and 1937 high flows through the Cache Valley), because the largest of them, such as Grassy Slough, were present before and after these flows and were not obliterated by them. The consistency of their elevations gives some clues to flow depth in the valley. The highest elevations of the whalebacks correspond well with terrace surfaces notes by Hughes (1987), but these features are not terraces. In the MCV, the 1937 flood reached an elevation of about 346 ft. NGVD29. At the Reevesville divide, the USCOE (1945) recorded an elevation of 355.5 ft. NGVD29. These flows just submerge most of the whalebacks, but are probably not sufficient to form them. Historical descriptions of the features, many of which have been somewhat rearranged by farming operations, mention sandy material in the whalebacks, with Bell's 1905 report mapping some of these as "sandy ridges." Lacking stratigraphic information on the features, I am hard pressed to date them. They could have been formed by a very large flood outside recorded history, or may date from the end of the last ice advance, when the valley carried very large meltwater floods, perhaps even flood events caused by the breaking of ice dams. The consistency, shape, and orientation of these structures, and the apparent lack of reworking by flows smaller than those that created them, suggests they are the product of a single superflood. It is possible that this flood was triggered by a major earthquake. Our ongoing investigation of seismic events in the Cache Valley will perhaps shed light on this possibility.

Aside from the small chutes and whalebacks in the valley, we see very distinctive features that resemble large river channels. Grassy Slough (Figure 7) and the swamplands of the MCV are prominent. The latter, shown in Figure 9, essentially appear as the paleochannel of a large river, with a meander bend radius of about 17,000 ft (3.2 miles, or 5,150 m), and a width averaging about 2,500 ft (762 m). Though now altered by navigation and flood control structures, these values correspond roughly with what we see in the nearby Mississippi and Ohio Rivers today. It appears that, for example, the area now managed as wetlands and flooded to an elevation of 328 ft NGVD29 in the MCV is an old low flow channel of the ancestral Ohio River.

To understand the geomorphology and hydrology of the present day MCV, it may help to organize its complex natural history. The Valley has seen at least 5 dominant energy states since the beginning of the Pleistocene Age 1.8 million years ago:

1. During the glacial advances and retreats of the Pleistocene, very high water and sediment discharges deeply scoured the valley to bedrock. This high energy state was

enhanced by lowered sea level, which acted to increased channel slope (Masters and Reinersten 1987). Several times during the Pleistocene, the valley is filled and scoured by glacial meltwaters and sediment.

2. During the Holocene, the Cache Valley saw a lesser energy level during the period between the last ice advance and the Ohio River's shift to another channel. This was a relatively short period during which glaciofluvial sediments were reworked. As Hughes (1987) notes, the valley moved from the high energy deposition of the Henry sands and gravels to deposition of the finer Cahokia alluvium during this time.

3. About 8,200 years ago, the Ohio River shifted south, greatly lowering sediment and water discharges. The Cache Valley becomes a megachute. The valley is often flooded by the Ohio River, but discharges are much less than before and sediment load quantity and character is changed, probably favoring much finer materials. The Equality formation is reworked, moving sand in valley. It is perhaps during this time that the whalebacks were formed. Interactions between floods, sediment, and woody plants begin to form a distinct wetland-riverine ecosystem in the Cache Valley. During this period, and possibly within the last 1,000 years, a tectonic event may have created sunklands in the MCV, and a tupelo cypress swamp formed there. This event may have also strongly influenced other wetlands in the area, including those in the Upper Cache River valley, by causing moderate subsidence of saturated, organic matter rich lacustrine sediments.

4. In 1915, the Post Creek Cutoff separates the Upper and Lower Cache Rivers, greatly reducing discharge to the MCV.

5. In the 1950's the USCOE completes the Reevesville levee, which blocks any Ohio River overflows into the MCV and Lower Cache.

Before the construction of the Reevesville levee, it appears the Ohio River significantly flooded the Cache Valley about once every ten years. Between 1883 and 1937, the USCOE (1945) recorded six events that overtopped the natural divide at Reevesville, giving an average return interval of nine years for this 54 year period. Demissie et al. (1990) published a stage return interval analysis for Lock and Dam 53 on the Ohio River, using this analysis, and simply carrying the gage elevation upstream to the mouth of Bay Creek (a 14 ft. difference), I obtained a return interval of roughly 18 years. It therefore appears, at least under the historic climate, that the MCV, on average, was flooded by the Ohio every 9 to 18 years. These floods are important not only because they moved water and sediment through the MCV, but also because they undoubtedly introduced huge volumes of woody debris to the valley, both from the Ohio River itself, and by mobilization of fallen trees and other sources within the valley. This material would have contributed to the logjams that commonly appeared in the MCV before European settlers began to clear them.

Hydrology

For this section I have relied heavily on Hutchison (2000) and Demissie et al. (1990), who give an exhaustive analysis of the historic and present day hydrology of the Cache River. Precipitation in the Cache Valley averages 47 inches per year, with most occurring as rainfall. Average annual runoff is about one-third of precipitation. Heaviest rainfall occurs March-June, when monthly rainfall averages from 4.5 - 5.3 inches (USCOE 1992). Seventy to eighty percent of the gaged floods in the valley occur during this period. Long, low-intensity winter storms can also cause flooding.

Prior to construction of the Post Creek Cutoff, the Cache River Basin drained 737 square miles (190,882 ha) at its confluence with the Ohio River near Cairo (Demissie et al. 1990). The Cutoff beheaded the Cache River's drainage network, sending runoff from 368 square miles (95,311 ha) of the Upper Cache's flow to the Ohio at river mile 957.8 (Demissie et al. 1990).

Only one long-term gage exists in the basin. It lies near Foreman where the Cache drains 244 sq. miles (63,195 ha), and has been in operation since 1923. This gage measures flow from most of the Upper Cache River. Tributaries to the MCV include Cypress Creek, with a watershed area of 110 sq. miles (28,489 ha) and Big Creek, which drains 53 sq. miles (13,726 ha). Basin elevations range from 890 ft NGVD29 to 290 ft NGVD29 at the Cache's former mouth at the Ohio River near its confluence with the Mississippi.

Before human alteration, the MCV had a drainage area of 523 sq. miles (135,456 ha). Though it lies at the downstream end of the MCV, I am including Big Creek in this drainage area because the very low slopes and poor drainage of the MCV made it a likely contributor to this wetland.

Drainage network morphology for the Cache River is unusual in that the Cache Valley is a former course of the Ohio River. Figure 5 shows long profiles plots of the Lower Cache River and its tributaries. Much of the Cache River's headwaters, and those of its tributaries, are in steep, dissected networks, while the Lower Cache has inherited a much flatter morphology from the ancient Ohio River. While modern day modifications of the upland drainages have made watershed response more flashy, the Cache Watershed of 200 years ago was certainly had a highly buffered response to rainfall. Figure 6 shows parts of the Upper Cache River as mapped in 1916, from the Vienna USGS 15' quad. Note the extensive wetland areas formed on lacustrine deposits, which are over 20 ft (6 m) higher than the floodplain of the Lower Cache. These Pleistocene deposits formed broad, flat plains and wetlands, even in upland areas, that acted to store and slowly release precipitation.

As the historic descriptions below reveal, the Cache Valley as it existed before European settlement had a diverse drainage network and complex hydrology. Two hundred years ago, the northern upland basins were probably still actively incising through lacustrine sediments deposited in their valleys in the Pleistocene. Some of these deposits, notably those on the flatter former course of the Ohio River, formed extensive wetlands covering much of the valley. These wetlands released runoff very slowly. The basin was covered in lush vegetation excepting a few rocky bluffs and barrens. The periodic Ohio River overflows through the Lower Cache Valley probably rearranged sediments, and may have acted to reset bottomland forest ecosystems by scouring some areas and depositing sediment in others. These flows almost certainly created large debris jams, especially in the flatter parts of the MCV and the Lower Cache River.

Given the vertically depressed nature of the MCV, its large drainage area dominated by wetland storage, and the dominance of debris jams, it appears likely that the MCV held permanent water. The wetland areas that existed in the Upper Cache Valley, as mapped in 1916, and shown in Figure 6, persisted with much smaller drainage areas, though we do not know if they held permanent water.

Historical evidence

Public Land Survey Records

Hutchison (1979) made a detailed review of the Public Land Survey (PLS) records with particular attention to mention of water features in the MCV. Parts of the Cache Valley were surveyed in 1807, well before significant alteration of its drainage network. The PLS surveyors were charged with laying section lines and also describing the nature of the land they crossed on this one-mile grid. They also described the species and diameter of witness trees they established at section and quarter and section corners. The surveyors noted when they encountered water, either as a stopping point beyond which they were unable to survey, or as a creek or river, in which case they recorded the width of the channel if they were able to cross it.

We can compare the notes of these surveyors with modern topographic maps to estimate water surface elevations and inundated areas at the time of the survey. Hutchison did this in great detail, also transcribing the original notes in the process, a difficult task because they can be very hard to read. I reviewed his work, and also did my own analysis, comparing digital scans of the original plats with modern 7.5 minute maps.

This analysis of the PLS is subject to errors. The surveyors must have encountered difficult conditions, though at least during the winter and early spring seasons, when the township I have analyzed was surveyed, they avoided the usual hindrances of heat, snakes, and tropical diseases. Surveying in swampy areas is difficult even with modern equipment. This brings into question the accuracy of some of the PLS descriptions. The modern 7.5-minute topographic quads were made with a contour interval of 10 feet, which is larger than we would prefer for this analysis.

Townships covering the MCV on the modern Karnak and Cypress 7.5' quads were surveyed in 1807. Much of the land below what is mapped (on the modern USGS quads) below the 340 ft. contour was recorded as lakes, ponds, and swamps. In many cases the notes indicate "swampy, can't be surveyed" below this elevation. The strong consistency between the wet areas noted in the PLS and current elevations of approximately 335 NGVD29 feet tells us that these areas were flooded in 1807.

The surveyors were professionals, and generally understood geography well. Hutchison (1979) notes that the PLS surveyors used the terms pond, cypress pond, and lake to denote water features. They also used several variations of swamp, including swamp ponds and cypress swamp. He makes a thorough analysis of the use of these terms and their likely meanings for the surveyors that I will not repeat here. He concludes, and I agree, that the surveyors had a good understanding of physical geography, and would not have used terms such as pond and lake to denote temporarily flooded timber .

We can retrace the lines of the PLS surveyors and be quite certain of the horizontal (i.e. latitude and longitude) locations at which they encountered water, and how they described it. In the MCV there are many lines that the surveyors were not able to survey. Figure 10 shows a detail of several sections just southwest of modern-day Perks showing lines marked "not run." In general, the surveyors ran the section lines until they encountered impassible areas. The distances from section corners to these points were recorded and are plotted on the original plat maps. In most cases, even with a modern resurvey, we would have problems determining the elevations of these points. The 7.5 minute quad map contour intervals are generally too coarse. In the past 198 years since the survey, the landscape has been altered by farming, erosion, and sedimentation. Drainage ditches were dug along many of the section lines and roads built along others, obliterating the original land surface.

We can see approximate elevations, however, and in some cases be relatively sure of the water surface elevations at the time of the PLS work. For my analysis, I focused on Township 14 S, Range 1E, and sections 13, 14, and 15. These sections lie just south and east of Perks on the Cypress 7.5' quad, and were surveyed beginning in early January of 1807 and completed on April 16, 1807. All the section line-water feature crossing points I examined are mapped between 340 and 330 ft. NGVD29 on the modern Cypress 7.5' quad (photos for which were taken in 1966). At most of the crossings, the land surface slopes on very gently, usually around 30 ft. per mile, or 0.6 percent. At two of the crossings, however, the land surface is unusually steep as it intersects the water surface at the time of the survey, giving a better indication of the elevation as mapped on the modern 7.5' quad, which is shown in Figure 10.

The first point lies near the corner of sections 15,16, 21, and 22 (about 2 miles south of Perks). Surveying north toward this corner, the surveyors stopped their line at 77.58 chains, or 160 ft (49 m) south of the section corner, where they note "to the lake," as they did when stopped by what they called a lake. This points lies on a relatively steep (5%) hillside on the modern quad between the 340 ft and 330 ft contours, as shown in Figure 10.

A second such point lies at the corner between sections 13, 14, 23, and 24 two miles to the east, shown on Figure 10. Here they ended their northern survey line at 40.0 chains (2,640 ft), indicating they were prevented from going further. They did not indicate why they were stopped here, but later completed as much of this line as they could from a northerly direction, indicating "to the lake" when stopped by the northern edge of the "lake." Note that the original plat maps indicate the direction these partial lines were surveyed (though the "north" and "south" are difficult to read). At the first point, the land is relatively steep, and again the point lies between 330 and 340 ft. NGVD29. Note also that, on the Cypress 7.5' quad (Figure 10), the mapped section line is bent at the two points on this section line where the surveyors were stopped by water, showing the slight error they made in accurately surveying it from two directions.

Bodies of water clearly caused the PLS surveyors difficulty in their survey of the MCV. The section line running across the Cache River between sections 13 and 14 southeast of Perks has a double offset (see Figure 10) in it at two points corresponding with elevations of about 330 ft. NGVD29, indicating that the surveyors hit deep water at these points and could not extend their line across the swamp there.

In 1892 C.B. Klingelhoefer, in a survey commissioned by the State of Illinois (as I understand, this needs to be checked), describes parts of Township 1E, R 14S (in which the PLS is above discussed) thus:

> The banks of the Cache River here as is the case all over the county are exceedingly flat and all the land within a mile and a half of it is subject to over-flow. In fact it has gone so far as to form a swamp nearly 3 miles wide and 16 miles long.

This report includes elevations, but it is my understanding (pers. comm. M. Hutchison 2005) that they were obtained barometrically. I found them to correlate very poorly with mapped elevations.

Other evidence

Roads and bridges built through the Cache Valley in the late 1800's and after the turn of the century may offer some evidence of presettlement hydrology. A.E. Corzine (2005) concludes that dry season pool elevations were about 323 ft NGVD29. His argument includes evidence of road and bridge construction, particularly of the Cache Chapel Road. In considering the Cache Chapel Road bridge, which crosses the Cache River about 2 miles southwest of Perks he makes a strong argument that the bridge and road would not have been built as they were if permanent water at an elevation of 328 NGVD29 had existed. The road and bridge were built in the early 1900's (Corzine 2005), and are depicted on the 1919 USGS 15' quad (for which surveying was completed in 1916). The argument is somewhat undermined by the old 15' quad itself. On this map, the Cache is mapped as a single thread, Eagle and Goose Ponds are nowhere to be found, and a large channelization has been completed on the main Cache channel downstream of Ullin. Further, the extend of wetlands is mapped as even less than it was on the modern 7.5' quad, for which photos were taken in 1966. Most likely there had been extensive clearing and snagging in the basin before the road was built. When the 1916 surveys were completed, the eastern Cache Valley and the Bay Creek basin had been extensively ditched. It is certainly possible, then, that drainage had lowered the presettlement water levels in the MCV prior to construction of this road. Roads such as this one may have been built because drainage work in the Cache Valley made them practical.

The 1903 Bell Survey

In 1903, on contract with the newly-formed Cache River Drainage Commission, A.H. Bell surveyed 98 miles of the Cache River from its mouth on the Ohio to the "Old Saratoga Bridge," near the Village of Saratoga. The survey was undertaken as a first step in draining the extensive wetlands in the Cache River Basin. Bell's results are contained in a bound report (Bell 1905) that includes maps of his survey showing both bed and bank elevations. I analyzed this survey with some difficulty. The line surveyed by Bell was a proposed route for channelization that deviated from the sometimes tortuous meandering of the Cache. And the "stations" used by Bell appear to have been instruments sets, i.e. they were not established at a set horizontal distance (now commonly 100 feet). By using an average station length as described in the Appendix, however, I was able to plot a good approximation of the Cache River's long profile as it existed in 1903. Though ditching had been completed in the basin before the survey, none of the MCV had yet been altered, and construction of the Post Creek Cutoff was still over 10 years away.

The long profile plot shown in Figure 11 is the result. It runs from Bell's station 350, which lies halfway between the towns of Ullin and Tamms (near the center of section 33, T14S, R1W), to his station 750, established just northwest of Forman (near the center of section 30, R3E, T13S, not far from Heron Pond). Figure 11 shows several geographic reference points on the survey. Readers should remember that these points are noted as they existed in 1903. The mouths of Cypress and Big Creek, for example, have been moved. The railroad crossings, however, have not. Note also that what was then known as the "Big Four" (or Cleveland, Cincinnati, Chicago and St. Louis) railroad crosses the plot twice, once near Karnak (which did not exist in 1903) and again northeast of Belknap. Figures 3 and 6, which are excerpts from the 1919 USGS 15' quads, best show these areas as they appeared during the Bell survey.

Alluvial river systems, especially large lowland systems, show a strong tendency toward certain patterns in long profile. The most typical is a gentle convex upward pattern with little deviation from and average curve drawn through surveyed bed and bank profile points. Clearly the long profile of the MCV shows something else. From the historic mouth of Big Creek (then in section 17, 2 miles southwest of Perks, see

Figure 6) upstream to a point due south of Belknap, a distance of nearly 8 miles (13 km), both the bed and banks of the Cache River appear vertically depressed relative the overall long profile. In Figure 11 I have drawn least squares lines through four sets of points. The first two sets are the bed and bank elevations up and downstream of the depressed part of the MCV. The least square lines through these two sets of points are dashed. Note that these points deviate little from the least squares line, and the line drawn through the bed points is exactly parallel to the bank points line–i.e. both have a slope of 0.0001 ft/ft.

The two solid least squares lines are drawn through the bed and bank points for the depressed MCV. Note that these, too, are parallel, but with a very different slope of 0.00005, half that of the overall valley, and essentially flat. This is a drop of less than 0.3 ft per mile, or 6 cm per km.

Such a strong discontinuity in a river's long profile begs explanation. It's unlikely that large fluvial features left behind after the Ohio River's shift over 8,000 years ago could persist that long–the Cache Valley has acted as chute since then, and certainly sediment transport processes, both sediment delivered by the Ohio River and materials reworked in the Cache Valley by large floods, would have evened out the Cache River's long profile over a period of several hundred years, let alone several thousand. When considered with evidence of tectonic activity in the valley as recently as 1,000 years ago, it appears that this part of the Cache River is a sunkland. This evidence includes possible sand blows in the MCV's alluvial plain, and sand dikes found by Tuttle et al. (1998) in exposures formed by the Post Creek Cutoff.

There is also a possibility that shallow subsidence played a role in the formation of the depressed MCV. Freshly deposited alluvial sediments have a relatively low density and, especially if allowed to drain, as much of the MCV was for a few years in the 1980's, may compact and lose volume. This can cause land surfaces to subside. Shallow subsidence, unlike that caused by groundwater withdrawal and mining, is usually not as pronounced. Subsidence can also be caused by oxidation of organic matter in alluvial or marine deposits that are drained. Although wells and other corings of the MCV have routinely turned up organic layers, I believe it is unlikely that the Valley has been drained sufficiently for such oxidation to take place, at least to the extent that would cause significant subsidence. It is possible, that shallow subsidence has acted in concert with, or been caused by tectonic activity.

Logjams and beavers

Both logjams and beavers may have influenced the MCV by creating barriers that would form swamps, wetlands, and permanent pools. Bell (1905) noted that logjams were frequent in the Cache River, and that many were so well established and tight that barely a trickle of water ran through them. Figure 12, a photo taken in the early 20th century, shows a massive logjam typical of the Cache River then. Given the Cache River Valley's function as an Ohio River megachute, it is likely that large volumes of wood from the Ohio were deposited in the valley during flood events.

The role of beavers in the valley is less clear. Hutchison (1984) reports "only a few vague references" to beavers, and that the species was extirpated by 1850. He believes that beavers were more abundant in the Upper Cache, where preferred food was more abundant, and that beavers did not significantly influence drainage in the Cache River Basin.

Post European settlement changes in the Cache River Valley

Though the scope of my research includes only the pre-European settlement hydrology of the MCV, some modern changes have bearing on our understanding of historical conditions. Both Hutchison (2000) and Demissie et al. (1990) give very thorough description of post 1900 changes to the hydrology of the Cache River.

Agriculture has greatly changed the Cache River Basin. Even before the Civil War, many farms established on the thin, highly erodible loess soils in the uplands had been worn out and abandoned (Hutchison 2000). Beginning before 1900 and proceeding rapidly after that, steam powered floating dredges plied the Cache River Valley, creating ditches to drain the wetlands. The 1903 Bell survey, so useful to us now, was a precursor to channelizing large parts of the valley, and construction of the Post Creek

Cutoff. Completed in 1915 by the Cache River Drainage Commission, this channel diverted flow from the Upper Cache south to the Ohio, bypassing the MCV and Lower Cache River. Latter the construction of the Cache River levee completed this disconnect, by creating a valley divide between the Upper and Lower Cache Rivers, and also protecting the Lower Cache Valley from Bay Creek and Ohio River flooding.

Beginning in about 1870, the extensive "sea of timber" in the Cache Valley became economically important, and large scale logging operations began (Hutchison 1984). In 1905 the Main Brothers founded the mill town of Karnak at the railroad junction there, and cut millions of board feet of timber from the valley before they ceased operations in the 1970's (Hutchison 1984).

Both Big Creek and Cypress Creek were relocated and straightened. In the 1950's the Reevesville levee was completed by the USCOE. This levee, shown in Figure 7, crosses the Cache Valley at the natural divide near Reevesville, separating the Bay Creek and Cache River watersheds and preventing Ohio River overflows from reaching the MCV.

In the 1950's and 1960's, economic trends encouraged the clearing and farming of much of the Cache Valley bottomlands. Wetland drainage techniques that had worked well elsewhere, such as the nearby Missouri Bootheel, proved ineffective on the soils and topography of the Cache River Valley, and many farms were in financial trouble by the 1980's (Hutchison 2000). By this time, however, the numerous drainage districts formed in the Valley had drained or attempted to drain almost all wetlands with any conceivable outlet, and much environmental damage had been done (Hutchison 2000).

This drainage, especially when combined with phenomenal soil erosion from upland areas, the bottomlands, and from incising drainage ditches, drastically altered the MCV. Reductions in flow to the MCV combined with greatly increased sediment loads encouraged sediment deposition. This deposition has reached depths of as much as 4 feet in some places (Hutchison 1984), though its depth is highly variable in the MCV (Allgire and Cahill 2001). In general, the deposition has greatly reduced deep water habitat in the MCV (Hutchison 1984, Corzine 2005).

Summary and Conclusions

The question I was asked to answer is deceptively simple: Did the MCV hold permanent water prior to alteration by European settlers, and if so, at what elevation? In seeking this answer, I discovered (as have others) that the Cache River Valley is exceedingly complex. Its geomorphology, a product of a complex geologic history, Pleistocene floods, the confluence of the great Ohio and Mississippi Rivers, and perhaps many tectonic events, is probably unique on a global scale. Its cultural and biological histories are no less rich. Though much has been written about the Cache Valley, I believe this synthesis of work, particularly the consideration of geomorphology and tectonic influences, will add much to our understanding of the Cache River.

We have two powerful and objective sources of historical evidence: The 1807 Public Land Survey (PLS) records, and the 1903 Bell survey. The PLS clearly shows that the MCV was flooded to an elevation of at least 330 ft. NGVD29 at the time of the survey. We may argue that this was unusually high water, and the MCV is subject to floods of long duration. But it seems the professional surveyors who did this work described flooded areas in the MCV using terms such as "lake," and "pond." It seems unlikely that these men, who were experienced geographers, would have described temporarily flooded timber using such terms.

The Bell survey, done in 1903, gives us a long profile 93 miles (150 km) of the Cache River. This survey shows that an eight mile (13 km) section of the MCV is sunken, and clearly not in fluvial equilibrium with the rest of the Cache River. Over a period of thousands of years of Cache River flows and Ohio River overflows since the Pleistocene, this sunken section should have reached an equilibrium form with reaches upstream and downstream. This lack of equilibrium begs explanation. Work remains to be done to better understand the reasons for this, but it appears that this section may be a sunkland, i.e. and area that subsided during one or more earthquakes. These areas are quite common to the south of the Cache River. Reelfoot Lake, and extensive sunkland, has been recently studied by Guccione (2002) found evidence there of earthquake events in A.D. 900, 1470, and 1812. She argues the Mississippi River was so disturbed by these events that it has yet to reach equilibrium. It appears that an unmapped extension of the Little Cache Fault Zone may run through the Cache Valley near Belknap. Movement of this fault over the past several hundred years may very well have created the sunken long profile of the MCV we see in the 1903 Bell survey. Work on this is ongoing.

Whatever the genesis of the sunken parts of the MCV, it is clear that they held permanent water before alteration by European settlers. The Upper Cache River holds several wetland areas, remnants of glacial lakes, that also were poorly drained swamplands. By way of hydrologic comparison, that these areas held water at higher elevations and with much smaller drainage areas, strongly suggests that the MCV was well supplied with water and tended to hold it. Bell (1905) and others described the numerous dense logjams in the area, specifically noting that some of them barely let a trickle of water through. Considering this evidence in light of the depressed nature of the MCV as shown by Bell's long profile survey, it seems likely that these dams acted to keep permanent water in the MCV.

Corzine (2005) argues that roads and bridges built in the MCV indicate that permanent water was much lower than 328 ft NGVD29, perhaps reaching summer lows of 323 NGVD29, early in the 20th century when these structures were built. I believe he may be right, but it appears that drainage efforts, particularly the removal of logjams, may have acted to lower water levels before these bridges and roads went in. Indeed, you might suspect that the drainage efforts were a precursor to building the roads. While I found his work with tree species location and elevation very interesting, I think more work needs to be done in this area, and in fact strongly recommend this line of research be continued. My investigation (and Corzine's work) is complicated by another possibility: That shallow subsidence has occurred in the MCV, possibly in conjunction with earthquakes. This may have cause alluvial sediments in the MCV to compact and surfaces to drop in elevation. Unfortunately, elevation control in the MCV is very poor, and there may be no suitable way to verify this. This question remains open. If indeed the land has sunk, however, we would see more extensive areal flooding with a given water surface elevation.

Figure 1. The Cache River Valley and watershed. Dashed lines show the Cache River Valley, formed by the ancestral Ohio River. The Middle Cache Valley is indicated. Modified from Hutchison (2000).

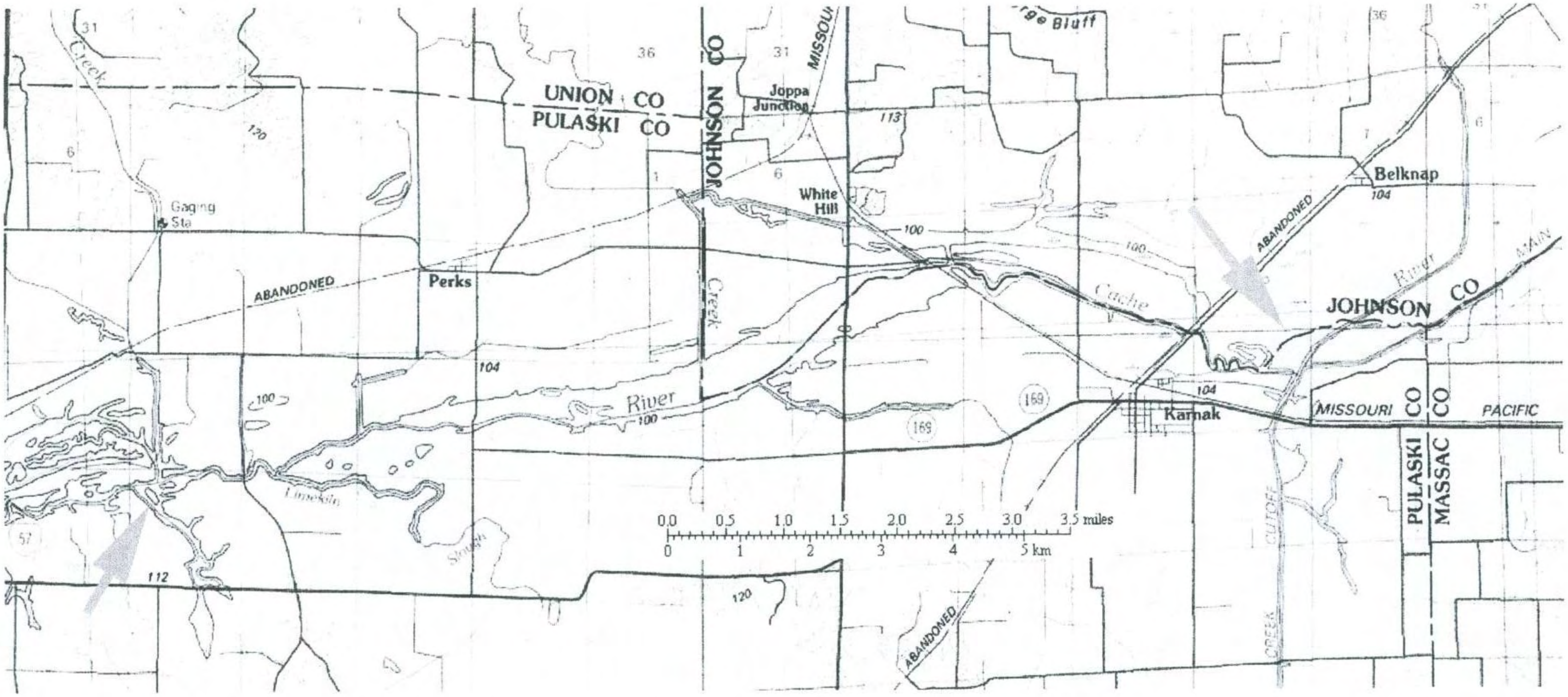

Figure 2. The Middle Cache Valley (MCV), running from the Post Creek Cutoff west to the mouth of Big Creek. Excerpted from the USGS 1:250,000 Paducah map.

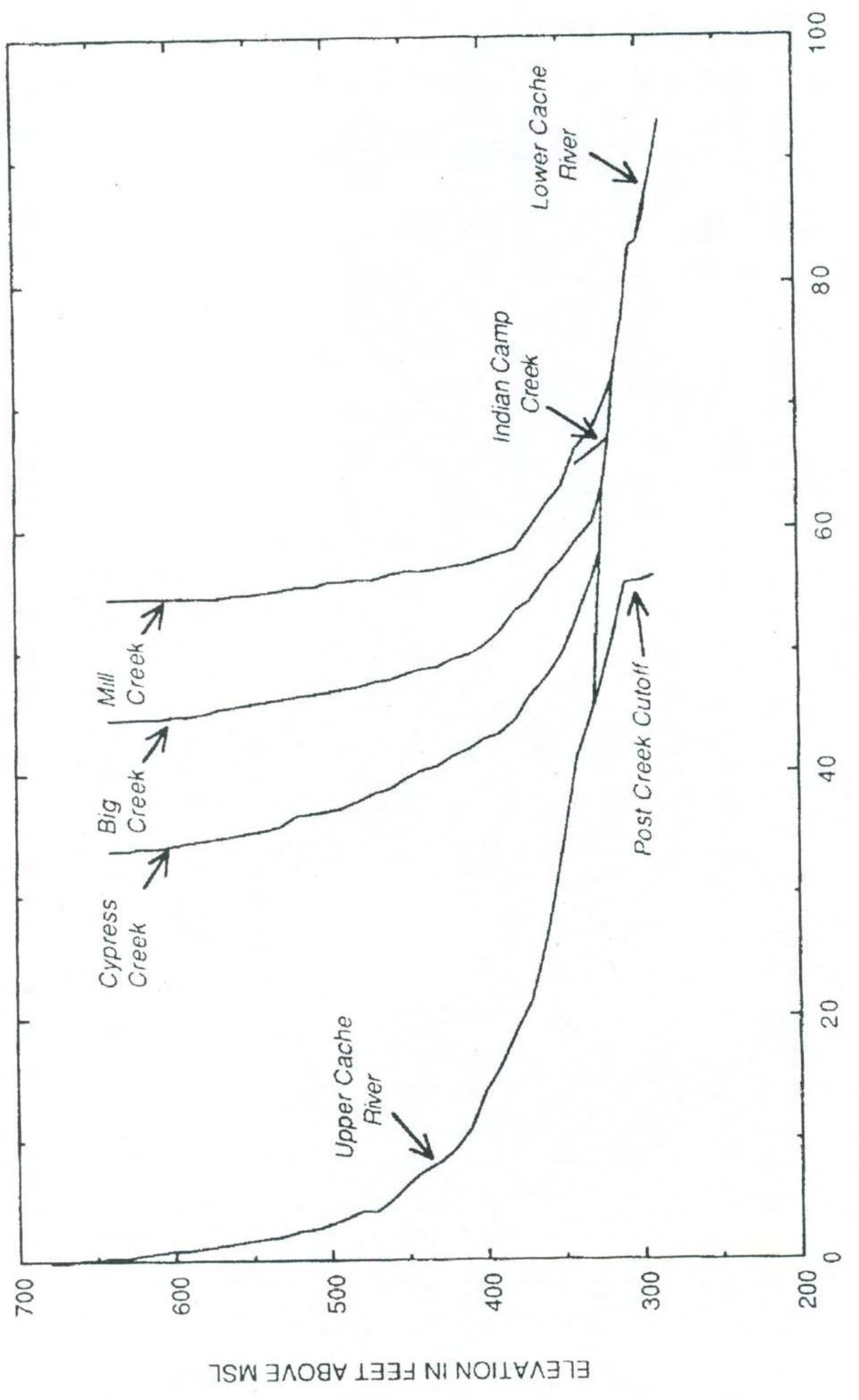

Figure 3. Long profile plots of the Cache River and its tributaries. Copied from Demissie et al. (1990).

Figure 4. Excerpt from the USGS Dongola 15' quadrangle, published in 1919. Note the channelized section south of Ullin, and that the Cache River is mapped as a single thread. Goose and Eagle Pond are not shown, and the extent of areas mapped as swamp in the MCV is less than that shown on the modern USGS quad, which was made from 1966 aerial photography. Sections are about one mile square.

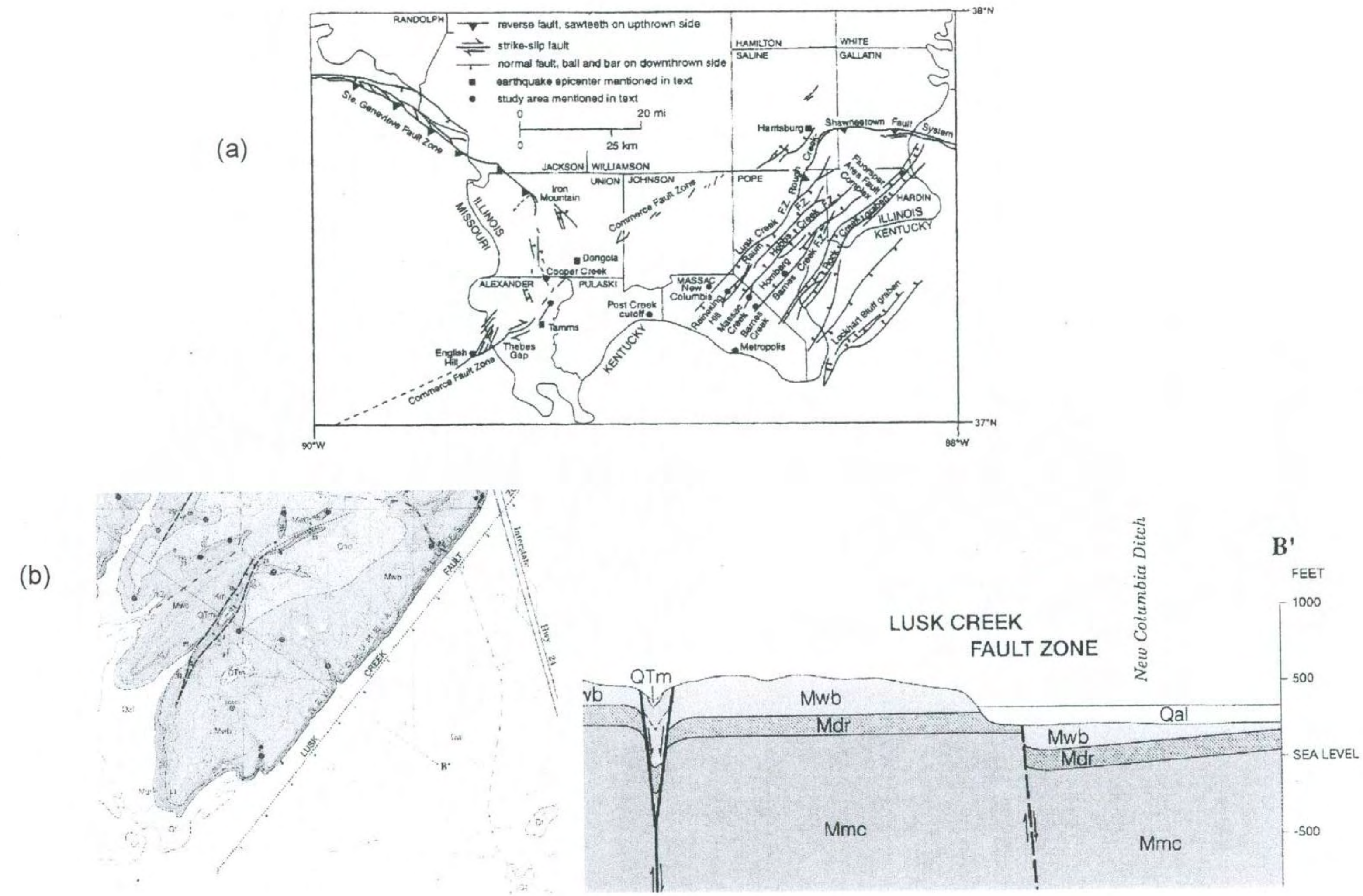

Figure 5. (a) Faults and fault zones in southern Illinois. From Nelson et al. 1997; (b) Excerpts copied from the Reevesville Quadrangle geologic map (Devera and Nelson 1997); section through the eastern Cache Valley showing the fault origin of the New Columbia Bluffs. Section lines on the plan map are one mile apart.

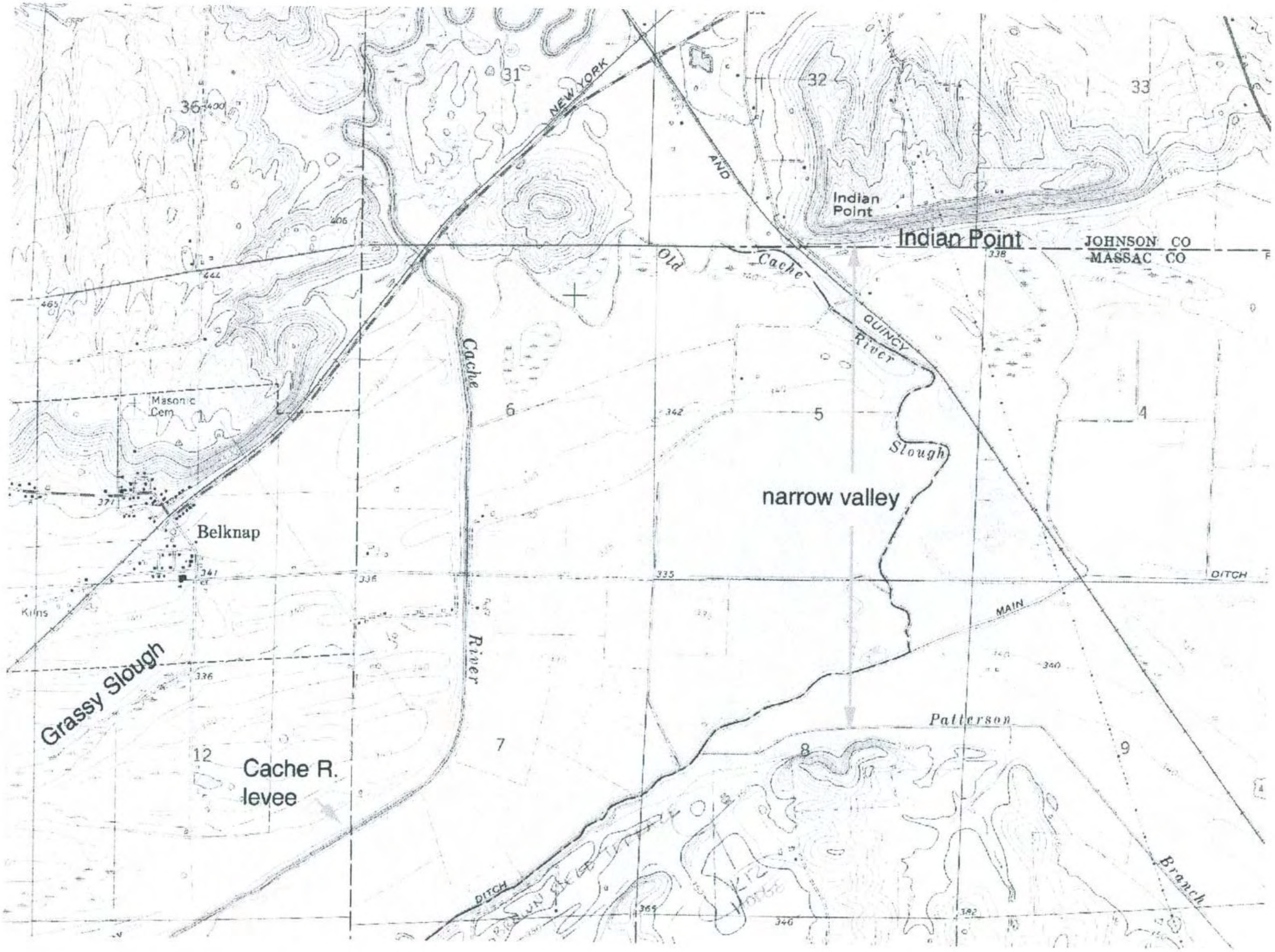

Figure 6. Excerpt from the Karnak USGS 7.5' quad, showing the relatively narrow valley at Indian Point, and the lack of large fluvial features in the valley there. To both the east and west, we see the large features, notably south of Belknap. Remnants of glacial lakes form wetlands at the uppers left. At left center, the Cache River levee runs along the west side of the straightened Cache River.

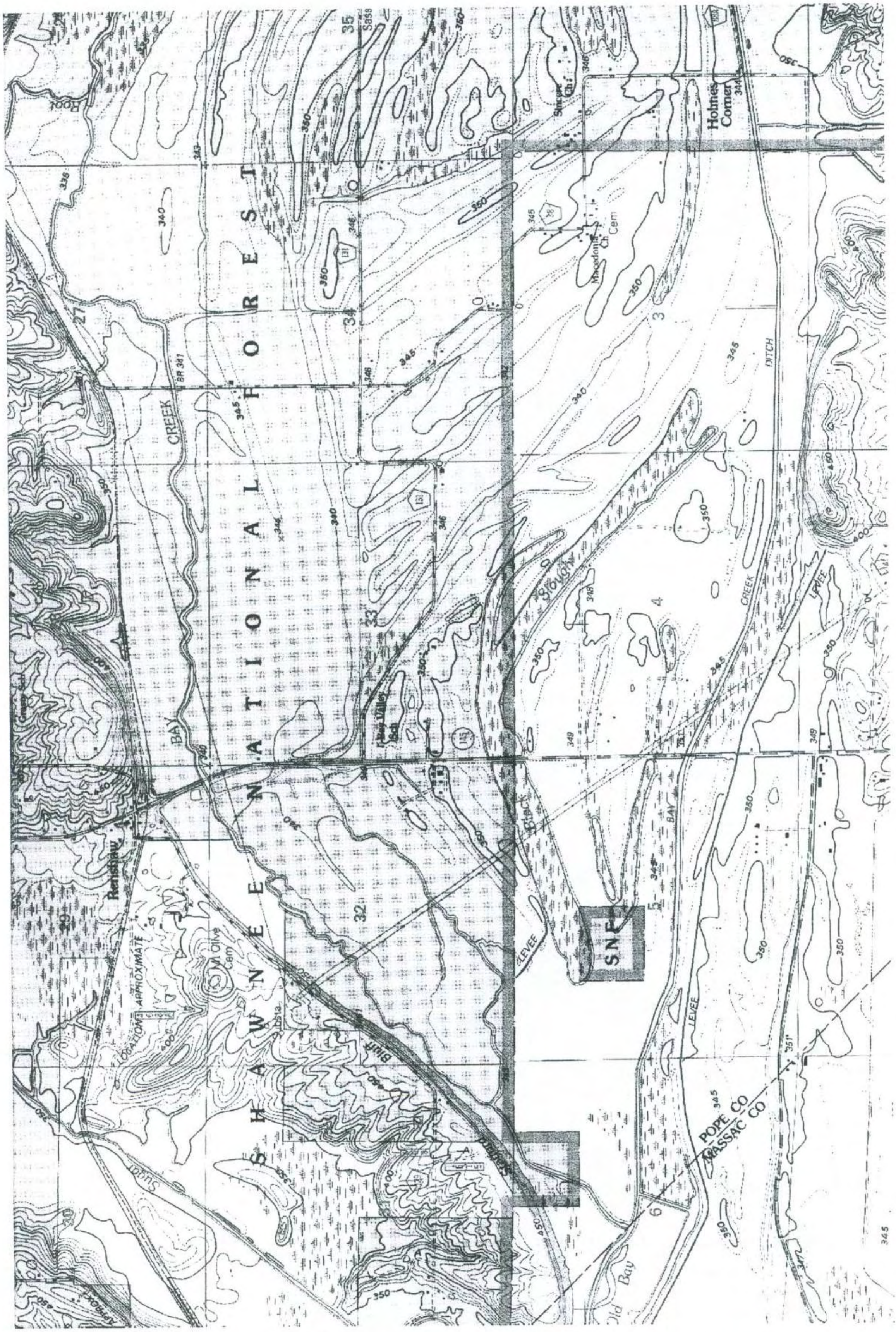

Figure 7. Section from the USGS Reevesville 7.5' quad showing large bars and chutes, and evidence of very high flows against the Stafford Bluff. Section lines are about one mile apart.

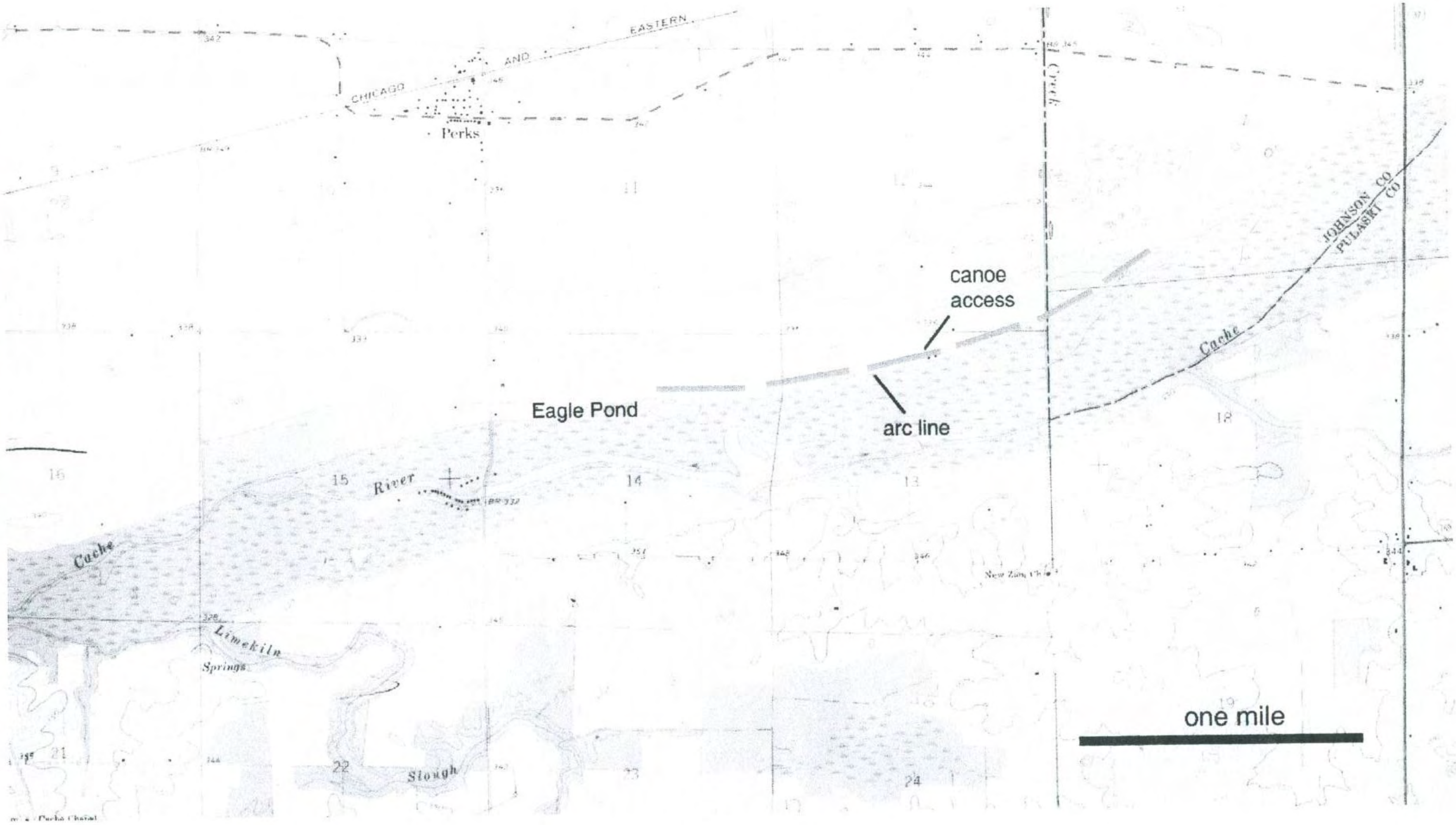

Figure 8. Detail of the MCV, excerpted from the USGS Cypress 7.5' quad, showing the very large bend radius, denoted "arc line" of the wetland boundary, which appears to be a paleochannel of the ancestral Ohio River. The grey dashed line follows a meander bend radius of about 17,000 ft (3.2 miles, or 5,150 m), Width of the channel (here mapped in green, because it is forested) averages about 2,500 ft (762 m).

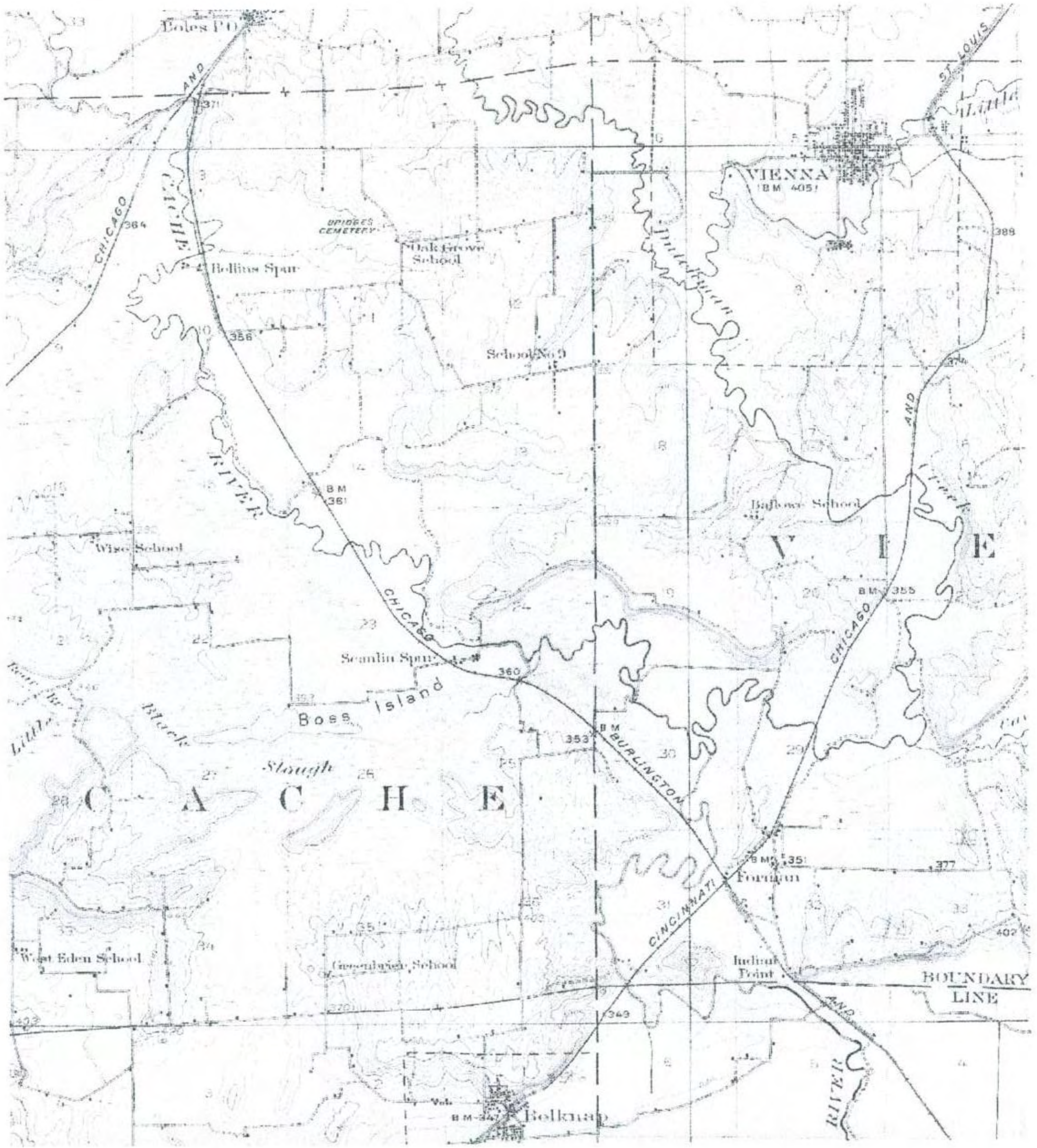

Figure 9. Section from the USGS Vienna 15' quad, published in 1919, showing the extensive wetland areas in the Upper Cache Valley. The Cache River and Dutchman's Creek work their way through lacustrine sediments of the Henry Formation.

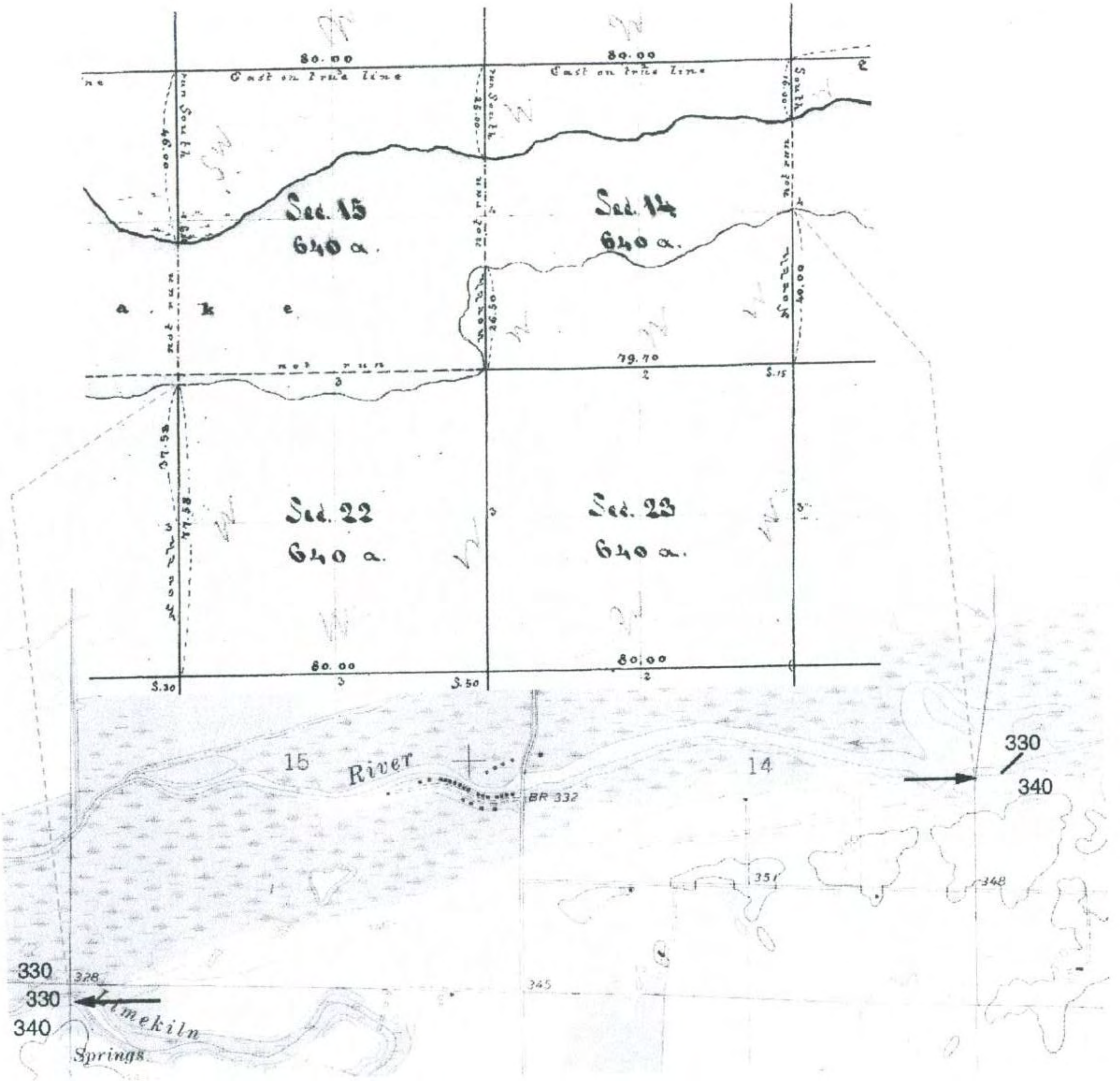

Figure 10. Section from the USGS Cypress 7.5' quad (bottom) with an excerpt from the Public Land Survey (PLS) Plat, surveyed in the later winter of 1807. Arrows on the 7.5' quad correspond with points on the PLS map where surveyors encountered water in 1807, and the dashed orange lines tie the points. At both points on the USGS map, land surface slope is relatively high for this valley, and so elevations are relatively easy to tie to horizontal measurements. At both points, the PLS section lines hit water at between 330 ft and 340 NGVD. Note the dashed lines and notation "not run" on section lines within the inundated areas. On both maps, section lines are about one mile apart.

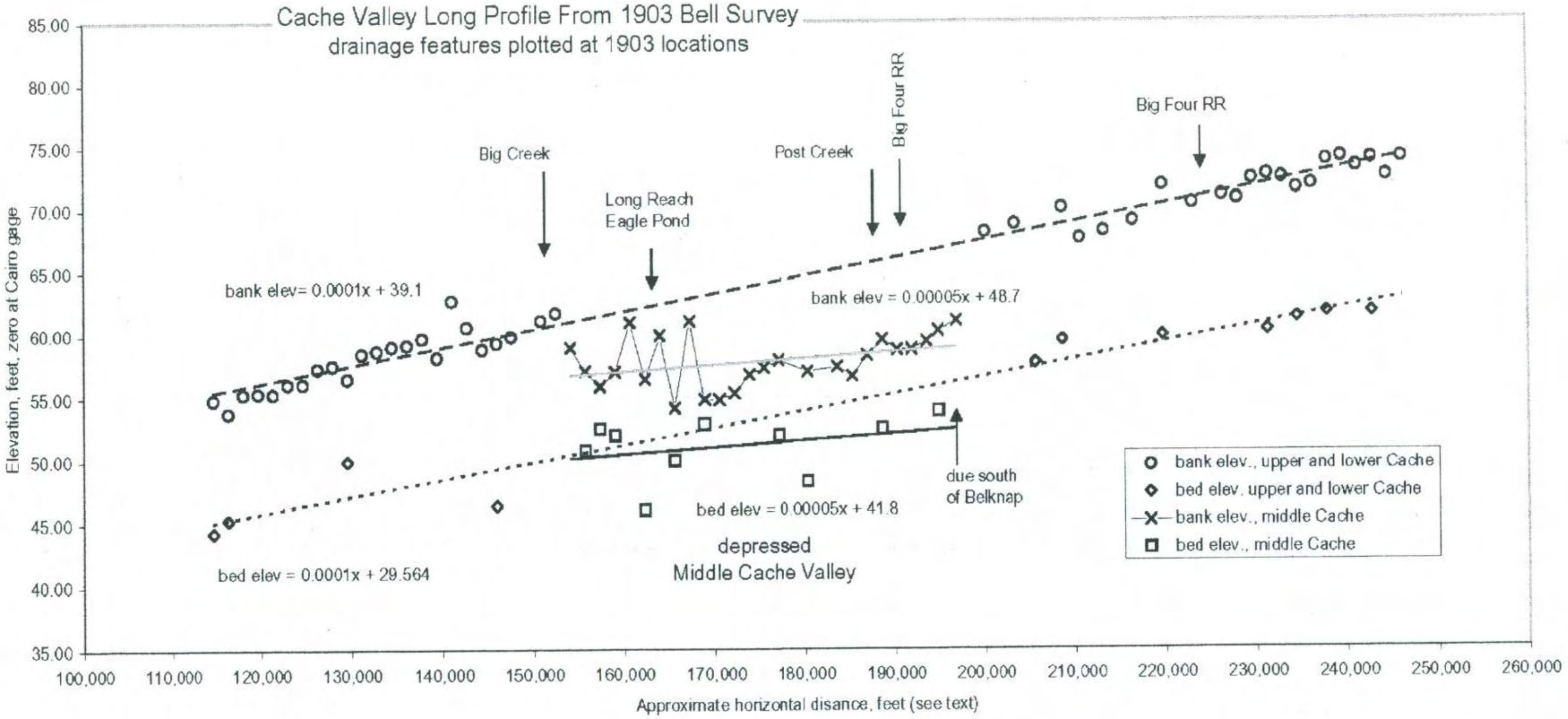

Figure 11. Long profile plot of the Cache River, taken from the 1903 Bell survey. Vertical datum is Bell's own, using "zero at the Cairo gage." Horizontal distances are approximate, as explained in the text and Appendix A. Note that geographic points are shown at their 1903 locations; the mouth of Big Creek has since been relocated. Both bank and bed data points for the sunken part of the MCV are plotted with different symbols and least-squares lines, so that the divergence from upstream and downstream lines is apparent. The "Big Four" railroad is now a bike trail. Note that it intersects the channel twice, once near Karnak, and again northeast of Belknap.

Figure 12. Debris blocking a channel in the Cache Valley in the early 1900's. Main Brothers photo.

Appendix. Vertical datum and notes on the 1904 Bell survey data

Two datum are in use in the United States, the National Geodetic Vertical Datum of 1929 (NGVD29) and the North American Vertical Datum of 1988 (NAVD88). Although these datum can have significant differences in other parts of North America, in the Cache Watershed the two are quite close, differing by no more than 0.34 ft. (0.106 m). In these notes "m.s.l." is used as it was in the 1905 Bell Report, for "mean sea level" prior to the adoption of the 1929 standards. I do not know how this m.s.l. used in this way would correspond to NGVD29.

Personal communication with Roy Frank, Dept. of Civil Engineering, Southern Illinois University - Carbondale (SIUC): The USCOE used different datum for each district. Railroad surveys could be a source of information, the 1903 survey could have set TBM's on railroad structures, and perhaps the original notes could be found. The USGS elevation points shown on 7.5' maps at road intersections, etc. are good only to ½ the contour interval.

Stationing; 1903 Survey. The survey was done by A. H. Bell, Chief Engineer, and reported in the Cache River Drainage Commission 1905 report. It appears that the stationing in this survey refers to instrument sets, and not a specific horizontal distance. Both plan and profile data are presented in the 1904 report so that horizontal distance is given along a proposed channelization (i.e. much straighter) route than the "meander survey" done along the existing channel. Through exhaustive analysis, I determined that the longest "station" distance was about 700 feet; the shortest was 382 feet. On one of the plates, Bell gives the total distance and elevation drop for the survey (ending at the "Saratoga Bridge." Total distance is 518,530 feet. Dividing the total number of stations (1,354) into this value, we get an average station distance of 383 feet. Since there are stations longer than this (from my examination of several reaches), this cannot be a firm stationing distance, and must therefore refer to instrument sets. This possibility was confirmed by interviews with surveyors Marty Merrill (surveyor, Asaturin & Eaton, Carbondale, Illinois) and Roy Frank (SIUC).

Railroad surveys could be very valuable, but were not obtained for this work. Max Hutchins reports some of these are kept in County Courthouses.

Elevation data from *Cache River Drainage District (n.d. circa 1905; "locations, plans, specifications and estimates of the proposed improvements").* Page 19, "Lower Cache Improvments." From Rago to Long Reach, and from the foot of Long Reach to Section 19:

> The grade at the initial point of cut-off number one if the improvement from Rago to Long Reach is 49.4 feet as shown on profile "G" (S.G: not included in publication) or 17.0 below the base of rail of the Chicago and Eastern Illinois Railway. Therefore the excavations in the Cache River below the aforesaid Railroad will begin at the point at which the grade coinsides (sic) with the bottom of the Cache River. **The base of rail above referred to is 66.4 feet, our datum, and 341.0 sea level datum.**

In the above reference, we have a tie to "m.s.l." that may allow us to tie Bell's elevation to modern datum.

> The elevations quoted here are tied to the permanent benchmarks of the C. & E.I. Ry, which are "T" rails set on end at or near each of their mile posts. The grade line for the work from this point of Section 19 is regular and is equal to 1.056 feet per mile. Benchmarks are set in the vicinity of each piece or parcel of work. The grade line for this work is shown on profile "G."

Bell's elevation datum. By using m.s.l. elev. = Bell datum - 66.4 + 341.0, I calculated and re-plotted the Bell survey. The elevations make sense, with bed elev's in the Long Reach area of approx. 325, bank elevations of roughly 332. These do not agree with those calculated using the "base rail" elevation above, differing by more than 3 ft. I was not able to resolve this problem.

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