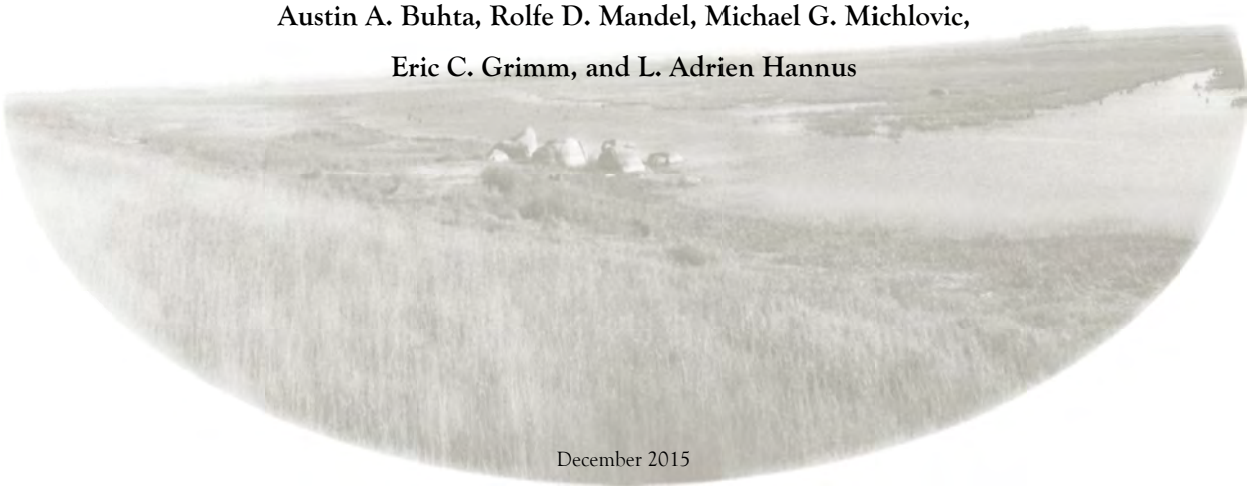
The Minnesota River Trench: An Archeological and Geomorphological Study of Its Prehistory and Settlement

Austin A. Buhta, Rolfe D. Mandel, Michael G. Michlovic, Eric C. Grimm, and L. Adrien Hannus



December 2015

Archeological Contract Series 274

Prepared by:
Archeology Laboratory
Augustana University
2032 South Grange Avenue
Sioux Falls, South Dakota 57105

Prepared for:
The Oversight Board of the Statewide Survey of Historical and Archaeological Sites and the Minnesota Historical Society
345 Kellogg Boulevard West
St. Paul, Minnesota 55102-1906

Funded by the Arts and Cultural Heritage Fund of the Minnesota Clean Water, Land, and Legacy Amendment
as part of the Statewide Survey of Historical and Archaeological Sites

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L. Adrien Hannus (Co-Principal Investigator)

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Cover Image: Overview of the Upper Minnesota River valley from Big Stone National Wildlife Refuge, Big Stone County, Minnesota.

ABSTRACT

This report presents the findings of a joint archeological and geomorphological investigation of the prehistory of the Minnesota River trench. The project, conducted by the Archeology Laboratory, Augustana University, Sioux Falls, South Dakota, is one of a series undertaken as part of the Legacy Amendment-funded studies focused on the investigation of poorly understood areas in the state. The primary objective of the study was to ascertain where prehistoric sites tend to be located within the valley and whether distinct settlement patterns are detectable among the primary prehistoric cultural traditions that are represented. Secondarily, the research potential of prehistoric site 21LP11 was to be evaluated through limited test excavations. The current study combined pedestrian surface reconnaissance with deep geomorphological testing of select landforms within the upper and lower reaches of the Minnesota Valley. Additionally, limited test excavations were conducted at site 21LP11 in the Big Stone National Wildlife Refuge, Lac Qui Parle County, Minnesota. Thirty different land parcels comprising a total of 1,446.24 acres were surveyed. Seven previously unrecorded sites were documented and 10 previously recorded sites were revisited during the study. The geomorphological component included the recovery of eight soil cores, examination of wall profiles of test units at site 21LP11, and completion of a detailed review and synthesis of previous geomorphological research in the Minnesota River valley. At 21LP11, efforts culminated in the excavation of 11 shovel tests, one 1-m-x-1-m unit, one 1-m-x-2-m block, one 2-m-x-2-m block, and one 1-m-x-50-cm expansion unit. To-date, the site has yielded 251 lithic artifacts; the majority consists of debitage. Most of the deposits are confined to a small, uncultivated area on the westernmost edge of the site. Deposits in this area derive, primarily, from a zone between 40 and 60 cmbs. Though no settlement features were identified, a collection of six overshot flakes was recovered from the 40–60 cmbs zone. With respect to modeling, the survey results seem to suggest an overall low probability of surficial sites within the valley, irrespective of cultural tradition. Proximity to major water sources appears to be the primary factor in perceived site selection regardless of cultural tradition and the majority of all sites have been identified in association with low terrace and blufftop landforms. Late Prehistoric site distribution seems to closely mirror that of early Historic-period Native American settlement. Woodland settlements are largely confined to low terraces and fans in the valley, whereas associated burial mounds are relegated to more elevated blufftop and high terrace landforms. Intact Archaic sites are most likely to be discovered buried in valley margin settings, such as alluvial fans and colluvial slopes. Paleoindian sites remain elusive; however, sites of this age are also most likely to remain intact in buried valley margin settings. Results of recent work in the lower reaches of the trench have identified a series of wetlands in the valley bottom that are only about 400 years old. Stratified Woodland and Archaic-period deposits have been discovered intact beneath these wetlands.

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1. PROJECT OVERVIEW

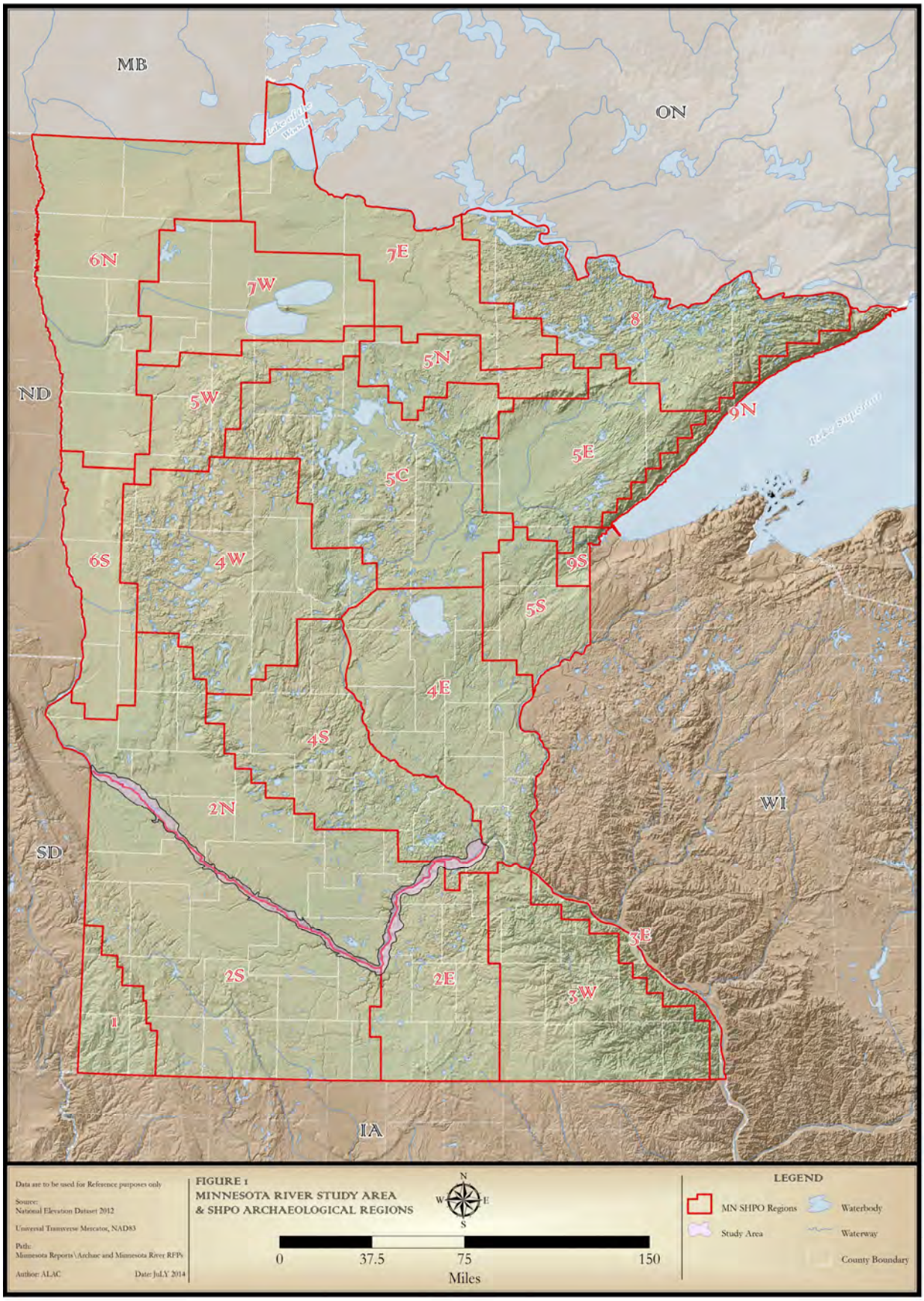
On August 8, 2014, the Archeology Laboratory, Augustana University (Augustana), Sioux Falls, South Dakota, entered into a contract (No. 4508831) with the Minnesota Historical Society (MHS), St. Paul to investigate the prehistory of the Minnesota River trench. The study is one of a series undertaken since 2010 as part of the Legacy Amendment-funded Statewide Survey of Historical and Archaeological Sites (www.osa.admin.state.mn.us; see Artz et al. 2013; Arzigian and Kolb 2011; Aulwes et al. 2013; Buhta et al. 2011, 2012, 2014; Gronhovd et al. 2013; Holley et al. 2011; Mulholland et al. 2011; Riley et al. 2010). These statewide survey projects have targeted areas of Minnesota that previously received little attention archeologically. The aim of the investigations is to collect basic site inventory data that will assist in future cultural resource management (CRM) planning, archeological research, and public education.

The Minnesota River trench is primarily located within the Prairie Lake Archaeological Region (Table 1; Figure 1), a natural area of level ground moraine defined by congruent distribution of tallgrass prairie vegetation and numerous shallow lakes. Its landforms are the result of the most recent glaciation and the vegetation of a relatively stable climate over the past 5,000 years. A short segment of the trench, just above its confluence with the Mississippi River, extends into the Central Lakes Deciduous Archaeological Region (see Table 1 and Figure 1), an area defined by the presence of expansive woodlands and numerous deep glacial lakes (see Anfinson 1990).

The Minnesota River valley dominates the Minnesota River Lowland. The river is a deeply entrenched, underfit stream flowing through an enormous valley that reaches depths of 250 feet and widths of five miles in certain locations; the valley spans approximately 350 miles from its source at Big Stone Lake to its confluence with the Mississippi River in St. Paul. Topographically and geomorphologically, the valley consists of high bluffs that overlook a complex, discontinuous network of strath (erosional) and fill (depositional) terraces, alluvial fans, and an expansive floodplain (Johnson et al. 1998:1). The Minnesota River valley is wholly a product of the Wisconsinan Glacial Episode, formed by Glacial River Warren, which served as the primary outlet for Glacial Lake Agassiz during the Lockhart phase (Clayton 1983) and again during the Emerson phase (Smith and Fisher 1993). Most scholars originally believed that Glacial River Warren carved the majority of the Minnesota River trench during the Lockhart phase as a result of a catastrophic flood event in the initial draining of Lake Agassiz; however, there is ongoing debate as to the timing and character of subsequent draining episodes via the southern outlet during the Lockhart and Emerson phases, and increasing evidence to suggest that catastrophic flood events had ceased through the southern outlet prior to the Emerson phase (ca. 9900–9500 B.P.) (see for example Hudak 2005; Lowell 2011) and possibly the latter stages of the Lockhart phase as well. Major archeological implications are inherent in the timing of Glacial River Warren and any associated potential catastrophic flood events, particularly pertaining to early Paleoindian occupation of the trench. If catastrophic floods occurred via the southern outlet during the Emerson phase, the earliest Paleoindian sites likely would have been destroyed. If not, there is a chance that intact Folsom- and/or Clovis-aged sites may exist in the higher terraces of the valley.

Table 1. Archaeological Region Identification Key.

Southwest Riverine	**1**
Prairie Lake	**2**
Prairie Lake North	***2N***
Prairie Lake South	***2S***
Prairie Lake East	***2E***
Southeast Riverine	**3**
Southeast Riverine East	3E
Southeast Riverine West	3W
Central Lakes Deciduous	**4**
Central Lakes Deciduous South	***4S***
Central Lakes Deciduous East	4E
Central Lakes Deciduous West	4W
Central Lakes Coniferous	**5**
Central Lakes Coniferous North	5N
Central Lakes Coniferous South	5S
Central Lakes Coniferous East	5E
Central Lakes Coniferous Central	5C
Red River Valley	**6**
Red River Valley North	6N
Red River Valley South	6S
Northern Bog	**7**
Northern Bog East	7E
Northern Bog West	7W
Border Lakes	**8**
Lake Superior	**9**
Lake Superior North	9N
Lake Superior South	9S


MB
ON
ND
SD
WI
IA
6N
7W
7E
8
5N
5W
9N
5E
5C
6S
4W
9S
5S
4E
4S
2N
3E
2S
2E
3W
1
Data are to be used for Reference purposes only
Source:
National Elevation Dataset 2012
Universal Transverse Mercator, NAD83
Path:
Minnesota Reports\Archae and Minnesota River RFPs
Author: ALAC
Date: JuLY 2014
FIGURE 1
MINNESOTA RIVER STUDY AREA
& SHPO ARCHAEOLOGICAL REGIONS
N
W
E
S
0
37.5
75
150
Miles
LEGEND
MN SHPO Regions
Study Area
Waterbody
Waterway
County Boundary

Archeological sites of all major prehistoric contexts have been documented in the Minnesota River trench, from Paleoindian through Late Prehistoric Village cultures and protohistoric groups. However, state records indicate that the total number of sites identified within the trench is comparatively few.

The project Request for Proposals (RFP) indicates that, for the 16 counties bordering the Minnesota River, the majority of identified prehistoric archeological sites are located *outside* of the trench and even fewer trench sites have been subjected to controlled excavations. However, MN/Model's Minnesota River Prairie Subsection Model predicts high site density along the majority of the Minnesota River and medium density along those portions not modeled as high site probability (Minnesota Department of Transportation [MNDOT] 1998:Figure 8.20.3). The reason for this disparity is likely due to limited surface expression and the high probability for landforms to contain buried components spanning the entire range of prehistoric archeological contexts. The current study attempts, via a multidisciplinary approach, to explore these and other issues related to prehistoric site distribution within the Minnesota River trench. The results of the investigation are reported in the following pages.

DESCRIPTION AND OBJECTIVES

As detailed on page 1 of the RFP, the objective of the investigation is "…to help determine where prehistoric sites are located within the Trench, to determine what statewide historic contexts are present, and to suggest productive directions for future archaeological research within the trench." Three primary tasks comprised the project:

1) Assess what is known about the prehistoric human occupation of the Minnesota River trench by reviewing the region's pertinent archeological, geological, geomorphological, paleoenvironmental, ethnographic, and historic literature. Data obtained from this review should allow for the generation of a predictive locational model for prehistoric sites in the study area. The model will assist in the identification of likely site locations for each of the major prehistoric cultural traditions in the valley.

2) Conduct a joint archeological/geomorphological field survey of select localities identified in the research design that are felt to reflect a good sample of varying landform settings with high site potential. The archeological component will focus on pedestrian reconnaissance of fields with good surface visibility and high surface/near-surface site potential; the geomorphological component will be directed towards the mechanical deep-testing of landforms identified as having high buried site potential (alluvial fans, fill terraces, colluvial slopes, etc.).

3) Complete an analytical and descriptive report that summarizes the literature search, field survey, geomorphology, paleoecology, and absolute dating results. The report should address the reconstruction of the study area's late Pleistocene and Holocene environmental history, summarize the prehistoric archeological contexts present or likely to be present there, construct a justifiable site locational model for such sites, and suggest productive avenues for future research.

A secondary objective of this study is the evaluation of archeological site 21LP11. Site 21LP11, located in Big Stone National Wildlife Refuge (BSNWR), Lac Qui Parle County, is a Paleoindian lithic scatter that was originally documented in 1973. The site was identified by personnel from the Archaeology Laboratory, University of Minnesota, as a light scatter of nine items (Caine 1974:3–6). Subsequently discovered among the items in the collection was a fluted projectile point base. The site was found on the surface of what, at the time, was a cultivated flax field. However, land adjoining the field has not been cultivated, suggesting the possibility that remnants of the site may be buried in an undisturbed context adjacent to the mapped surface scatter in the cultivated field. Because of the great antiquity of 21LP11, the site was felt to have potential to address certain research questions concerning the timing and character of Glacial River Warren's discharge and, by extension, the likelihood of additional undisturbed early Paleoindian sites within the Minnesota River trench.

The three primary tasks described above, coupled with the evaluative testing of site 21LP11, served as the foundation for the research design that was ultimately constructed.

Research Design

A research orientation was established and field methodology was implemented pursuant to the specifications set forth in the RFP, as well as to governing state (Anfinson 2011; see also Monaghan et al. 2006) and federal (Advisory Council on Historic Preservation [ACHP] 2012) standards for the management and protection of cultural resources. The RFP states that the first task of the project is to assess what is known about the prehistoric human occupation of the Minnesota River trench through a review of literature related to the valley's geology, geomorphology, paleoenvironment, and prehistoric archeology, as well as relevant ethnographic and historic records.

Site records and reports were reviewed at the Minnesota Office of the State Archaeologist (OSA), Ft. Snelling History Center, and the MHS State Historic Preservation Office (SHPO), St. Paul on August 18–19, 2014 by Augustana personnel and project geomorphologist, Rolfe Mandel. During this time, meetings were also held with MHS, OSA, and MNDOT staff concerning various aspects of the project. Archived records from the University of Minnesota, Twin Cities (U-of-M), MHS, and the Institute for Minnesota Archaeology (IMA), now curated at the OSA, were also consulted, as were resources available at Augustana and the Center for Western Studies (CWS), Augustana University, Sioux Falls, South Dakota.

The desired outcome of the background research was the recognition of potential trends or patterns in prehistoric site composition and distribution within the Minnesota River trench, particularly with respect to the identified geomorphic landforms. In addition to reviewing the literature for site distribution and settlement patterns, previously constructed site locational models, such as Minnesota's MN/Model (Hudak et al. 2002), were utilized. Particularly valuable in this respect were the GIS site boundary and geomorphic landform datasets provided by MNDOT for the Minnesota River study area. These data afforded a clearer visualization of the prehistoric site distribution by landform in the valley.

The second task outlined in the RFP is the completion of a joint archeological/geomorphological field investigation of select localities within the Minnesota River trench. Areas targeted for pedestrian survey included those containing previously recorded sites and alpha[1] sites where boundaries were poorly defined, as well as select localities felt to reflect a good sample of varying landform settings with high potential for harboring surface and/or near-surface prehistoric archeological deposits. The selection of survey areas was based on several factors, including previously documented site locations, a review of soils and topographic maps, landowner permission, landform composition, ground surface visibility, and a combination of vegetation/crop cover. Ultimately, although the survey area selection intentionally incorporated both probabilistic and non-probabilistic methodology similar to that employed during the MN/Model investigations and the Minnesota Statewide Archaeological Survey (MNSAS [MHS 1981]), the majority of parcels were selected to maximize site discovery. Because of this, and because the parameters governing the archeological survey component largely limited it to a pedestrian surface reconnaissance, cultivated fields located above the present floodplain were a focal point.

The geomorphological field component involved mapping surfaces and describing and sampling sections of alluvial fills from different landforms within the trench. An effort was made to locate natural exposures of late Pleistocene and Holocene alluvium in stream cutbanks; however, a lack of adequate exposures along the stream courses within the study area necessitated the sampling of landforms with the use of a Giddings hydraulic soil corer. In this instance, focus was directed towards those landforms along the valley margins with the greatest potential for harboring intact, buried sites of the various identified contexts. Eight soil cores were extracted from six localities as part of this component. Samples for radiocarbon dates were obtained from paleosols at multiple different coring localities (see Appendix A). Samples were also obtained for stable carbon isotope and phytolith analyses. Results of these findings are currently in preparation. The walls of two test units at 21LP11 were also examined and profiled by the project geomorphologist.

The archeological component culminated in the investigation of 30 individual land parcels comprising 1,446.24 acres. Seven previously unrecorded sites were identified and documented. In addition, 10 previously recorded/reported sites

[1] *Alpha* designations are assigned to those sites that are based on correspondence or written accounts but that have not been field-verified by a professional archeologist. Examples include sites reported to the SHPO or OSA by landowners or those mentioned in historic accounts.

were revisited during the course of the study and five reported site areas were mapped. Evaluative testing was also undertaken at site 21LP11.

The final task outlined in the RFP is the compilation of a comprehensive investigation report detailing the findings of the study, a site locational model, and recommendations for future research. The framework and components of this report are outlined below.

PERSONNEL AND PROJECT ORIENTATION

The project was conducted under the overall supervision of L. Adrien Hannus and Rolfe D. Mandel; Hannus supervised the archeological component while the geomorphological component was overseen by Mandel. Austin A. Buhta served as archeological Field Director. Personnel responsible for GIS data management and map production were Buhta and Jason M. Kruse. Buhta also assisted with the geomorphological field investigations and conducted background research, model development, and report writing. Additional background research was undertaken by Michael G. Michlovic, Minnesota State University, Moorhead and Eric C. Grimm, Illinois State Museum, Springfield. Collected artifacts were analyzed by Hannus and Buhta. Additional archeological field crew members included Jason Kruse, Timothy V. Gillen, Edward J. Lueck, Jason Bassett, and Creighton Gerber. Linda Palmer completed the artifact curation tasks. Lynette Rossum administered the project.

REPORT FRAMEWORK AND ORGANIZATION

Seven chapters comprise the report of this investigation. A brief synopsis of each chapter is provided below.

Report Chapters

1) **Project Overview** presents a general study overview, including the research objectives of the investigation, a general description of the project area, project methodology and roles of personnel involved, and an outline of the framework and organization of the report (Austin A. Buhta).

2) **Background Culture History and Archeology of the Minnesota River Trench** details the culture history of the Minnesota River valley. Overviews are provided of the various prehistoric cultural groups known to have inhabited the region through time, beginning with Paleoindian occupation and concluding with late precontact and protohistoric habitation. Although a detailed background of the historic-period settlement of the valley is not a focal point of this study, an ethnohistoric discussion is included as it is believed that accounts of contact-period settlement patterns throughout the valley can prove insightful in understanding settlement and use patterns prehistorically. This chapter also discusses the history of archeological research within the trench (Michael G. Michlovic).

3) **Paleoenvironments of the Minnesota River Valley** provides an overview of the environmental parameters comprising the Minnesota River valley. Topics addressed include the geology, landscape composition and topography, regional climate and ecology, the significance of glacial processes in the region, and the role of these processes in paleoenvironmental change. Particular focus is directed towards the initial formation of the trench via the flow of Glacial River Warren through Lake Agassiz's southern outlet, the number of times the outlet was open, and the character of discharge during each of these episodes (Eric C. Grimm).

4) **Archeological Field Investigations** details the results of the archeological pedestrian survey conducted during the study. Descriptions of surveyed parcels and the associated geomorphic landforms, individual archeological sites identified, and the associated artifact assemblages are presented. Documentation for each site includes artifact and material type inventories and analysis, as well as photographs and map data. Also included in this chapter are the results of evaluative testing and geomorphological study at site 21LP11 (Austin A. Buhta with contributions by Rolfe D. Mandel).

5) **The Effects of Late Quaternary Landscape Evolution on the Archeological Record of the Minnesota River Valley** provides a geomorphological assessment of the Minnesota River study area. Included are the results of deep soil cores extracted from alluvial fans in the valley. Also provided are the results of a detailed review and synthesis of previous geomorphic research in the Minnesota River valley. A preliminary inventory of landforms capable of housing intact deposits of various prehistoric ages is presented (Rolfe D. Mandel).

6) **Synthesis and Recommendations** presents a discussion of the project research and evaluates the results and avenues available for further exploration. Data from the archeological and geomorphological studies are integrated and the state of prehistoric archeology in the Minnesota River trench is reevaluated based on these findings and within the context of the utilized site predictive model. Suggestions for refinement of the model are offered, as are a list of landforms capable of housing prehistoric sites and the likelihood of discovering such sites at varying depths below surface (Austin A. Buhta, Michael G. Michlovic, and Rolfe D. Mandel).

7) **References Cited** provides a comprehensive list of sources cited in the report.

2. Background Culture History and Archeology of the Minnesota River Trench

Introduction

Historical, cultural and archeological background for the prehistoric archeology of the Minnesota River trench is arranged here in three parts. The first of these consists of a discussion of the historical resources available for understanding the Indian, or pre-European, settlement history of the Minnesota Valley and the information provided in these resources about the Indian peoples and their use of the Valley. Second is a review of the archeological work previously completed in this part of Minnesota, highlighting the best known portions of the archeological record and identifying those portions of the prehistoric record that are presently deficient. Finally, there is a summary of data in the site database for the Minnesota River valley made available through the Office of the State Archaeologist. This is presented mostly in table form followed by a few observations.

Anfinson (2014) divides the Minnesota River valley into Lower and Upper sections. The lower valley extends from the dramatic bend in the river at Mankato, from where it flows northward to its juncture with the Mississippi. By linear distance this is about 66 miles. The upper Minnesota Valley extends west and north from Mankato across the southern portion of Minnesota to its headwaters in Big Stone Lake. The distance is approximately 180 miles.

During the Historic period these divisions of the river course are significant. The heaviest settlement and use of the Valley was in the lower portion, while the upper Valley was used less intensively and frequently; however, the area around Big Stone Lake at the Minnesota headwaters was heavily used. During the early to middle nineteenth century, steamboats made many regular stops along the Mississippi up to St. Paul. Steamboats would also paddle up the Minnesota to the vicinity of Mankato, but seldom ventured farther northwest along the river (Hart and Ziegler 2008:108). During this period in the history of Minnesota, most settlement was along rivers, a pattern that mimicked that of the prehistoric period. Just as the lower Minnesota River in the early nineteenth century was the practical limit of heavy traffic on that stream, so too in the earlier historic period and in prehistoric times as well, the lower Minnesota was a focus of a great amount of cultural activity. West and north of Mankato the number of settlements diminished, particularly above the mouth of the Cottonwood River near modern day New Ulm. This pattern of settlement stood until the coming of the railroads around 1870, when settlement and related activities came to be concentrated along the line of the newly built railroad (Hart and Ziegler 2008:192–193).

Certainly, into the nineteenth century the lower Minnesota River was heavily used by the Dakota. If we read Nicollet's account of his travels up the Minnesota from Fort Snelling in the 1830s, he describes large Dakota villages south of Fort Snelling and north of the great bend at Mankato, such as Black Dog's village, Village of the Sandbar, White Rock village and others. As he proceeds northwest on the river toward the Cottonwood River, very few settlements are mentioned (Bray and Bray 1976:43ff). This is not to say that over the course of the entire prehistoric period the same pattern obtained, but it is suggestive of some patterning nonetheless. It is interesting to note that the MN/Model of prehistoric site density in the different regions of Minnesota offers a prediction of relatively high site frequency along the upper Minnesota, while the lower segment of the river has very high site frequency. Ecologically this makes good sense since the upper reaches of the Minnesota are in prairie with limited resources aside from the bison herds, while the lower Minnesota was a more varied environment with prairie and woodlands mixed, a larger and more resource abundant river, and proximity to the confluence with the Mississippi.

Historical Record of Indian Use of the Minnesota River Valley

One historical note of interest is that during the French and English periods in Minnesota, the Minnesota River was referred to first as the St. Pierre, and afterwards as the St. Peter. Following the organization of Minnesota territory in 1849 (Minnesota achieved statehood in 1858), the river was officially named "Minnesota," in 1852. This comes from the Dakota compound term for cloudy water, suggesting milky, or turbid. One informant stated that the Dakota illustrated the meaning of the term by dropping some milk into water to show what it meant (Upham 2001:4–5).

Before proceeding, there are a few cautions appropriate to consider when evaluating the historical evidence presented below. It is often comforting to the archeologist to read early accounts of various ethnic groups, their travels and conflicts and territories, and make the easy assumption that these documents are unproblematic. Often they are not altogether reliable. One anecdote from Doane Robinson's history of the Dakota (1904:108–109) may serve as an example. He describes a line of stones extending along a blufftop for over a mile, and claims from an old Indian story that it is a memorial by a Sioux warrior to a slain Arikara who was wounded by the Sioux and hobbled away to escape. The Sioux caught up to him and killed him, but admiring his courage, placed a stone at every point where the poor Arikara left a drop of blood. More likely the stones were a drive line for bison, but by the time the bison had gone an Indian source told a fanciful story that made sense in the contemporary context. Aside from these etiological stories there is some evidence that the standard views of historic migrations by Indian groups, well attested in the historical literature, are not altogether accurate. Recent work in southeastern North Dakota at the Biesterfeldt site suggests the real possibility that some or most of the well-known Cheyenne migration accounts of movement up the Minnesota River valley in the seventeenth and eighteenth centuries did not occur as described in early historic documents (Michlovic et al. in press). Also, work in the Maple River valley of southeastern North Dakota has raised the possibility that the western Dakota, or Teton, may have practiced a mixed economy as hunter/farmers in the fifteenth century, long before the migration presumed from the historic literature (Michlovic 1985).

Aside from the occasional error in historical documents, there is at least one case of a suspicious historical source on the Minnesota River region that must be treated with caution. One of the most widely known accounts of the Valley in the early period of European contact is Jonathan Carver's description of his travels up the Minnesota River after the French and Indian War (1766–1768). Unfortunately, ever since Bourne's (1906) study of the Carver account there has been deep skepticism about the narrative. Evidence indicates that his material was taken from other sources, specifically Lahontan, Charlevoix, and Adair. His descriptions of the Dakota in this region were little more than transposed descriptions of other Indian peoples offered in earlier accounts by the above-mentioned sources. For this reason, one of the most promising sources on the early history of the Minnesota Valley, and one which might have been expected to shed light on the later portion of the prehistoric period, is in this discussion set aside.

E. D. Neill (1882) provides an overview of some of the earliest recorded European contacts with the Indians of the Minnesota Valley region. He begins his review with a Dakota Indian claim that the juncture of the Minnesota River with the Mississippi is at a location directly over the center of the world (Neill 1882:1). This would indicate that the mouth of the Minnesota River was regarded as a place of special significance. As we review the importance of the Valley of the Minnesota in Dakota history, this claim will take on deeper meaning.

There are few descriptions of the Minnesota River valley or of the people living there before about 1700. Hennepin's journals describe central Minnesota country and its peoples from around Mille Lacs at about 1680, although direct reference to the Minnesota River is absent. Mott Wedel (1974) provides an overview of the French trader Le Sueur's account of the Minnesota River region from around 1700. She uses La Harpe's notes, which were based on a journal kept by Le Sueur and prepared about 20 years after Le Sueur's stay on the Minnesota River. Le Sueur is important for understanding the history of the Minnesota River insofar as his provides one of the earliest accounts of the region. Besides his journals, he contributed to the famous Franquelin Map of 1697. This map was based on the work of Delisle, and probably had information on it derived from Le Sueur. Delisle's own 1702 map of New France, which depicted the Minnesota Valley region, was apparently made with Le Sueur's recommendations and advice.

Mott Wedel (1974:159–161) recounts Le Sueur's activities in Wisconsin and occasionally in Minnesota in the 1680s and 1690s. For instance, he was at Lake Pepin in 1689, reached the Falls of St. Anthony in 1691, and had a hand in building the French forts near Lake Pepin. It seems that he visited the Blue Earth and Minnesota rivers by 1695. Le Sueur returned to the Minnesota River on September 9, 1700 after some political maneuvering to secure his appointment. He had permission from the crown to trade in deer, bison, and other hides besides beaver (the French market was glutted with beaver at the time). During the winter of that year, his men killed 700 bison, 300 deer, a few bear and numerous game birds, and his party explored the Minnesota River northwestward to at least the mouth of the Cottonwood River (Mott Wedel 1974:162). It was during this time that Fort L'Huillier was built by Le Sueur, just upstream from the mouth of the Blue Earth. He was hoping to mine quantities of copper ore in this area, which he believed was contained in the blueish earth exposed regionally. The hides from hunting, and the "ore" were returned

to Louisiana, but there was no copper or any other worthwhile mineral in the blue-green clay he recovered from the vicinity of the Minnesota and Blue Earth rivers. Geologists have yet to identify the precise location of Le Sueur's "mines" (Mott Wedel 1974:162).

Mott Wedel (1974) also discusses Le Sueur's description of the Dakota use of the Minnesota Valley in about 1700. Le Sueur distinguished the Sioux of the East and the Sioux of the West. Some of the western Sioux were the "Tintons," settled heavily around Big Stone Lake at the Minnesota River headwaters. The Sioux of the West were described by Le Sueur as having 13 villages, while the Eastern Sioux had seven. At another point, however, he describes the Sioux of the West as a people without villages who lived entirely by the hunt (Mott Wedel 1974:163, 166). On the other hand, at least one Jesuit estimate in 1658 was that the western Sioux had 30 villages, while their woodland relatives maintained 40 villages (Anderson 1984:16). Most of the Minnesota River at this time was occupied by the western Sioux or Dakota. Their villages were listed as the Hinhancton, as those of the Hantiton, and the villages of the Tintons, or nation of the prairies (Mott Wedel 1974:166). Although in 1700 many Dakota villages were located along the course of the Minnesota River and at Big Stone, they are described by Le Sueur as occasional visitors to a more extensive region, ranging from the area around the Illinois River to the southeast, to Green Bay in the east, to Lake Winnipeg in the north, and westward to the Des Moines drainage (Mott Wedel 1974:165).

The population of the early historic Dakota in the Minnesota Valley is uncertain. An overall assessment of Sioux numbers in 1780 is 25,000; although by this time it is estimated that population decline from introduced epidemic diseases had already impacted people in the Minnesota region (Anderson 1984:15). Dakota villages are thought to have had lodges providing space for 10–15 individuals, and at least some villages had over 150 lodges. While such an instance might have been an unusually large settlement, it would appear there were Dakota villages with populations of well over 1,000 individuals. If Le Sueur's estimate of 20–23 villages for all of the Dakota in 1700 is accurate, the population of the Dakota, including the Tetons, would fit within the 25,000 range often given as an approximate contact period number (Anderson 1984:15–19). Bray (1994:169) estimates that the population of all the Sioux in Minnesota was perhaps in the range of 21,000–28,000, with probably half that number belonging to the Eastern and half to the Western Sioux. Over the course of about a century, from 1655–1765, the total population is estimated by Bray (1994:170) to have declined by about 30 percent as a result of epidemic diseases. The size of this population, even though scattered through an area of perhaps 50–60 thousand square miles, represents a density of about one person per two square miles. For a hunting and gathering population this would represent a moderately well-populated landscape. These numbers obviously reflect the fact that at the beginning of the Contact period the native people of the Minnesota Valley and surrounding areas were probably successful in supplementing their diet beyond the natural potential of the regional landscape; in other words, using domestic plants.

A map from 1688 made on the basis of Hennepin's description shows a tributary of the Mississippi that is clearly the Minnesota River. At the headwaters of this stream, the map illustrates lodges and has a description stating: "Tinthonha, ou gens de Prairies" (Fite and Freeman 1969:172–173). Most likely, the Hennepin map is accurate in locating the "Tinthonha" or Teton in this location since later maps also show the headwaters of the Minnesota at Big Stone to be a major area of settlement for Lakota, and later, Dakota groups. For instance, the 1718 Delisle Map (Figure 2) again shows "Tintons" around Big Stone Lake, while along the middle stretches of the Riviere St. Pierre (Minnesota) are the Hinhancton (Yanktons). On the same map, the Aiaouez (Ioway) are shown considerably to the south on the far side of the Moingona River. In fact, the 1755 map by Ellis Hushe and William Faden's map of 1777 both show the Teton at the head of the St. Peter's River at Big Stone Lake (Fite and Freeman 1969:176–177, 186–187, 232–233). The Delisle map and the Faden map agree as well in showing the Hinhanctons along the central portion of the St. Peter's River.

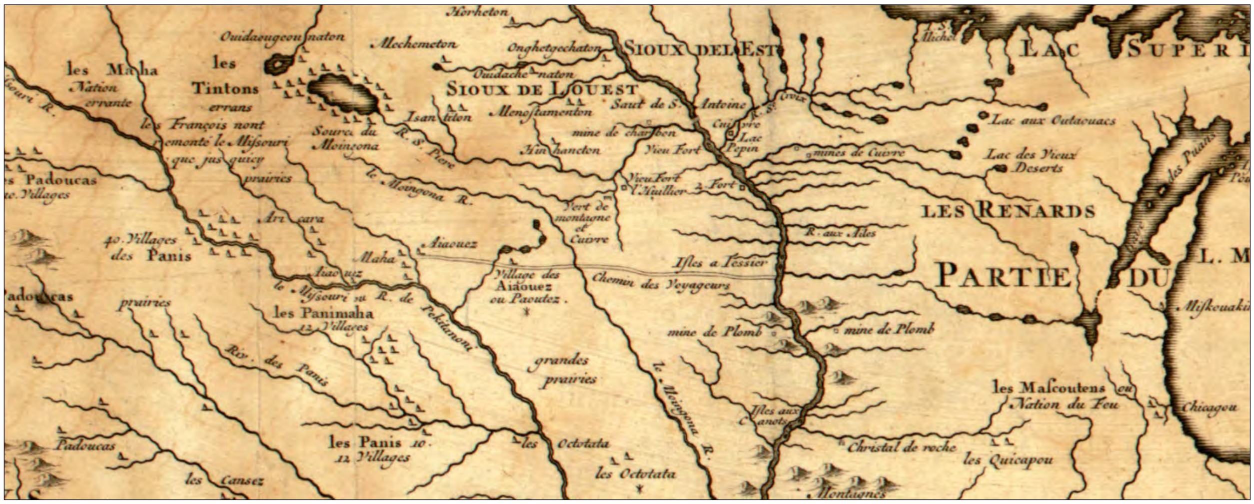


Figure 2. Portion of 1718 Delisle map depicting the Minnesota (St. Pierre) River and some of its inhabitants.

By the early part of the nineteenth century, the Joseph Nicollet map of the Upper Mississippi region (Figure 3) has the Sisseton at Big Stone Lake, while the central portion of the Minnesota Valley is displayed as the territory of the "Warpeton" (Nicollet 1843). The Nicollet map also shows several villages on the lower Minnesota River, including the villages of Six and Black Dog. A Sisseton village is also illustrated at the confluence of the Minnesota and Waraju rivers (Dakota for 'Cottonwood'). This would suggest that the Teton and Yanktons occupied the Minnesota Valley in the eighteenth century, to be replaced by the Sisseton and Wahpeton in the early portion of the nineteenth century.

Figure 3. Portion of 1843 Nicollet map depicting the Minnesota (St. Peter) River and some Indian villages along its course.

Woolworth's (1974:18) work on the history of the Dakota, particularly the Yankton, summarizes both primary and secondary sources to review the movement of the Sioux out of the Minnesota woodlands. Basing his conclusions on the historical sources, Woolworth argues the Dakota groups left the Mississippi headwaters sequentially, Teton first, Yankton next, and finally, in the middle of the eighteenth century, the Mdewakanton. Alexander Ramsey, the governor of the territory of Minnesota, claimed that the Mdewakanton Dakota left the Mississippi headwaters because there were many buffalo on the Minnesota River, but that they had to drive the Ioway out of that area in order to settle there. In any case, the Dakota bands were leaving their heartland around Minnesota's Mille Lacs country between 1680–1700, at least according to tradition and historic sources. By this time the Teton had already located to the prairies and were settled heavily around Big Stone Lake. During this move, some of the Dakota were involved in warfare with the Oto and the Omaha, and also with the Sac and Fox (Woolworth 1974:17, 23).

Bray (n.d.) probes more deeply into the Dakota use of the Minnesota River region in his treatment of the Oglala Sioux and Le Sueur's trading efforts at the very beginning of the eighteenth century. Relying on historical documents, archeological evidence, and interviews with descendant families at Pine Ridge, Bray shows that the southern part of the Minnesota River valley had an eventful history during the period of initial European contact. Around 1700, he believes the Dakota-Lakota groups known from more recent times may have been in the initial stages of formation. The Oglala, for instance, may have only just begun to coalesce as an ethnic entity. Although not discussed in detail, Bray also suggests that there were a number of villages on the lower Minnesota River that would later become Teton, even as there were settlements attributed to the Teton at Big Stone Lake at the end of the seventeenth century.

Complicating this picture even further, Nicollet reports a curious fact which is quoted here from Bray and Bray (1976:45):

> [Monday, June 11, 1838.] Village of the Little Rapids, 15 lodges in winter, made of bark; these are the people of the leaf (the Warhpetonwan) [Wahpeton] of whom the chief is Maza Omanki—who walks or will get himself in iron [Iron Walker]. The other parts of this tribe are at Lac qui Parle and at Big Stone Lake.

Apparently, single bands, or tribes as Nicollet describes them, were sometimes fragmented and lived in different communities hundreds of miles apart. This ethnohistoric detail is of some interest and might be profitably factored in to the understanding of the distribution of artifact similarities over the region in the prehistoric period.

One of the features of the early Historic period use of the southern Minnesota Valley was a great rendezvous held periodically on the Blue Earth River. This event, when held, attracted many of the Dakota-Lakota bands, as well as the Omaha, Iowa, Oto and probably others as well. In the earlier part of the Historic period, bison hunting on the prairies south of the Minnesota was alternated with wild rice collecting in the fall as well as with beaver trapping (Bray n.d.). Truteau (in Nasatir 1990:301), almost a century later, also remarks on a trading system between the Dakota of the Minnesota River area and those bands farther to the west. It was the custom of the western bands to travel east to the Minnesota to trade their furs for merchandise. Mackay also reports on the trade centered on the Minnesota when he writes in about 1796 that the English were trying to entice the Omaha to trade with them on that river (Nasatir 1990:359). Baron de Carondelet even proposed building a fort on the Minnesota with a military garrison to counter the traders coming from Michilimackinac (Nasatir 1990:402, 420).

There were incursions of hostile Algonkian speaking groups into this area. In historic times, the Fox and Mascoutin were particularly notorious among the Dakota for the danger they posed. Overall, the Minnesota River valley seems to have been Dakota Territory, but a territory visited and occasionally used by three or four other ethnic groups, particularly the Siouan speaking Iowa and Oto. Warfare was commonplace. Furthermore, these groups all possessed a relatively complex village lifestyle with populous villages, hereditary chiefs, and special societies along with well-developed ritual practices.

Sometime after 1650 there was mention of the Huron and Ottawa settling in the Mississippi River area, probably to the east of the Minnesota Valley, but certainly near enough to raise the possibility of their occasional presence in the Minnesota River trench. In the 1690s, the Dakota in this area were at war with the Fox (Meskwaki) and Miami (Nasatir 1990:38), and Le Sueur reports an attack on the Dakota on the Minnesota by the Fox and Mascoutin in 1702 (Mott Wedel 1974:163). Robinson (1904:42–43) recounts a 1696 Dakota war with the Fox and Miami. Not long after,

the Dakota and Iowa were at war with the Sac, Fox, Kickapoo and Mascoutin. Some of this fighting was in Illinois country, and Father Marest in a missive to Le Sueur warned of the war parties. In 1700, the Dakota were on their way to work vengeance on the Illini for killing some Dakota. At about that time the Dakota stated to Le Sueur that the Minnesota/Blue Earth confluence belonged to the Iowa, Oto and Teton, and that Dakota Territory extended to the mouth of the Minnesota, but apparently not to the Blue Earth.

Most likely, these Algonquian tribes were occasional interlopers into southwest Minnesota and were not residents of the Minnesota River valley at any time. Winchell (1911) mentions that the Franquelin map locates "les Mascoutin Nadouscioux" on the upper Des Moines River and that these may be the Wisconsin Mascoutin, presumably the very same people the Dakota occasionally warred with in and around the Minnesota River valley. Although the lower Minnesota Valley was the territory of a number of Dakota villages, it was also frequented by the Iowa and Oto, who probably controlled the area of the Blue Earth to the vicinity of Mankato until after 1700. Winchell thought that in addition to the Dakota, the Gros Ventre, Assiniboine, Omaha, Iowa, and Cheyenne all lived on or near the lower Minnesota River at one time (Holley and Michlovic 2013:153).

According to Robinson (1904:23), by the middle of the eighteenth century, the Dakota, comprising the several Santee divisions, drove the Iowa entirely from the Minnesota Valley, and the Teton had driven the Omaha from the Valley of the Big Sioux to occupy the territory south of the Missouri. The Teton drove the Arikara out of their lands around Pierre, South Dakota by 1790 or so, and allowed the Yankton to have the James Valley, while the Sisseton moved into the old home of the Teton at the Minnesota headwaters on Big Stone Lake. The Teton tenure at Big Stone may be preserved in the Minneconjou band name, which means "to plant by the water" because they had in earlier times planted their fields next to Big Stone Lake (Robinson 1904:26).

Pond (1986:5–6) reports that in the early 1800s nearly all the Dakota in Minnesota were living on the Mississippi or Minnesota rivers, or in the vicinity of the Minnesota headwaters at Big Stone Lake and Lake Traverse (the Red River headwaters). For a period of about 150 years (1680–1840), the Dakota habitation and use of the Minnesota River valley was persistent, even if with some conflict and movement. Furthermore, just as the early eighteenth century observers noted that settlements were concentrated at the Minnesota headwaters around Big Stone and on the lower Minnesota from Mankato to the Mississippi confluence, so too in the early to middle nineteenth century Pond reports the majority of settlements in the same areas. That some of the Dakota considered the mouth of the Minnesota River the center of the world is not surprising.

The lifeway of the Dakota on the Minnesota River from early historical times is clear. Already mentioned was Le Sueur's account from 1700 that his party at Fort L'Huillier, including many Dakota, took numerous bison, deer and game birds. The hunting routine targeted a variety of large and small game sources. They lived in lodges (presumably tipis) with two or three families together, and the men practiced polygyny. Pond reports that, in the early 1800s, large numbers of deer were being taken on the lower Minnesota near Shakopee. On the other hand, farther upstream, bison was the primary game animal. Early reports are that Dakota on the lower Minnesota traded for bison hides with the Teton upstream (Mott Wedel 1974:162–165). In fact, Landes (1968:161) reports that in the 1930s this relationship was still remembered by the Mdewakanton that she interviewed. The Mystic Lake people knew about bison hunts from hearsay, and noted that the hunts could last for up to five months, but they themselves were much more interested in hunting deer than bison.

Raising crops was also a Dakota practice, although they preferred to think of themselves as hunters (Pond 1986:66). The Dakota did not raise very much corn and most was eaten when harvested; however, they did sometimes produce a surplus.

> The corn that was not to be used immediately was put in barrels made of bark, and buried in the ground to be dug up when needed. It was usually left buried until the owners returned from the deer-hunt in January, and was so concealed that, when the snow was on the ground, none but the owners could easily find it [Pond 1986:27].

Spector (1993) reviews the nineteenth century archeological and historical materials for a Dakota settlement at Little Rapids; Inyan Ceyaka Atonwan. The site, covering about five hectares, was a summer planting village used in late spring through the summer season. Planting, tending and harvesting corn was the primary activity. The large cabins or

lodges might hold up to four families and might be used for seven or eight years (Spector 1993:76, 101). She also reports that the pits at the site contained grapes, raspberries, elderberries, strawberries, cherries, plums and hazelnuts. The historical records indicate the Dakota in the area also used several water roots and tubers, including aquatic and marshy ground plants they referred to as *psincha* and *psinchincha*. Prairie turnip was a highly desired plant food as well. Fish, especially drumfish, and turtle were the most abundant animal remains at the site. In other seasons the Dakota hunted deer, duck, geese, elk, bear, muskrat, skunk, ermine, mink, raccoon, rabbit, otter, beaver and fisher; many of these for their pelts (Spector 1993:111–113). During these times, the Dakota inhabited camps in different locations. In late summer, they moved to a ricing camp and deer hunting camps at various times; in winter to camps in protected areas; and to maple sugar camps in March, during which time women and children collected sugar while men often trapped muskrat at muskrat camps (Spector 1993:67–75). Also found at the site was a low oval enclosure of raised earth, which Spector (1993:120) interpreted as a dance area. It suggests that some enclosures from the prehistoric period may not have been for defensive purposes; at least that may well have been the case for embankments rather than ditches.

All of this suggests several significant features of the early historic period use of the Minnesota Valley area. First, there were a number of ethnic groups in the region and they were in active conflict some of the time, while at others there was peaceful interaction, occasionally punctuated by substantial trade fairs such as the one on the Blue Earth River. Second, even prior to the widespread use of the horse, Indian people were wide-ranging. The following statement gives an idea of the extent of these pre-equestrian travels; "…somewhere near St. Louis on the 30th of July, 1700, he [Le Sueur] met seventeen Dakotas in seven canoes going down to get even with the Illinois for having killed three Dakota prisoners…" (Robinson 1904:43). The distance involved here, between the lower Minnesota and St. Louis would be about 400 miles in a straight line. Third, in the early Historic period the Dakota were not yet regarded as the occupants of the lower Minnesota near Blue Earth, but were apparently entrenched farther to the north near the Minnesota-Mississippi confluence. At the same time, the Big Stone area was regarded as the territory of the Teton, who were clearly distinguished from, albeit related to, the Dakota. Evidence, tentative in nature, shows that some bands of the Dakota or Lakota were in the process of formation at the time of European contact; for example, the Oglala and Miniconjou. In any case, it seems that the Dakota occupied the Minnesota Valley throughout a period of profound change involving population dislocations, epidemic diseases, and warfare. Fourth, the Dakota and their neighbors lived in populous villages with somewhere in excess of a thousand inhabitants in some settlements. Undoubtedly related to the size of their villages, Dakota organization was relatively complex and diverse. Simply reviewing Pond's (1986) listing of Dakota practices illustrates the point. There were many and varied institutionalized ceremonies performed in the villages including the Medicine Dance, Sun Dance, Wakan feasts, Raw Fish feast, Heyoka feast, Thunder Dance, Elk Dance, War Dance, and Scalp Dance. The multiplicity of organized feasts, dances and ceremonies among the Dakota reflects the obvious need for social controls; exactly what might be expected for a people whose population numbered in the thousands, which featured hereditary chiefs, and whose populous villages consisted of extended kin groups of two to four families in individual lodges.

If we combine our understanding of Dakota village life and organization from the late seventeenth through the middle nineteenth century, and recognize the archeological signature of these villages at locations such as Inyan Ceyaka Atonwan as described by Spector (1993), it is obvious that the rich village culture known from the historical records produced archeological remains that are very much comparable to those of the prehistoric village cultures in the same region. As Gibbon (2012:137) suggested, the cultures the Europeans witnessed in southern Minnesota during the early contact period were quite comparable to the cultures that had flourished there since about A.D. 1000.

PREVIOUS ARCHEOLOGICAL STUDY IN THE MINNESOTA RIVER VALLEY

Traditionally the prehistory of Minnesota and most of North America was divided into four major periods or stages: Paleoindian, Archaic, Woodland and Mississippian. Gibbon (2012:204) attempts to abandon this time-worn system initially developed for the woodland areas of the eastern United States. He suggests a more descriptive classification for Minnesota. It includes Pioneer foragers as a substitute for the Paleoindian, followed by a threefold hunting adaptation that varied from the boreal forest in the northeast, to deciduous woodlands in central and southeastern Minnesota, and finally to prairie grassland in the southwest and western part of the state. This comprised the Archaic. The former Woodland period is replaced in Gibbon's system by proto-wild rice harvesters in the north, proto-

horticulturists in the south, and late bison hunters on the western prairies. In the Late Prehistoric period, the Mississippian is replaced by horticulturists and intensive wild rice harvesters.

For southwestern Minnesota, including the Minnesota River valley, Anfinson (1997) divided the area's prehistory into Early (10,000–3000 B.C.), Middle (3000 B.C.–A.D. 950) and Late Prehistoric (A.D. 950–1650) periods consisting of defined traditions and phases. The Early Prehistoric included the old Paleoindian through the Early and Middle Archaic, while the Middle Prehistoric comprised the Late Archaic and earlier parts of the Woodland. The Late Prehistoric, in Anfinson's system, consisted of the later portion of the Woodland and the various village cultures, such as Great Oasis, Cambria and other village manifestations. This division makes sense for several reasons. Archeologists have long recognized that there was little difference in lifestyle between the Paleoindian and earlier parts of the Archaic period, particularly in the Upper Midwest and Plains areas. Also, the earliest part of the Woodland period was often impossible to distinguish from the later portion of the Archaic unless ceramics were present. In fact, the major change in lifestyle, and in the apparent rate of culture change, seemed to happen only with the appearance of more intensive horticulture or farming by larger communities during the last part of the prehistoric period.

There is reason to welcome some substantial revision in how the prehistoric period is divided and characterized in Minnesota. For instance, the discovery of 'probably domestic' squash at a 2,500-year-old Late Archaic site near Lake Pepin shows that horticulture may have been practiced earlier than archeologists traditionally accepted (Perkl 1998:279). This should not be surprising insofar as modern hunter-gatherer research shows that some of these peoples occasionally plant and harvest small amounts of crops. Also, in some instances relatively complex burials and even mound construction are known for the later portion of the Archaic. The Runck burial, for example, may date to the Late Archaic even though it featured a cobble-lined pit. It was exposed in a plowed field, and Anfinson (1997:46–47) speculates there may have been a mound over it at one time. In any case, it does suggest a degree of burial ceremonialism and grave construction similar to that found in traditional Woodland-period interments. On the other hand, the familiarity archeologists have with the traditional classification makes use of any alternative terminology cumbersome, at least until one or another system is widely adopted.

Early archeological work in the Minnesota River valley was carried out by William Nickerson at the Cambria site in 1913 and 1916, and also at the Judson site (Anfinson 1997:22; Nickerson 1988). For the most part, however, archeological study in the Valley was limited, as it was in much of Minnesota through the 1960s. As active archeology began at Mankato State University in the 1970s, the lower portions of the Minnesota Valley began to receive attention, while at the same time, the initiation of cultural resource management projects led to additional work in several portions of the Valley.

In *Southwestern Minnesota Archaeology*, Anfinson (1997) reviews work that was done prior to the middle 1990s. He notes that after Nickerson and Wilford, little work was done in the Valley until Mankato State resumed work at Cambria locality sites, including the Price and Nelson sites. Also at about this time, the Science Museum of Minnesota and the MNDOT Highway program conducted archeological surveys and excavations in the Minnesota Valley. CRM archeology and occasional research projects continue through to the present. Since about 2009, funds from Minnesota's "Legacy Amendment" have provided for some additional work in the Minnesota Valley region (e.g., Holley and Michlovic 2013).

Occasional fluted point finds from the early prehistoric in Brown, Yellow Medicine and Blue Earth counties have been reported, but unfortunately, no Paleoindian excavations have been completed in the Minnesota Valley. Buhta et al. (2011) report the known distribution of points found in the field and present in collections. The Minnesota Valley, regarded as part of the Prairie Lake region, has the second highest density of Paleoindian sites reported for the state. Thirty-eight sites or about 28 percent of the total Paleoindian finds in Minnesota are from the Prairie Lake region. This suggests a very good likelihood that additional sites of this early age may be found in the Valley; however, only a few have actually been documented on or very near the Minnesota River itself (Buhta et al. 2011:123 and Figures 9, 11, and 15).

The Archaic period, or the late part of the early prehistoric, is not well known in the Minnesota Valley, an unfortunate fact that is true for much of the Upper Midwest. One important site was found on terrace deposits near Granite Falls,

sometimes known as the Granite Falls Bison Kill (21YM47) (see Anfinson 1997:36 for a review of this site). Dates for this site range from about 7,500–8,000 years ago and are roughly coincident with dates from the Itasca site, Horizon II at the Cherokee site (northwest Iowa), Logan Creek (eastern Nebraska) and the Rustad site (southeast North Dakota). Another site with a probable Archaic component was excavated by the Science Museum, also near Granite Falls. This is the Hildahl site (21YM35), excavated by the Science Museum of Minnesota in 1977. Point styles suggest a preceramic occupation from between 8,500–4,500 years ago. Fauna found here include bison, raccoon, muskrat, turtle and fish (Anfinson 1997:32–33). In the 1990s, several seasons of work were performed at the J Squared site (formerly Jackpot Junction) (21RW53). This also is an Archaic site with evidence of bison use, along with some smaller species such as raccoon and possible game birds. Unfortunately, no diagnostic artifacts are reported for the excavated sample, although a side-notched point was initially found in shovel probes (not mentioned in the report but noted on the site form). A suite of radiocarbon dates places the site occupation between 5,000–4,000 years ago. No ceramics were found (Bower et al. 1996:84–86). Granite Falls, Hildahl and J Squared, along with similar sites in nearby regions, indicate a widespread bison hunting adaptation in the Northeastern Plains during the Middle Holocene, although many sites from this period in the prairie region contain evidence of small game use.

The Runck site (21BW7) comprises another probable Archaic period site along the Minnesota River, although Anfinson (1997:74) suggests it may belong to the Fox Lake phase. It is a burial on a terrace near New Ulm. As mentioned previously, a single interment was found here. There was no pottery, but the burial was associated with Parkdale Eared points. These are similar to Oxbow points, the name normally used for such points on the Northwestern Plains. They are routinely assigned to the Archaic, although they probably postdate the type of points usually associated with the Middle Holocene sites such as Granite Falls. As already mentioned, the burial at Runck was in a pit lined with cobbles (Anfinson 1997:46–47). The paucity of funerary remains makes it impossible to position the Runck site in any sort of pattern that might shed further light on Archaic period burial ceremonialism.

Recently, additional Archaic or early prehistoric sites were discovered in the southern Minnesota Valley in and near Minneopa State Park, immediately west of Mankato. A 2003 survey resulted in the identification of a Late Archaic site, 21BE271. Its age is estimated based on a diagnostic Late Archaic projectile point found there (Radford 2015:2). More substantial is a very large surface scatter of lithic debris, supplemented by subsurface material found in shovel probes and test excavations at Minneopa State Park. The site is recorded as 21BE304 and is located on a broad, flat intermediate terrace overlooking the Minnesota River. It is reported to have produced Archaic point forms ranging in age from about 8,000–2,000 years ago, including Little Sioux, Hanna, Brewerton and Pelican Lake styles. Thousands of lithic flakes were also recovered. The diagnostic points seem to fit mostly into Middle and Late Archaic contexts (Radford 2015:4). In test excavations, artifacts were found mostly from 10–35 cm below the ground surface (cmbs). Locally available Prairie du Chien chert is the most common lithic raw material. One feature, consisting of several rock slabs, was also discovered. Although no charcoal was observed in association with the feature during excavation, soil matrix surrounding the slabs was recovered for microscopic analysis in the hopes of identifying a sample of charcoal suitable for AMS-dating (LeRoy Gonsior, DNR Archaeologist, personal communication 2015). The site is interpreted as a lithic base camp (Radford 2015:6, 8).

More is known in the Valley about the Archaic occupation when compared to the Paleoindian. Even so, there is very little known from the few excavations into the Archaic period in this region and far more work is needed before there can be any definitive commentary on the lifestyles and culture history of the Archaic peoples of this period. At Granite Falls, the Archaic materials reflect a dependence on bison, and this site mimics those found in other portions of the Northeastern Plains. Hildahl also features bison, but the faunal remains reflect a broader diet including small game and fish. At the Minneopa Park sites, the point styles, while comparable to those from the Northern Plains in some instances, in others appear to resemble points from sites farther to the east. One other widely recognized difficulty in the identification and study of Archaic sites is the similarity in diagnostic artifacts, particularly point styles, to those of the later Woodland period. This is especially true for the small, notched forms typical of the Early Plains Archaic, some of which might be mistaken in form and size for arrow tips.

After the Archaic period, archeologists in Minnesota define a Woodland period characterized by the use of ceramic vessels, construction of burial mounds and the beginnings of regional horticulture. There is little evidence of horticulture in the Minnesota Valley associated with any of the earlier ceramic complexes, and the same is true for

evidence of widespread burial mound ceremonialism. While mounds are common on the Minnesota River terraces, they are probably associated with the last part of the Middle Prehistoric period and with the entire Late Prehistoric period. Some burials, such as the one at Saienga (21CP2) in Chippewa County, contain interments made during the early contact period (Anfinson 1997:71–72, 84) and indicate that the use of burial mounds continued into Historic times.

The earliest ceramics well-attested in the Minnesota Valley belong to the Fox Lake culture. However, this was only occasionally expressed in the Minnesota Valley, and no full-scale excavation of Fox Lake has been done along the Minnesota itself. Anfinson (1997:54) lists five Fox Lake sites along the Minnesota River, 21YM35, 21YM3, 21RW11, 21BW53 and 21BW56. The diagnostic artifacts defining Fox Lake are ceramics that are grit-tempered, cordmarked, and decorated with incised lines over cordmarked surfaces, bosses, puctates, and stamp impressions (Anfinson 1997:59). Based on sites excavated elsewhere, the subsistence base focused on hunting big game such as bison and deer, fishing, trapping small animals and fowling. There is evidence that Fox Lake is a long-standing adaptation that endures for almost a thousand years (Anfinson 1997:65). Whether there is any indication of internal changes in the Fox Lake culture during this time is unclear, although evidence of such is not available in the Minnesota Valley. It is instructive to compare the Fox Lake subsistence pattern with that documented for the Little Rapids village site from the early nineteenth century. There appear to be overlaps in almost every way save for the presence of domestic plants at Little Rapids and their absence in Fox Lake assemblages.

Probably contemporaneous with the Fox Lake materials are those from the Heyman's Creek site (21NL30) in Nicollet County. Here, ceramics with smooth exteriors, horizontally placed bosses, and triangular decorations in panels of dentate stamping were recovered. These are similar to central Midwestern Havana pottery dated to before 1,600 years ago. Radford (2015:5) also discovered a Havana-style rimsherd at Minneopa State Park, immediately east of the above-mentioned Archaic site. This site, 21BE303, is a somewhat less-extensive site than the nearby Archaic one, but in the same topographic position. In addition to the Havana-like rim, Lake Benton and Plains Village (probably Cambria) pottery was also recovered here. Both the Heyman's Creek site and the Minneopa Bison Pasture East site (21BE303) reflect influence from the southeast, representing either diffusion of artifact styles or the actual intrusion of peoples. It is also worth noting, from a site taphonomy perspective, that both the Archaic 21BE304 and the Woodland 21BE303 are on the same intermediate terrace of the river, and are at approximately the same depth, yet one of the sites is considerably older than the other (Radford 2015:5–6). This points to the important fact that the processes of site burial in the Minnesota Valley are complex and need to be assessed carefully on a site-by-site basis. Depositional agencies and soil formation must both be studied to understand the context of archeological materials.

In Anfinson's (1997) system, the Middle Prehistoric period ends with a complex known as Lake Benton. It follows Fox Lake and endures into the Late Prehistoric. Others would refer to Lake Benton as Late Woodland. The characteristic decoration on Lake Benton pottery is generally called cordwrapped stick or object impressions, sometimes with punctates below the obliquely oriented stick impressions (Anfinson 1979:110). This ceramic ware is widespread in the Late Woodland period in Minnesota and in surrounding areas as well, making it difficult sometimes to decide whether fragmented sherds belong to the Lake Benton type or to another, similar ceramic expression; for example, Onamia or St. Croix (Anfinson 1979:110; Gibbon 2012:150). It is clear, however, that these ceramics are common in the Minnesota Valley, and Lake Benton is regarded as the pottery type most commonly represented in the ceramic collections in the study area. There is no evidence of horticulture with Lake Benton, and the subsistence routine is regarded as similar to Fox Lake (Anfinson 1997:83).

Michael Scullin studied the Nelson site (21BE24), which produced ceramics with twisted cord decoration similar in some instances to Late Woodland styles, for example Lake Benton and Loseke wares, and also to Plains Village ceramics belonging to the Middle Missouri tradition (Scullin n.d.). Ceramics of this sort are possibly early expressions of Late Prehistoric village cultures in the area. They also reflect possible influences in the northern Blue Earth Valley (near Mankato) that mimic the types of cultural relationships found in the early Historic period when the Iowa, for instance, lived in an area extending from the southern perimeter of the Minnesota Valley into northern Iowa. A comparison of the Dakota and Iowa tribal areas is oddly similar to the distribution found for the Lake Benton and Loseke ceramics (cf. distribution maps in Benn 1990:131).

The Late Prehistoric period in the Minnesota Valley begins sometime after A.D. 1000. The primary feature characterizing this period is the development of village life; meaning relatively large communities numbering in the hundreds, or perhaps thousands, supporting themselves through intensive exploitation of the local resources, whether they be bison, wild rice, deer or other abundant wild foods, but more commonly sustaining themselves with farming, or intensive gardening. In the Minnesota Valley, several archeological expressions of village culture have been reported: Cambria, Big Stone, Great Oasis and Oneota.

The best known of these village cultures is Cambria, named after a small town about midway between New Ulm and Mankato. Cambria sites are dated to around A.D. 1000–1250 (Anfinson 1997:104), although recent dates obtained through a Minnesota Legacy grant seem to suggest a narrower and somewhat later suite of dates, ranging from A.D. 1150–1300 (Holley and Michlovic 2013:142–143). This is somewhat later than the A.D. 1000–1200 date for Cambria offered recently by Gibbon (2012:165). The main Cambria sites are on terrace positions of the Minnesota River northwest of Mankato and include Cambria (21BE2), Owen Jones (21BE5), and Price (21BE36). These settlements were substantial and reflect a mixed economy of intensive gardening, hunting and gathering.

Cambria is best known for its ceramics, which in certain ways are distinctive, but are also problematic. A small percentage of the Cambria pottery is similar to ceramics from Cahokia, center of the Late Prehistoric Mississippian culture. Other Cambria pottery is clearly related to types found to the west in the Missouri Valley area, such as Sanford ware. Some archeologists prefer to associate Cambria with the Initial Middle Missouri culture of North and South Dakota (Henning and Toom 2003), while others see it more like the village cultures of the Midwest. Scullin (2012:33), for instance, highlights the uncertainty about Cambria's affiliations in these terms:

> Although for many years I considered the Cambria Focus to be the easternmost of the western Plains villages I have completely reversed myself and now consider it to be the westernmost of the eastern village complex with its strongest affinity being to Silvernale near Red Wing.

Gibbon (2012:165–166), in his recent overview of Minnesota archeology, associates Cambria with the Initial Variant of the Middle Missouri tradition. He does acknowledge, along with Scullin, that there are reasons for maintaining the eastern affiliation with Mississippian culture for Cambria. At the Lewis Mound group, Mississippian-like extended burials were documented, and at the Odessa site, a flat-topped pyramidal mound was recorded by T. H. Lewis, presumably associated with Cambria materials.

Several types of sites have been identified for Cambria, including large villages, smaller and possibly satellite settlements near the large communities, small upland sites and burials (Gibbon 2012:165; Johnson 1991). Burials are often expressed as circular mounds near the Cambria village sites. Whether this hierarchy of sites is in any way related to significant features of the social order of these village communities has not been discussed at length.

A second village culture known for the Minnesota Valley is found mostly in the upper Valley near Big Stone Lake. This was originally defined by James Haug, and elaborated by Anfinson (for an in-depth discussion see Anfinson 1997:104–112), and is defined as the Big Stone phase. Sites belonging to this entity in Minnesota are all in Big Stone or Traverse counties at the Minnesota River headwaters. Other sites are found in Roberts and Grant counties of South Dakota. Toom (2004) suggested that Big Stone is part of a cultural development out of Cambria and leading to certain cultural expressions in the Missouri Valley of North Dakota. Big Stone phase sites are positioned on high ground overlooking the Minnesota and Red rivers headwaters at Big Stone and Traverse lakes. The best known site is Hartford Beach on the South Dakota side of Big Stone. This site was excavated by Haug (1983) and was primarily behind the definition of this phase. Other sites include Shady Dell, Tenney and Bunker Hill, all in Traverse County and not in the Minnesota Valley, although immediately north of the Minnesota headwaters. Overall the Big Stone phase sites feature a ceramic assemblage that appears to represent a combination of types, some of which are related to Middle Missouri styles, while others are comparable to Late Woodland types such as Lake Benton. This is not uncommon in the region and seems to be true of Cambria as well; that is, Late Prehistoric village sites with mixed ceramic assemblages resembling Mississippian or Plains village vogues combined with Late Woodland types (cf. Mitchell 2012).

A review of the ceramic collections from sites assigned to the Big Stone phase has led to one reevaluation of the phase. Holley and Michlovic (2013:83–85) argue that Big Stone is perhaps more appropriately defined as a region rather than

as a phase. Ceramics from more than one period are mixed at sites throughout this attractive environment where rivers, lakes and prairies meet. Village culture ceramic types at some locations are more closely related to Cambria than to Missouri Valley types, and some of the Woodland types may not be associated with the village occupations.

A third village expression from southwestern Minnesota is Great Oasis, but since this is only represented in the study area by occasional sherds, it is not considered further here. Great Oasis sites, often regarded as a development toward village lifestyle, are found in Iowa, South Dakota, and Minnesota south and west of the Minnesota Valley.

The fourth village culture documented for the Minnesota Valley is Oneota. Dating throughout much of the Late Prehistoric, Oneota is believed to persist into the Historic period. Many believe Oneota to be the archeological expression of the late prehistoric Iowa, Oto, and perhaps Winnebago. Most sites are located south of the Minnesota Valley, although one major component was discovered at historic Fort Ridgely (21NL8). Oneota people engaged in a dual hunting/gathering-horticultural economy in southern Minnesota. Ceramics include distinctive globular jars, shell tempering, trailed line designs and oftentimes strap handles. Settlements tend to be on elevated parts of river floodplains (Anfinson 1997:114, 118).

ARCHEOLOGICAL SITE LOCATION IN THE MINNESOTA VALLEY

During the years 1977–1981, the MHS conducted the MNSAS, which utilized a stratified random sampling procedure in a variety of counties from different environmental regions in Minnesota. The results of the surveys conducted in various regions of Minnesota produced generally consistent results. Sites were strongly correlated with the presence of water. Where there were lakes, they were most likely to have archeological sites along their perimeter. If there were rivers, sites were preferentially located near those permanent streams. Few sites were located away from water sources, and those that were tended to be ephemeral sites; single artifact finds or small lithic scatters. Several Minnesota River Valley counties were surveyed; however, no deep testing was performed, and the survey in Carver County did not include any work below the edge of the bluff (MHS 1981).

The University of South Dakota conducted a survey in the upper Minnesota River watershed in 1982. Only about six prehistoric sites were found in the watersheds of several tributary streams and the upper Minnesota Valley itself (Beissel et al. 1984). The conclusions that follow from this work are that villages occur in all topographic locations in major drainages, and that campsites are found in minor drainages and on hilltops. Mounds and tipi ring sites are also on high ground (Beissel et al. 1984:162–163).

In the late 1980s, Dobbs (1989) conducted an archeological survey in several river valleys flowing into the Minnesota: the Cottonwood, Redwood and Yellow Medicine rivers. The team surveyed 40-acre tracts chosen through a stratified random process using pedestrian survey, shovel probes, cutbank inspection, auguring, and informant interviews. His crew located 35 new archeological sites in a survey area comprising 2,300 acres. Only four sites contained pottery, and in all, only about 10 small sherds were found. Diagnostic points ranged from Archaic types through the Late Prehistoric. Sites were most likely on floodplains of these tributary streams, and along the margins of lakes; they were somewhat less common on terrace deposits, and very unlikely away from water.

In 2002, the MNDOT (Hudak et al. 2002) published the results of a massive statewide undertaking to model the distribution of archeological sites in Minnesota. The intention was to expedite planning CRM surveys for road and bridge work. This work included a survey of Nicollet County, but without deep testing. The project results for the Minnesota River valley show high predicted site frequency near the Minnesota River and its tributary streams, with a much heavier concentration of sites on the lower Minnesota as it approaches its junction with the Mississippi. High site frequency is also indicated for the area of the Minnesota River headwaters around Big Stone Lake. Few sites are predicted away from water. These results are consistent with the original MNSAS (MHS 1981), with the work of Beissel et al. (1984), and with Dobbs's (1989) work in the tributary valleys. It is also consistent with the historical documents that show many Dakota villages on the lower Minnesota, with fewer settlements on the upper parts of that stream, but with a higher incidence of settlements around Big Stone.

More recently, Minnesota State Archaeologist Scott Anfinson (2014) assembled a database of various types of archeological sites in the Minnesota Valley and their relationship to regional natural features. The results of some of his work are presented in table form below. The value of this database is that different types of sites and landforms or other natural features can be easily correlated.

Tables 2 and 3 list general site types, as well as those belonging to standard cultural traditions. Table 4 lists earthwork sites by mound frequency. In Tables 5 and 6, sites are listed by different topographic position and relative to their distance from potable water, respectively. Tables 7 and 8 consist of cross tabulations of site types and topography, cultural traditions and topography, and the same associations in terms of percentages (see also Figures 4 and 5). These tables are arranged here with the most abundant sites on the upper parts of the tables and less frequent sites arranged below. In some of the tables, rare sites and infrequently occupied topographic localities are deleted for clarity. Also, in some tables, sites with multiple descriptors, such as earthwork and artifact scatter, are counted both as an earthwork site and as an artifact scatter, since that is actually true of the find. Multicomponent sites are regarded as examples of each component, so a site with Archaic and Woodland components is counted as an Archaic site and as a Woodland site.

Table 2. Site Type Frequency.*

Site Type	Count (Percent)
Lithic Scatter	192 (37.57)
Artifact Scatter	88 (17.22)
Single Artifact	54 (10.57)
Earthwork	149 (29.16)
Lithic Scatter and Earthwork	8 (1.57)
Artifact Scatter and Earthwork	20 (3.91)
Total	**511 (100)**

*** some rare site types excluded.**

Table 3. Sites Assignable to Definable Cultural Traditions.

Cultural Tradition	Count	Single Component Count
Paleoindian	16	3
Archaic	37	9
Woodland	110	68
Plains Village	23	9
Oneota	14	2
Total	**200**	**91**

Table 4. Earthworks.

Earthwork Sites Classed by Earthwork Frequency	Count
0 (mounds)	2
1 (mounds)	72
2-5	42
6-10	23
11-20	15
21-40	14
41-90	6
91-118	3
Total Earthwork Sites	**177**

Table 5. Topographic Position of Sites.

Topographic Position	Count
Blufftop	182
Floodplain	13
Alluvial Fan	36
High Terrace	87
Low Terrace	182
Island	17
Hill	2
Total	**519**

Table 6. Site Location Near Water Source.

Site Relation to Water	Count
Lake, Lake-Marsh, Lake-River/Stream	85
River or Stream or Confluence	143
Marsh	33
Oxbow	14
Spring	3
Total	**278**

Table 7. Types of Sites (and Percentages) in Major Topographic Settings.

Site Type	Fan	Blufftop	Floodplain	High Terrace	Island	Low Terrace	Total (percent)
Lithic Scatters	11 (5.47)	65 (32.34)	2 (1.00)	36 (17.91)	12 (5.97)	75 (37.31)	201 (100)
Earthworks	6 (3.41)	97 (55.11)	1 (0.57)	33 (18.75)	0 (0.00)	39 (22.16)	176 (100)
Artifact Scatters	2 (2.10)	18 (18.95)	10 (10.53)	10 (10.53)	2 (2.10)	53 (55.79)	95 (100)
Single Finds	4 (7.41)	17 (31.48)	0 (0.00)	12 (22.22)	3 (5.56)	18 (33.33)	54 (100)
Total (count)	**23**	**197**	**13**	**91**	**17**	**185**	**526 (100)**

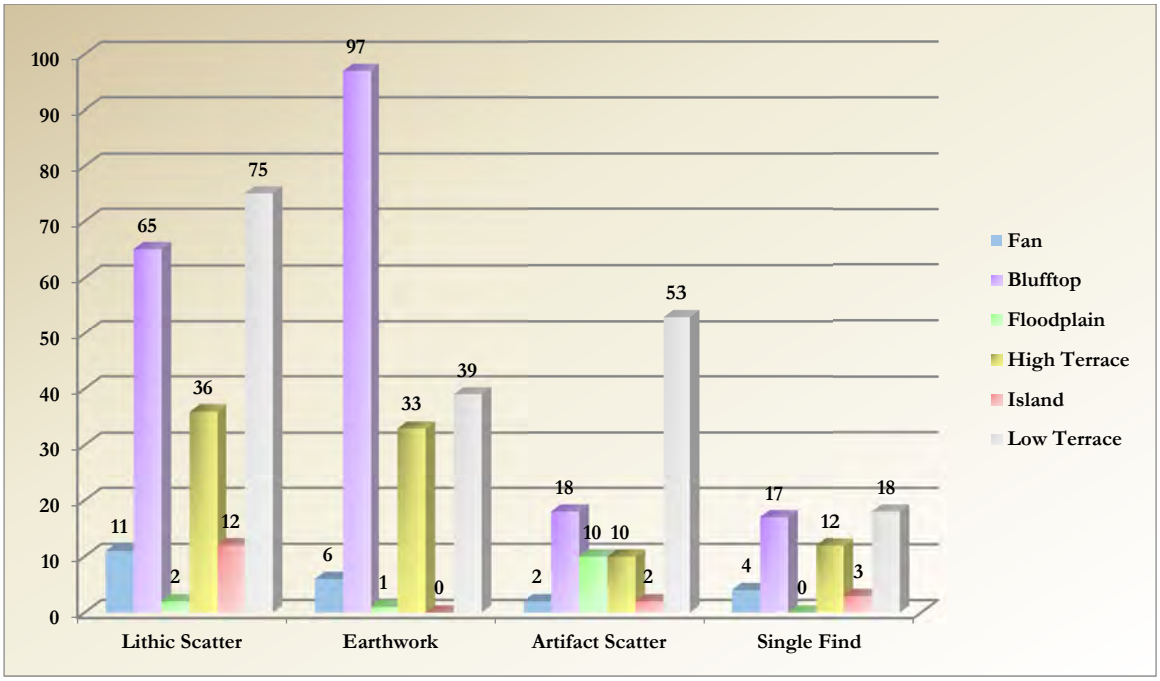


Figure 4. Graphic illustration of data presented in Table 7, above.

Table 8. Cultural Affiliation of Sites (and Percentages) in Major Topographic Settings (raw counts).

Cultural Tradition	Fan	Blufftop	Floodplain	High Terrace	Island	Low Terrace	Total (percent)
Paleoindian	3 (20.00)	2 (13.33)	0 (0.00)	2 (13.33)	1 (6.67)	7 (46.67)	15 (100)
Archaic	6 (16.22)	9 (24.32)	0 (0.00)	5 (13.51)	0 (0.00)	17 (45.95)	37 (100)
Woodland	12 (11.11)	24 (22.22)	10 (9.27)	12 (11.11)	2 (1.85)	48 (44.44)	108 (100)
Oneota	1 (7.69)	4 (30.77)	1 (7.69)	1 (7.69)	0 (0.00)	6 (46.16)	13 (100)
Plains Village	3 (16.66)	6 (33.33)	1 (5.56)	1 (5.56)	0 (0.00)	7 (38.89)	18 (100)
Total (count)	**25**	**45**	**12**	**21**	**3**	**85**	**191 (100)**

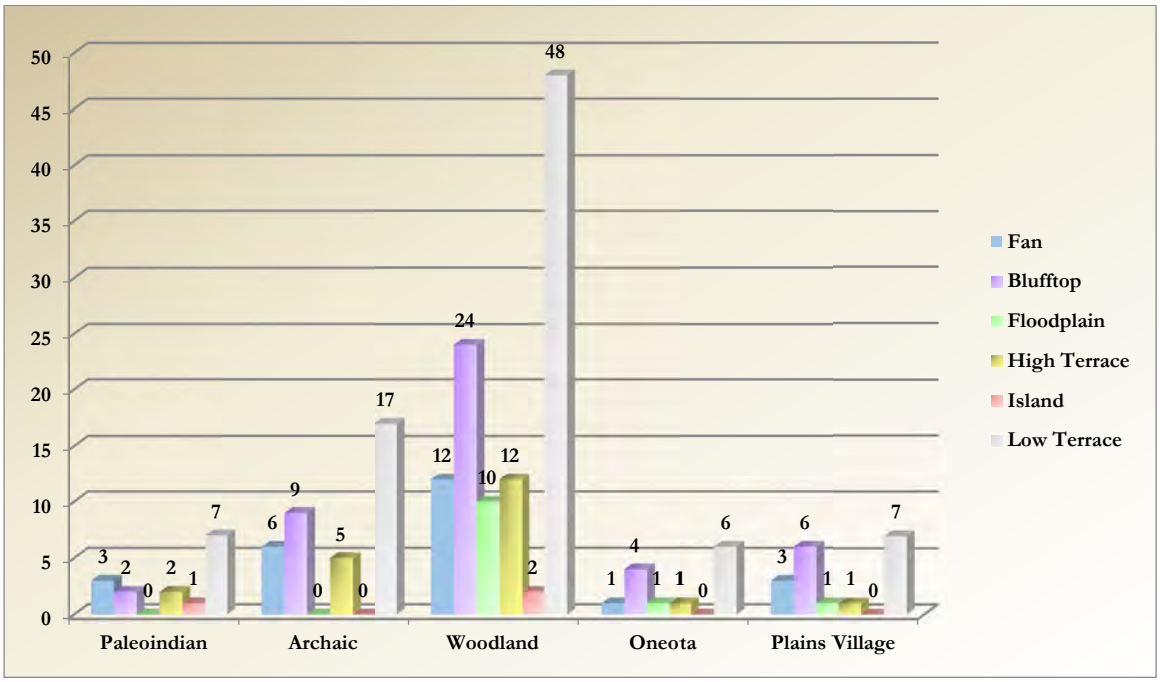


Figure 5. Graphic illustration of data presented in Table 8, above.

The database used here was assembled by Minnesota State Archaeologist, Scott Anfinson. He is not responsible for the interpretations offered here, and we thank him for providing the database for use in this report. It is also important to note that site locations were based on site form information which is sometimes variable in quality. Further, landforms had to be estimated from topographic maps and are best regarded as estimated identifications. The following observations are offered tentatively and as guides to future studies of Minnesota River valley archeology and site location.

1) For the earliest sites in the database, Paleoindian and Archaic, there are no components listed in the floodplain of the river. Sites from the later periods on the other hand, are represented in floodplain deposits. Any of several factors may be responsible for this. Perhaps water levels in the river were too high to accommodate any occupations from this early time period. Or, maybe early sites were eroded by the river. Also possible is that early sites were deeply buried by later alluvium and do not appear in near-surface contexts.

2) Almost 90 percent of single finds are on elevated landforms, including bluffs and terraces. None are on the floodplain. Earthworks are likewise found on elevations with only a single instance of an earthwork on the floodplain and none represented on islands. If single finds reflect travel routes or incidental passage, the pattern of abundance suggests that this off-site debris was commonly deposited by pedestrian travel that may

have been preferable outside the valley bottoms. High ground might also have been preferable since the terrace positions may have been more heavily populated, while the floodplain was either heavily wooded or more likely to feature settlements that might curtail overland travel.

3) Artifact scatters, that is, sites with both lithic and ceramic remains were located on all topographic positions. Since sites with ceramics are also sites from the periods postdating the Archaic, this finding dovetails with the conclusion reached in Observation 1, above.

4) Roughly 10–20 percent of the sites from all cultural periods are represented on fan deposits. It is unlikely that alluvial fans comprised a comparable fraction of the area within the Minnesota Valley, so it may be surmised that alluvial fans were favored localities for situating settlements in the prehistoric period.

5) The favored locations for sites of all types and cultural periods seem to be blufftops and low terraces. Even though about 57 percent of the components are Woodland, Table 8 seems to suggest that these landscape positions were preferred areas throughout the prehistoric period and for several different types of sites. Do note, however, that the high incidence of sites on blufftops is skewed by the very high number of earthworks rather than habitations. The lithic scatters common on blufftops may be primarily from earlier or preceramic periods. The single finds situated mostly on blufftops mentioned in item 2 above, may have been preceramic items representing off-site debris from these early periods, or perhaps indicators of upland travel during the ceramic period, when a higher number of sites are located on lower elevations.

6) Earthworks are not found on floodplains or islands but almost entirely on blufftops and terraces. Mounds were placed in locations where they could be seen. This is one of the most obvious of all the implications of the data presented in the tables.

7) The Minnesota River region is probably best known in archeology as the geographic center of the Cambria culture. Cambria is here classified as part of the Plains Village tradition, which in the database also includes Great Oasis and Big Stone phase sites. However, if we examine the tables we find that Plains Village sites are actually relatively rare, and furthermore that only a portion of those classified in this category actually comprise Cambria sites. Most Cambria is found at a few sites near Mankato. Plains Village sites clustered around Big Stone Lake are listed in the tables as Big Stone phase, but Saienga (21CP2) and Harbo Hill (21BE10) may be Cambria (Anfinson 1997:103; see also Holley and Michlovic 2013:83ff).

The Minnesota River Valley presents great potential for understanding Minnesota's prehistoric past. There is continuity between the Late Prehistoric and Early Historic periods that may deepen our understanding of both of these periods in regional history, as well as expand our appreciation for the stability of cultural adaptations in this portion of the Midwest and Plains. The similarity in the adaptation and settlement pattern found in the documented Historic period and that of the later portion of the Prehistoric period offer the opportunity to reason from the better known, more recent past, to the less well-known, older past. This was formerly known as the Direct Historical Approach, and it may be readily applied to the Minnesota River region. The similarity between the village adaptations of the Late Prehistoric period and those of the Historic period also lend support for the claims of an adaptational stability in southwestern Minnesota. There is also the geographical fact that the transit of the Minnesota River from western prairies to eastern woodlands allowed it to serve as a conduit for cultural influences in both directions, and work done so far indicates the penetration of eastern influences along the lower course of the river. The prevalence of eastern projectile point styles, and even of Havana ceramics at the Minneopa State Park sites, is one example. The predominance of the western prairie adaptation of bison hunting and Plains projectile point types, on the other hand, is well-attested at sites such as the Granite Falls Bison kill. While much still requires attention in the Valley, it is clear from the discoveries made already that the Minnesota River trench holds real promise for archeology in years to come.

3. PALEOENVIRONMENTS OF THE MINNESOTA RIVER VALLEY

INTRODUCTION

The Minnesota River Valley (MRV) extends across Minnesota from Big Stone Lake along the Minnesota/South Dakota border to the confluence of the Minnesota and Mississippi rivers near St. Paul. During the Pleistocene, the valley was repeatedly glaciated. Glacial lobes flowing down the valley built moraines on either side on pre-glacial bedrock highs. During the late-Wisconsin, the Des Moines lobe flowed down the valley building a series of moraines dating to ~17,000 cal yr B.P. (~14,000 RCYBP). Ice retreated rapidly from this position, and the valley was deglaciated by ~15,500 cal yr B.P. (~13,000 RCYBP) (Dyke et al. 2003; Hobbs and Goebel 1982; Wright et al. 1973). From its source at Big Stone Lake to Mankato, the MRV traverses a broad plain of ground moraine, the Olivia Till Plain to the northeast and the Blue Earth Till Plain to the southwest. At Mankato, the MRV turns sharply north, then northeastward, where it cuts through the Des Moines stagnation and end moraines of the Owatonna Moraine Area and finally the Eastern St. Croix Moraine deposited by the Superior Lobe (Wright 1972a).

The continental divide lies between Big Stone Lake and Traverse Lake along the Minnesota/South Dakota border. Following deglaciation of the MRV, ice still lay to the north, forming a dam for Glacial Lake Agassiz, which existed for ~5,200 years, from ~13,700–8400 cal yr B.P. (10,900–7700 RCYBP). The southern outlet of Lake Agassiz was Glacial River Warren, which flowed down the MRV. The level of Lake Agassiz varied repeatedly due to erosion of the southern outlet, the opening of new outlets to the north, readvancement of the Laurentide Ice Sheet, and isostatic rebound. The longest period during which the southern outlet was active was the Lockhart phase dating to ~13,670–12,740 cal yr B.P. (~11,800–10,900 RCYBP). The outlet was active again briefly during the early Emerson phase ~11,600 cal yr B.P. (~10,100 RCYBP) and for three additional periods, with final abandonment during the early Nipigon phase ~10,500 cal yr B.P. (~9300 RCYBP) (Lepper et al. 2007; Leverington and Teller 2003; Teller and Leverington 2004). The modern Minnesota River is underfit, or undersized relative to its valley, which was carved by Glacial River Warren, which carried very large volumes of water when the southern outlet of Lake Agassiz was active.

At the time of European settlement in the nineteenth century, tallgrass prairie covered the broad till plains northwest of Mankato (Figure 6). From Mankato until the Minnesota River turns more northeastward, the MRV formed the southwest boundary of the Big Woods, a large area of mesic deciduous forest dominated by elm (*Ulmus* spp.), oak (*Quercus* spp.), sugar maple (*Acer saccharum*), and basswood (*Tilia americana*). The valley and river formed an effective firebreak, protecting the fire-sensitive trees of the Big Woods (Grimm 1984). The MRV then turns northeastward through the Big Woods and the Owatonna Moraine complex.

PALEOENVIRONMENTS

A number of sites proximal to the MRV provide a history of paleoenvironments (Table 9; see Figure 6), including some of the earliest palynological sites in Minnesota (Buhta et al. 2011). The data for these sites are available from the Neotoma Paleoecology Database (www.neotomadb.org), except for Fish Lake and Madelia, which were assembled by Grimm (2011).

Unfortunately, most of these sites are not well-dated. The older sites have only bulk-sediment radiocarbon dates, which suffer from an old-carbon reservoir effect owing to both dissolved carbonate in the groundwater (the "hardwater" effect) and from carbon in carbonaceous rocks, particularly shales (Grimm et al. 2009). Only three sites (Fish Lake, Kimble Pond, and Sharkey Lake) have AMS radiocarbon dates on terrestrial macrofossils, which are generally reliable. Only Fish Lake has a well-dated late-glacial section. Because of these problems together with the generally large errors on the older conventional radiocarbon dates, the dating accuracy available for this review is probably no better than several hundred years.

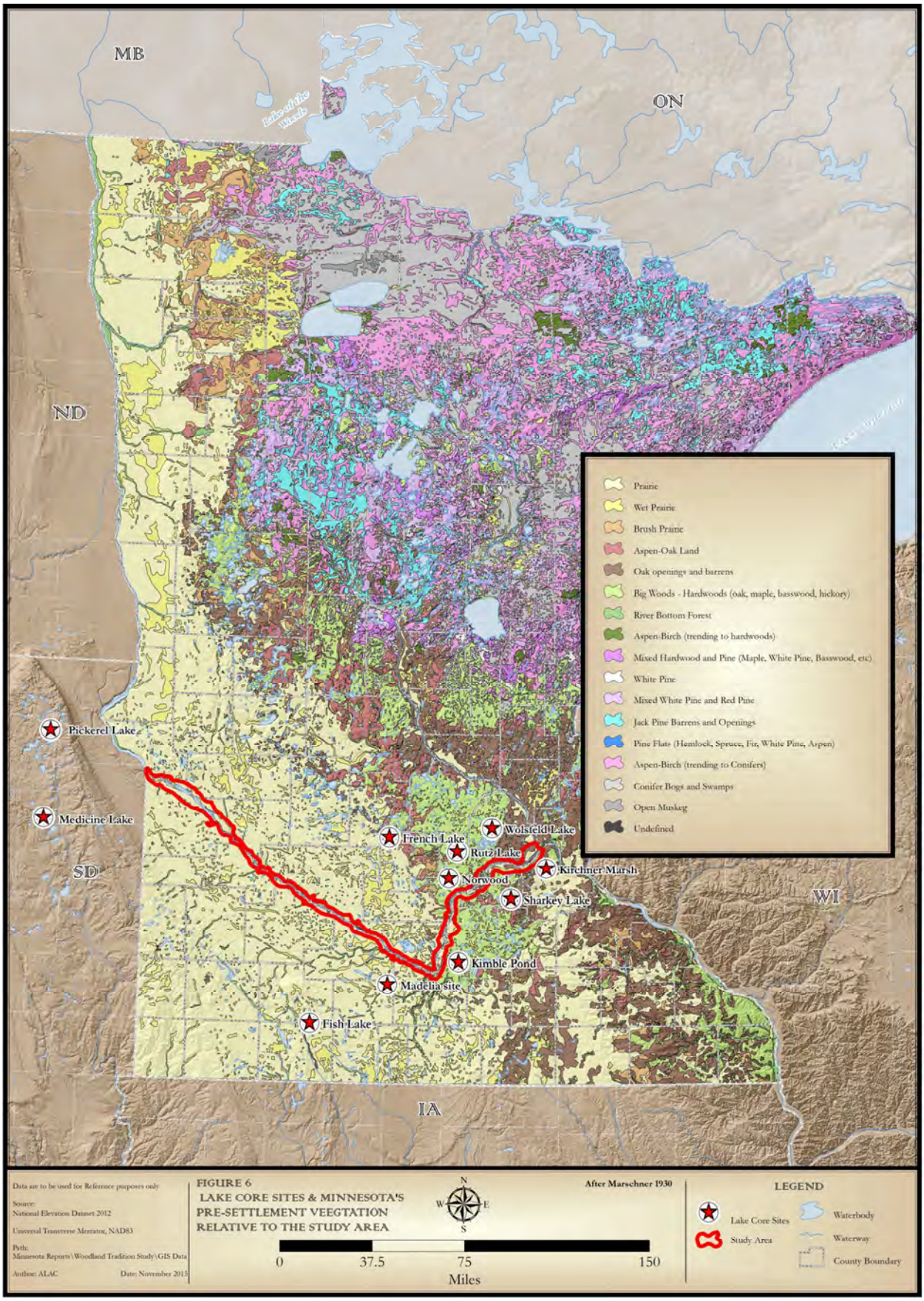

MB
ON
ND
SD
WI
IA
Lake of the Woods
Pickerel Lake
Medicine Lake
French Lake
Wolsfeld Lake
Rutz Lake
Kirchner Marsh
Norwood
Sharkey Lake
Kimble Pond
Madelia site
Fish Lake
Prairie
Wet Prairie
Brush Prairie
Aspen-Oak Land
Oak openings and barrens
Big Woods - Hardwoods (oak, maple, basswood, hickory)
River Bottom Forest
Aspen-Birch (trending to hardwoods)
Mixed Hardwood and Pine (Maple, White Pine, Basswood, etc)
White Pine
Mixed White Pine and Red Pine
Jack Pine Barrens and Openings
Pine Flats (Hemlock, Spruce, Fir, White Pine, Aspen)
Aspen-Birch (trending to Conifers)
Conifer Bogs and Swamps
Open Muskeg
Undefined
Data are to be used for Reference purposes only
Source:
National Elevation Dataset 2012
Universal Transverse Mercator, NAD83
Path:
Minnesota Reports\Woodland Tradition Study\GIS Data
Author: ALAC
Date: November 2015
FIGURE 6
LAKE CORE SITES & MINNESOTA'S
PRE-SETTLEMENT VEEGTATION
RELATIVE TO THE STUDY AREA
N
W
E
S
After Marschner 1930
0
37.5
75
150
Miles
LEGEND
Lake Core Sites
Study Area
Waterbody
Waterway
County Boundary

Table 9. Paleoecological Sites in Proximity to the Minnesota River Valley.

Site Name	Latitude	Longitude	Reference
Fish Lake	43.8472	-95.0443	(Buhta et al. 2011)
French Lake	44.9458	-94.4207	(Grimm 1983)
Kimble Pond	44.2190	-93.8402	(Camill et al. 2003; Geiss et al. 2003)
Kirchner Marsh	44.7709	-93.1226	(Wright et al. 1963)
Madelia site	44.0833	-94.4167	(Jelgersma 1962)
Medicine Lake	44.9842	-97.3501	(Radle 1981)
Norwood site	44.7093	-93.9268	(Ashworth et al. 1981)
Pickerel Lake	45.5014	-97.2768	(Watts and Bright 1968)
Rutz Lake	44.8708	-93.8590	(Waddington 1969)
Sharkey Lake	44.5924	-93.4132	(Camill et al. 2003; Geiss et al. 2003)
Wolsfeld Lake	45.0050	-93.5727	(Grimm 1983)

The oldest palynological records are from the Madelia (Jelgersma 1962) and Norwood (Ashworth et al. 1981) sites. Basal pollen zones at Madelia (Figure 7) and Norwood are dominated by sedges (*Cyperaceae*). Scattered grains of tundra plants, such as purple saxifrage (*Saxifraga oppositifolia*), also occur at Madelia (Jelgersma 1962), and leaves of mountain avens (*Dryas integrifolia*) occur at Norwood. These plants represent a tundra-like vegetation in the region, much of which may have covered superglacial deposits such as those described by Curry et al. (2010) in northeastern Illinois. Pollen and macrofossils of spruce (*Picea*) and other woody plants (e.g., bearberry – *Arctostaphylos uva-ursi,* silverberry – *Elaeagnus commutata*, buffaloberry – *Shepherdia canadensis*) indicate a forest-tundra vegetation rather than pure tundra. The estimated age of >16,000 cal yr B.P. for the base of this zone at Madelia is extrapolated from the lowermost calibrated median age of 14,942 cal yr B.P. (12,650 ± 350 RCYBP) on bulk lake sediment and may be too old. However, at Norwood, wood in a peat layer immediately above the forest-tundra zone dated to 12,400 ± 60 RCYBP (95.4 percent range 14,859–14,145 cal yr B.P., median 14,477 cal yr B.P.), indicating that the forest-tundra existed before ~14,500 cal yr B.P.). Fossil insects recovered from Norwood have forest-tundra, boreal forest, and western affinities with no modern analog, but indicate a primarily boreal forest climate. Thus, Ashworth et al. (1981) interpret the tundra-like vegetation as being primarily successional in nature.

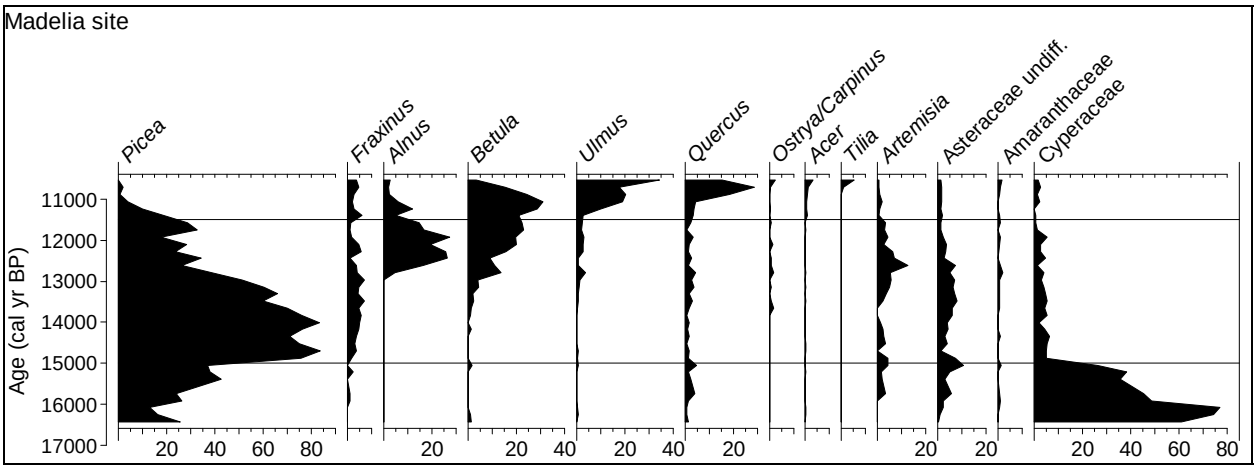


Figure 7. Pollen diagram from the Madelia site.

Buried ice in stagnation and end moraines took some time to melt, and most kettle lakes developed after spruce had covered the landscape several hundred years after initial deglaciation. These sites include Pickerel Lake and Medicine Lake to the west of the MRV; Fish Lake to the south; and Rutz Lake, Wolsfeld Lake, Kimble Pond, Sharkey Lake, and Kirchner Marsh to the east and northeast. Along with Madelia, only Fish Lake (Figure 8) and Kirchner Marsh (Figure 9) extend very deeply into the late-glacial spruce zone and have much detail; only Fish Lake is well-dated with AMS

dates on terrestrial macrofossils. These sites show spruce (*Picea*) pollen percentages up to 80 percent from ~15,000 to 13,000 cal yr B.P. Spruce then declines gradually, disappearing ~12,000 cal yr B.P., at the Pleistocene/Holocene boundary. Black ash (*Fraxinus nigra*) also occurred with spruce and is the preeminent deciduous member of the late-glacial no-analog forest in the upper Midwest. Modeling studies in northern Illinois indicate that this vegetation resulted from cool, wet climate, especially wet winter climate (Gonzales et al. 2009). In northern Illinois, the Younger Dryas Chronozone is clearly evident in the pollen record through an increase in spruce pollen and a decrease in black ash. Although not as marked in the Minnesota sites, all three of the high-resolution records (Madelia, Fish, Kirchner) do show minimal spruce values somewhat after 13,000 cal yr B.P. with a slight increase afterward, consistent with the Younger Dryas pattern seen in Illinois. The Pleistocene/Holocene transition is marked by peaks of birch (*Betula*) and alder (*Alnus*), which may be partly successional in nature as spruce quickly died out at the end of the Pleistocene, presumably with rapidly increasing temperatures. Thus, throughout the late-glacial through essentially the Bølling, Allerød, and Younger Dryas Chronozones, spruce forest with an admixture of deciduous trees covered the entire MRV. Climate was cool and wet.

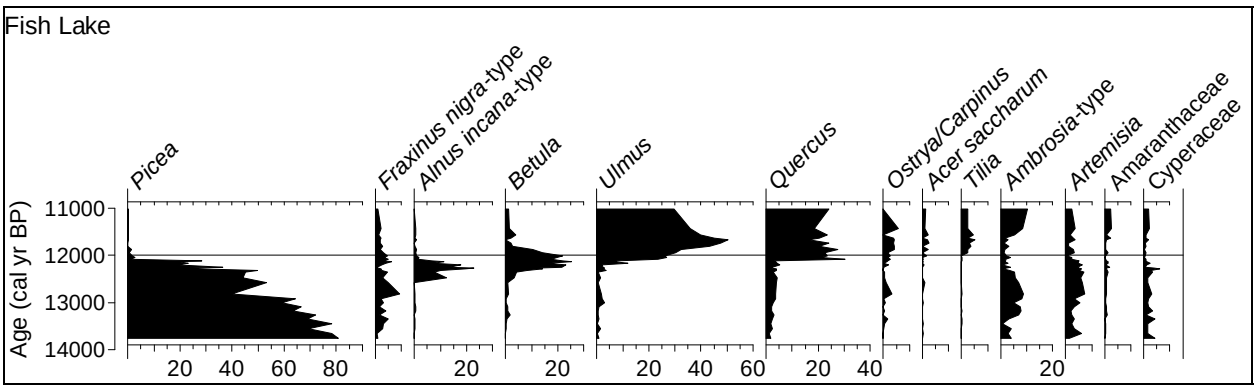


Figure 8. Pollen diagram from Fish Lake.

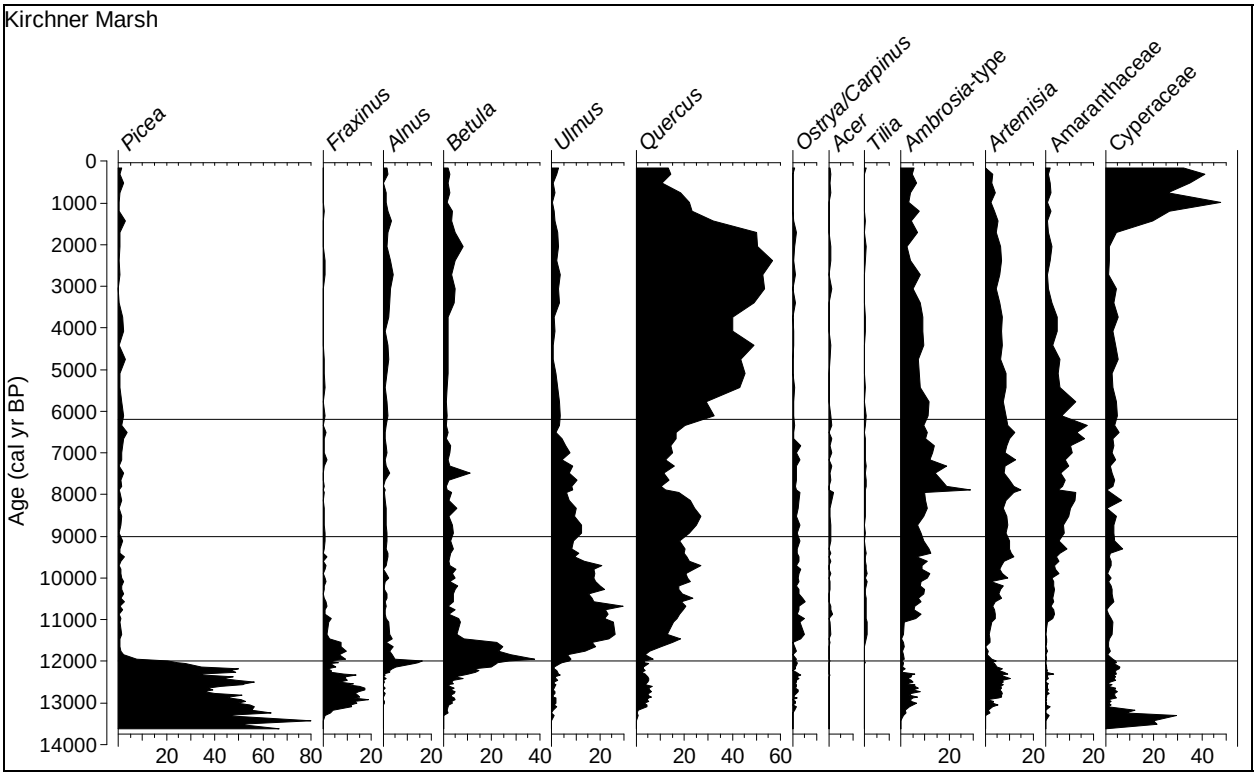


Figure 9. Pollen diagram from Kirchner Marsh.

The peaks of birch and alder at the Pleistocene/Holocene transition evident at Fish Lake and Kirchner Marsh occur across the entire region as far west as Pickerel Lake (Figure 10) and Medicine Lake (Figure 11) on the Prairie Coteau in South Dakota. These peaks are followed by increases in elm (*Ulmus*) and oak (*Quercus*) pollen, marking a transition to mesic deciduous forest in the early Holocene. This deciduous forest phase was shorter lived in the western part of the area. It is not very well-dated at Pickerel and Medicine lakes, but this phase ended by 10,000 cal yr B.P. or earlier. At the easternmost site, Kirchner Marsh, elm declined ~10,000 cal yr B.P., but remained a significant member of the forest until ~7000 cal yr B.P. Oak declined ~8000 cal yr B.P. at Kirchner. At Kimble Pond (Figure 12), Sharkey Lake (Figure 13), and Wolsfeld Lake (Figure 14), elm and oak also show a similar pattern of decreasing before 10,000 cal yr B.P.; however, they maintain significant values until 8000–7000 cal yr B.P.

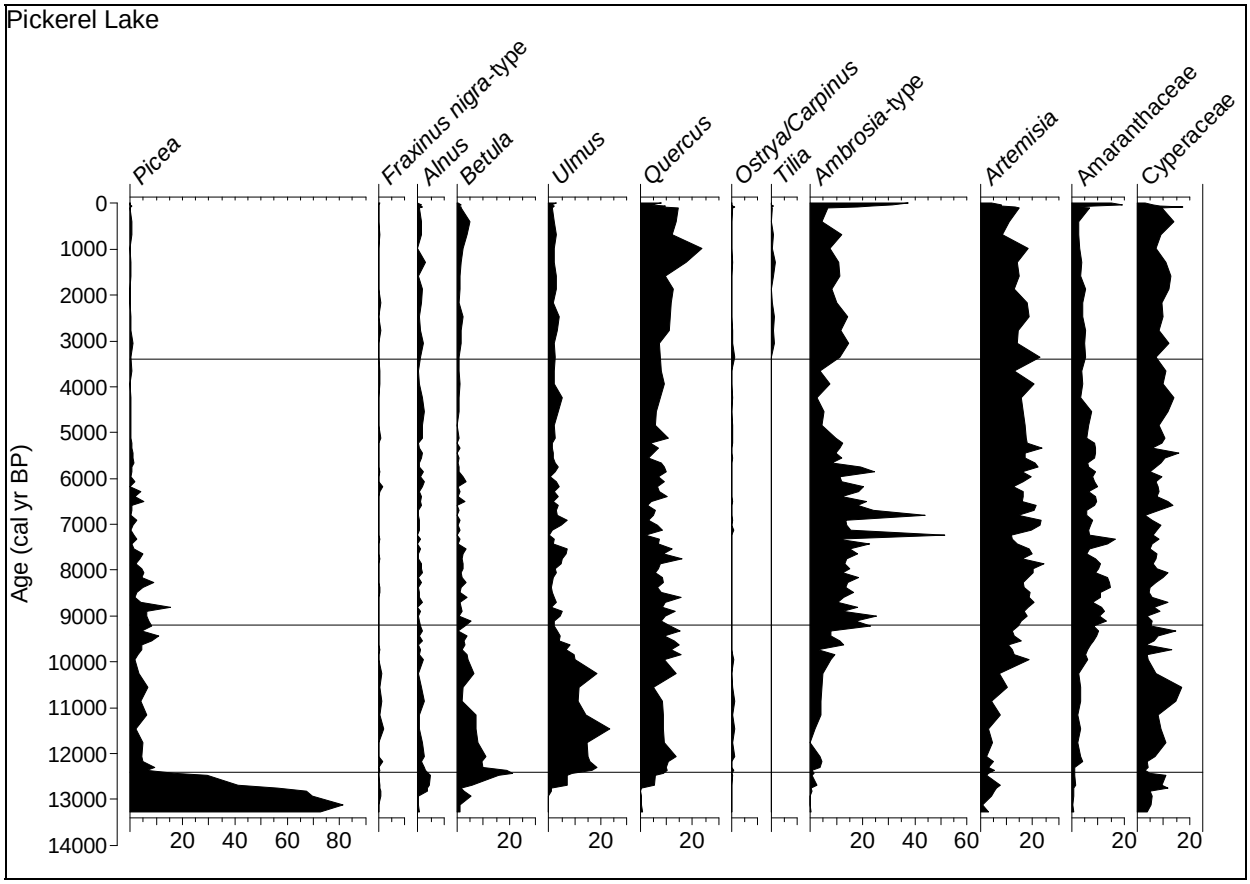


Figure 10. Pollen diagram from Pickerel Lake.

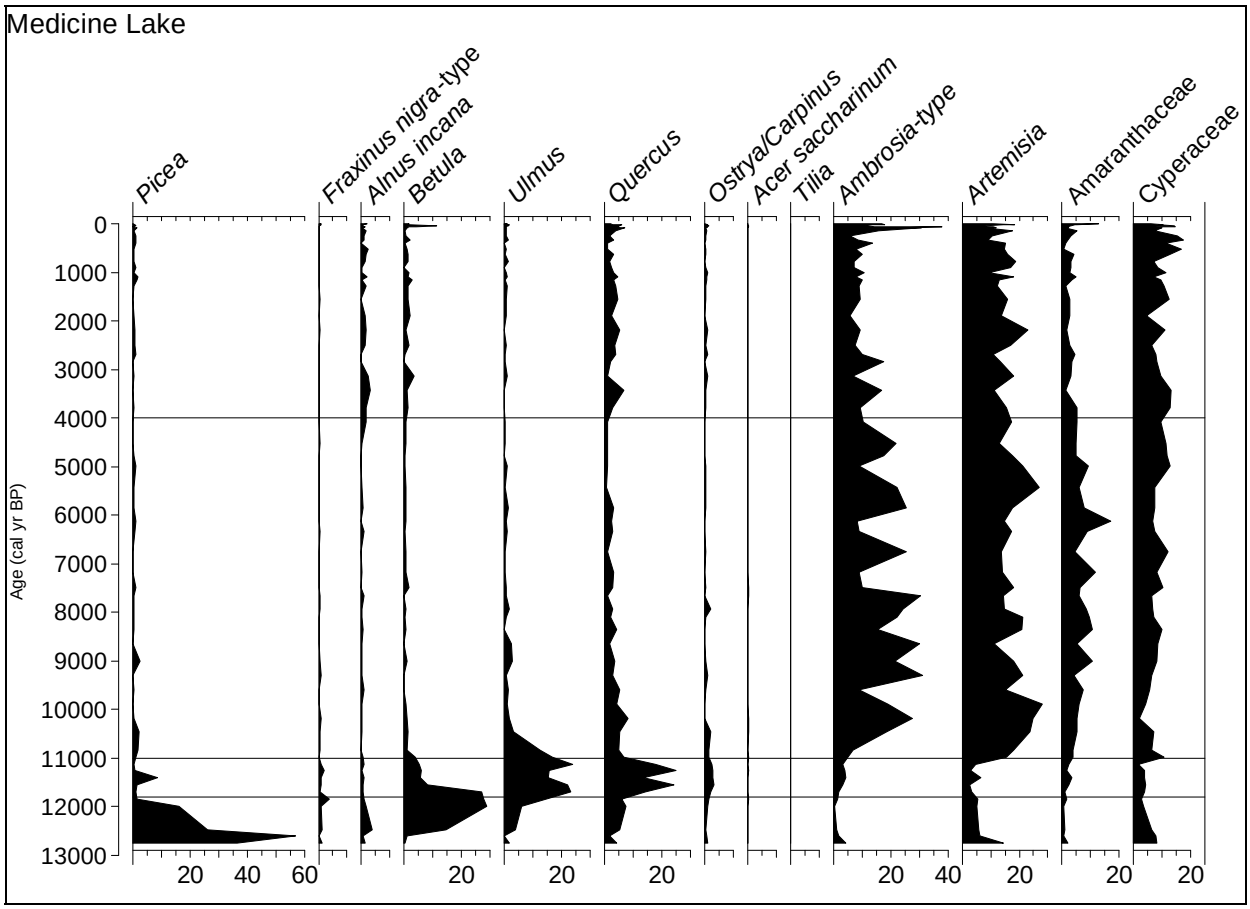


Figure 11. Pollen diagram from Medicine Lake.

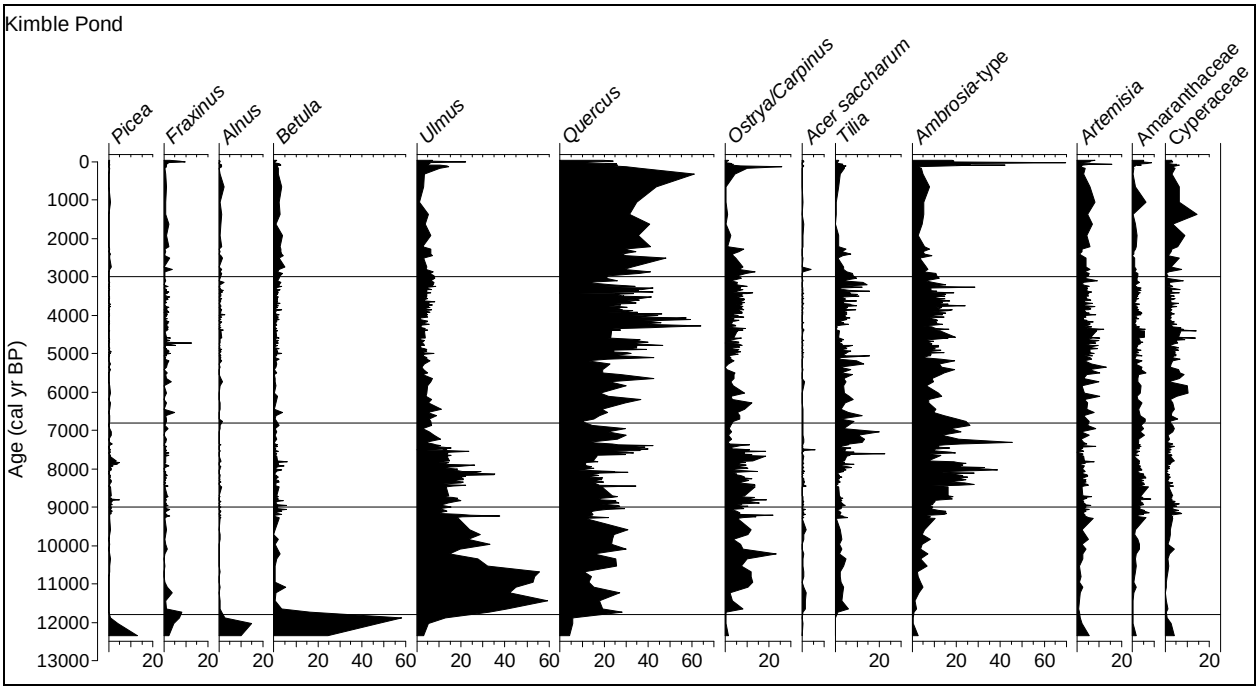


Figure 12. Pollen diagram from Kimble Pond.

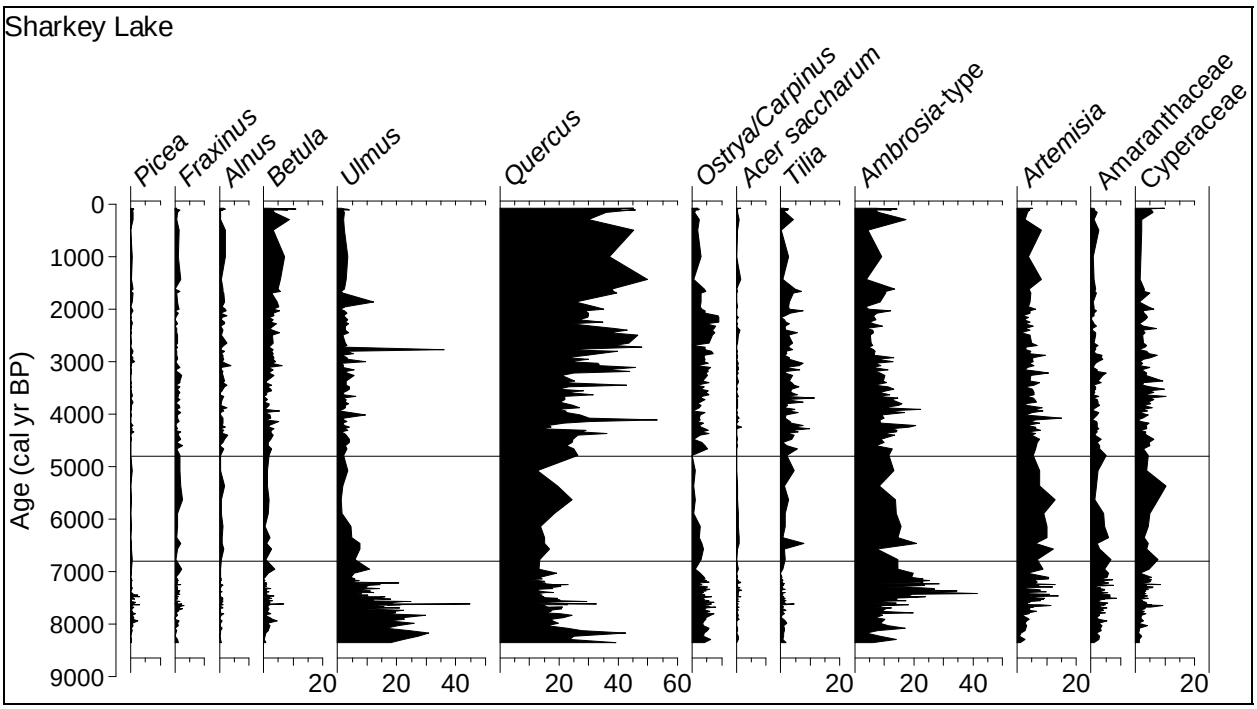


Figure 13. Pollen diagram from Sharkey Lake. This diagram extends to the spruce zone, but has few samples with uncertain dating, so has been truncated to the section more securely dated.

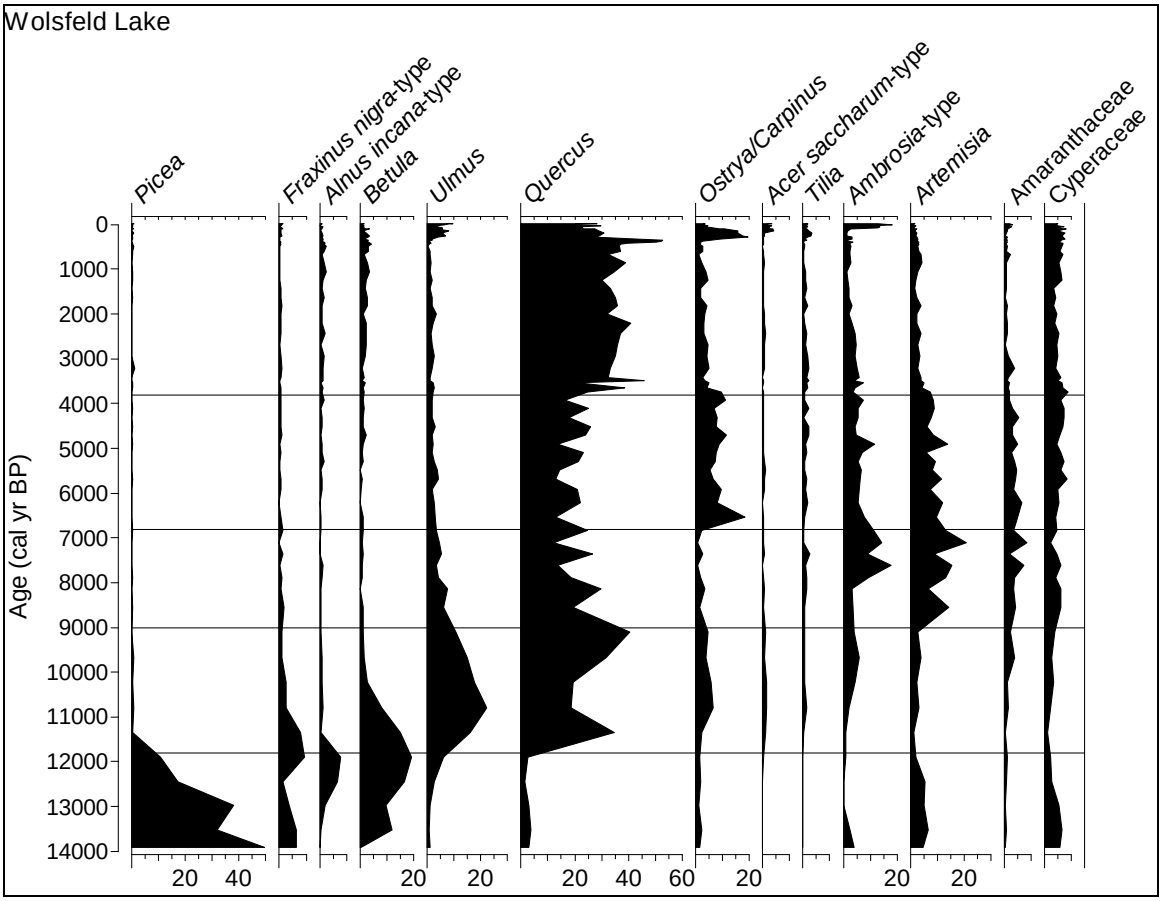


Figure 14. Pollen diagram from Wolsfeld Lake.

Across the entire region, prairie expanded as deciduous elements declined between 11,000 and 10,000 cal yr B.P. At the western sites, Pickerel Lake and Medicine Lake, deciduous forest completely disappeared except perhaps for small groves near lakes as today; whereas in the eastern part of the region significant areas of forest remained, especially near Wolsfeld Lake and Kimble Pond. Thus, deciduous forest covered the area in the early Holocene, and then was gradually replaced by prairie beginning ~11,000 cal yr B.P. in the west. In the eastern part of the area, some sites show more development of prairie than others, suggesting the development of a prairie/forest mosaic, with forest and mesic trees persisting in areas more protected from fire.

Several sites across the region show a transition ~9000 cal yr B.P. to maximal prairie development, including Pickerel Lake, Kimble Pond, Wolsfeld Lake, and Rutz Lake (Figure 15). At Kirchner Marsh, maximal development appears delayed until ~8000 cal yr B.P., but the bulk sediment dates have not been corrected for a reservoir effect, so this transition could well be closer to 9000 cal yr B.P. At Kettle Lake, a very well-dated site in northwestern North Dakota, a multiproxy study of pollen, mineralogy, and charcoal indicates a major drought ~9250 cal yr B.P. possibly related to a sudden drop and northward retreat of Lake Agassiz (Grimm et al. 2011). The maximal development of prairie across the MRV at ~9000 cal yr B.P. is consistent with this date.

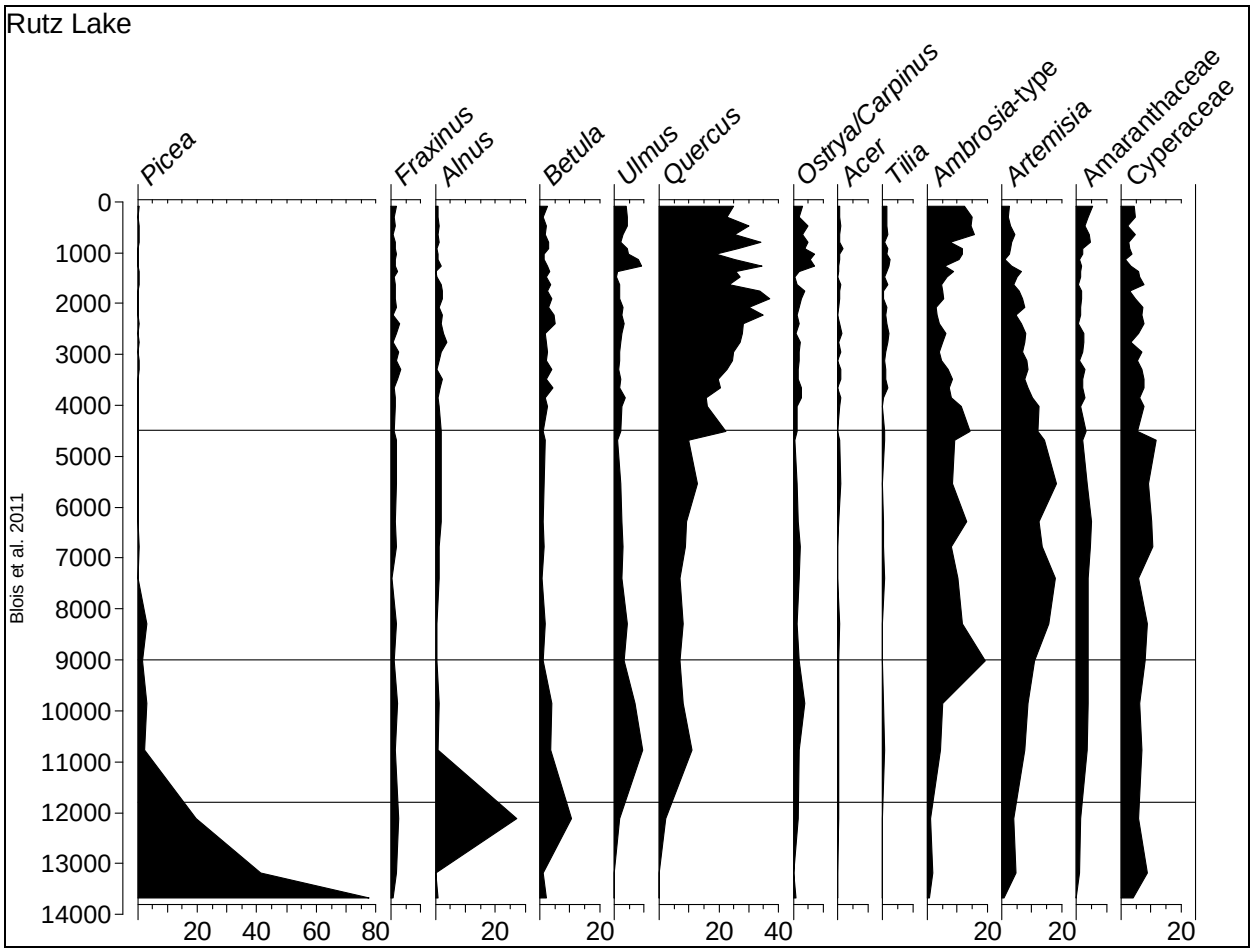


Figure 15 Pollen diagram from Rutz Lake.

The mid-Holocene from ~9000 to 4000 cal yr B.P. was the driest, and probably the warmest, time of the Holocene. Prairie completely dominated the landscape in the western portion of the region and expanded in the eastern Big Woods portion. However, significant areas of forest or woodland persisted in the Big Woods area, perhaps similar to the modern vegetation on the Alexandria Moraine northwest of French Lake (Figure 16). Kimble Pond is remarkable in that mesic taxa hornbeam (*Ostrya/Carpinus*) and basswood (*Tilia*) maintain high percentages throughout the mid-Holocene, indicating that some patches of mesic Big Woods-type forest persisted throughout this period. Again, this

pattern is reminiscent of that on the Alexandria Moraine, where small patches of mesic forest formed islands west of the main prairie-forest border (see Figure 6). Kimble Pond is also notable in that it is a high-resolution record that shows considerable variability in the percentages of woody taxa, including *Quercus*, *Ostrya/Carpinus*, and *Tilia*, along with the prairie taxa such as *Ambrosia*-type. This high variability has long been noted in prairie sites farther west, and has been particularly investigated in detail at Kettle Lake (Grimm et al. 2011), where it is tied to high-frequency moisture cycles. The Kimble Pond record suggests that this high variability also extended across the MRV region, and the cycling of deciduous tree taxa suggests a strong vegetation-fire feedback with climate as do the charcoal data themselves (Camill et al. 2003).

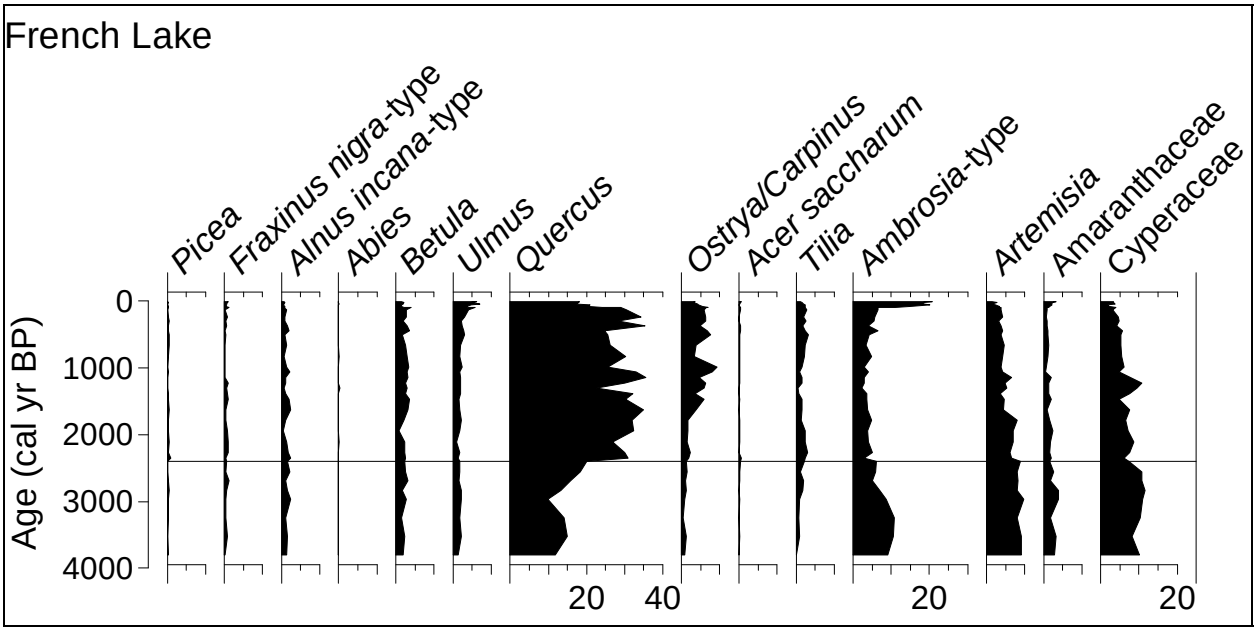


Figure 16. Pollen diagram from French Lake.

In the eastern portion of the region, the Big Woods area, forest or woodland began to reinvade prairie and mesic taxa expanded within the wooded area beginning as early as ~8000 cal yr B.P. However, the timing and nature of forest expansion varied greatly across the region. At Kimble Pond, *Tilia* increased ~8000 cal yr B.P. At Wolsfeld Lake, *Ostrya/Carpinus* increased just after 7000 cal yr B.P., but *Quercus* not until ~4000 cal yr B.P. At Sharkey Lake, *Quercus*, *Ostrya/Carpinus*, and *Tilia* increased ~5000 cal yr B.P. At Kirchner Marsh, *Quercus* increased ~6000 cal yr B.P., but this age may be somewhat too old. At Rutz Lake, *Quercus* expanded ~4500 cal yr B.P., and at French Lake, near the northwestern margin of the Big Woods, *Quercus* expanded ~2400 cal yr B.P. Thus, the expansion of woodland or forest and expansion of more mesic trees within the forest began as early as 8000 cal yr B.P. and continued to at least 2400 cal yr B.P. Whereas the demise of forest in the early Holocene was quite sudden across the region, the reforestation following maximal drought ~9000–8000 cal yr B.P. was gradual. This "asymmetric" vegetation response has been noted by others (Umbanhowar et al. 2006; Williams et al. 2009) and is ascribed to feedback relationships with climate and fire, with fire promoting prairie expansion during drought but inhibiting reforestation as moisture increases along with prairie fuel loads.

Although the region west of the Big Woods remained in prairie throughout the Holocene, patches of woodland and mesic trees did expand somewhat on the Prairie Coteau, presumably around lakes and in ravines protected from fire. *Quercus* increased at Medicine Lake after ~4000 cal yr B.P., and *Tilia* increased at Pickerel Lake after ~3000 cal yr B.P.

By ~2400 cal yr B.P., the modern pattern of prairie and forest in the MRV region was well-established. The most significant change in the past two millennia was the development of the modern Big Woods 400–300 years ago (Grimm 1983). This development, first noted by McAndrews (1968) from a transect of short cores across the Big Woods, is seen in greatest detail at Wolsfeld Lake, where first oak (*Quercus*) increases to its largest postglacial values, then the mesic, fire-sensitive trees elm (*Ulmus*), hornbeam (*Ostrya/Carpinus*), sugar maple (*Acer saccharum*), and

basswood (*Tilia*) all expand. All of these taxa occurred throughout the area during the entire Holocene, so no migration was involved, but rather a rapid expansion from small, but widespread protected areas. Most of the mesic taxa, particularly *Ostrya/Carpinus* and *Tilia*, reached Big Woods levels at various sites throughout the Big Woods during the Holocene, but the expansion of *Ulmus* is the greatest since the early Holocene, except at Sharkey Lake, where Big Woods vegetation seems to have persisted periodically throughout the mid- and late-Holocene. The expansion of these fire-sensitive trees and of *Ulmus*, which prefers more poorly drained soils, suggests not only a decrease in fire frequency, but also an increase in effective moisture coincident with the Little Ice Age.

Europeans rapidly settled the area after A.D. 1850 (100 cal yr B.P.), converting most of the region into agricultural and urban use. The prairies were tiled, drained, and converted to agricultural land. The Big Woods was mostly deforested. An increase in *Ambrosia* pollen is the principal indicator of this change, although minor cereal grains and other introduced plants such as alfalfa (*Medicago*) and sweetclover (*Melilotus*) also appear (Grimm 1983).

SUMMARY

The postglacial climate and vegetation history of the MRV region may be divided into seven phases.

16,000–15,000 cal yr B.P. – Forest-tundra evident at two sites (Madelia and Norwood) in the eastern part of the region. Climate was cool, but fossil beetle data suggest not as cold as modern tundra, so vegetation may have been primarily successional in nature.

15,000–12,000 cal yr B.P. – Spruce forest with an admixture of deciduous trees, especially black ash, covers the entire region. Spruce gradually declines in the upper part of this zone and, at the more highly resolved sites, shows a minor increase during the Younger Dryas. Spruce suddenly declines and disappears at the end of this period, with peaks of birch and alder at the Pleistocene/Holocene transition. Climate was cool and wet.

12,000–9000 cal yr B.P. – Expansion of deciduous forest dominated by elm and oak after the decline of spruce. Prairie begins to expand in the western part of the area. Elm and oak gradually decline.

9000–8000 cal yr B.P. – Rapid expansion of prairie and decline of woody taxa across the region, with maximal prairie development. This period was the driest of the Holocene.

8000–2400 cal yr B.P. – Gradual expansion of woody cover and of mesic taxa within wooded areas in the Big Woods region, at most sites between ~6000 and 4000 cal yr B.P. Climate gradually becoming wetter, but highly variable throughout much of this period. Strong positive feedbacks between climate, fire, and vegetation controlling forest invasion of prairie. Extensive forest does not develop in the western part of the region. Wooded areas around lakes in in ravines expand on the Prairie Coteau.

2400–400 cal yr B.P. – The modern distribution of forest and prairie established, although not the modern composition of forest. Climate generally similar to today.

400–100 cal yr B.P. – Development of mesic, fire-sensitive forest with dominants of elm, sugar maple, basswood, and hornbeam along with oak throughout the Big Woods area.

4. Archeological Field Investigations

Field Methodology

Fieldwork was conducted over 12 sessions from September 17, 2014 to October 30, 2015. Investigations consisted of complementary archeological and geomorphological components. The archeological component included inventory survey and evaluative testing subcomponents. Thirty land parcels were investigated as part of the combined study (Tables 10 and 11; Figures 17–35). Additional areas were visited but were ultimately not subjected to formal pedestrian surveys due to poor ground surface visibility or lack of access permission; these areas were not assigned formal parcel numbers (see for example Figures 23 and 32). In the investigated parcels, 1,446.24 acres were surveyed archeologically; seven previously unrecorded sites were documented and 10 previously recorded sites were revisited during the survey. Additionally, subsurface testing was undertaken at site 21LP11. Eight soil cores were also recovered and test unit profiles were examined at site 21LP11; the geomorphological study is the subject of Chapter 5.

Table 10. Summary of Parcels Surveyed in the Minnesota River Trench.

Parcel No.	Landform Sediment Assemblage(s)	Acreage (Total)	Modeled Site Probability	New Site Identified‡
1	Colluvial Slope	12.32	H – 57%; M – 43%	No
	Floodplain	75.21		No (1 soil core)
	Marginal Channel	02.35		No
	Meander Belt	01.87		No
		(91.75)		
2	Erosional Residual	32.13	H – 5%; M – 95%	Yes – 21LP44
	Floodplain	04.03		No
		(36.16)		
3	Erosional Residual	50.74	M – 100%	No
	Floodplain	01.14		No
		(51.88)		
4	Bar	00.77	H – 62%; M – 38%	No*
	Floodplain	00.26		No
	Terrace	43.60		No
		(44.63)		
5	Alluvial Fan	18.06	H – 86%; M – 14%	No* (2 soil cores)
	Colluvial Slope	02.07		No
	Marginal Channel	17.89		No
		(38.02)		
6	Erosional Residual	03.48	H – 100%	No* (soils profiled)
	Bar	00.59		No* (soils profiled)
		(4.07)		
7	Alluvial Fan	00.64	M – 100%	No (soil core taken)
		(0.64)		
8	Upland Bluff	40.84	H – 87%; M – 13%	Yes – 21RN42
		(40.84)		
9	Alluvial Fan	53.54	H – 100%	Yes – 21BW112*
	Floodplain	10.41		
	Terrace	02.09		
		(66.04)		
10	Alluvial Fan	11.84	H – 100%	No*
		(11.84)		
11	Upland Bluff	08.19	H – 100%	No*
		(8.19)		
12	Alluvial Fan	36.39	H – 100%	No (2 soil cores)
	Colluvial Slope	01.27		
		(37.66)		

*** Previously recorded site present.**
‡ Not listed are sites 21LE150 and 21NL149, three reported site localities and one soil core as they are not in a formally surveyed parcel.

Table 10 (continued).

Parcel No.	Landform Sediment Assemblage(s)	Acreage	Modeled Site Probability	New Site Identified
13	Alluvial Fan	8.70	H – 84%; M – 16%	No (1 soil core)
	Colluvial Slope	0.85		No
	Terrace	1.24		No
		(10.79)		
14	Floodplain	4.49	H – 32%; M – 68%	No
		(4.49)		
15	Alluvial Fan	16.84	H – 87%; M – 13%	No
		(16.84)		
16	Upland Bluff Slopes	14.10	H – 2%; M – 98%	Yes – 21NL150
		(14.10)		
17	Bar	52.97	L – 29%; M – 71%	No
		(52.97)		
18	Bar	122.92	L – 94%; M – 6%	No
		(122.92)		
19	Bar	63.17	L – 87%; M – 13%	No*
		(63.17)		
20	Bar	35.90	H – 24%; M – 76%	No
		(35.90)		
21	Unmapped (Terrace)	141.04	Unknown – 100%	No
		(141.04)		
22	Upland Bluff	2.76	H – 66%; M – 10%; Unknown – 24%	No‡ – but 21LE144 is immediately adjacent
		(2.76)		
23	Upland Bluff	14.64	H – 9%; M – 8%; L – 1%; Unknown – 82%	No
		(14.64)		
24	Upland Bluff	73.87	H – 21%; M – 12%; L – 2%; Unknown – 65%	No
		(73.87)		
25	Alluvial Fan	2.87	H – 100%	No
	Floodplain	13.13		No
		(16.00)		
26	Unmapped (Upland Bluff)	97.77	H – 8%; M – 3%; Unknown – 89%	Yes – 21LE148
		(97.77)		
27	Alluvial Fan	16.73	H – 38%; M – 61%; L – 1%	No
		(16.73)		
28	Marginal Channel	1.03	H – 19%; M – 81%	No
	Terrace	4.40		No†
		(5.43)		
29	Alluvial Fan	72.16	L – 32%; Unknown – 68%	No
	Colluvial Slope	1.78		No
	Marginal Channel	53.71		No
		(127.65)		
30	Unmapped (Alluvial Fan; Terrace; Marginal Channel)	40.08	M – 1%; L – 37%; Unknown – 62%	No
		121.61		No
		35.76		No
		(197.45)		

*** Previously recorded site present.**
† Site reported by area informant.
‡ Previously recorded site *and* reported site area in same location immediately adjacent to this parcel.

As was previously mentioned (see Chapter 1, page 4, above), although a combination of probabilistic and non-probabilistic methodology was utilized in the survey parcel selection process, the focus was primarily directed towards the maximization of previously undocumented site discovery. It was initially felt that some degree of random sampling would be ideal. However, it soon became apparent that, due to a number of factors such as landowner permission, crop harvest schedule, weather, and time, a random sampling strategy would be too cumbersome to effectively and

efficiently employ while adhering to the primary objective of maximizing site discovery. Instead, the process of selecting survey parcels focused more on attempts to target a variety of different landform settings in areas of high modeled surface and near-surface site potential. Landforms currently modeled as *unknown* site potential were also targeted for the purpose of expanding model data coverage. Table 10, above, provides the division of surveyed parcel acreage by LfSA and classifies each parcel by its modeled site probability; newly identified sites, where present, are noted.

Table 11. Acres Surveyed by Mapped Landform Sediment Assemblage.

Landform Sediment Assemblage (LfSA)	Acres Surveyed (Percent of Total)
Alluvial Fan	277.85 (19.21)
Bar	276.32 (19.11)
Colluvial Slope	18.29 (1.26)
Erosional Residual	86.35 (5.97)
Floodplain	108.67 (7.51)
Marginal Channel	110.74 (7.66)
Meander Belt	1.87 (0.13)
Terrace	313.98 (21.71)
Upland Bluff	252.17 (17.44)
Total	**1,446.24 (100.00)**

The original survey sampling design was intended to reflect a variety of different landforms evenly distributed throughout the valley. While a variety of different landforms were, indeed, investigated (see Table 11), there are some gaps in parcel distribution within the study area. In particular, survey coverage in the lowermost reaches of the valley, as well as in the upper valley between survey Parcels 3 and 5, is lacking (see Figure 17). In the lower valley, much of the land is either not conducive to pedestrian survey (e.g., low marshland, uncultivated government tracts with no ground surface visibility, developed, airport property) or was previously surveyed. In the upper valley between Parcels 3 and 4, the area along Swift County was not targeted because it was previously investigated by Holley et al. (2011). Other properties within and downstream of BSNWR lacked parcels with adequate ground surface visibility and/or are presently inundated through previous stream damming. Downstream of Montevideo, the Upper Sioux Agency State Park was visited; however, lands in the park also lacked adequate ground surface visibility and a formal parcel number was not assigned to this area. In Renville County, survey crews were denied access to several parcels associated with a number of farms in the Morton vicinity.

Selected land parcels within the project area were investigated by means of a 100-percent intensive pedestrian survey utilizing parallel, linear transects spaced at approximately 20-m intervals or less. In areas of reduced visibility, or where sites were previously recorded or reported, survey transects were narrowed to 10-m intervals or less. The surface investigation was further augmented by the examination of rodent burrows and backdirt piles, road cuts, cutbank exposures, and gravel bars in instances where such features were present.

Standardized documentation procedures were utilized during field investigations. Digital photographs were obtained for overviews of each site and parcel investigated, as well as for any specific features identified. The position of each artifact and cultural feature observed was marked with high-visibility pin flags, and site boundaries were then recorded with the use of a Trimble *Juno*® model, differentially corrected GPS unit. All features and diagnostic artifacts also were individually plotted with the GPS, as were the boundaries of all land parcels examined. These data were subsequently plotted on 1:24,000-scale topographic quadrangle maps and 1:3,000-scale aerial orthoimagery/LiDAR mashup maps.

Descriptions of documented cultural resources along with general environmental descriptions of each land parcel were recorded in field journals, including: artifact specimen inventories identifying type, modification, raw material utilized, and count; additional site feature descriptions and measurements; and general environmental descriptions of each site

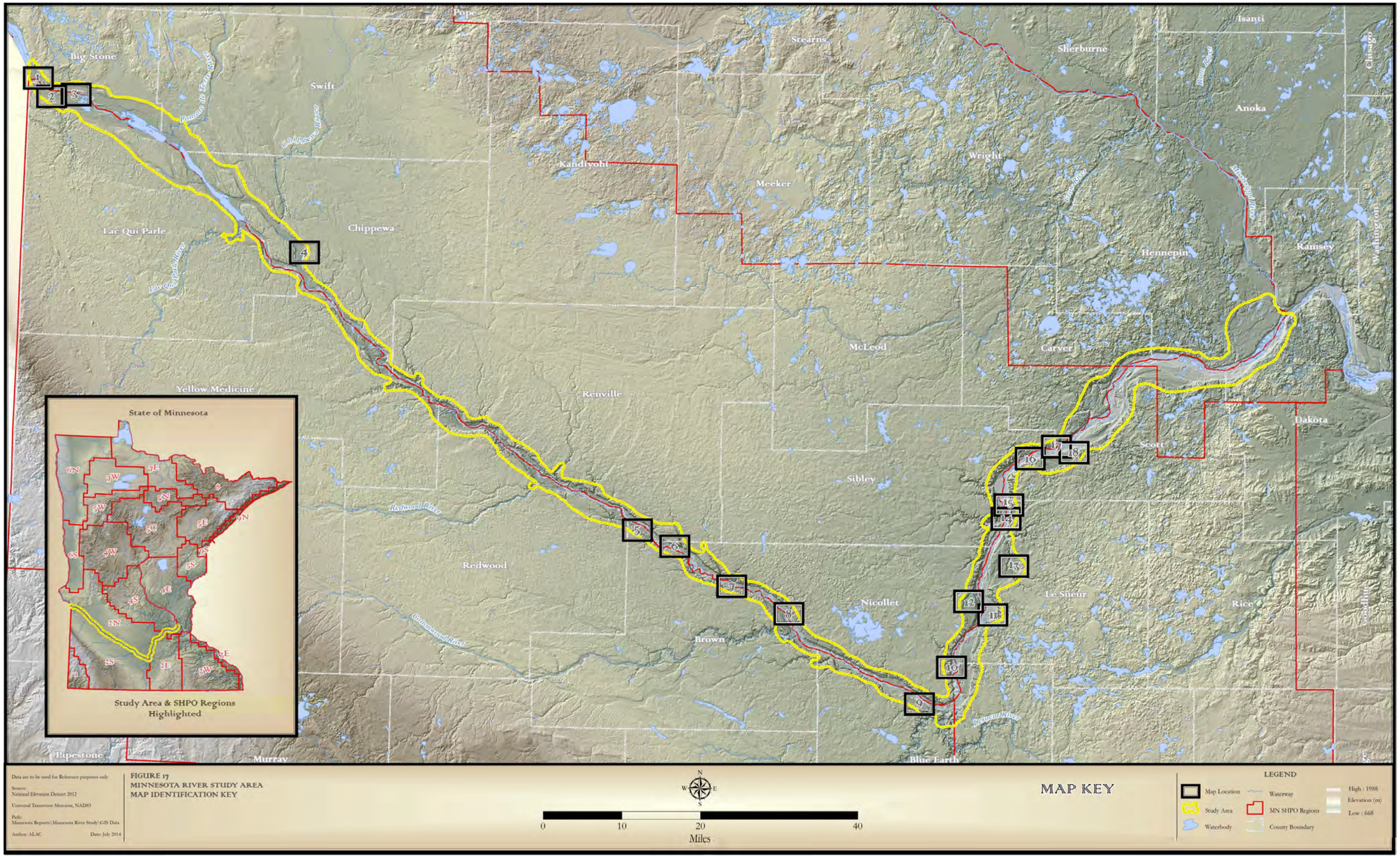
area. In most instances, cultural material documented was left in situ; only those artifacts deemed culturally or functionally diagnostic were collected. Minnesota archeological site forms were completed for all cultural resources identified or revisited within the project area.

A subcomponent of the archeological study included subsurface test excavations at site 21LP11. At 21LP11, test locations were determined based on a combination of factors, including landform position, previous cultivation, and the location and results of previous excavations and field surveys. Tests included a combination of standard shovel tests and formal excavation units. In total, seven square meters, one 1-m-x-50-cm extension unit, and 11 shovel tests were excavated at the site. All test localities were mapped with the GPS. A reading was taken at the southwest corner of each formal unit or block grid. All square units and blocks were oriented along the cardinal axes. Excavations were carried out through a combination of shovel-skimming and hand-troweling. All tests were excavated in arbitrary 10-cm levels. All tests were terminated at bedrock or in sterile subsoil when the majority of one arbitrary level was found to be devoid of artifacts. Shovel test and unit level forms were completed for each test excavated, and profile and plan view drawings were executed when appropriate. All test units opened were subsequently backfilled.

With one exception, all excavated soil matrix was sieved through standard ¼-inch wire mesh screen on-site. A series of arbitrary one-gallon (3.79-liter) soil samples were collected from alternating quadrants of Levels 3–6 in XU3. These samples were processed by means of flotation at Augustana's laboratory. Heavy fraction from these features was subsequently sieved through $^{1}/_{8}$-inch wire mesh screen. All soils data was described utilizing Munsell Soil Color Charts® (Munsell Color 2000). Project geomorphologist Rolfe Mandel profiled the soils at the site.

Laboratory analyses of recovered and loaned cultural material were conducted between November of 2014 and August of 2015. Standardized procedures aimed at the production of readily comparable datasets were utilized in the analyses. Diagnostic artifacts were subjected to both macroscopic and microscopic identification procedures for the purposes of determining material typology, manufacture techniques, usewear patterning, and source material locations. Representative samples of recovered specimens were photographed. Artifacts were subjected to various suites of dimensional measurements based upon ascribed individual typology, and technical descriptions were provided. Diagnostic artifacts collected from private property were returned to their respective owners following laboratory analysis; material collected from state or federal land was curated at MHS under Repository Agreement Nos. 671 and 627.

Soil matrix from paleosols recovered from soil cores was processed by way of water flotation following analysis by the project geomorphologist. Organic carbon samples obtained from identified paleosols were submitted to Beta Analytical for radiocarbon assay (see Appendix A). Soil samples were also collected from recovered cores, trenches, and excavation units for stable carbon isotope and phytolith analyses.


Big Stone
Swift
Pope
Stearns
Sherburne
Isanti
Chisago
Anoka
Wright
Meeker
Kandiyohi
Chippewa
Lac Qui Parle
Hennepin
Ramsey
Washington
Carver
McLeod
Renville
Yellow Medicine
Dakota
Scott
Sibley
Redwood
Nicollet
Le Sueur
Rice
Goodhue
Brown
Pipestone
Murray
Blue Earth
State of Minnesota
Study Area & SHPO Regions Highlighted
Data are to be used for Reference purposes only
Source:
National Elevation Dataset 2012
Universal Transverse Mercator, NAD83
Path:
Minnesota Reports\Minnesota River Study\GIS Data
Author: ALAC
Date: July 2014
FIGURE 17
MINNESOTA RIVER STUDY AREA
MAP IDENTIFICATION KEY
0
10
20
40
Miles
MAP KEY
LEGEND
Map Location
Study Area
Waterbody
Waterway
MN SHPO Regions
County Boundary
High : 1988
Elevation (m)
Low : 668

Big Stone City
ORTONVIL
River
MINNESOTA
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
GRANT CO
BIG STONE CO
LAC QUI PARLE CO
Quarry
Radio Tower
Gravel Pits
Gravel Pit
Pit
Main St
Washington St
Mill Rd
14th St
Data are to be used for Reference purposes only
Source: U.S. Geological Survey 7.5 minute topographic quadrangle Ortonville (1971)
Universal Transverse Mercator, NAD83
T121N, R46W
Path: Minnesota Regions\Minnesota River Study\GIS Data
Author: ALAC
Date: February 2015
FIGURE 18
SURVEY PARCEL 1 AND
HEDGE CORE 1 LOCALITY
N
W
E
S
0
0.25
0.5
1
Miles
MAP 1
Legend
Hedge Core 1
Survey Parcel
Previous Survey
Study Area

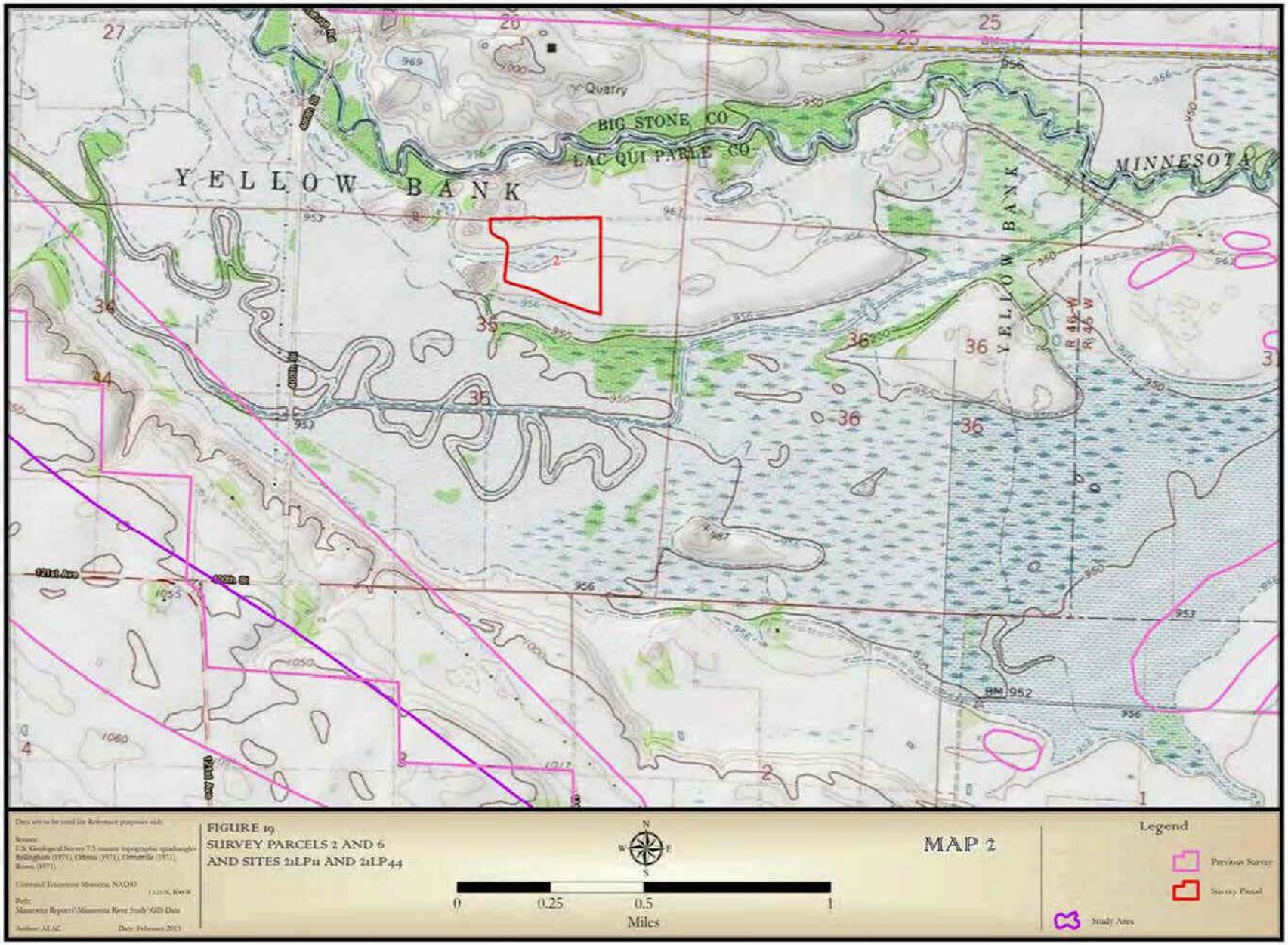
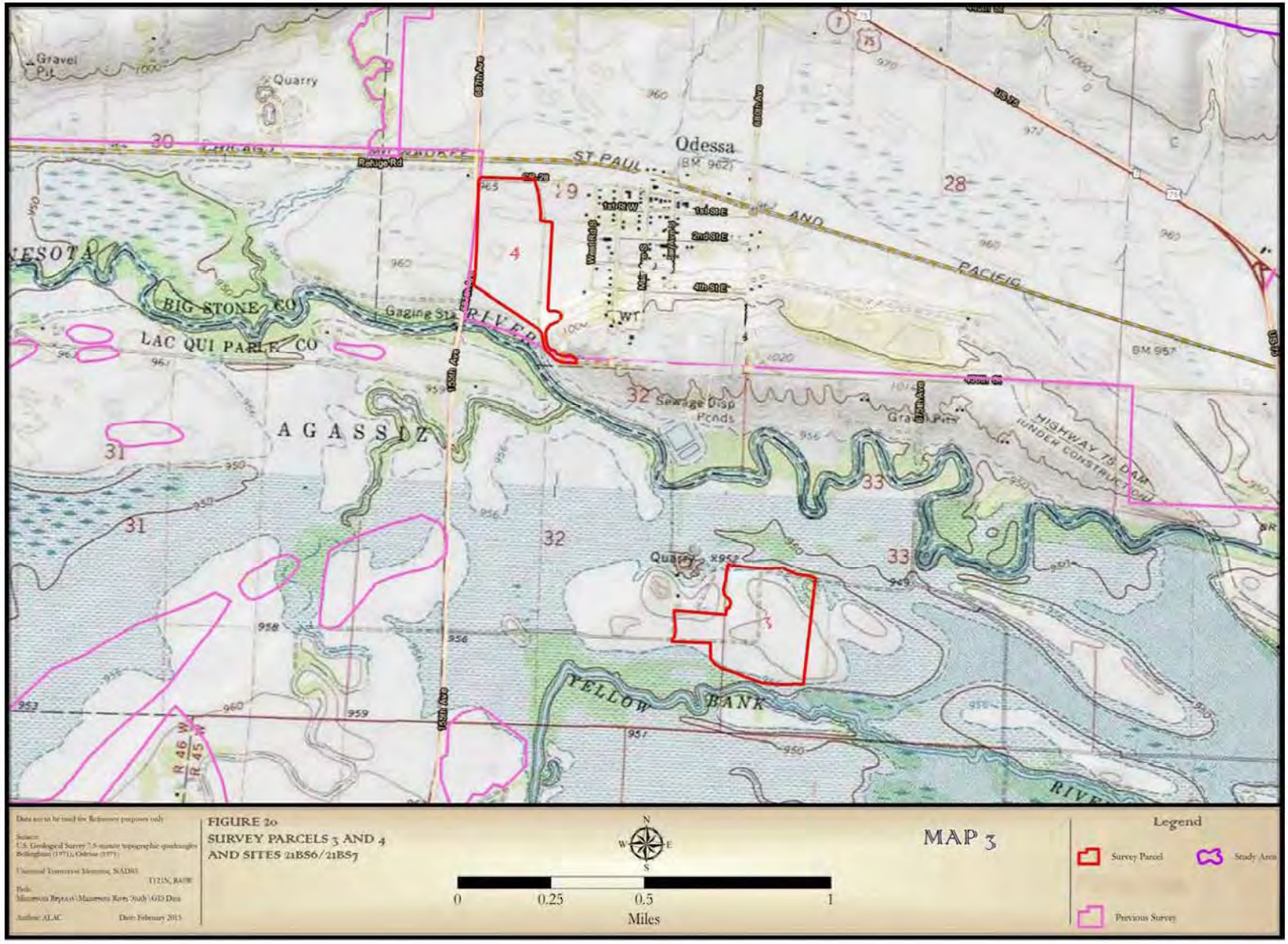


FIGURE 19
SURVEY PARCELS 2 AND 6
AND SITES 21LP11 AND 21LP44

MAP 2



Data are to be used for Reference purposes only

Source:
U.S. Geological Survey 7.5-minute topographic quadrangles Bellingham (1971), Odessa (1971)

Universal Transverse Mercator, NAD83

T121N, R43W

Path:
Minnesota Bryan \Minnesota River Study \GIS Data

Author: ALAC

Date: February 2013

FIGURE 20
SURVEY PARCELS 3 AND 4
AND SITES 21BS6/21BS7

N
W E
S

0 0.25 0.5 1
Miles

MAP 3

Legend

Survey Parcel

Study Area

Previous Survey

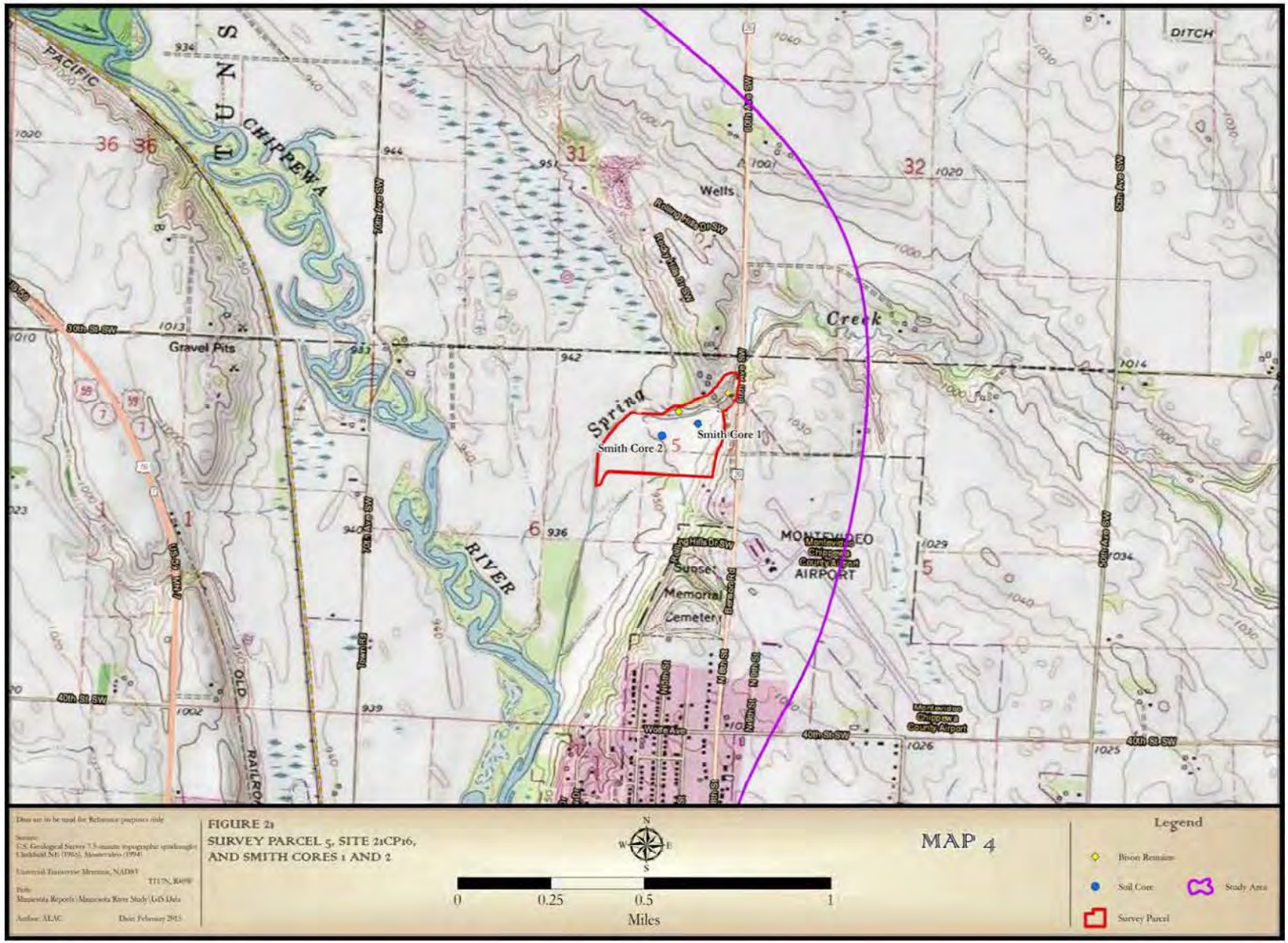
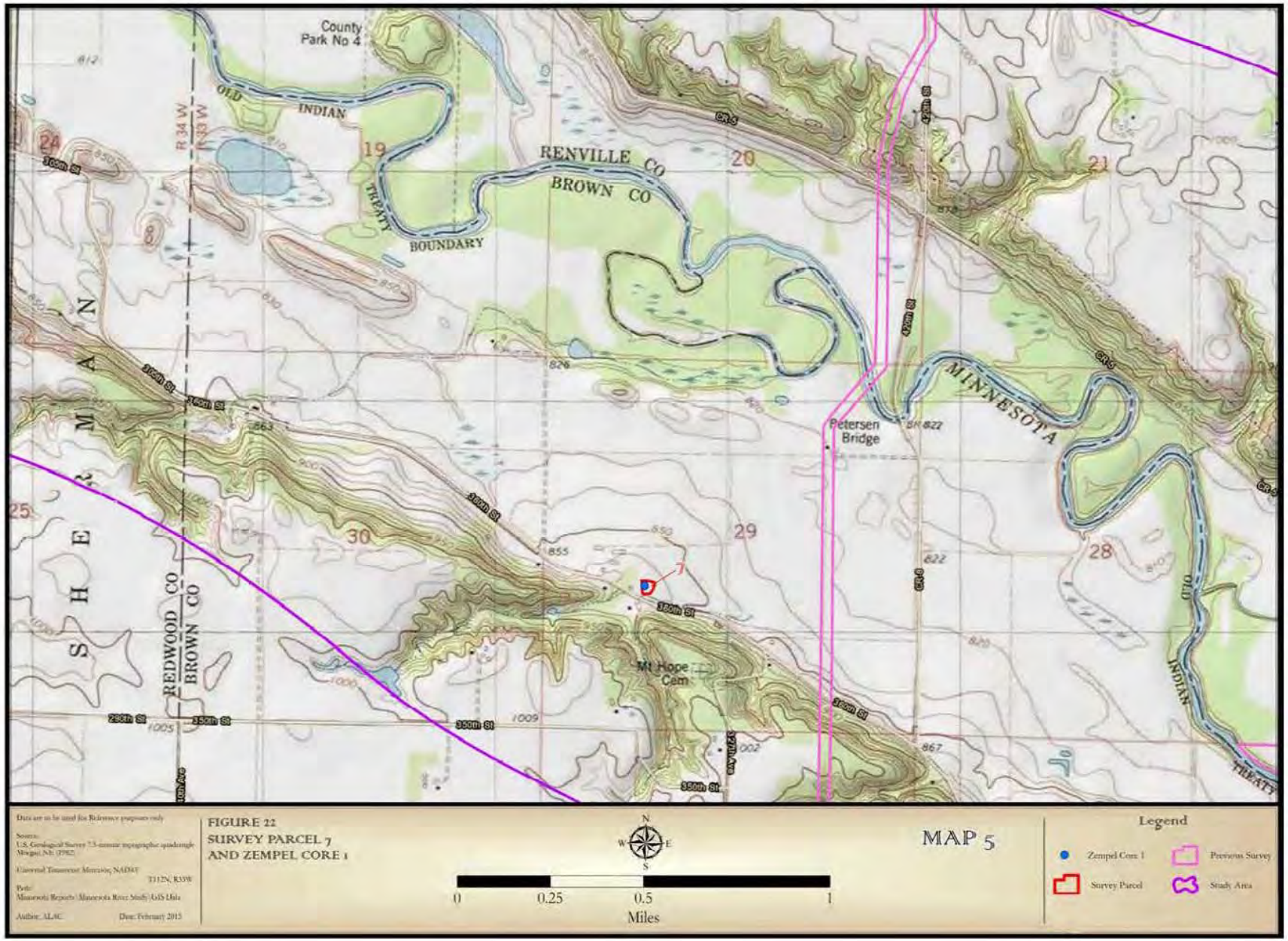


FIGURE 21
SURVEY PARCEL 5, SITE 21CP16,
AND SMITH CORES 1 AND 2

MAP 4


County Park No 4
OLD INDIAN TREATY BOUNDARY
RENVILLE CO
BROWN CO
R 34 W
R 33 W
MINNESOTA
Petersen Bridge
Mt Hope Cem
REDWOOD CO
BROWN CO
S H E R M A N
OLD INDIAN TREATY
19
20
21
24
25
28
29
30
7
Data are to be used for Reference purposes only
Source:
U.S. Geological Survey 7.5-minute topographic quadrangle Morgan, NE (1982)
Universal Transverse Mercator, NAD83
T112N, R33W
Path:
Minnesota Reports \ Minnesota River Study \ GIS Data
Author: ALAC
Date: February 2015
FIGURE 22
SURVEY PARCEL 7
AND ZEMPEL CORE 1
N
W
E
S
0
0.25
0.5
1
Miles
MAP 5
Legend
Zempel Core 1
Survey Parcel
Previous Survey
Study Area

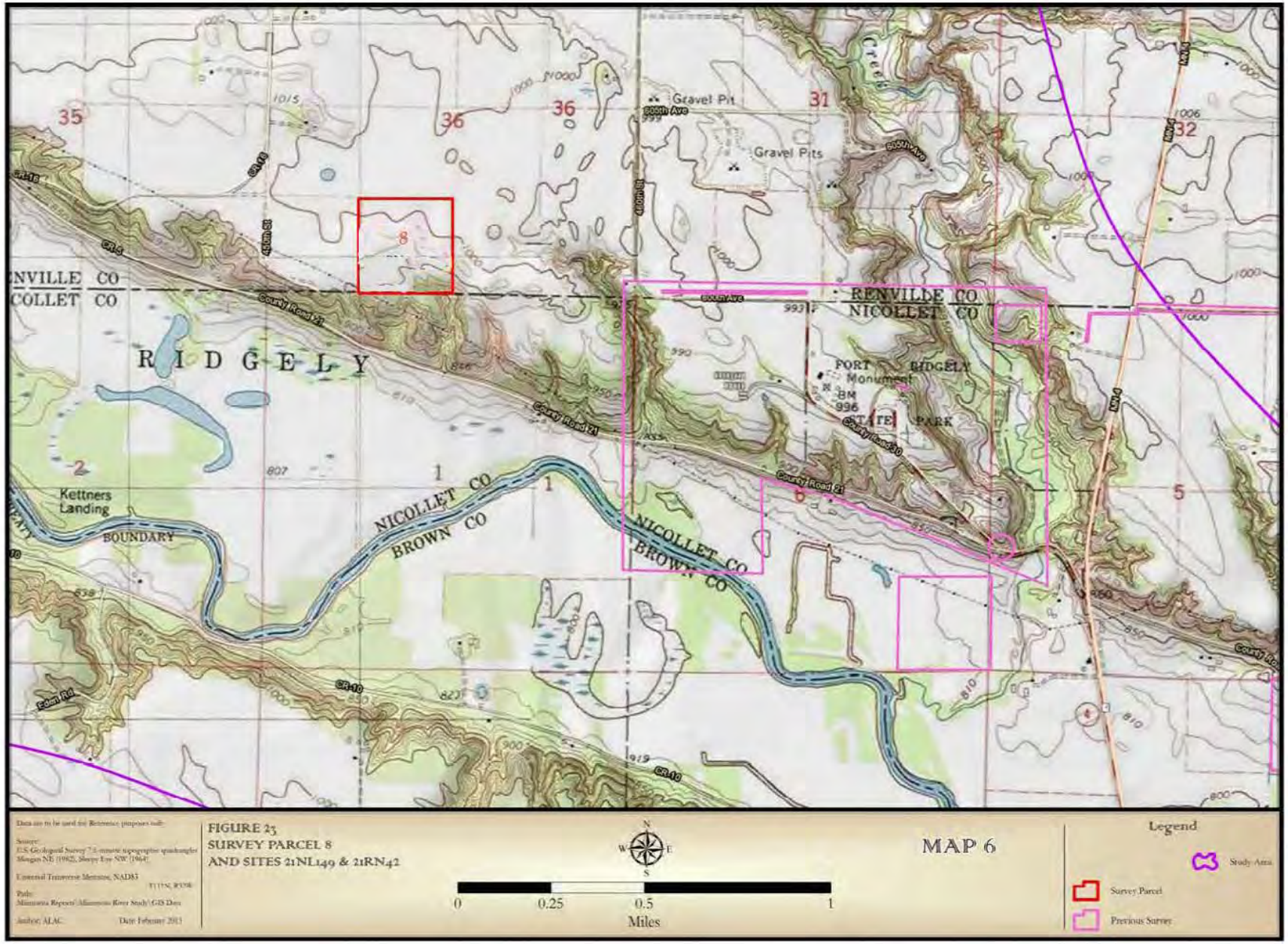
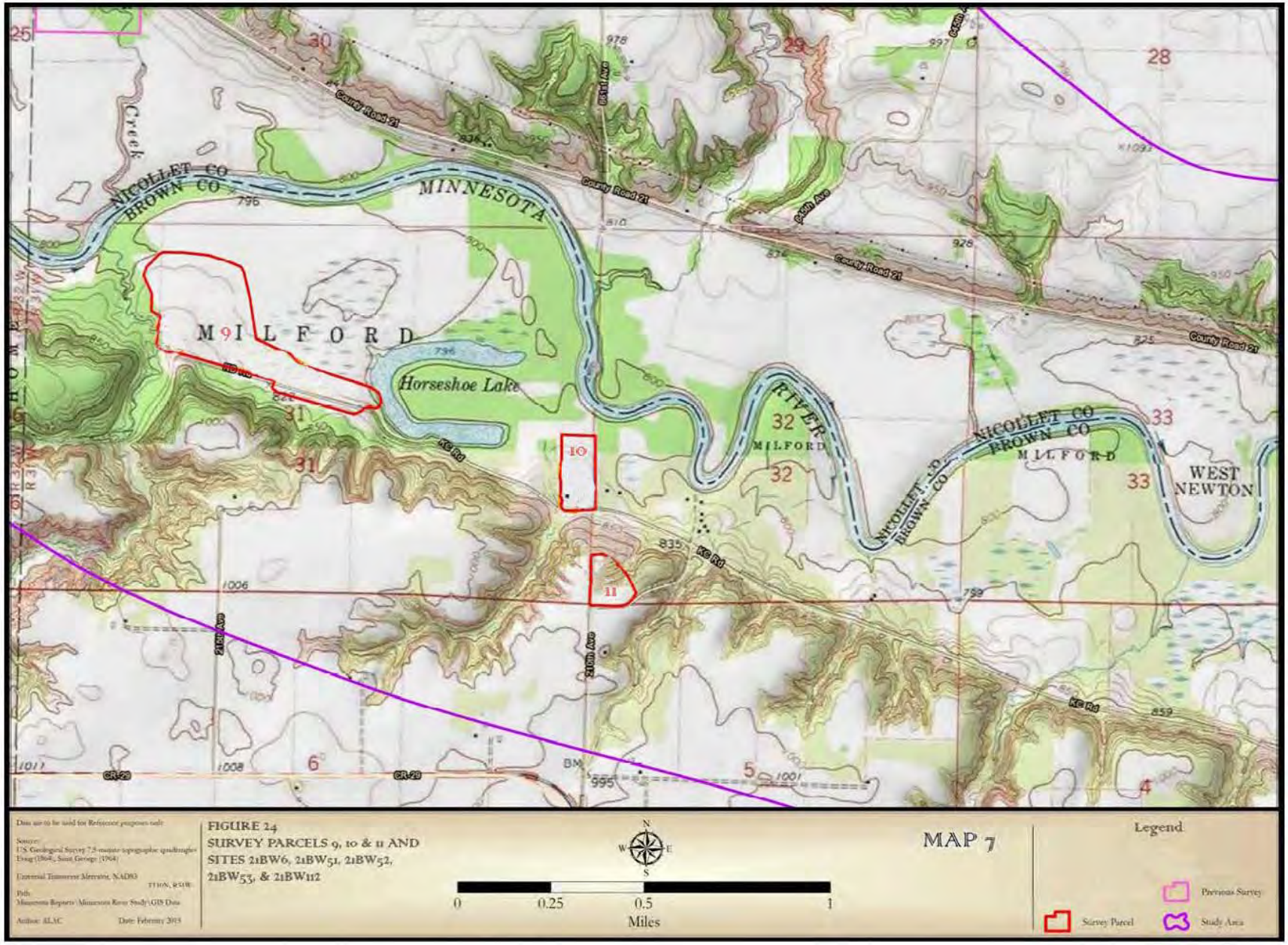


FIGURE 25
SURVEY PARCEL 8
AND SITES 21NL149 & 21RN42



Data are to be used for Reference purposes only

Source:
U.S. Geological Survey 7.5-minute topographic quadrangles
Essig (1964), Saint George (1964)

External Transverse Mercator, NAD83
T110N, R31W

Path:
Minnesota Reports \ Minnesota River Study \ GIS Data

Author: ALAC Date: February 2015

FIGURE 24
SURVEY PARCELS 9, 10 & 11 AND
SITES 21BW6, 21BW51, 21BW52,
21BW53, & 21BW112

MAP 7

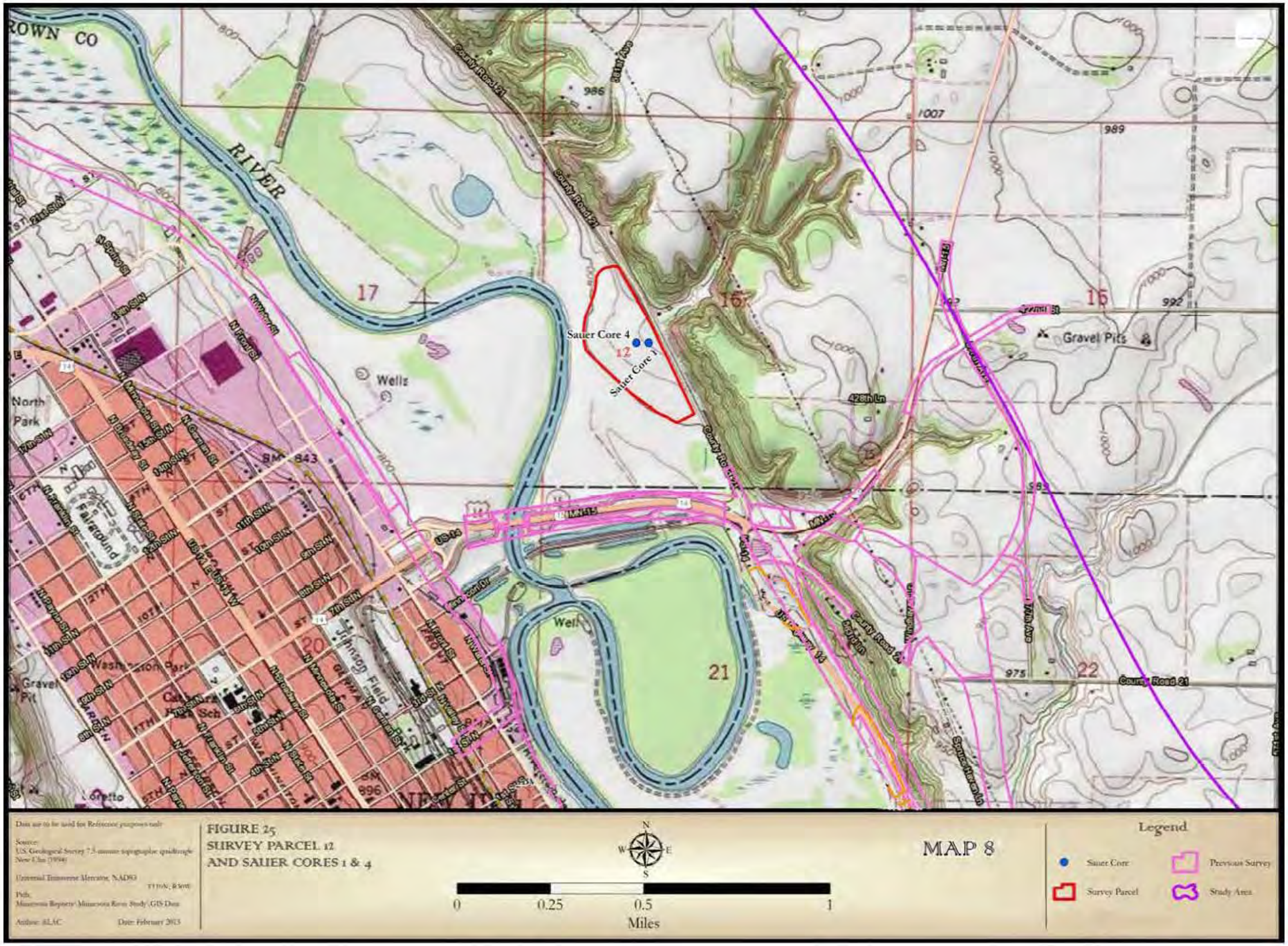


FIGURE 25
SURVEY PARCEL 12
AND SAUER CORES 1 & 4

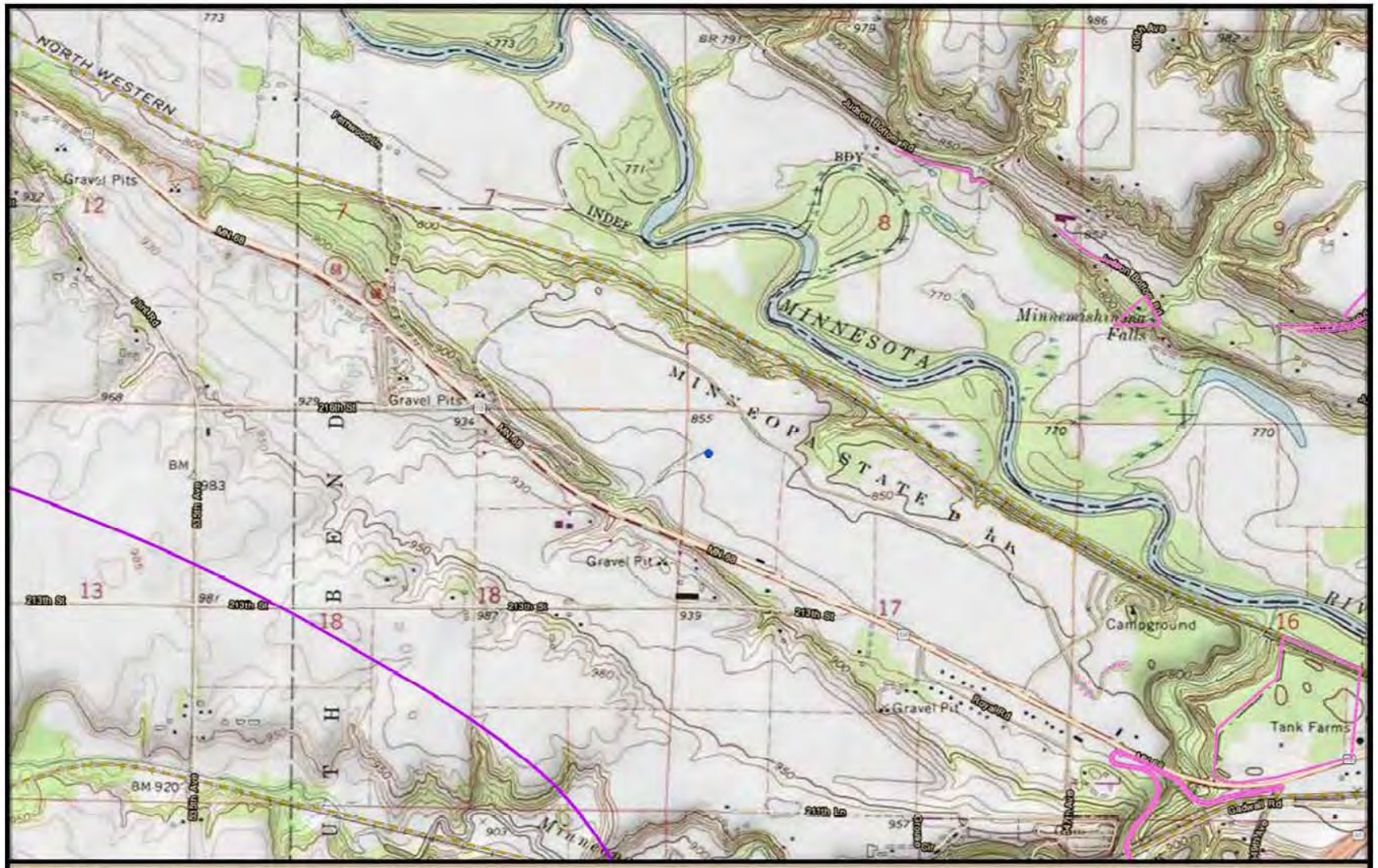


FIGURE 26
SITES 21BE303 & 21BE304
AND MINNEOPA CORE 1

FIGURE 27
SURVEY PARCEL 13
& MANN CORE 1

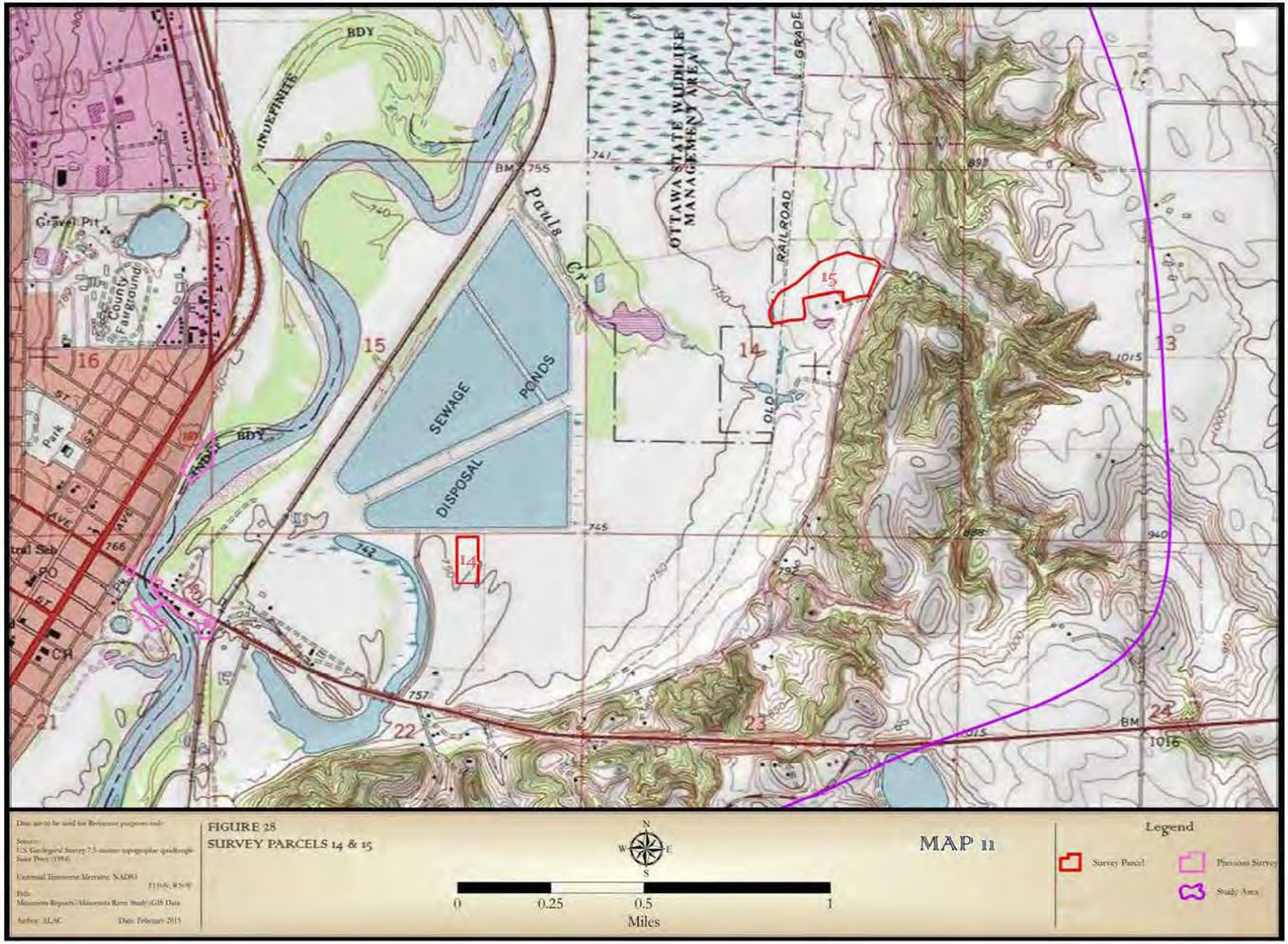
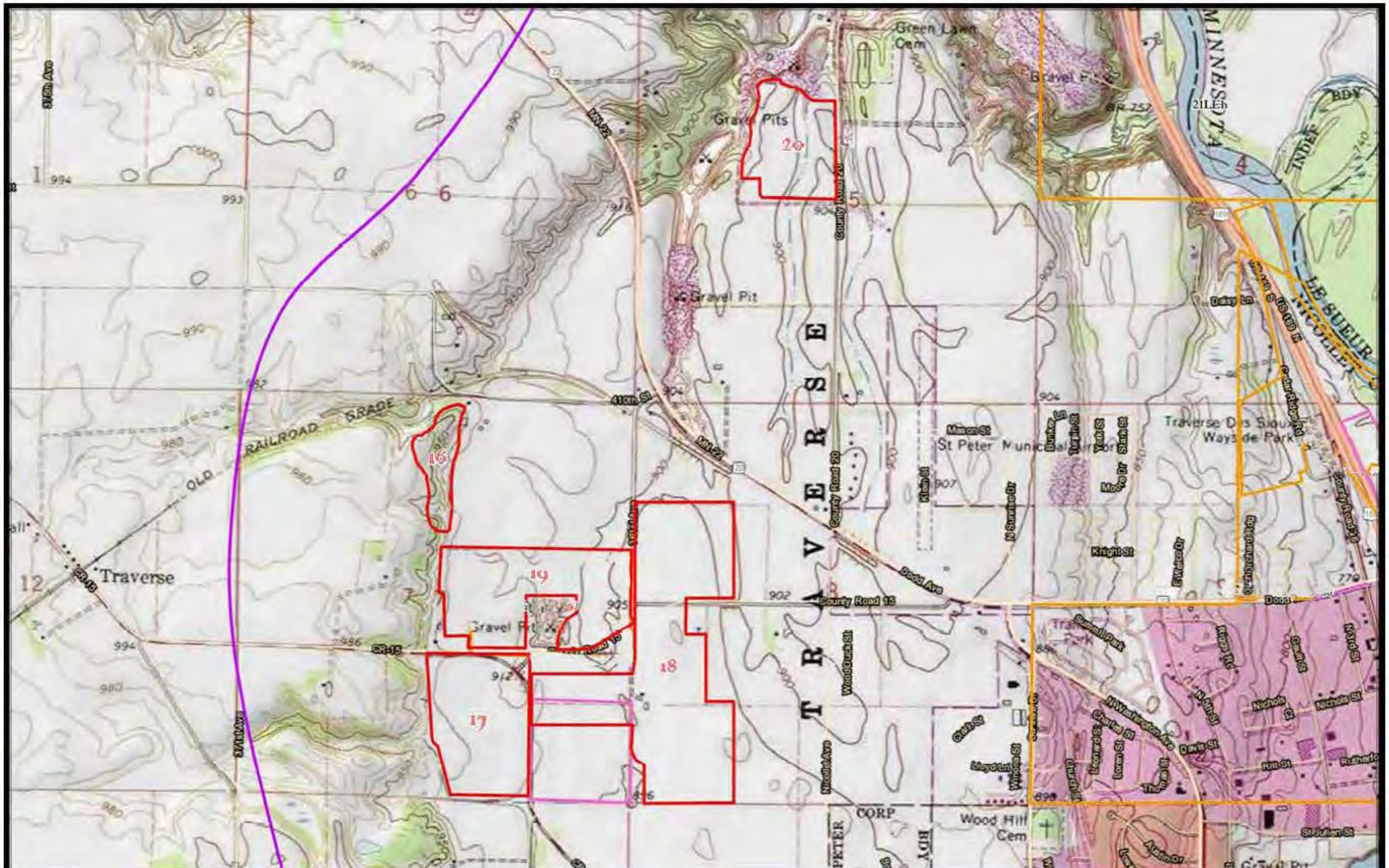


FIGURE 28
SURVEY PARCELS 14 & 15



Data are to be used for Reference purposes only

Source:
U.S. Geological Survey 7.5-minute topographic quadrangles
Saint Peter (1994) and North Star (1977)

Universal Transverse Mercator, NAD83
T110N, R26W

Path:
Minnesota Reports\Minnesota River Study\GIS Data

Author: ALAC Date: February 2015

FIGURE 29
SURVEY PARCELS 16-20
& SITES 21NL9 & 21NL150

N W E S

0 0.25 0.5 1
Miles

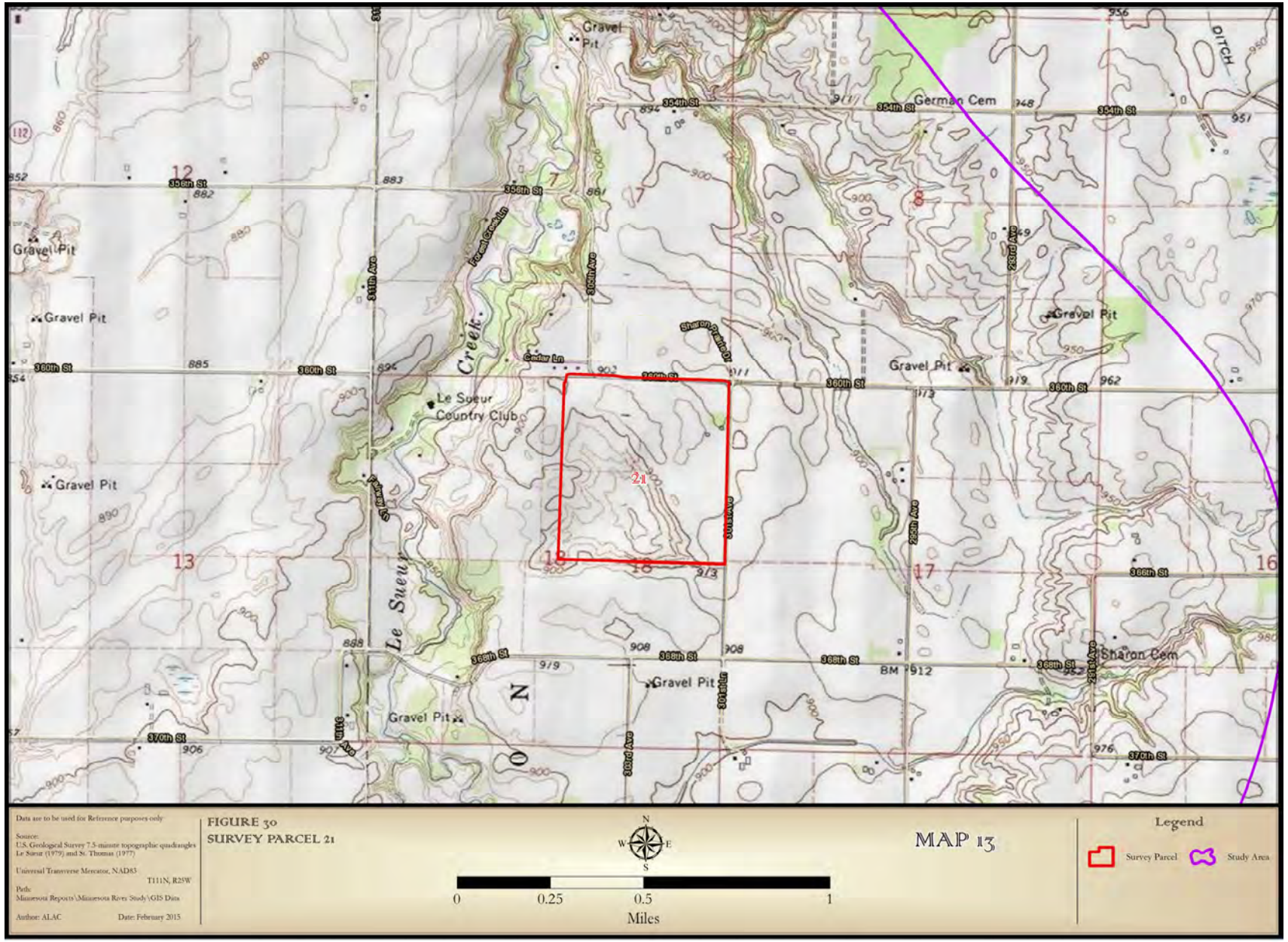
MAP 12

Legend

Survey Parcel

Previous Survey

Study Area



Data are to be used for Reference purposes only

Source:
U.S. Geological Survey 7.5-minute topographic quadrangles
Le Sueur (1979) and St. Thomas (1977)

Universal Transverse Mercator, NAD83

T111N, R25W

Path:
Minnesota Reports \Minnesota River Study\GIS Data

Author: ALAC Date: February 2015

FIGURE 30
SURVEY PARCEL 21

N
W E
S

0 0.25 0.5 1
Miles

MAP 13

Legend
Survey Parcel
Study Area

Data are to be used for Reference purposes only
Source:
U.S. Geological Survey 7.5-minute topographic quadrangles Belle Plaine South (1981), Henderson (1981), Le Sueur (1979), and St. Thomas (1977)
Universal Transverse Mercator, NAD83
T112N, R25W & T112N, R26W
Path:
Minnesota Reports\Minnesota River Study\GIS Data
Author: ALAC
Date: October 2015
FIGURE 31
SURVEY PARCELS 22, 23, 24, 26, & 28
AND SITES 21LE148 & 21LE149
N
W
E
S
0
0.25
0.5
1
Miles
MAP 14
Legend
Previous Survey
Survey Parcel
Study Area
Joseph Cem
Hilltop Sch
Gravel Pit
Rush River
LE SUEUR
CORP BDY
CHICAGO AND NORTH WESTERN
R 26 W
R 25 W
Station
Henderson Station Rd
Pumpkin Hill Rd
Ridge Rd
Maple Ridge Dr
Walnut Blvd
Sunset Dr
South St
300th St
308th Ln
316th St
Forest Heights Rd
US Highway 169
US-169 N
US-169 N/US-169 S
11
12
13
14
17
18
23
24
26
28
29

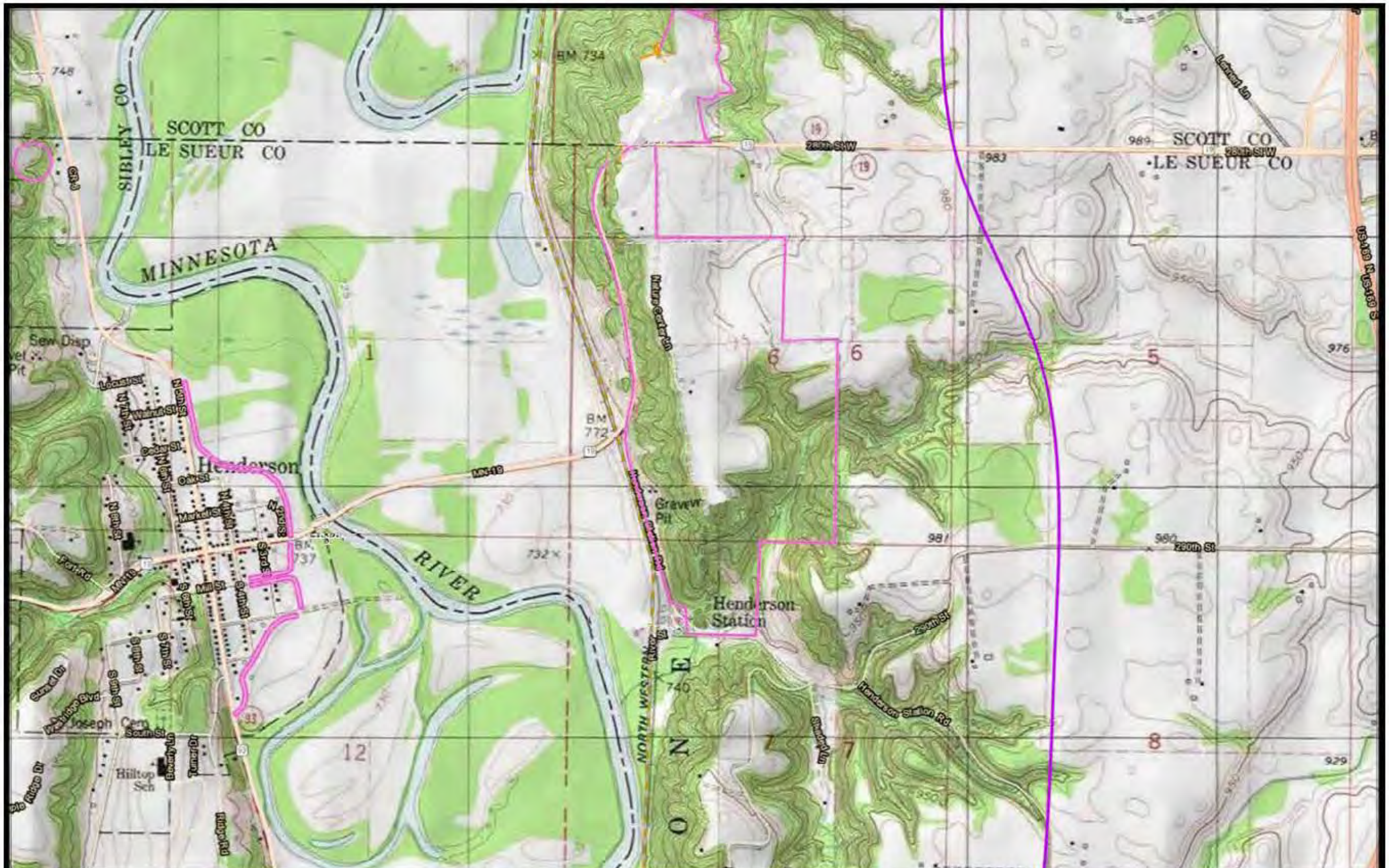


FIGURE 32
REPORTED SITES AT NEY CENTER
& HENDERSON STATION

MAP 15

0 0.25 0.5 1
Miles

Legend
Study Area
Previous Survey

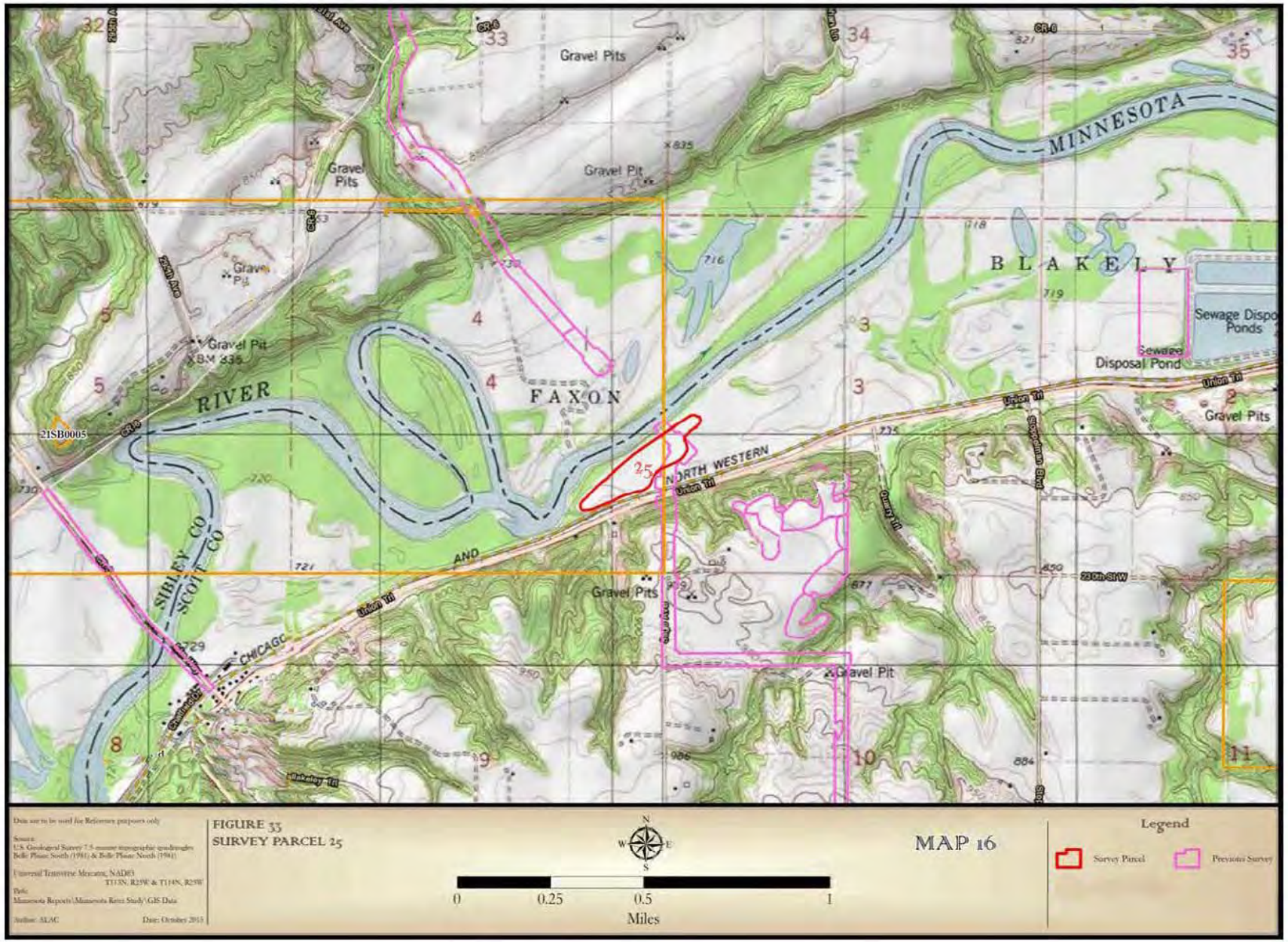
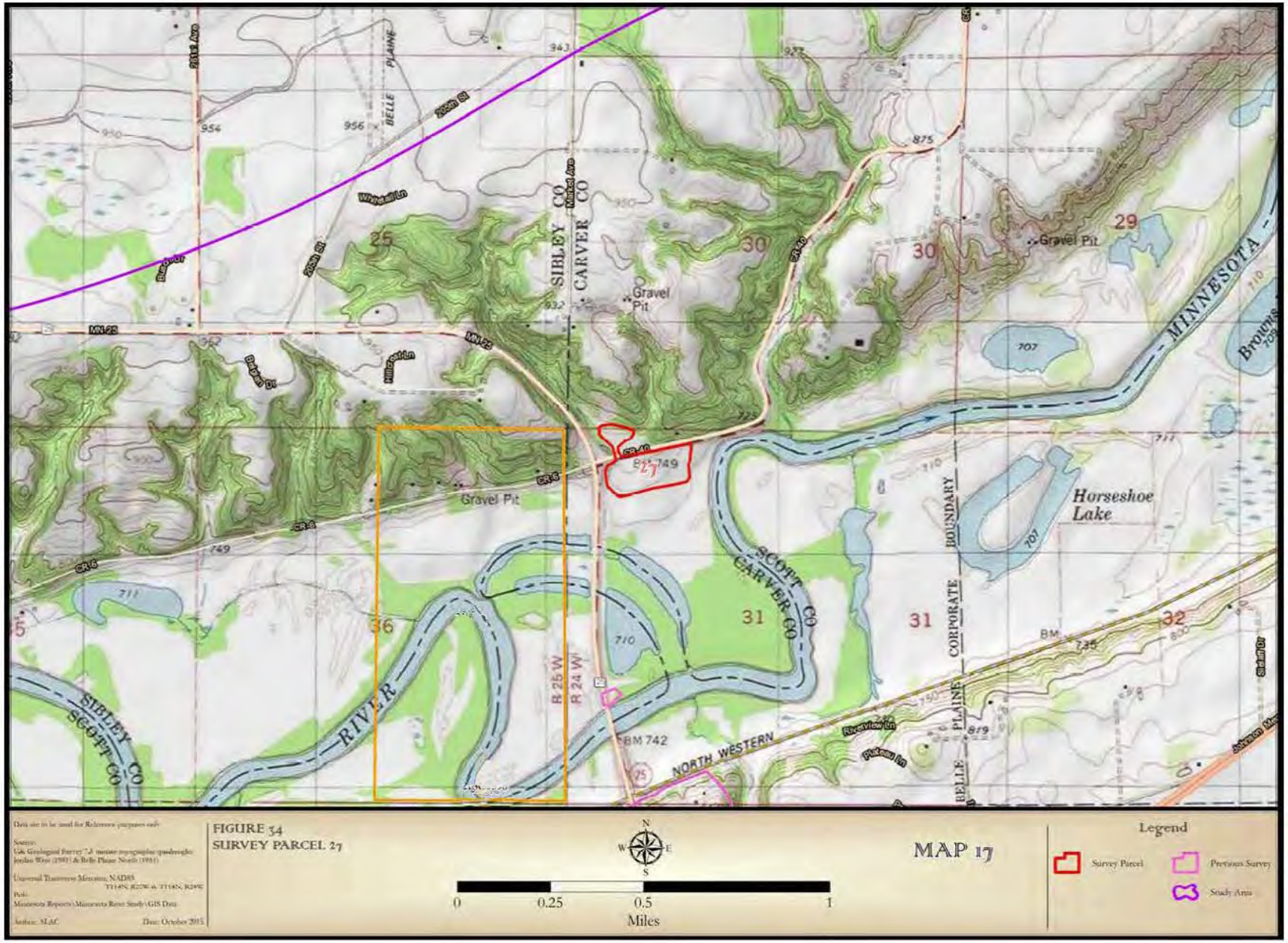


FIGURE 33
SURVEY PARCEL 25

MAP 16



Data are to be used for Reference purposes only

Sources:
US Geological Survey 7.5 minute topographic quadrangles: Jordan West (1980) & Belle Plaine North (1981)

Universal Transverse Mercator, NAD83
T114N, R25W & T114N, R24W

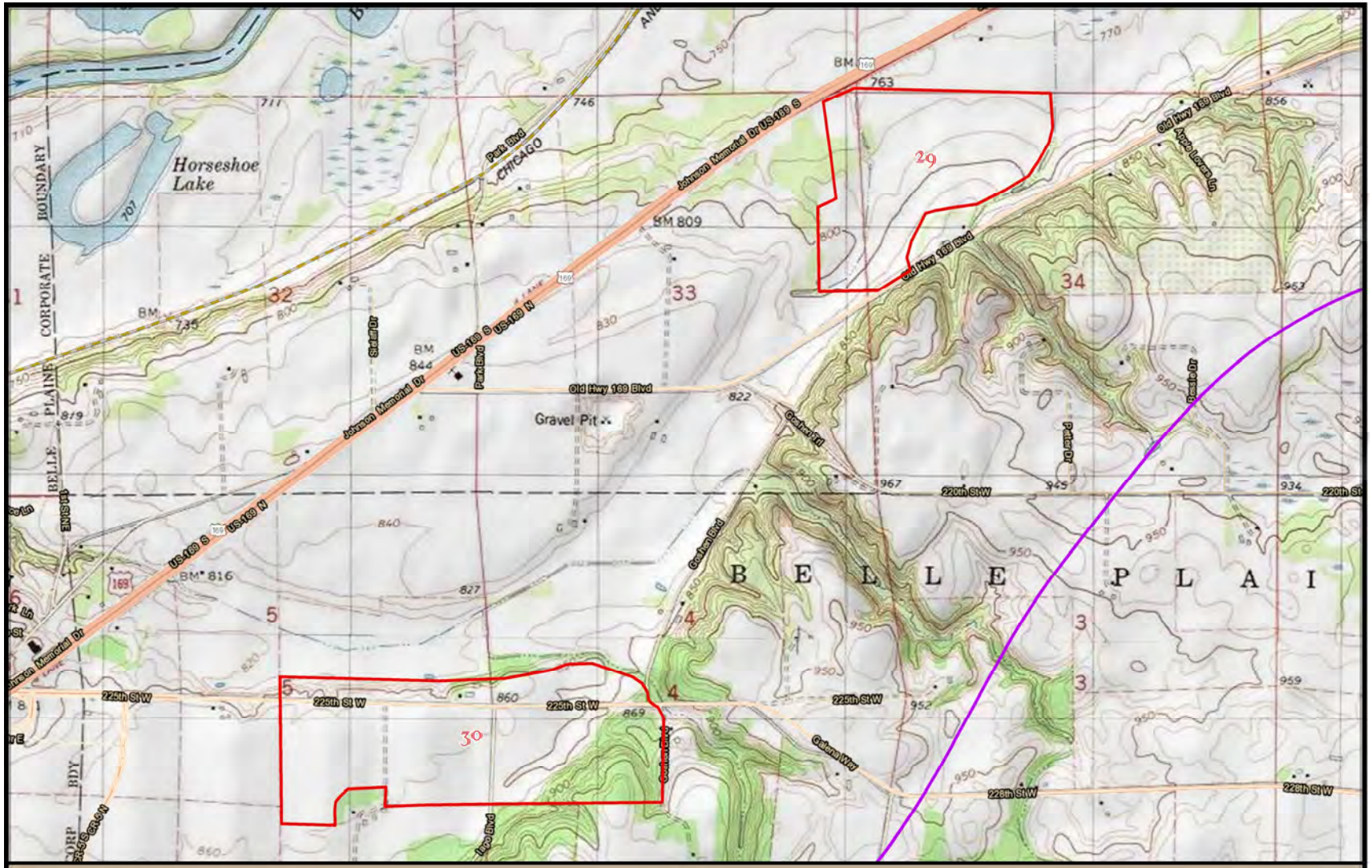
Path:
Minnesota Reports\Minnesota River Study\GIS Data

Author: MAC Date: October 2015

FIGURE 34
SURVEY PARCEL 27

MAP 17

Legend
Survey Parcel
Previous Survey
Study Area



Data are to be used for Reference purposes only

Source:
U.S. Geological Survey 7.5 minute topographic quadrangles
Jordan West (1981) & Union Hill (1981)

Universal Transverse Mercator, NAD83
T113N, R24W & T114N, R24W

Path:
Minnesota Reports\Minnesota River Study\GIS Data

Author: ALAC Date: October 2015

FIGURE 35
SURVEY PARCELS 29 & 30

N W E S

0 0.25 0.5 1
Miles

MAP 18

Legend
Survey Parcel
Study Area

DOCUMENTED ARCHEOLOGICAL PROPERTIES

Archeological field investigations in the study area resulted in the identification and documentation of seven previously unrecorded archeological properties; 10 previously recorded site areas, or portions thereof, were also revisited during the course of the study (Table 12). Five additional site localities were reported by a local informant; four in Le Sueur County and one in Sibley County. However, due to the lack of access permission, ground surface visibility issues, or failure to identify additional cultural material during a survey, formal site and/or survey parcel numbers were not assigned to these areas. Instead, their locations are designated on maps as *reported site* (see Figures 31 and 32, above). One of these reported areas corresponds with the location of recently documented site 21LE144 (Schirmer et al. 2015:172–173) but dense ground cover precluded a formal pedestrian survey within the mapped site boundary during the current study. All sites documented during the current study are discussed below; descriptions are presented in numeric order and alphabetically by county.

Table 12. Archeological Sites Documented/Revisited During the Current Study.

Site Number	Cultural Affiliation (Specific Context)	Site Type	County (Archaeological Subregion)	Notes/ Comments
21BE303	Prehistoric (Woodland; Plains Village)	Artifact Scatter (Habitation)	Blue Earth (2s)	Map 9; Reintroduced prairie grasses—no surface visibility.
21BE304	Prehistoric (Archaic; Woodland)	Lithic Scatter (Habitation)	Blue Earth (2s)	Map 9; Reintroduced prairie grasses—no surface visibility.
21BS6/7	Prehistoric (Unknown)	Mound	Big Stone (2n)	Map 3; Surveyed below the mounds in fields. Results negative.
21BW6	Prehistoric (Archaic & Woodland)	Artifact Scatter (Habitation)	Brown (2s)	Map 7; Extensively collected. Visited by Science Museum & U-of-M.
21BW51	Prehistoric (Unknown)	Lithic Scatter	Brown (2s)	Map 7; Extensively collected. On alluvial fan. Visited as part of MnSAS.
21BW52	Prehistoric (Woodland & Possible Mississippian)	Artifact Scatter	Brown (2s)	Map 7; Extensively collected. On alluvial fan. Visited as part of MnSAS.
21BW53	Prehistoric (Woodland)	Artifact Scatter	Brown (2s)	Map 7; Collected. On bluffs. Visited as part of MnSAS.
21BW112	Prehistoric (Unknown)	Single Artifact	Brown (2s)	Map 7; End scraper on alluvial fan.
21CP16*	Prehistoric (Unknown)	Cemetery (Kill?)	Chippewa (2n)	Map 4; Bison bones washed-out of creek.
21LE148	Prehistoric (Unknown)	Single Artifact	Le Sueur (2e)	Map 14; Tested cobble/informal tool on uplands.
21LE149	Prehistoric (Unknown)	Single Artifact	Le Sueur (2e)	Map 14; Pecked/groundstone maul on upland stream terrace.
21LP11	Paleoindian (Clovis & Late Prehistoric)	Lithic Scatter	Lac Qui Parle (2s)	Map 2; Test excavations.
21LP44	Prehistoric (Unknown)	Single Artifact	Lac Qui Parle (2s)	Map 2; Flake in rodent backdirt mound.
21NL9	Unknown	Three Dug Pits	Nicollet (2n)	Map 12; Site not within currently mapped location. LiDAR suggests that it is located just west of its mapped position.

*** Landowner reported finding grooved mauls at site. Listed as *cemetery* in site file.**

Table 12 (continued).

Site Number	Cultural Affiliation (Specific Context)	Site Type	County (Archaeological Subregion)	Notes/ Comments
21NL149	Prehistoric (Unknown)	Lithic Scatter	Nicollet (2n)	Map 6; No visibility—information based on artifact collection and landowner information
21NL150	Prehistoric (Unknown)	Single Artifact	Nicollet (2n)	Map 12; Informal uniface on bluff toe slope.
21RN42	Prehistoric (Unknown)	Lithic Scatter	Renville (2n)	Map 6; Two main concentration areas

Sites 21BE303 (Minneopa Bison Pasture East) and 21BE304 (Minneopa Bison Pasture West)

Site Numbers (Name): 21BE303 (Minneopa Bison Pasture East) & 21BE304 (Minneopa Bison Pasture West)	**Survey Parcel/Map Reference:** None/9
Site Type/Function: Artifact Scatter/Habitation (21BE303); Lithic Scatter/Habitation (21BE304)	**Legal Location:**
Landform Position: Terrace	**Site Area (ac):** 24.13 (21BE303); 104.88 (21BE304)
Elevation Above Mean Sea Level (ft): 850	**Valley Section:** Upper
Cultural Affiliation: Prehistoric	**Site Condition:** Disturbed
USGS 7.5' Quadrangle(s): Judson (1974); Mankato West (1993)	**Archaeological Subregion:** 2s

Research History

Sites 21BE303 and 21BE304 were documented between April and September of 2014 by archeologists with the Minnesota DNR, Division of Parks and Trails. The sites, located on the edge of an expansive high terrace in Minneopa State Park, were discovered through a combination pedestrian survey/subsurface testing program initiated after a series of prescribed burns within the park. Site 21BE303 is an artifact scatter consisting of lithic and ceramic material with Early Woodland, Middle Woodland, and Plains Village cultural components. Site 21BE304 is an extensive lithic scatter with Archaic and Early Woodland components. Intact soils and subsurface deposits were identified throughout the site areas and an intact FCR feature was discovered in association with site 21BE303. Radford (2015) provides a thorough overview of the results of the work at sites 21BE303 and 21BE304.

Description

Sites 21BE303 and 21BE304 are located in Minneopa State Park just northwest of Mankato in Blue Earth County. The sites were revisited by Augustana on April 10 and 11, 2015. The sites lie approximately 450 m apart on the edge of a high terrace above the right bank of the Minnesota River (Figures 36 and 37; see Figure 26, above); at the time of Augustana's visit, the park area was in reseeded native prairie grasses. Ground surface visibility was 0 percent at the time of the site visit. Due to the lack of ground surface visibility and the recent, thorough documentation of the sites, a formal pedestrian survey was not conducted. However, DNR and Augustana personnel had previously agreed that the collection of a soil core from an alluvial fan on the southern edge of the terrace might provide complementary data to that obtained from the recent DNR archeological investigations. Augustana's project geomorphologist, Rolfe Mandel, extracted a single core from the fan, the position of which was mapped with a GPS instrument (see Figure 36). An AMS date was acquired from a buried soil discovered near the base of the fan deposits in the core (see Appendix A). Although a detailed soil profile and diagram of the core is provided in Chapter 5 (Mandel, Chapter 5, pp. 146–148), a summary of Mandel's findings is offered below:

> ...a 1.95-m-long core was taken on the distal end of a large, low-angle alluvial fan in Minneopa State Park near Mankato. The fan developed on a broad strath terrace that is covered with many cobbles and boulders. A surface soil (Soil 1) with an A-AC-C profile occurs above an A horizon of a buried soil (Soil 2) at a depth of 1.68–1.95+ m. Only the upper 27 cm of Soil 2 was penetrated; the core was refused at a depth of 1.95 mbs, perhaps by a cobble or boulder resting on the strath terrace. Organic matter from the upper 10 cm of the Ab horizon of Soil 2 yielded an AMS radiocarbon age of 1695 ± 25 RCYBP (1595 cal. yr B.P.). Hence, Soil 2 was buried after ca. 1700 RCYBP (1600 cal. yr B.P.).
>
> Based on the information gleaned from the core, there is high potential for cultural materials beneath the surface of the alluvial fan, and those materials are most likely to be associated with Soil 2. Unfortunately, the full thickness and age of Soil 2 is unknown. Nevertheless, given the minimum age of the Ab horizon (1700 RCYBP; 1600 cal. yr B.P.), Soil 2 has potential for containing Early Woodland and Late Archaic deposits [Mandel, Chapter 5, pg. 146].

7
8
18
17
Data are to be used for Reference purposes only
Source:
National Agricultural Imagery Program (2013)
Universal Transverse Mercator, NAD83
T108N, R27W
Path:
Minnesota Reports\Minnesota River South\GIS Data
Author: ALSC
Date: October 2013
FIGURE 36
MINNEOPA CORE 1 AND
SITES 21BE303 & 21BE304
N
W
E
S
0
87.5
175
350
Meters
Legend
Minneopa Core 1
Section
Archeological Site

Figure 37. Overviews of the terrace at Minneopa State Park, Blue Earth County, Minnesota. Views include the coring locality on the fan with Seppman Mill visible in the distance (left) and a stretch along a two-track (right).

Interpretation and Recommendations

Sites 21BE303 and 21BE304 are extensive, multicomponent prehistoric habitations with documented Archaic, Woodland, and Plains Village cultural components. The landform on which the sites are located was mapped as a combination of high and medium overall site potential by MN/Model. MN/Model GIS data designate the mapped LfSA containing sites 21BE303 and 21BE304 as containing no paleosols and assign a landscape suitability rating (LSR) of *low* for harboring surface and shallowly buried prehistoric archeological deposits. The site's landform was assigned an *unsuitable* LSR for moderately and deeply buried deposits. Sites 21BE303 and 21BE304 were documented between April and September of 2014. Investigations by DNR archeologists revealed the presence of multicomponent prehistoric habitations with intact, buried archeological deposits and features along the terrace edge in the park. Both sites were recommended eligible for listing in the National Register of Historic (Radford 2015:7–8).

The alluvial fan from which the soil core was extracted was assigned a *high* LSR for buried archeology and is classified as likely to contain paleosols. Results of the soil core analysis support the modeled LSR for the alluvial fan, as a paleosol was encountered at a depth of 1.68–1.95+ mbs (see Mandel, Chapter 5, pp. 146–148). An organic sample was extracted from this paleosol and submitted for radiocarbon assay; it yielded an uncalibrated AMS radiocarbon age of 1695 ± 25 RCYBP (see Appendix A). The paleosol was, therefore, buried by fan deposits around 1700 RCYBP. There is high potential for cultural materials beneath these fan deposits, and those materials are most likely to be associated with the paleosol. Although the full thickness and age of the soil are presently unknown, it has potential for containing Early Woodland and Late Archaic cultural deposits.

Site 21BS6/21BS7

Site Number (Name): 21BS6/21BS7	**Survey Parcel/Map Reference:** 3
Site Type/Function: Mound/Burial	**Legal Location:**
Landform Position: Bar	**Site Area (ac):** 10.25
Elevation Above Mean Sea Level (ft): 1,020	**Valley Section:** Upper
Cultural Affiliation: Prehistoric	**Site Condition:** Unknown
USGS 7.5' Quadrangle(s): Odessa (1971)	**Archaeological Subregion:** 2n

Research History

Site 21BS6/21BS7 was first investigated in August of 1883 by T. H. Lewis as part of the *Northwestern Archaeological Survey* (Lewis 1898). Lewis recorded five mounds on a hilltop about 60 feet above the river. One mound (Mound 1) was described as "diamond-shaped," while the other four (Mounds 2–5) were described as linear embankments (Lewis 1883:14). Twenty-eight years later, Newton Winchell (1911:121–122) reported on the site in his publication *Aborigines of Minnesota*. In his description, Winchell provides a detailed sketch map of the arrangement of the mounds comprising the site (Figure 38). Winchell notes that the site was reexamined in 1907 and that, during the time since Lewis's survey, the mounds had "…all been flattened by the weather…" The diamond-shaped feature is described as being constructed from a reddish clay that was very distinct from the soils elsewhere on the hilltop (Winchell 1911:121).

Site location information edit

Figure 38. Sketch map of mounds comprising site 21BS6/21BS7 (from Winchell 1911:122).

The site was visited in 1943, and again in 1954, by Lloyd Wilford. Wilford's notes discuss further disturbance to the mounds via both natural and human processes, indicating that a waterline trenching project unearthed human bones from the vicinity of one of the mounds A site form update, completed in 1959 by Elden Johnson, notes that only two of the originally identified mounds remain visible. At some point, the same site was assigned two different numbers—21BS6 and 21BS7. The 21BS6 boundary is far more accurate than the mapped 21BS7 site area.

Description

Augustana personnel investigated a portion of the 21BS6/21BS7 site area and adjacent fields on October 22, 2014. The confirmed presence of burial mounds at site 21BS6/21BS7 prompted a desire to investigate the terrace landform below the site to explore the possibility of an associated habitation locale. As a result, the majority of Parcel 4 investigated by Augustana lies just beyond 21BS6/21BS7; only a very small segment along the base of the hill falls within the mapped site boundary (see Figure 20, above). The surveyed parcel is just west of the community of Odessa; it is confined, almost entirely, to a broad strath terrace above the left bank of the Minnesota River. Very small segments of the survey area fall within mapped floodplain and bar landforms—the bar landform lies along the base of the hill immediately below site 21BS6/21BS7. At the time of the survey, the area investigated was divided into two cultivated fields; the western field (which encompassed approximately 90 percent of the area within the survey parcel) was harvested soybeans while the eastern field was unharvested corn. One-half of the beanfield was subsoiled. Unharvested crops limited the pedestrian survey in the cornfield to the perimeter of the field around the base of the hill. Ground surface visibility in the beanfield averaged 90 percent in the subsoiled half and 40 percent in the other; visibility averaged 80 percent around the perimeter of the cornfield (Figures 39 and 40). No sites were identified in either field.

Figure 39. Overview of a portion of Parcel 4 just west of site 21BS6/21BS7.

Interpretation and Recommendations

Site 21BS6/21BS7 is a burial mound group located atop a hill on a flood bar landform near Odessa. A field investigation, focused on the strath terrace below the site as a means of exploring the possibility of a habitation area associated with the mounds, yielded negative results. Only a very small portion within the mapped 21BS6/21BS7 site boundary was investigated during the current study. MN/Model GIS data designate the mapped LfSA below the site (Parcel 4) as containing no paleosols and assign a landscape suitability rating (LSR) of *unsuitable* for harboring buried prehistoric archeological deposits; the landform was assigned a LSR of *low* for surface archeological deposits.

The strath terrace below site 21BS6/21BS7 possesses virtually no potential for harboring buried cultural deposits and, given the previous cultivation of the fields, any surface or near-surface deposits would likely have been detected during the pedestrian survey. The pedestrian survey results coupled with the geomorphological context of the terrace landform suggest that the likelihood of a habitation site on this landform is extremely low. No further work is recommended for Survey Parcel 4.

29
100
300
West Rd 8
Data are to be used for Reference purposes only
Source:
National Agricultural Imagery Program (2013)
Universal Transverse Mercator, NAD83
T121N, R45W
Path:
Minnesota Reports\Minnesota River Study\GIS Data
Author: ALAC
Date: October 2015
FIGURE 40
SURVEY PARCEL 4
AND SITE 21BS6/21BS7
N
W
E
S
0
50
100
200
Meters
Legend
Section
Survey Parcel
Previous Survey

Site 21BW6 (Vogel)

Site Number (Name): 21BW6 (Vogel)	**Survey Parcel/Map Reference:** 7
Site Type/Function: Artifact Scatter/Habitation	**Legal Location:**
Landform Position: Alluvial Fan	**Site Area (ac):** 7.44
Elevation Above Mean Sea Level (ft): 820	**Valley Section:** Upper
Cultural Affiliation: Prehistoric	**Site Condition:** Disturbed
USGS 7.5' Quadrangle(s): Essig (1964)	**Archaeological Subregion:** 2s

Research History

The first record of site 21BW6 in the state files is found in the 1954 field notes of Lloyd Wilford, who conducted a surface survey of the area in that year. The file also notes that Elden Johnson field-checked the site in 1959; however, no additional information about these earliest visits is included. The site was revisited in June of 1978 as part of the MNSAS project. At that time, the site was again subjected to a pedestrian survey, and a 1-m-x-1-m formal unit was also excavated; additionally, a collection of artifacts in the possession of the landowner was examined. The site records state that, at the time, the landowner's collection was divided into specific groups based on provenience. The site file also indicates that Archaic and Woodland cultural components are likely associated with 21BW6. The following excerpt from the site file details the findings of the 1978 investigations:

> Numerous points, sherds, flaked stone tools, and flakes in surface collection; points and copper reported from here by owner. Village debris extensive and deep, concentrating near house. Good source of clay here. Owner has large collection, divided by collecting area.
>
> Surface collection – June '78; test excavation Oct '78 (Science Museum of Minnesota). House and yard; cultivated field. some undisturbed patches in house yard. "sherds to 20 cm in test excavation – pit taken to 90 cm with shell and flakes, material was evident in probing below that." SMM – Ready, 1978 [21BW6 site file].

Although the site file notes otherwise, a sketch map of the site area is not included. It does, however, indicate that the 1-m-x-1-m unit excavated in 1978 was located northeast of the house (21BW6 site file).

Description

Site 21BW6 is located northwest of the community of New Ulm in Brown County. It was revisited by Augustana personnel on June 8, 2015. The site covers the majority of an alluvial fan just north of the road; it is about one mile southeast of the fan containing sites 21BW51, 21BW52, and 21BW112. Site 21BW53 is located approximately 170 m southeast of 21BW6 on the bluffs (see below). Part of 21BW6 lies within what is now a largely abandoned farmyard; the remainder of the site beyond the farmyard was planted to corn at the time of Augustana's survey (Figures 41 and 42; see Figure 24, above). Ground surface visibility averaged 0 percent in the farmyard and 70 percent in the cornfield at the time of the investigation. Artifacts were observed extending to the easternmost edge of the field during the survey, which prompted an extension of the site boundary eastward for a distance of 35 meters. The site area was photodocumented and the easternmost extension was mapped with a GPS instrument (see Figure 42).

Figure 41. Overview of a portion of site 21BW6, Brown County, Minnesota. View is facing across the site from the road.

site location information edit

Data are to be used for Reference purposes only

Source:
National Agricultural Imagery Program (2012)

Universal Transverse Mercator, NAD83
T111N, R31W

Path:
Minnesota Reports\Minnesota River Study\GIS Data

Author: ALAC Date: October 2013

FIGURE 42
SURVEY PARCEL 10 & 11
AND SITES 21BW6 & 21BW53

N
W E
S

0 50 100 200
Meters

Legend

Archeological Site
Section
21BW6 Extension
Survey Parcel

Investigation of the field resulted in the documentation of an ephemeral scatter of lithic debitage (shatter, secondary, and tertiary flakes) and FCR. Two tiny fragments of unidentifiable animal bone were also observed. Documented lithic material types consisted, primarily, of Swan River chert; however, lesser amounts of various other cherts and chalcedonies were also noted. Similar to site 21BW53 (see below), heat-treating was prolific among the lithic specimens. No diagnostic artifacts were observed during this visit and no material was collected.

The landowner has acquired a large collection of artifacts from 21BW6 and other nearby sites (21BW51, 21BW52, and 21BW53) over the years, and a portion of this assemblage was examined during the current investigation. The landowner shared some photographs of the collection with Augustana personnel, as well as material from two display cases. Unfortunately, the material in the cases could not be removed and the majority of the collection has been packed away in the owner's basement and is inaccessible. Therefore, it was not possible to discern which material in the collection derived from which site area. The material observed in photographs and the display cases included fully grooved and three-quarter-grooved mauls and axes (Figure 43), numerous chipped stone bifaces and projectile points (see Figure 43), and small quantities of scrapers and ceramics, as well as some catlinite pipe pieces (see Figure 43). The observed projectile points ranged from larger stemmed and corner-notched dart points to smaller side-notched and triangular unnotched arrow points. Only one photograph depicted pottery; a total of 11 ceramic specimens was observed (see Figure 43). Among these were six bodysherds with varying smoothed-over and/or cord-roughened surface treatment. The five rimsherds/near-rims in the photograph appear fairly thick in cross-section and include decorative punctates and trailed patterns both at and below the lip.

Figure 43. Artifacts collected from sites 21BW6, 21BW51, 21BW52, and 21BW53, Brown County, Minnesota. Grooved mauls and axes (upper left); projectile points and bifaces (upper right); catlinite pipe fragments (lower left); ceramic rim and bodysherds (lower right).

Interpretation and Recommendations

Site 21BW6 is a multicomponent prehistoric site located on an alluvial fan. It was initially documented as a habitation or village, although no settlement features were positively identified. MN/Model GIS data designate the mapped LfSA containing site 21BW6 as commonly containing paleosols and assign a landscape suitability rating (LSR) of *high* for harboring buried prehistoric archeological deposits; testing conducted at the site in 1978 revealed the presence of ceramics buried at a depth of 20 cmbs and lithics at least as deep as 90 cmbs. Although the surface component is heavily disturbed from previous cultivation and development associated with the farm, it is highly probable that undisturbed buried components are present in the fan deposits at the site. Artifacts collected from the surface of 21BW6 illustrate the presence of Archaic and Woodland cultural groups; the landowner recalls collecting copper artifacts from the 21BW6 site area, which likely served as the impetus for the Archaic component designation (21BW6 site file).

Site 21BW6 is a multicomponent prehistoric site located on an alluvial fan landform. The landform containing the site possesses high potential for harboring buried cultural deposits; a high likelihood for hitherto undetected buried components exists across the site area. Limited testing in 1978 confirmed the presence of buried archeological components within the site boundaries. Site 21BW6 is believed to possess significant research potential for future investigations. Augustana recommends further subsurface investigation of the alluvial fan harboring site 21BW6.

Site 21BW51 (Bastian)

Site Number (Name): 21BW51 (Bastian)	**Survey Parcel/Map Reference:** 7
Site Type/Function: Lithic Scatter/Unknown	**Legal Location:**
Landform Position: Alluvial Fan	**Site Area (ac):** 4.58
Elevation Above Mean Sea Level (ft): 825	**Valley Section:** Upper
Cultural Affiliation: Prehistoric/Protohistoric	**Site Condition:** Disturbed
USGS 7.5' Quadrangle(s): Saint George (1964)	**Archaeological Subregion:** 2s

Research History

Site 21BW51 was first recorded in April of 1978 as part of the MNSAS project. MHS archeologists surveyed and mapped the site area (Figure 44), conducted limited subsurface testing, collected a sample of material from the surface (MHS Accession No. 157-50), and examined a sizeable collection of artifacts in the possession of the landowner. The state site file identifies probable Archaic, Woodland, Mississippian, and protohistoric cultural components associated with 21BW51 (but see notes below). The following excerpt from the site file details the findings of the 1978 investigations:

> Large collection owned by Harley Vogel, owner…Area reported as Indian camp in 1855.
>
> Large side scraper found on hill slope. Artifacts also reported on shore of Horseshoe lake, although "not much there." Shore is often obscured by overflow from Minn. River.
>
> Numerous flakes from area S.W. of house, eroding from bank along creek. Concentration n.w. of barn, although exposure is poor. Undisturbed areas present. Flakes, historic debris n.e. of house in garden, lithic scatter in field e. of house in field.
>
> Vogel has pts and hafted stone tools from here.
>
> Note – Vogel's collection contains BW52 & BW51 although he is positive about finding specific Woodland points at BW51, he is not so sure about Archaic and Mississippian. Cultural affiliation is based on point types – only one common sherd found in area & that was most likely from BW52 [21BW51 site file].

The site file describes the surface artifact distribution at the site as "dense," and further notes that FCR was discovered at a depth of 50 cmbs in a test unit northeast of the modern house. The Indian village mentioned above is depicted in this location on an 1855 surveyor's map. The site is noted to have high potential for National Register eligibility (21BW51 site file).

site location information edit

Figure 44. 1978 sketch map of 21BW51 site area (from 21BW51 site file).

Description

Site 21BW51 is located northwest of the community of New Ulm in Brown County. It was revisited by Augustana personnel on June 8, 2015. The site is positioned on the apex of an alluvial fan just north of the road. Northern and eastern portions of the site are in a cultivated soybean field that afforded 70 percent ground surface visibility; however, the majority lies within the yard of an occupied farm (Figures 45 and 46; see Figure 24, above). During the examination of the 21BW51 site area, Augustana documented only a single gray-colored (10YR 6/1) chert tertiary flake; it was located just east of the farmyard on the edge of the soybean field. The site area was photodocumented; however, it was not mapped with a GPS instrument as all observed cultural material was confined to the site boundaries as originally defined. Sites 21BW112 and 21BW52 (see below) are located on the same landform approximately 188 m northeast, and 268 m east-southeast, of 21BW51, respectively.

Figure 45. Overview of a portion of site 21BW51, Brown County, Minnesota. View is facing across the site.

The landowner has acquired a large collection of artifacts from 21BW51 and other nearby sites (21BW6, 21BW52, and 21BW53) over the years, and a portion of this assemblage was examined during the current investigation (see 21BW6 site description for more information).

site location information edit
FIGURE 46
SURVEY PARCEL 9 AND
SITES 21BW51, 21BW52, & 21BW112
N
W
E
S
0
50
100
200
Meters
Legend
Site (Isolate)
Section
Archeological Site
Survey Parcel

Interpretation and Recommendations

Site 21BW51 is a multicomponent prehistoric/protohistoric site located at the apex of an alluvial fan. It was historically documented as a protohistoric habitation and likely functioned similarly in prehistory. MN/Model GIS data designate the mapped LfSA containing site 21BW51 as commonly containing paleosols and assign a landscape suitability rating (LSR) of *high* for harboring buried prehistoric archeological deposits; testing conducted at the site in 1978 revealed the presence of FCR buried at a depth of 50 cmbs. Although the surface component is heavily disturbed from previous cultivation and development associated with the current farm, it is highly probable that undisturbed buried components are present in the fan deposits at the site. Artifacts collected from the surface of 21BW51 and other nearby sites illustrate the presence of Archaic, Woodland, Mississippian, and protohistoric cultural groups; the landowner recalls collecting specific Woodland-type projectile points from the 21BW51 site area (21BW51 site file).

Site 21BW51 is a multicomponent prehistoric/protohistoric site located on an alluvial fan landform. The landform containing the site possesses high potential for harboring buried cultural deposits; a high likelihood for hitherto undetected buried components exists across the entire landform. Following site investigations in 1978, 21BW51 was found to have high potential for National Register eligibility and significant research potential. Augustana concurs with these previous findings and recommends further subsurface investigation of the alluvial fan harboring site 21BW51.

Site 21BW52 (Vajen)

Site Number (Name): 21BW52 (Vajen)	**Survey Parcel/Map Reference:** 7
Site Type/Function: Artifact Scatter/Unknown	**Legal Location:**
Landform Position: Alluvial Fan	**Site Area (ac):** 8.36
Elevation Above Mean Sea Level (ft): 815	**Valley Section:** Upper
Cultural Affiliation: Prehistoric	**Site Condition:** Disturbed
USGS 7.5' Quadrangle(s): Saint George (1964)	**Archaeological Subregion:** 2s

Research History

Site 21BW52 was first recorded in April of 1978 at the same time as nearby site 21BW51 (see above). MHS archeologists surveyed and mapped the site area (Figure 47), collected a sample of material from the surface (MHS Accession No. 157-51), and examined a sizeable collection of artifacts in the possession of the landowner. The state site file identifies probable Late Woodland and Mississippian cultural components associated with 21BW52. The following excerpt from the site file details the findings of the 1978 MNSAS investigations:

> Artifacts were scattered for 600 meters east-west, but only from the road north to 300 meters, ending where concentrations of shell began…Three smooth grit-tempered sherds, a biface, numerous worked flakes and debitage in surface collection.
>
> 2a: Scatter of lithic material – triangular pt., drill, numerous flakes. On rise n. of road.
>
> 2b: Wide scatter of lithic and ceramic material – 3 sherds, Knife River flint scraper, many flakes, burnt bone, unburnt bone. Collected by H. Vogel, too [21BW52 site file].

site location information edit

Figure 47. 1978 sketch map of 21BW52 site area (from 21BW52 site file).

An examination of the sketch map (see Figure 47, above) indicates that the artifacts were discovered in two distinct concentrations (2a and 2b), separated by an area of low-lying land (the concentrations are likely associated with two separate lobes of the same fan). The site is noted to have high potential for further research (21BW52 site file).

Description

Site 21BW52 is located northwest of the community of New Ulm in Brown County. It was revisited by Augustana personnel on June 8, 2015. The site is positioned on the easternmost portion of an alluvial fan just north of KC Road. The site is in a cultivated soybean field that afforded 70 percent ground surface visibility (Figure 48; see Figures 24 and 46, above). During the examination of the 21BW52 site area, Augustana documented one white-colored (10YR 8/1) chert tertiary flake and one very pale brown-colored (10YR 8/2) Swan River chert primary flake with unifacial retouch on one lateral margin. The site area was photodocumented; however, as with site 21BW51, it was not mapped with a GPS instrument as all observed cultural material was confined to the site boundaries as originally defined. Sites 21BW112 and 21BW51 (see above and below) are located on the same landform approximately 224 m northwest, and 268 m west-northwest, of 21BW52, respectively.

Figure 48. Overview of a portion of site 21BW52, Brown County, Minnesota. View is facing across the alluvial fan at the site (red arrow denotes the site area).

As previously discussed, a portion of the landowner's artifact collection from 21BW52 and other nearby sites was examined by Augustana personnel (see 21BW6 description, above). The collection included an array of specimens from at least four different sites in the area and it was not possible to determine which specific items derive from 21BW52.

Interpretation and Recommendations

Site 21BW52 is a multicomponent prehistoric site located at the edge of an alluvial fan. It was initially documented as a habitation or village, although no settlement features were positively identified. MN/Model GIS data designate the mapped LfSA containing site 21BW52 as commonly containing paleosols and assign a landscape suitability rating (LSR) of *high* for harboring buried prehistoric archeological deposits. Although the surface component is heavily disturbed from previous cultivation and collecting, undisturbed buried cultural components are likely to be present in the fan deposits at the site. Site 21BW52 is documented as containing artifact material types of Late Woodland and Mississippian cultural affiliation (21BW52 site file).

Site 21BW52 is a multicomponent prehistoric site located on an alluvial fan landform. The landform containing the site possesses high potential for harboring buried cultural deposits; a high likelihood for hitherto undetected buried components exists across the entire landform. Following site investigations in 1978, 21BW52 was found to have high future research potential. Augustana concurs with these previous findings and recommends further subsurface investigation of the alluvial fan harboring site 21BW52.

Site 21BW53 (Harley)

Site Number (Name): 21BW53 (Harley)	**Survey Parcel/Map Reference:** 7
Site Type/Function: Artifact Scatter/Habitation	**Legal Location:**
Landform Position: Upland Bluffs	**Site Area (ac):** 8.33
Elevation Above Mean Sea Level (ft): 990	**Valley Section:** Upper
Cultural Affiliation: Prehistoric	**Site Condition:** Disturbed
USGS 7.5' Quadrangle(s): Essig (1964)	**Archaeological Subregion:** 2s

Research History

Site 21BW53 was first recorded in April of 1978 at the same time as nearby sites 21BW51 and 21BW52 (see above). MHS archeologists surveyed and mapped the site area (Figure 49), collected a sample of material from the surface (MHS Accession No. 157-53), and examined a sizeable collection of artifacts in the possession of the landowner. The state site file indicates probable Middle Woodland cultural components associated with 21BW53. The following excerpt from the site file details the findings of the 1978 MNSAS investigations:

> Plowed field overlooking valley, above Vogel site (21 BW 6).
>
> A cord-wrapped, near-rim sherd with bosses, a side-notched point, a 'firestone' and numerous flakes found on surface. Owner reports 'dozens of points' from here.
>
> Mr. Vogel walked with the team, found "firestone." Has concentric rings w/in circular hole, smoothed bottom w/in hole. Site high on hill above Mn. River Valley, visibility 2 mi upstream, 2-3 mi downstream [21BW53 site file].

site location information edit

Figure 49. 1978 sketch map of 21BW53 site area (from 21BW53 site file).

The sketch map notes a 3-meter-wide strip along the edge of the bluffs that is undisturbed by cultivation (see Figure 49, above) Like sites 21BW51 and 21BW52, 21BW53 is noted to have high potential for National Register eligibility (21BW53 site file).

Description

Site 21BW53 is located northwest of the community of New Ulm in Brown County. It was revisited by Augustana personnel on June 8, 2015. The site is positioned on upland bluffs south of KC Road and overlooking the right bank of the Minnesota River. The site is in a cultivated cornfield that afforded 50 percent ground surface visibility (Figure 50; see Figures 24 and 42, above). The site area was photodocumented; however, as with sites 21BW51 and 21BW52, it was not mapped with a GPS instrument as all observed cultural material was confined to the site boundaries as originally defined. Site 21BW6 (see above) is located approximately 170 m northwest of 21BW53 and immediately below the bluffs.

Figure 50. Overview of a portion of site 21BW53, Brown County, Minnesota. View is facing across the site from the road.

During the examination of 21BW53, Augustana documented multiple secondary and tertiary flakes produced from Swan River chert, as well as one unifacially retouched informal tool and one broken projectile point (Figure 51). The two tools were collected. Both tools, as well as the majority of observed flakes, appeared to be thermally altered.

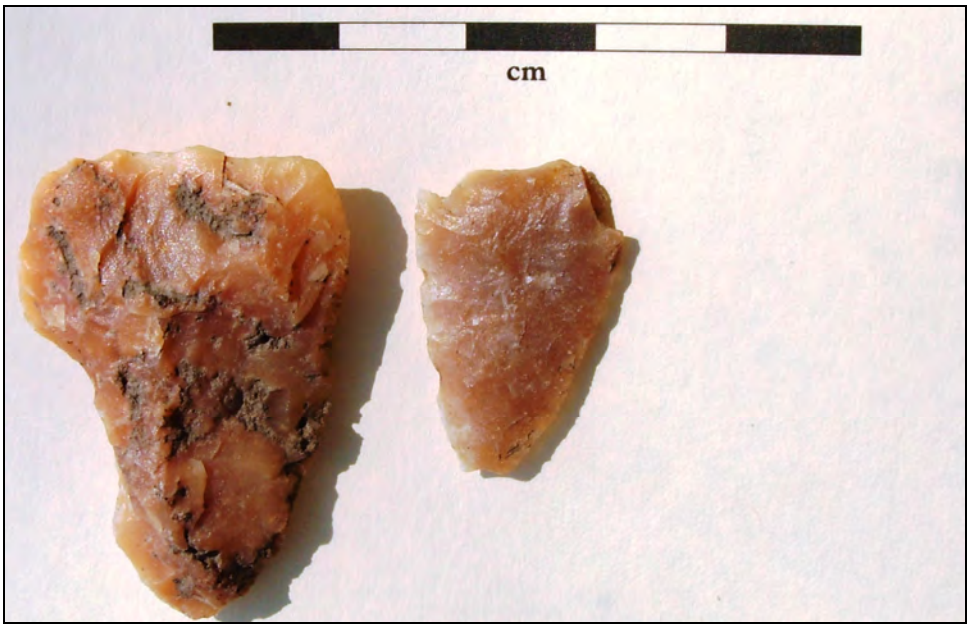


Figure 51. Artifacts recovered from site 21BW53. Thermally altered unifacially retouched informal tool (left) and thermally altered corner-notched projectile point (right).

The unifacially retouched specimen is manufactured from a light reddish brown-colored (5YR 6/4) piece of heat-treated Swan River chert. The specimen measures 3.75 cm in maximum length, 2.62 cm in maximum width, and 1.02 cm in maximum thickness. Retouch is present along two margins of the obverse face. The projectile point specimen is manufactured from a piece of heat-treated, reddish brown-colored (5YR 6/4) Swan River chert. It is a corner-notched arrow point with the distal tip and the base removed. The point measures 2.42 cm in maximum length (broken), 1.61 cm in maximum width, and 0.56 cm in maximum thickness. The two collected tools were returned to the landowner following documentation.

Interpretation and Recommendations

Site 21BW53 is a prehistoric site located on upland bluffs overlooking the Minnesota River valley. It was initially recorded as a habitation, although no settlement features were positively identified. The site file also indicates that 21BW53 contains artifacts of Middle Woodland cultural affiliation based on the presence of a near-rimsherd with boss and punctate decorations and cordmarked surface treatment. Upland sites in cultivated fields almost always manifest surficially due to the shallow depth to sterile subsoil. The upland landform on which the site is located does not harbor paleosols and, although an LSR was not assigned to the site area, it would almost certainly be classified as *unsuitable* for buried archeology. The majority of the surface component is heavily disturbed from previous cultivation and collecting. However, there is a narrow, 3-m-wide strip along the very edge of the bluffs that was not plowed, as well as a grassy hilltop mapped as undisturbed on the 1978 sketch map. These areas were not explored during the 1978 investigation or the present study.

Site 21BW53 is a prehistoric site located on upland bluffs. The landform within the mapped boundaries of the site possesses no potential for harboring buried cultural deposits. Following site investigations in 1978, 21BW53 was found to have high potential for National Register eligibility. Augustana disagrees with this assessment as far as the immediate site area is concerned. However, it is possible that subsurface investigations focused on exploring the uncultivated areas along the bluff edge and grassy hilltop may yield additional, undisturbed components of site 21BW53. It is recommended that any future research conducted at 21BW53 be directed at these uncultivated areas.

Site 21BW112

Site Number (Name): 21BW112	**Survey Parcel/Map Reference:** 7
Site Type/Function: Single Artifact/Unknown	**Legal Location:**
Landform Position: Alluvial Fan	**Site Area (ac):** 0.01
Elevation Above Mean Sea Level (ft): 810	**Valley Section:** Upper
Cultural Affiliation: Prehistoric	**Site Condition:** Disturbed
USGS 7.5' Quadrangle(s): Saint George (1964)	**Archaeological Subregion:** 2s

Research History

Site 21BW112 was not documented prior to the current study. No previous investigations of the site area are mapped in the state GIS database; however, two previously recorded prehistoric sites are located in close proximity to 21BW112 and on the same landform.

Description

Site 21BW112 is located northwest of the community of New Ulm in Brown County. It was documented by Augustana personnel on June 8, 2015. The site was discovered on a distal portion of an alluvial fan in a cultivated soybean field just north of KC Road (Figure 52; see Figures 24 and 46, above). Ground surface visibility averaged 70 percent at the time of the investigation. The site consists of a single chipped stone end scraper; it was discovered on the ground surface. The site area was photodocumented and mapped with a GPS instrument. No additional cultural material was documented in the immediate vicinity of the site; however, two previously recorded prehistoric sites, 21BW51 and 21BW52 (see above), are located on the same landform approximately 188 m southwest, and 224 m southeast, of 21BW112, respectively.

Figure 52. Overview of site 21BW112, Brown County, Minnesota. View is facing across the site.

Site 21BW112 consists of a single chipped stone end scraper. The specimen is manufactured from a very pale brown-colored (10YR 7/3) chert cobble (Figure 53). It measures 25.34 mm in maximum length, 17.36 mm in maximum width, and 5.78 mm in maximum thickness; it is complete. Minor damage present along the steeply beveled, distal margin suggests some degree of use. The specimen was returned to the landowner after being photographed and measured.

Figure 53. End scraper recovered from site 21BW112.

Interpretation and Recommendations

Site 21BW112 is an isolated prehistoric end scraper located on the surface of a cultivated soybean field on an alluvial fan. MN/Model GIS data designate the mapped LfSA containing site 21BW112 as commonly containing paleosols and assign a landscape suitability rating (LSR) of *high* for harboring buried prehistoric archeological deposits. The site's landform was assigned a *low suitability* LSR for surface archeological deposits by MN/Model. The landform is classified as having high overall site potential. Without subsurface testing, it is not possible to ascertain the extent of this site or whether buried diagnostic artifacts are present that may speak to its function or cultural affiliation. The scraper is a ubiquitous example common among artifact assemblages throughout North American prehistory; cultural affiliation could not be ascertained from this lone artifact. However, it is probable that some affiliation exists between this site and nearby previously documented sites 21BW51 and 21BW52—both of which are also surface sites from the same landform (see above); 21BW52 has an identified Woodland component.

Site 21BW112 is an isolated prehistoric end scraper located on the surface of a cultivated soybean field. The site is confined to an alluvial fan landform that possesses high potential for harboring buried cultural deposits. The artifact's geomorphological context, coupled with its close proximity to other previously documented prehistoric sites on the same fan landform, strongly suggests an affiliation with one or both of these other sites. Additionally, a high likelihood for hitherto undetected buried components exists across the entire landform. Augustana recommends further subsurface investigation of the site area as a means of exploring this assertion.

Site 21CP16 (Rueben Rongstad)

Site Number (Name): 21CP16 (Rueben Rongstad)	**Survey Parcel/Map Reference:** 4
Site Type/Function: Artifact Scatter/Kill(?)	**Legal Location:**
Landform Position: Alluvial Fan	**Site Area (ac):** 9.29
Elevation Above Mean Sea Level (ft): 950	**Valley Section:** Upper
Cultural Affiliation: Prehistoric (Unknown)	**Site Condition:** Disturbed
USGS 7.5' Quadrangle(s): Montevideo (1994)	**Archaeological Subregion:** 2n

Research History

The first record of site 21CP16 in the state files is from Elden Johnson, who visited the area in July of 1959 after it was reported that bison bones had been found eight feet below the surface in a cutbank along Spring Creek. The site is described as being in pasture, with the cutbanks along a creek varying between six and eight feet in height. Further details about the 1959 site visit are not provided in the site file; however, three photographs depict overviews of the site area and a cutbank profile that was documented (Figures 54 and 55). The site was revisited in May of 1978 as part of the MNSAS project. It was subjected to a pedestrian survey that focused on an examination of creek bank exposures south and west of the house. The following excerpt from the site file details the findings of the 1978 investigations:

> Along the creek in places where it widens—probably along most of the creek but especially at wide points, which may have been watering places—.
>
> Note—mud along creek is very deep—even though I was there in a dry time—one step would be "terra firma"—the next I'd just sink—if always like this it may have made a good trap for animals—but also animals may have bogged down without any assistance whatsoever
>
> Mrs. Smith said former owners had told them about bones—she & husband also found bones (complete) that were darkly stained. She'll let us know if she finds them. Walked along creek & along edges of adjacent fields—found a # of bones—> 1 animal—no evidence of artifacts—MS Smith said none found here ever that she knew of
>
> E.J. says a local collector claimed he found some points here—were prob. Archaic/poss. Paleoindian. Informant secretive. Info. not substantiated [21CP16 site file].

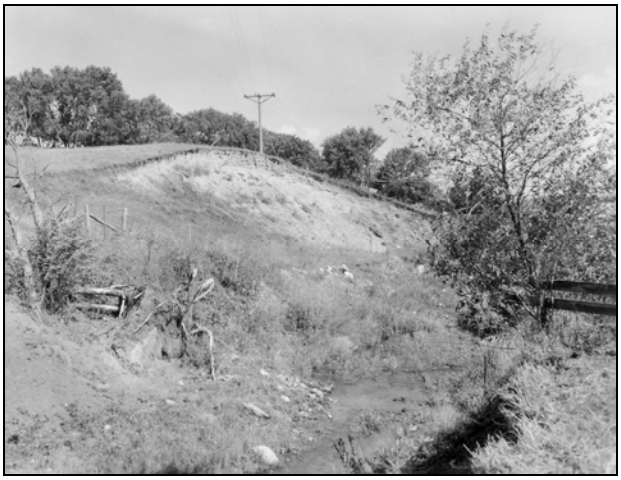


Figure 54. Overviews of the areas along the creek investigated in 1959 (from 21CP16 site file).

The areas along the creek banks where bison bones were observed during the 1978 investigation are mapped as being southwest of the house; however, it is also noted that bones are likely to be located along most of the creek in this area (21CP16 site file). This note appears to be substantiated as at least one of the 1959 photos seems to depict a segment further upstream along the creek near the base of the bluffs east of the house (see Figure 54). The area east of the house is also the location from which the recently reported bison cranium was recovered (see below).

Description

Site 21CP16 is located north of the community of Montevideo in Chippewa County. It was first revisited by Augustana personnel on October 22, 2014. The site is located at the base of upland bluffs on a small alluvial fan where a creek enters the Chippewa River valley (Figures 56 and 57; see Figure 21, above). It lies upstream of the Chippewa River/Minnesota River confluence. During the site visit, the landowner allowed Augustana personnel to examine the cranial vault of a bison that, earlier in the year, was discovered in the cutbank of Spring Creek just east of the house (Figure 58); this location was subsequently identified by the landowner. The landowner also indicated that a large leg bone was discovered in the creek due south of the house during the 1970s. In addition, he mentioned that grooved mauls had been previously found in one of the fields near the house; however, he could not recollect the exact location where the mauls were found or their present whereabouts. The creek is apparently prone to severe, seasonal episodic flooding in this area and such an episode occurred immediately prior to the discovery of both the bison leg bone and cranium (landowner, personal communication 2014).

Figure 55. Profile view of the creek cutbank exposure examined during 1959 field visit (from 21CP16 site file).

Figure 56. Overview of site 21CP16, Chippewa County, Minnesota. View is facing across the site.

The bison cranium was briefly examined. It is a partial cranium consisting of a complete left horn core, a nearly complete right horn core, and incomplete frontal and occipital elements; a posterior portion of the right orbital remains intact. A fully fused sagittal suture suggests a mature animal. No evidence of human modification was observed. The cranium is in a fragile state and remains partially filled with sediment. The specimen was not removed from the table on which it rested for fear of causing additional damage. The complete left horn core straight-line dorsal measurement from tip to burr equals 219 mm. A horn core spread measurement taken from the tip of the left core to the broken end of the right core equals 660 mm. A full tip-to-tip horn core spread measurement could only be inferred by assuming an equal length for each horn core. Following this assumption, an extrapolated tip-to-tip horn core spread measurement would equal approximately 722 mm. These measurements would place the specimen within the upper documented size range for adult male *Bison bison bison* (McDonald 1981:96). However, the measurements also fall within the mid-to-lower documented size range for adult male *Bison bison occidentalis* and could conceivably fit at the very upper size range of female documented *B. b. occidentalis* specimens as well (McDonald 1981:87). Unfortunately, variation in cranial measurements and horn core size and orientation between bison species (and within a given species) is pronounced, and accurate species-level determination using an incomplete suite of such measurements is not possible; McDonald (1981) provides a suite of 18 different cranial measurements for this purpose and cross-species overlap can occur even with the use of a full complement of these measurements.

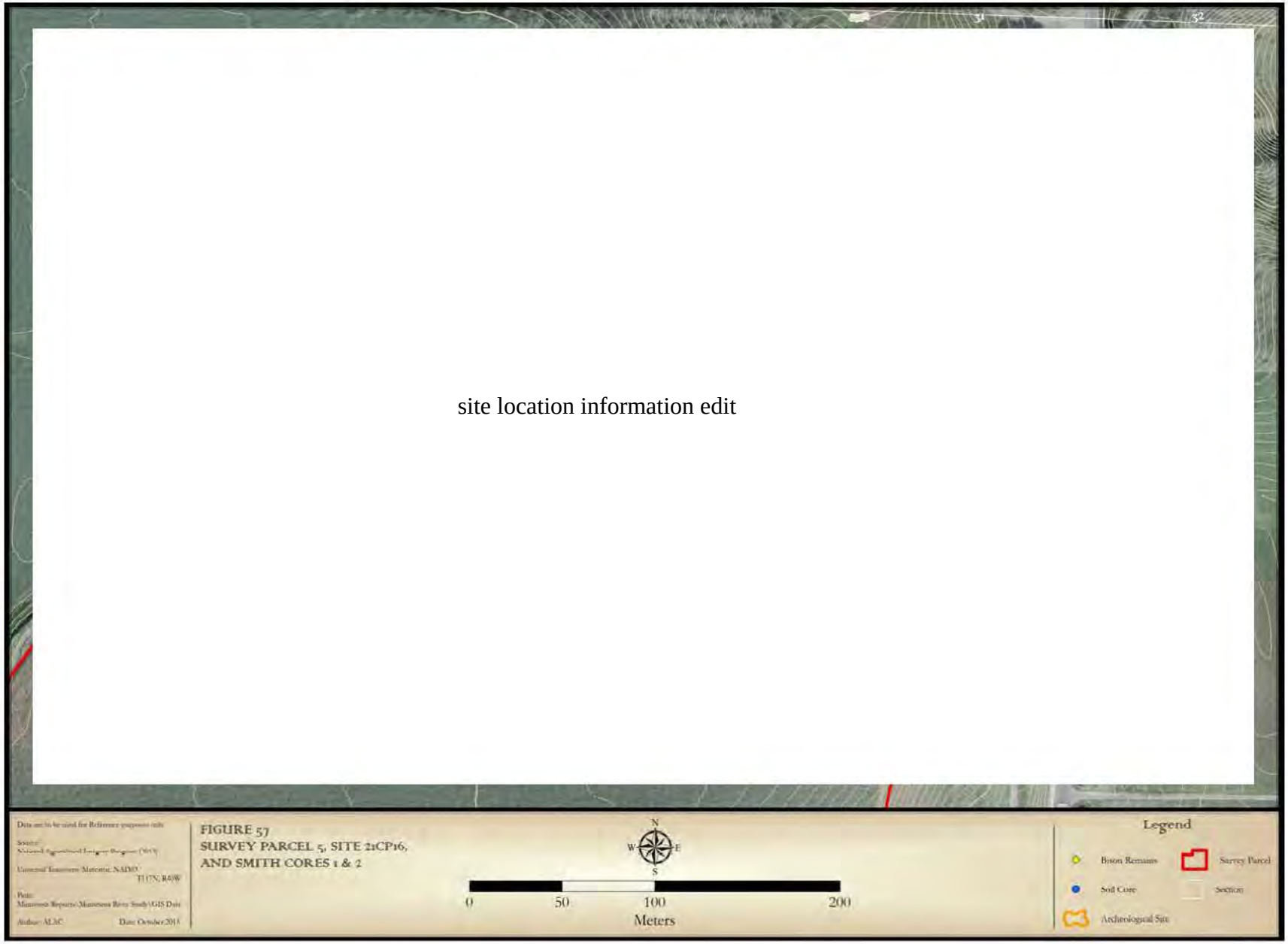

site location information edit
FIGURE 57
SURVEY PARCEL 5, SITE 21CP16,
AND SMITH CORES 1 & 2
N
W
E
S
0
50
100
200
Meters
Legend
Bison Remains
Survey Parcel
Soil Core
Section
Archeological Site

Figure 58. Cranial vault of bison recovered from the creek cutbank, site 21CP16.

Following the examination and photodocumentation of the cranium, the cutbanks along Spring Creek were examined and the location of the bison find was mapped with the GPS instrument (see Figure 59). Unfortunately, an examination of the creek valley further upstream east of the highway was not possible due to a lack of permission to access the property. A pedestrian survey was conducted across a portion of the alluvial fan and floodplain landforms in and beyond the mapped 21CP16 site boundaries south and west of the house. The majority of the surveyed parcel was in a recently harvested and subsoiled soybean field south of the left bank of the creek. Ground surface visibility in the field was 90 percent at the time of the investigation. A small, 25-m-wide strip along the right bank of the creek was examined subsequent to the soybean field investigation. Visibility averaged 40 percent along this stretch. Investigations in and around the 21CP16 site area failed to identify material that was definitively cultural in nature. However, a small fragment of large mammal bone and an adjacent piece of bovid tooth enamel were documented along the right bank of the creek. No evidence of human modification was observed on the bone fragment. Though unconfirmed, this material is also suspected to be bison. The location of the faunal remains was mapped with a GPS instrument and the material was left with the landowner (see Figure 57).

Figure 59. Location of bison cranium find near the house, site 21CP16.

Augustana returned to the 21CP16 site area on November 4, 2014 with project geomorphologist Rolfe Mandel. With the intention of exploring the potential for buried archeological deposits in the alluvial fan landform, two soil cores were extracted with the use of a Giddings hydraulic soil probe. The location of the cores was mapped with the GPS instrument (see Figure 57, above). Core 1 was extracted from the upper midsection of the fan, and Core 2 from the distal end of the fan. Both cores exposed a surface soil with an overthickened (90 cm) cumulic A horizon above a stratified sandy and gravelly C horizon. Although a peaty muck occurs at a depth of 2.53–2.74 mbs and 1.20–1.35 mbs

in cores 1 and 2, respectively, buried soils were not observed. The top of the peaty muck represents a buried floodplain wetland; hence, it marks the boundary between floodplain deposits and the overlying fan deposits.

In Core 1, organic matter from the upper 10 cm of the peaty muck and lower 10 cm of the A horizon yielded uncalibrated AMS radiocarbon ages of 4160 ± 30 and 1635 ± 30 RCYBP, respectively (see Appendix A). Based on these ages, aggradation of the fan began soon after ca. 4,100 years ago. Aggradation was initially rapid, but by ca. 1600 RCYBP, sedimentation slowed, allowing formation of the nearly 1-m-thick cumulic A horizon of the surface soil.

There is moderate potential for buried Early to Late Woodland cultural deposits in the cumulic A horizon of the surface. Below a depth of 90 cmbs, however, the potential for cultural deposits is greatly diminished (see Mandel, Chapter 5, pp. 145–146 for more information).

Interpretation and Recommendations

Site 21CP16 is a locality where numerous bison remains have been documented. Two unsubstantiated reports of prehistoric artifacts are also associated with the site locale. Bison remains were reported in cutbank exposures from depths of up to eight feet (2.44 m) below surface. The bison cranium recently discovered by the landowner derived from an approximate depth of 1.5 mbs (4.9 feet) in the creek bank. During the current investigation, the landowner reported finding grooved mauls in the fields near the house. The 21CP16 site file identifies another collector who reportedly discovered projectile points in the site area; however, no associated artifacts have been documented in field visits by professional archeologists. A 2014 surface survey of the fields in and around the site area yielded no definitive cultural deposits; only a fragmented bovid bone and adjacent piece of bovid tooth enamel were discovered. The portion of Spring Creek that contains site 21CP16 is prone to violent, episodic seasonal flooding and the bison remains observed at the site in cutbank exposures may well have been redeposited from a location further upstream. MN/Model GIS data do not indicate whether the mapped LfSA containing site 21CP16 is likely to harbors paleosols. A LSR of *moderate* for harboring buried prehistoric archeological deposits between 0 and 2 mbs is assigned, whereas the landform was assigned a *low suitability* LSR for surface and deeply buried (2–5 mbs) archeological deposits. Analysis of the extracted soils cores support these modeled LSRs. Although the position of site 21CP16 along a perennial creek on an alluvial fan landform supports the likelihood of additional intact, buried deposits, these deposits are likely to be confined to the cumulic A horizon between the surface and 90 cmbs. Radiocarbon data indicate that cultural deposits confined to the cumulic A horizon will be Woodland-age or younger. Below this depth, the extracted soil cores are characterized by laminated sands overlying peaty muck deposits with an absence of paleosols to depths of 2.53–2.74 mbs (Core 1) and 1.20–1.35 mbs (Core 2). This evidence typifies largely unstable land surfaces, both on the fan below 90 cmbs and on the valley floodplain immediately below the fan. Such environments would not be conducive to extended periods of human habitation.

Site 21CP16 is a faunal site consisting of bison remains and reported, albeit unverified, associated projectile points and grooved mauls. Reported high-energy flood episodes along Spring Creek in the 21CP16 site area are evidenced in two soil cores extracted from the alluvial fan adjacent to the site. The cores indicate a lack of the requisite land surface stability for extended cultural habitation below 90 cmbs. The geomorphic setting suggests moderate potential for in situ buried archeology in the immediate site vicinity to a depth of 90 cmbs; however, no cultural deposits were identified surficially during the pedestrian survey and previous cultivation would have exposed any material in the upper ca. 30 cmbs of this soil. The violent nature of past flood events in the creek valley suggests the possibility that bison remains observed in the exposed cutbanks were relocated from their original depositional context further upstream; as no bison remains were reported to have been discovered in the upper 90 cmbs, the geomorphology supports this supposition. Unfortunately, the area upstream of the current site could not be investigated due to the lack of access permission. Results of the current investigation at site 21CP16 are largely inconclusive and suspected, definitive human association with the site was not verified. Current survey work along the creek valley also failed to identify additional bison remains exposed in cutbanks; this precluded a clear understanding of depositional context and left unresolved the question of whether the bison remains were in situ or redeposited from further upstream via high-energy flood events. Geomorphic data from two soil cores suggest that the latter scenario is more plausible; however, this also remains unconfirmed. Although the immediate 21CP16 site area likely offers little in the way of future research potential, further exploration upstream is felt to hold merit. It is also recommended that verification of reported artifact finds—particularly those related to the collected projectile points—in the site area be pursued, as these could provide valuable data related to the relative age of the site and historic context associations.

Site 21LE148

Site Number (Name): 21LE148	**Survey Parcel/Map Reference:** 14
Site Type/Function: Single Artifact/Unknown	**Legal Location:**
Landform Position: General Uplands	**Site Area (ac):** 0.01
Elevation Above Mean Sea Level (ft): 970	**Valley Section:** Lower
Cultural Affiliation: Prehistoric	**Site Condition:** Disturbed
USGS 7.5' Quadrangle(s): Belle Plaine South (1981)	**Archaeological Subregion:** 2e

Research History

Site 21LE148 was not documented prior to the current study. No previous investigations of the site area are mapped in the state GIS database.

Description

Site 21LE148 is located northeast of the community of Le Sueur in Le Sueur County. It was documented by Augustana personnel on October 22, 2015. The site is located on uplands just east of the bluff edge that overlooks the right bank of the Minnesota River. A single artifact was discovered in a cultivated soybean field east of Pumpkin Hill Road. Ground surface visibility in the field was 40 percent at the time of the investigation (Figures 60 and 61; see Figure 31, above). Further investigations in and around the site area failed to identify additional cultural material. The location of the site was mapped with a GPS instrument and photodocumented.

Figure 60. Overview of site 21LE148, Le Sueur County, Minnesota. View is facing across the site.

Site 21LE148 consists of a single tested cobble/informal tool. The specimen is manufactured from a piece of poor-quality brown-colored (10YR 4/3) chalcedony (Figure 62). The artifact is a small cobble measuring approximately 4 cm in length by 3 cm in width; it was split longitudinally by percussion flaking. Cortex is present on two opposite margins of the specimen. Percussion flaking removed one flake from the obverse face and one from the reverse face. The two flake scars converge at the margin of the piece (see arrow, Figure 62). Minor edge-wear present along this margin suggests temporary use as an expedient cutting tool. Upon request of the property owner, the specimen was returned to the location at which it was discovered following documentation.

site location information edit
Data not to be used for Reference purposes only
Source:
National Agricultural Imagery Program (2013)
Universal Transverse Mercator, NAD83
T112N_R25W
Path:
Minnesota Reports\Minnesota River Study\GIS Data
Author: ALAC
Date: October 2015
FIGURE 61
SURVEY PARCEL 26
AND SITE 21LE148
N
W
E
S
0
50
100
200
Meters
Legend
Site (Isolate)
Section
Survey Parcel

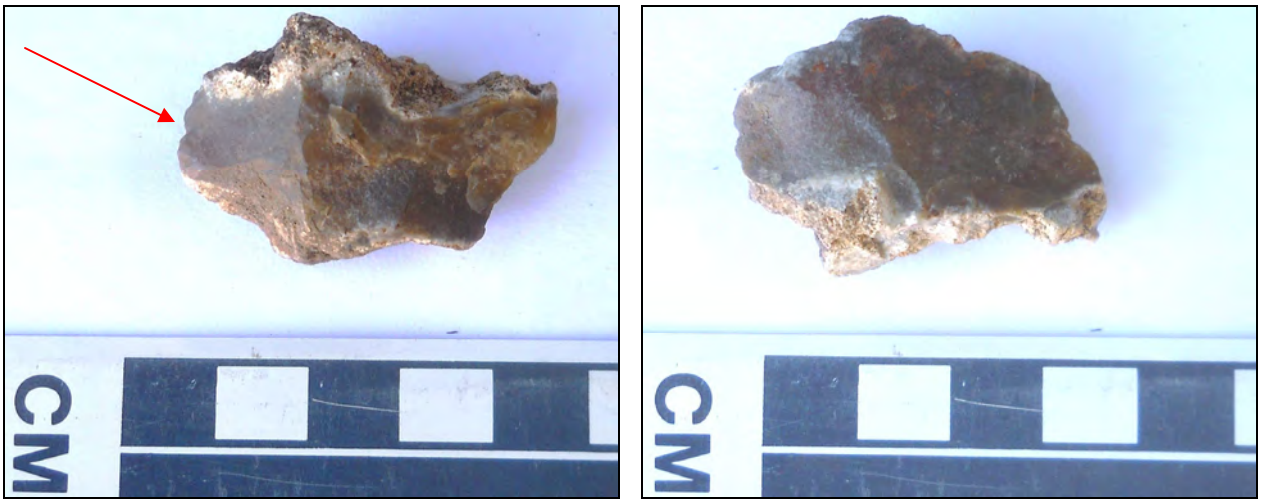


Figure 62. Tested cobble/informal tool recovered from site 21LE148 obverse (left); reverse (right). Arrow depicts marginal damage consistent with usewear.

Interpretation and Recommendations

Site 21LE148 is an isolated prehistoric artifact located in a cultivated upland soybean field. Its position in a cultivated upland field suggests either a surface or near-surface deposit disturbed, at least minimally, by agricultural practices. Upland sites in cultivated fields almost always manifest surficially due to the shallow depth to sterile subsoil. Despite this, no evidence of additional artifacts was detected in the vicinity of the site. Furthermore, the ubiquity of the specimen renders any cultural taxonomic assignment impossible; the site setting is capable of containing prehistoric sites from all but the very earliest documented cultural groups. The upland landform on which the site is located does not harbor paleosols and, although an LSR was not assigned to the site area, it would be classified as *unsuitable* for buried archeology based on the reasons noted above.

Site 21LE148 consists of a single informal chipped stone tool/tested cobble located in a cultivated upland field. The geomorphic setting suggests no potential for buried archeology in the immediate site vicinity and no additional cultural deposits were identified in association with the specimen. The ubiquity of the tool precludes its assignment to a specific local or regional cultural tradition. The site is incapable of answering significant research questions related to the prehistory of the Minnesota River valley. No further work is recommended at site 21LE148.

Site 21LE149

Site Number (Name): 21LE149	**Survey Parcel/Map Reference:** None/14
Site Type/Function: Single Artifact/Unknown	**Legal Location:**
Landform Position: Terrace	**Site Area (ac):** 0.01
Elevation Above Mean Sea Level (ft): 910	**Valley Section:** Lower
Cultural Affiliation: Prehistoric	**Site Condition:** Disturbed
USGS 7.5' Quadrangle(s): Belle Plaine South (1981)	**Archaeological Subregion:** 2e

Research History

Site 21LE149 was not documented prior to the current study. No previous investigations of the site area are mapped in the state GIS database. The site was originally discovered by a local historian who found an artifact in a farm field several years ago (Arthur Straub, informant, personal communication 2015).

Description

Site 21LE149 is located on a small terrace bench above an upland stream east of the bluff edge that overlooks the right bank of the Minnesota River. The site was reported to Augustana by Mr. Art Straub, a local historian who previously discovered it. It is presently in a cultivated cornfield along the west side of Henderson Station Road about three miles northeast of the community of Le Sueur (Figures 63 and 64; see Figure 31, above). Augustana personnel visited the site on October 22, 2015 with Mr. Straub, who pointed-out the location in the field where the site was discovered. Corn was not harvested from the field at the time of the visit and permission to access the property had not been obtained; no formal pedestrian survey of the parcel was completed. Instead, the site area was photodocumented from the adjacent roadway and GPS coordinates were obtained from the right-of-way adjacent to the site.

Figure 63. Overview of site 21LE149, Le Sueur County, Minnesota. View is facing across the site.

Site 21LE149 consists of a single, incomplete pecked/groundstone grooved maul. The specimen is manufactured from a cobble of very dark grayish brown-colored (10YR 3/2) gabbro (Figure 65). It measures 20.57 cm in length by 13.11 cm in maximum width. It is broken in two longitudinally; therefore, no thickness measurement was obtained. Although broken, it appears as though the groove would have been continuous. The informant observed no additional artifacts in the vicinity of the tool when it was found; however, lack of access permission to the property precluded field verification by Augustana personnel. The specimen remains in the possession of Mr. Straub.

site location information edit

Data not to be used for Reference purposes only

Source:
National Agricultural Imagery Program (2013)

Universal Transverse Mercator, NAD83
T112N, R29W

Path:
Minnesota Reports\Minnesota River Study\GIS Data

Author: ALAC Date: October 2015

FIGURE 64
SITE 21LE149

N
W E
S

0 50 100 200
Meters

Legend

Site (Isolate) Section

Figure 65. Grooved maul recovered from site 21LE149. Obverse (left); reverse (right).

Interpretation and Recommendations

Site 21LE149 consists of a single, incomplete pecked/groundstone grooved maul collected from the surface of a cultivated upland creek terrace. The artifact was collected by a local resident several years ago and Augustana did not survey the field due to lack of access permission. The landform on which the site is located was not mapped for LSR as part of the MN/Model project as it is too far removed from the Minnesota valley. Without surveying the fields or conducting subsurface testing, it is not possible to ascertain the true extent of the site or whether buried diagnostic artifacts are present that may speak to its function or cultural affiliation. Despite this, similar terrace landforms throughout the Plains and Midwest have been found to harbor buried and/or stratified archeological deposits; this terrace should possess at least modest potential for containing such sites.

Site 21LE149 is a single pecked/groundstone grooved maul. The artifact was recovered from a terrace landform with at least modest potential for harboring buried cultural deposits; the site area was not systematically surveyed. The geomorphological context of site 21LE149 suggests the potential for hitherto undetected buried components. Augustana recommends further investigation of the site area as a means of exploring the potential for both surface and buried archeology.

Site 21LP11

Site Number (Name): 21LP11	**Survey Parcel/Map Reference:** 2
Site Type/Function: Lithic Scatter	**Legal Location:**
Landform Position: Bar/Erosional Residual	**Site Area (ac):** 2.52
Elevation Above Mean Sea Level (ft): 1,070	**Valley Section:** Upper
Cultural Affiliation: Paleoindian (possible Clovis) & Late Prehistoric	**Site Condition:** Disturbed
USGS 7.5' Quadrangle(s): Rosen (1971)	**Archaeological Subregion:** 2s

Site 21LP11 is a small, multicomponent prehistoric lithic scatter containing artifacts associated with Late Prehistoric and early-period Paleoindian groups. It is located in the uppermost reaches of the Minnesota River valley in what is presently the Big Stone National Wildlife Refuge (BSNWR) (Figures 66–68; see Figure 19, above). The site is primarily situated on a landform classified as erosional residual; however, the easternmost portion of the site transitions to a bar landform (see Hudak and Hajic 1999). The site area lies just west of a large, exposed outcrop of granite bedrock in a catastrophic flood landscape carved by Glacial River Warren. The substantial exposures of bedrock typify the landscape in this portion of the valley.

Figure 66. Overview of site 21LP11 from granite bedrock outcrop.

Figure 67. Overview of uncultivated portion of site 21LP11 among the sumac.

site location information edit

The predominant vegetation at the site is presently mixed prairie grass with a dense grove of sumac along the eastern margin of the outcropping bedrock; ground surface visibility was nonexistent. All but the westernmost portion of the site area—now largely defined by the distribution of sumac—was farmed prior to 1973.

Research History

Site 21LP11 (Figures 69–71) was first documented in the summer of 1973 by a field crew from the University of Minnesota's Archaeology Laboratory (Caine 1974). The site was discovered during a National Park Service-sponsored investigation of lands comprising what was then the Big Stone-Whetstone Refuge Area (presently the BSNWR). At the time, site 21LP11 was documented as a sparse scatter of seven lithic artifacts distributed across the surface of a roughly 50-m-x-100-m area. It was situated in the corner of a fallow, recently cultivated flax field adjacent to bottomlands along the right bank of the Minnesota River; large granitic bedrock outcrops were identified as being immediately west of the site (Caine 1974:4). Test excavations were undertaken at the site in the fall of 1973. Two units were excavated at the time; they were placed in the fallow field and separated by a one-meter unexcavated area (Caine 1974:4). Site records indicate that two additional lithic artifacts were recovered from the "…upper level of a test pit." Caine's (1974:4) report confirms that this "upper level" was within the plowzone. At the time, artifacts recovered from site 21LP11 were identified as nondiagnostic and the site was found to be too disturbed to warrant additional investigations (Caine 1974:6).

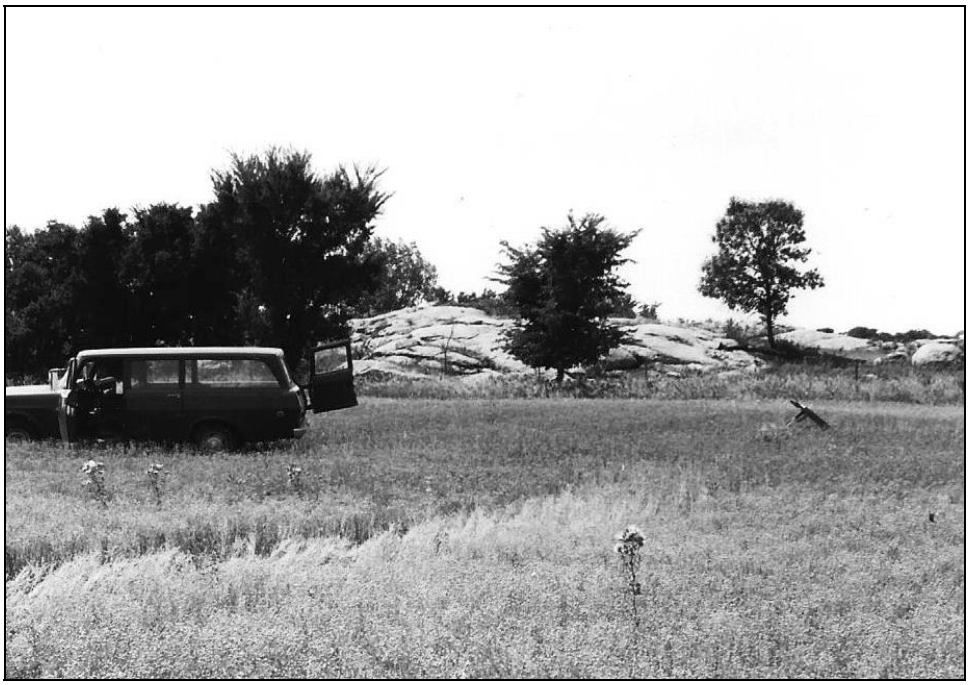


Figure 69. 1973 view of a portion of site 21LP11 with granite outcrop in background (image courtesy of Minnesota OSA).

Figure 70. 1973 view of site 21LP11, test excavations in progress (image courtesy of Minnesota OSA).

Figure 71. Test Pit 1 during excavations in 1973, site 21LP11 (image courtesy of Minnesota OSA).

In the spring of 2013, the small collection of artifacts from the site was being prepared for cataloging when OSA and MHS personnel noticed that a projectile point base recovered from the site (Specimen *L* [Catalog No. IL2014.66.1]) exhibited heavy basal and lateral grinding and a flute remnant; the specimen was identified as Clovis (Figure 72). Because of the great antiquity of the artifact, the scarcity of documented Paleoindian sites in Minnesota, and because a small locality along the eastern edge of the outcropping granite was never cultivated, it was felt that additional testing was warranted.

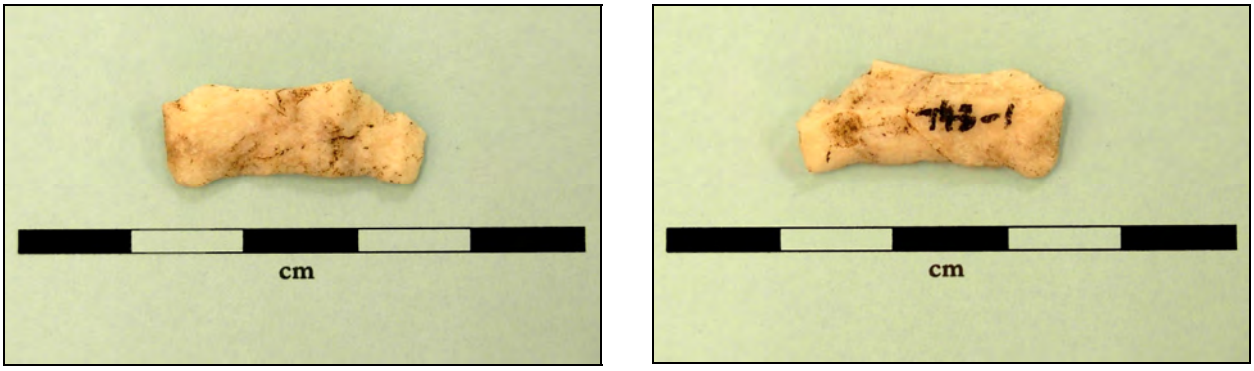


Figure 72. Fluted projectile point base (Artifact L [Catalog No. IL2014.66.1]), site 21LP11: obverse (left); reverse (right).

As part of Augustana's reinvestigation of 21LP11, the collection of lithics recovered during 1973 was borrowed from the MHS (Figure 73). Artifacts examined included the projectile point base (Specimen L), two small chert end scrapers (Specimens I and M), two heat-treated Swan River chert biface fragments (Specimens E and F), one chalcedony end/side-scraper (Specimen G), one Swan River chert spokeshave (Specimen D), one large Swan River chert reduction flake (Specimen C), and one chert reduction core (Specimen N). With the exception of the projectile point base, artifacts comprising the collection are nondiagnostic. Specimens D and N were recovered during test excavations.

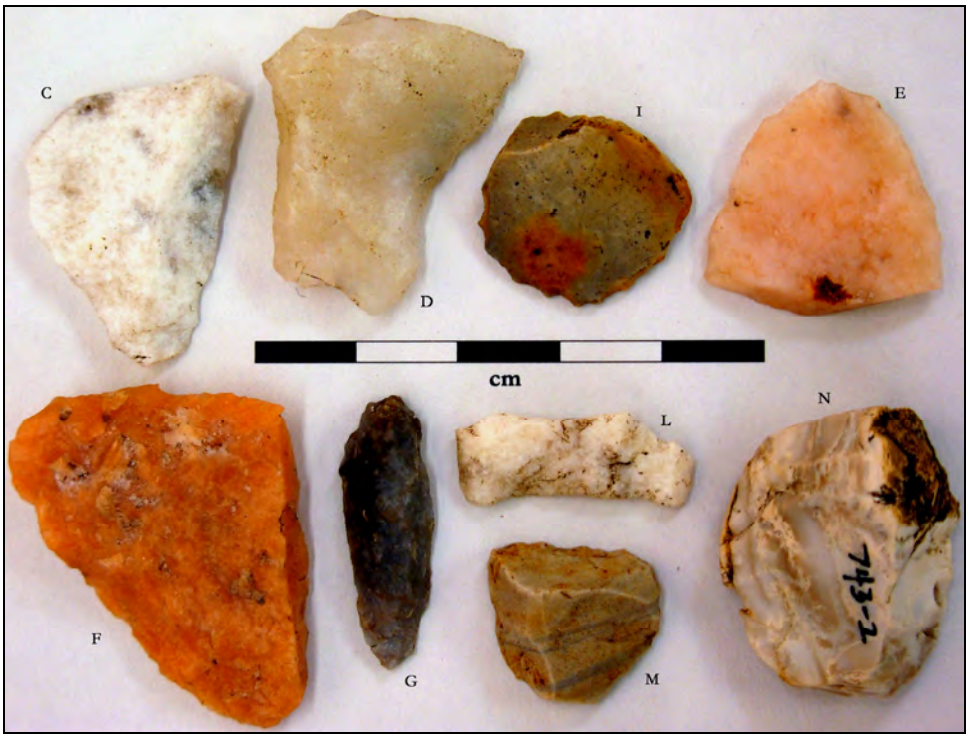


Figure 73. Lithics recovered from site 21LP11 during the 1973 investigation. Letter designations are those originally assigned by Caine (1974:5-6).

The projectile point base (Specimen L) is produced from white-colored (5Y 8/1) Swan River chert (see Figure 72, above). Morphologically, the specimen is lanceolate in form and exhibits a slightly concave base and excurvate blade margins; it is tabular in cross-section. Evidence of fluting is present on the obverse face of the specimen; however, it does not exhibit evidence of bifluting. The lateral margins of the specimen are heavily ground, as is the base. The reverse face exhibits what appears to be a tiny, approximately 3.4-mm-diameter, potlid cavity. The specimen measures 9.5 mm in maximum length (broken), 23.0 mm in maximum width, and 4.5 mm in maximum thickness; the flute scar on the obverse face measures 14.4 mm in maximum width. The specimen exhibits a transverse bend fracture, the

cause of which could not be definitively ascertained. However, previous experiments have demonstrated that such fractures can occur as a result of impact during use as a projectile or thrusting weapon (see Bergman and Newcomer 1983), during tool manufacture—particularly as part of the fluting process (see Hashizume 2009:278), and from trampling (see Midoshima 1994; Nielsen 1991).

Description

Augustana's investigations at site 21LP11 were carried-out during four field sessions between September 17, 2014 and August 31, 2015. A total of seven 1-m-x-1-m formal units, one 1-m-x-50-cm expansion unit, and 11 ca. 40-cm-diameter shovel tests were excavated at the site during this time. The focus of investigations was directed towards the westernmost portion of the site within the sumac grove near the bedrock outcrop as this area has never been cultivated. However, limited work was also conducted in the eastern portion of the site because a different landform is mapped in that area. Shovel tests were numbered sequentially in the order in which they were excavated; these were designated ST1–ST11. Formal units were excavated as a single 1-m-x-1-m unit (designated XU1), a 1-m-x-2-m block (designated XU2), and a 2-m-x-2-m block (designated XU3). Individual 1-m-square units within the larger blocks were assigned subdesignations based on cardinal directions. Thus, the XU2 block, which was positioned along a north-south axis, was comprised of individual units XU2-N and XU2-S. The XU3 block consisted of individual units XU3-NE, XU3-NW, XU3-SE, and XU3-SW. The 1-m-x-50-cm unit was opened as an expansion along the eastern edge of the southeast quadrant of XU3; it was designated XU3-SE-A. Only three tests excavated during the current study, ST1, ST9, and ST11, were devoid of cultural deposits; all additional tests were positive. With the exception of ST7 and XU2, all testing was conducted within a sumac grove that had a dense, interconnected root system extending to depths of between 20 and 25 cmbs throughout the area. This uppermost zone was heavily affected by bioturbation.

Shovel Test Findings

Eleven 40-cm-diameter shovel tests were excavated at site 21LP11. STs 1, 9, and 11 were sterile; the remainder yielded prehistoric lithics. STs 1–7 were excavated along an east-west transect in the westernmost portion of the site. STs 8–10 were aligned perpendicular to STs 1–7 along a north-south transect. XU1, which was placed between STs 3 and 4, served as the point of intersection for the two transects (see Figure 68, above). Shovel tests along the east-west transect were spaced at 5-m intervals; STs 8 and 9 were placed along the north-south transect 20 m south and north of XU1, respectively. Twenty meters was the extent to which tests could be placed along this transect without being on top of bedrock. Tests in the north-south transect were designed to explore the northern and southern limits of the site along the eastern edge of the bedrock outcrop. A positive test would confirm the lateral extent of the site in a given direction and obviate the need for additional tests closer to XU1. A negative test, conversely, would prompt the opening of an additional test 5 m closer to XU1 along the transect. The process would continue until cultural material was encountered or XU1 was reached. As it happened, ST9, which was placed 20 m north of XU1, was sterile, thereby prompting the excavation of ST10 5 m to the south. ST11 was not placed along a transect; rather, it was excavated atop the bedrock outcrop in an area with some degree of soil development in order to explore the depth to which the soil reached. STs were excavated to bedrock or sterile subsoil; all were terminated less than 70 cmbs (Figure 74).

Figure 74. Close-up of ST3, site 21LP11. Note the relatively shallow depth to bedrock that typified the area.

Only two STs (3 and 7) yielded a significant quantity of lithics (almost 57 percent of all specimens recovered from the STs); artifacts in the other four tests were extremely sparse (Table 13). ST7 was located just inside the previously cultivated field and, thus, exhibited a distinct plowzone. All artifacts recovered from this test derived from the plowzone (the upper 30 cmbs); this is consistent with the findings from the 1973 testing (Caine 1974:4) and XU2 (see below). In the remaining tests, the vast majority of cultural material (over 89 percent) was recovered from a zone between 40 and 60 cmbs, though a few items were discovered both above and below these depths (Table 14).

Table 13. Lithic Material Recovered from Positive Shovel Tests, Site 21LP11.

Shovel Test No.	Artifact Type						
	Flake	Shatter	Core	Formal Tool	Informal Tool	FCR	Total
2	1	3	—	—	—	—	**4**
3	26	6	—	—	—	—	**32**
4	8	2	—	—	—	—	**10**
5	5	1	1	—	—	—	**7**
6	7	1	—	—	1	—	**9**
7	21	—	1	—	—	—	**22**
8	4	—	—	—	—	—	**4**
10	6	1	—	—	—	—	**7**
Total	**78**	**14**	**2**	**0**	**1**	**0**	**95**

Table 14. Composite Distribution and Count of Recovered Artifacts by Depth from Shovel Tests in the Uncultivated Portion of Site 21LP11.*

Depth (cmbs)	Artifact Type						
	Flake	Shatter	Core	Formal Tool	Informal Tool	FCR	Total
0–10	—	—	—	—	—	—	**0**
10–20	2	—	—	—	—	—	**2**
20–30	3	—	—	—	—	—	**3**
30–40	—	1	—	—	1	—	**2**
40–50	16	5	—	—	—	—	**21**
50–60	35	8	1	—	—	—	**44**
60–70	1	—	—	—	—	—	**1**

*** List excludes ST7 as it fell within the confines of the previously cultivated field.**

The predominant artifact type comprising the recovered lithic assemblage is debitage (Figure 75). Nearly 97 percent of the total recovered assemblage consists of flakes and shatter; almost 85 percent of this total consists of reduction flakes. Specifically among flake specimens, the recovered inventory equates to 56 tertiary flakes (72 percent), 17 secondary flakes (22 percent), and 5 primary flakes (6 percent). The predominant material type in the assemblage is Swan River chert; it comprises 74 percent (70 items) of the recovered specimens. Other material types recovered include Prairie du Chien chert (8 items), unspecified quartz, chalcedonies and cherts (4 items each), Burlington chert (2 items), Tongue River silica (2 items), and gabbro (1 item).

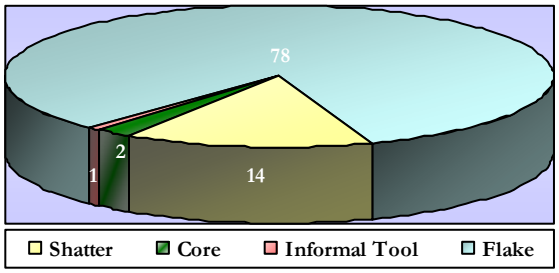


Figure 75. Artifact type breakdown from shovel tests, site 21LP11.

General soil profiles were documented following the excavation of each shovel test. In all but ST7, soils appeared similar to those observed in XUs 1 and 3. Soils in these tests graded from a black (10YR 2/1), organic-rich silt loam surface soil into a very dark brown (10YR 2/2) or dark brown (10YR 3/3) silt loam subsoil that becomes increasingly dark yellowish brown (10YR 4/6) with more gravels at depth. Soils in ST7 were similar to those observed in XU2; a clearly defined black (10YR 2/1) silt loam plowzone extended from the surface to a depth of between 26 and 30 cmbs, where it transitioned abruptly into a dark yellowish brown (10YR 4/4) silt loam subsoil.

Excavation Unit 1 Findings

A 1-m-x-1-m unit, designated Excavation Unit 1 (XU1), was established at the intersection of the two shovel test transects (Figure 76; see Figure 68, above). The unit was positioned 2 m east of ST3 and 2 m west of ST4 along the east-west transect; it was positioned 20 m north of ST8 and 20 m south of ST9 on the north-south transect. XU1 was excavated to a depth of 63 cmbs, where it was terminated atop a scree of decomposing granitic gravels distributed amidst several large granite boulders (Figure 77). Excavations were carried out in arbitrary 10-cm levels by shovel-skimming and hand-troweling. Artifacts recovered from XU1 consisted entirely of lithics, all but two of which were debitage. This parallels findings from the shovel tests. Also similar to the shovel test findings are the specimen and material types recovered and, excluding ST7, the vertical distribution of artifacts within the unit. Eighty-six artifacts were recovered from XU1 (Table 15); over 94 percent derived from the zone between 40 and 60 cmbs.

Figure 76. Overview of XU1 along the shovel test transect, site 21LP11.

Figure 77. Photograph (left) and plan view illustration (right) of the base of Level 6, XU1, site 21LP11.

Table 15. Distribution and Count of Lithic Material Recovered by Depth Below Surface, XU1, Site 21LP11.

Depth (cmbs)	Artifact Type						
	Flake	Shatter	Core	Formal Tool	Informal Tool	FCR	Total
0–10	—	—	—	—	—	—	**0**
10–20	2	—	—	—	—	—	**2**
20–30	3	—	—	—	—	—	**3**
30–40	—	—	—	—	—	—	**0**
40–50	44	10	—	—	—	—	**54**
50–60	21	4	2	—	—	—	**27**
Total	**70**	**14**	**2**	**0**	**0**	**0**	**86**

Similar to the excavated shovel tests, artifacts recovered from XU1 consisted almost entirely of debitage (nearly 98 percent). Two reduction cores were discovered in Level 6; the remaining 84 items were flakes and shatter (Figure 78). As with the shovel tests, the majority of debitage (over 83 percent) consisted of reduction flakes. Of the flakes recovered, 61 were tertiary flakes (87 percent), 8 were secondary flakes (11.5 percent), and 1 was a primary flake (1.5 percent). Swan River chert was again found to be the overwhelmingly dominant material type, comprising almost 91 percent (78 items) of the inventory. Other material types recovered include Prairie du Chien chert (1 item), unspecified chert, jasper, and quartzite (1 item each), quartz (2 items), Burlington chert (1 item), and Tongue River silica (1 item).

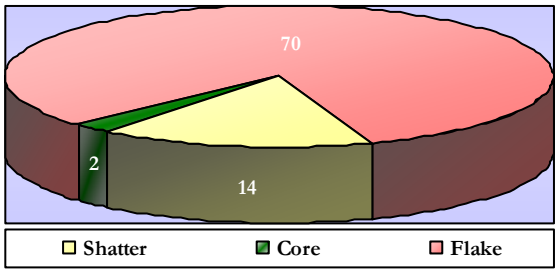


Figure 78. Artifact type breakdown from XU1, site 21LP11.

A soil profile drawing of the north wall of XU1 was completed following its excavation (Figure 79). The soils comprising XU1 were similar to those observed among the shovel tests (except ST7). Soil horizon transitions in XU1 were fairly subtle, grading from a black (10YR 2/1) silt loam into a very dark brown (10YR 2/2) silt loam. Roots were prolific in the upper 15–20 cmbs; few to no gravels were present in this zone. Gravel content increased with depth while roots grew fewer; fragments of decomposing granite pervaded the unit below 50 cmbs.

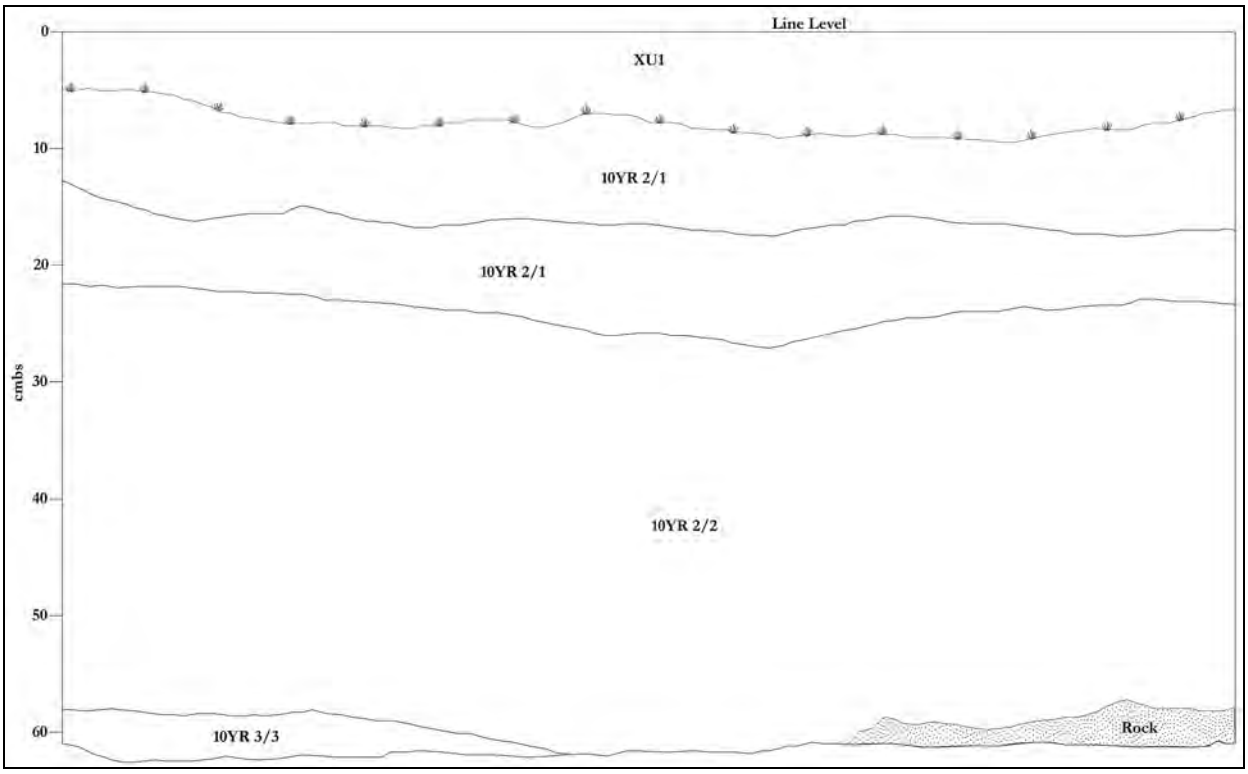


Figure 79. Soil stratigraphic profile, north wall, XU1, site 21LP11.

Excavation Unit 2 Findings

Excavation Unit 2 (XU2) is a 1-m-x-2-m block that was established approximately 57 m east-southeast of ST7 in a previously cultivated area of the site on what is mapped as a bar landform (Figure 80; see Figure 68, above). The XU2 block consisted of two adjacent one-meter-square units positioned along a north-south axis. Individual one-meter-square units were designated XU2-N and XU2-S, respectively. With one exception, XU2 was excavated in arbitrary 10-cm levels by a combination of shovel-skimming and hand-troweling. The exception was the uppermost 5-cm sod zone, which was designated Level 1. The sod zone was left as intact as possible and not screened with the intention of replacing it upon completion of backfilling the unit. XU2 was excavated to a maximum depth of 46 cmbs; excavations were terminated in sterile subsoil atop a dense scatter of large granite cobbles and boulders (Figures 81 and 82). An abrupt, clearly defined plowzone transition was exposed between 25 and 30 cmbs in the block. All artifacts recovered were confined to the plowzone, from depths varying between 5 and 25 cmbs. These findings are consistent with those from ST7, as well as from the testing conducted in 1973 (Caine 1974:4).

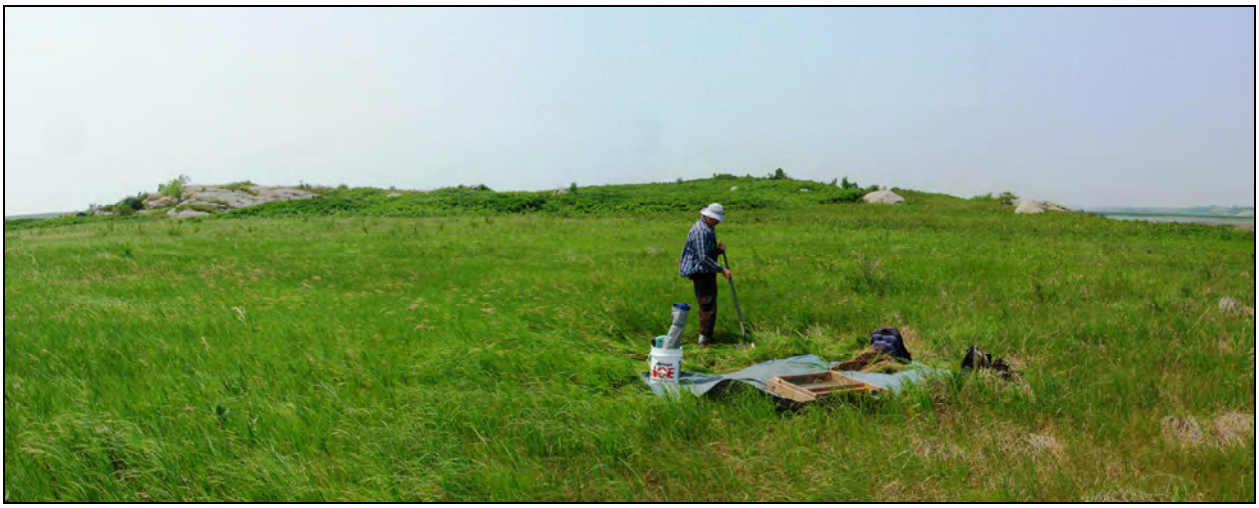


Figure 80. Overview of XU2 area, site 21LP11. The sumac grove and bedrock outcrop are visible in the background.

Figure 81. Photograph of the base of Level 5 at 45 cmbs, XU2, site 21LP11.

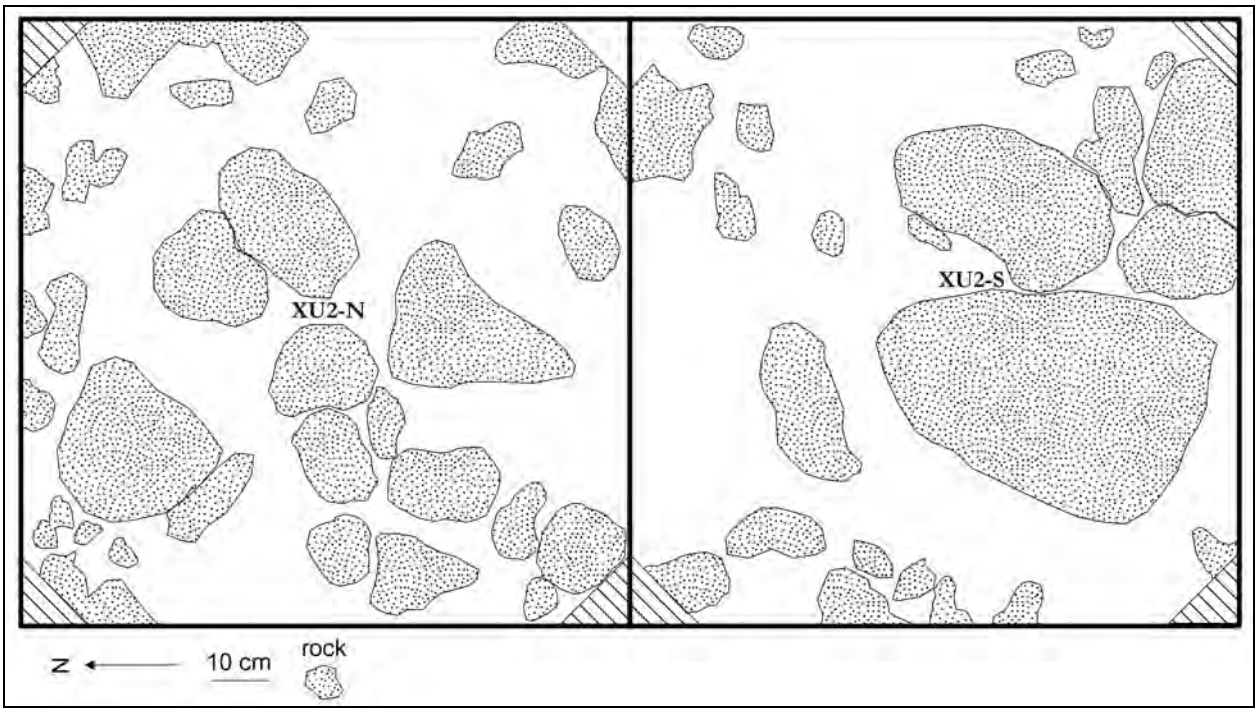


Figure 82. Plan view illustration of the base of Level 5 at 45 cmbs, XU2, site 21LP11.

Only eight total artifact specimens—all lithic debitage—were recovered from the XU2 block (Table 16); XU2-N yielded seven of these items. Five tertiary flakes and three pieces of shatter comprise the recovered assemblage; one tertiary flake exhibits unifacial retouch along one lateral margin. Four of the items (50 percent) are produced from Swan River chert. Material types of the remaining specimens are unspecified chert (3 items) and chalcedony (1 item).

Table 16. Distribution and Count of Lithic Material Recovered by Depth Below Surface, XU2, Site 21LP11.

Depth (cmbs)	Artifact Type						
	Flake	Shatter	Core	Formal Tool	Informal Tool	FCR	Total
0–5	—	—	—	—	—	—	**0**
5–15	4	2	—	—	—	—	**6**
15–25	1	1	—	—	—	—	**2**
25–35	—	—	—	—	—	—	**0**
35–45	—	—	—	—	—	—	**0**
Total	**5**	**3**	**0**	**0**	**0**	**0**	**8**

In addition to the artifacts, two narrow, parallel, linear soil stains of very dark brown color (10YR 2/2) were observed below the plowzone between 25 and 27 cmbs, at the transition between Levels 3 (15–25 cmbs) and 4 (25–35 cmbs). The stains, designated Feature 1 (F1), extended across the entirety of the block at an angle approximately 10 degrees south of east. Each stain varied in width between 2 and 2.5 inches (roughly 5–6.5 cm); they were separated by a consistent horizontal distance of 30.5 inches (about 77.5 cm) (Figure 83). The stains extended only about 2 cm below the plowzone transition before disappearing. Features similar to F1 can be generated by agricultural subsoiling equipment fitted with conventional (non-wing-tipped) shanks. Conventional subsoiling shanks typically range in thickness between 0.75-inch and 1.5-inch and are spaced between 30 and 42 inches along the deck (Kees 2008:5). Wing-tipped shanks can be spaced farther apart than conventional shanks. This portion of the site was farmed as recently as the early 1970s and the F1 stains are almost certainly a relic of this modern activity.

Figure 83. Base of Level 3 at 25 cmbs, XU2, site 21LP11. The dark, linear soil stains are identified by the red arrows.

A soil profile drawing of the east wall of XU2 was completed following its excavation (Figure 84). The soils comprising XU2 were similar to those observed in ST7. The plowzone/subsoil transition in XU2 was abrupt and clearly defined, grading from a black (10YR 2/1) silt loam into a dark brown (10YR 3/3) silt loam. Several small and tiny roots were present between the surface and about 15 cmbs, as were numerous tiny pebbles. Gravel content increased below this depth while roots became fewer. By 30 cmbs, numerous larger rocks and cobbles were visible in the floor of the unit. Around 35 cmbs, the subsoil gradually transitioned into a dark yellowish brown (10YR 4/4) silt loam. Rock content continued to increase until the unit was terminated; at the base of Level 5, XU2 was littered with boulders and large cobbles (see Figure 81, above).

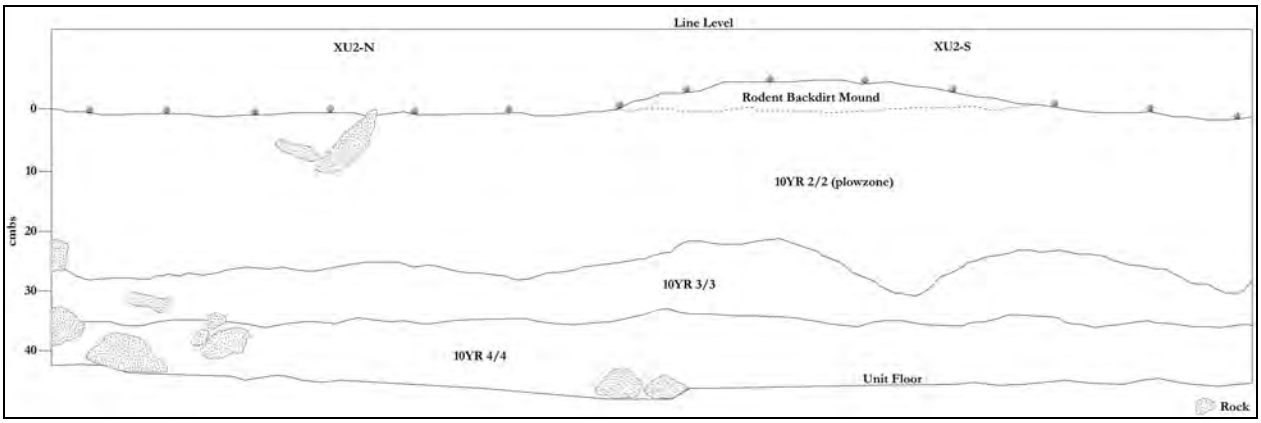


Figure 84. Soil stratigraphic profile, east wall, XU2, site 21LP11.

Excavation Unit 3 Findings

Excavation Unit 3 (XU3) was established on the north-south shovel test transect amidst the sumac grove along the western edge of the site. It was placed 5 m south of XU1 and 13 m north of ST8 (Figure 85; see Figure 68, above). XU3 was initially established as a 2-m-x-2-m block comprised of four contiguous one-meter-square units. The individual units were designated XU3-NE, XU3-NW, XU3-SE, and XU3-SW, respectively. After initiating excavations in the block, a decision was made to open a 1-m-x-50-cm expansion unit along the east edge of the southeastern quadrant. This expansion, designated XU3-SE-A, was opened to explore an area slightly further east in the sumac. The

units comprising XU3 were excavated in arbitrary 10-cm levels to a total depth of 60 cmbs; a combination of shovel-skimming and hand-troweling was employed. Excavations were terminated in sterile subsoil atop a dense scatter of large granite cobbles and boulders (Figures 86 and 87). XU3 yielded a total of 53 artifacts. The artifacts recovered from XU3 consist entirely of lithics (Table 17); however, eight seeds/seed fragments were also recovered from the unit. The majority of the lithics is, again, debitage. These findings remain consistent with those from excavations throughout the site area. Also similar to the previous findings are the specimen and lithic material types recovered. The vertical distribution of artifacts within the unit largely mirrors that from the other tests located west of the previously cultivated field edge. Almost 53 percent of the lithic material was recovered from between 40 and 60 cmbs. Of note, however, is that 17 pieces of debitage were recovered from Level 4 (30–40 cmbs) in the block. These items, which equate to approximately 32 percent of the total recovered lithic sample from the block, are noteworthy because only two other specimens from all other tests in the uncultivated portion of the site, derived from this depth.

Figure 85. Overview of the XU3 locality among the sumac, site 21LP11.

Figure 86. Photograph of the base of Level 6 at 60 cmbs, XU3, site 21LP11, eastern orientation.

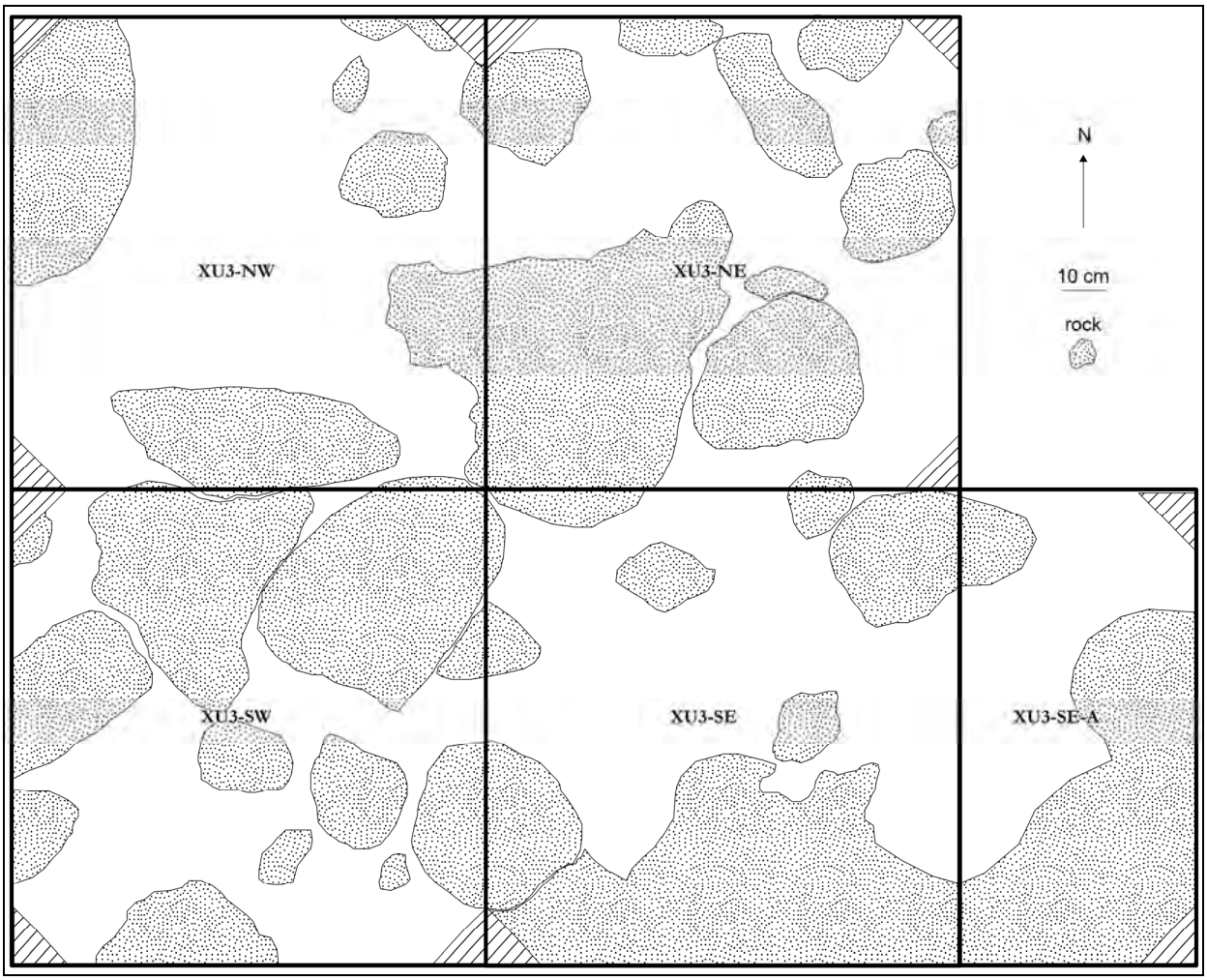


Figure 87. Plan view illustration of the base of Level 6 at 60 cmbs, XU3, site 21LP11.

Table 17. Distribution and Count of Lithic Material Recovered by Depth Below Surface, XU3, Site 21LP11.

Depth (cmbs)	Artifact Type						
	Flake	Shatter	Core	Formal Tool	Informal Tool	FCR	Total
0–10	1	—	—	—	—	—	**1**
10–20	3	1	—	1	—	—	**5**
20–30	—	2	—	—	—	—	**2**
30–40	15	2	—	—	—	—	**17**
40–50	8	6	—	—	—	—	**14**
50–60	9	4	1	—	—	—	**14**
Total	**36**	**15**	**1**	**1**	**0**	**0**	**53**

An analysis of the eight seed casings and fragments revealed a common species—smooth sumac (*Rhus glabra*)—the same sumac that presently grows throughout the western portion of the site area. As none of the recovered macrobotanical specimens were charred, and as smooth sumac is prolific in the immediate site area, the recovered seed specimens were classified as noncultural and culled from the collection assemblage. Just over 96 percent of the artifacts recovered from XU3 consisted of debitage. One core was recovered from Level 6 and one projectile point was discovered at the base of Level 2; the remaining 51 items were flakes and shatter (Figure 88). Almost 71 percent of the recovered debitage (36 items) consisted of reduction flakes. Of the flakes recovered, 20 were tertiary flakes (56 percent), 12 were secondary flakes (33 percent), 2 were primary flakes (5.5 percent), and 2 were microflakes recovered during flotation (5.5 percent). Seventy-one percent (39 items) of the recovered lithics were produced on Swan River chert. Other material types recovered include Prairie du Chien chert (3 items), unspecified chert, jasper, and chalcedony (1 item each), and quartz (8 items).

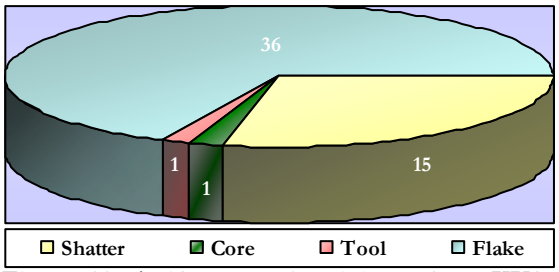


Figure 88. Artifact type breakdown from XU3, site 21LP11.

There are two significant finds in the lithic assemblage from XU3. The first of these is projectile point specimen IL2015.15.68, which was recovered from the base of Level 2 at 20 cmbs in XU3-SE-A. It is a complete, triangular unnotched arrow point produced from heat-treated Swan River chert (Figure 89). It measures 22.10 mm in length, 15.11 mm in maximum width, and 3.16 mm in maximum thickness. The specimen is similar in form and function to other ubiquitous arrow points employed during the late prehistoric and protohistoric periods in western Minnesota and elsewhere throughout the Northern Plains and Upper Midwest. Stratigraphically, its position at the base of Level 2 (20 cmbs) is a minimum of 20 cm above the primary cultural zone (40–60 cmbs) identified in the uncultivated portion of the site. Specimen IL2015.15.68 represents the first clear indicator that site 21LP11 includes multiple cultural components.

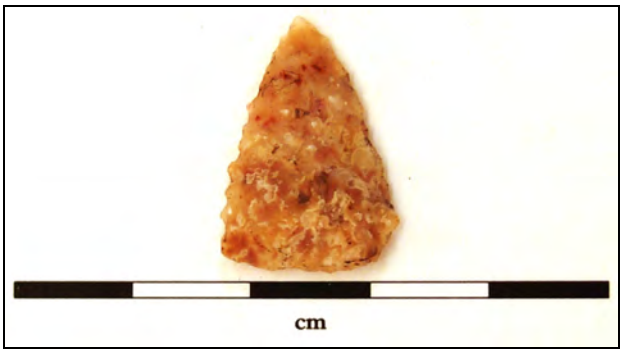


Figure 89. Projectile point specimen IL2015.15.68 recovered from 20 cmbs in XU3-SE-A, site 21LP11.

The second find of note consists of a small collection of six flakes exhibiting characteristics consistent with those of a very specific bifacial reduction flake originally identified by François Bordes as *outrepassé*, or overshot (Figure 90). Overshot flakes begin on an artifact's lateral margin, pass across one face and either terminate at the other margin or wrap around it, removing a portion of the opposite face of the artifact in the process. Although isolated overshot flakes can be found among artifact assemblages from throughout the prehistoric record in the New World, their localized presence in any significant number is argued by some researchers to be a hallmark of Clovis technology (see Stanford and Bradley 2012:12). The premise that overshot flakes are diagnostic of Clovis absent an association with other diagnostics items (e.g., fluted bifaces) continues to be debated (see for example Eren et al. 2014:60; Huckell 2014:151); however, their proliferation throughout known Clovis sites and near absence elsewhere cannot be ignored. The six overshot flakes identified among the XU3 assemblage were recovered from 40–60 cmbs; five of the flakes derived from the 40–50 cmbs level.

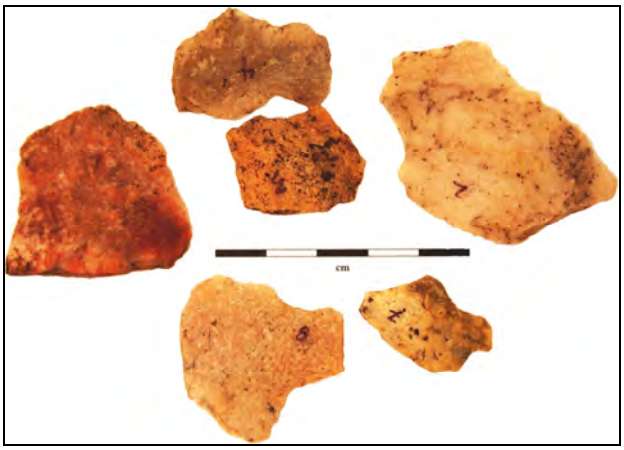


Figure 90. Overshot flakes recovered from 40–60 cmbs in XU3, site 21LP11.

A soil profile drawing of the west wall of XU3 was completed following the excavations (Figure 91). The soils comprising XU3 were similar to those observed among the shovel tests (except ST7) and XU1. Soil horizon transitions were fairly subtle, grading from a black (10YR 2/1) silt loam into a very dark brown (10YR 2/2) silt loam. Roots were prolific in the upper 15–20 cmbs; few to no gravels were present in this zone. Gravel content increased with depth while roots grew fewer; fragments of decomposing granite pervaded the unit below 50 cmbs. This increase in granitic fragments was largely coincident with a transition to lighter-colored subsoil.

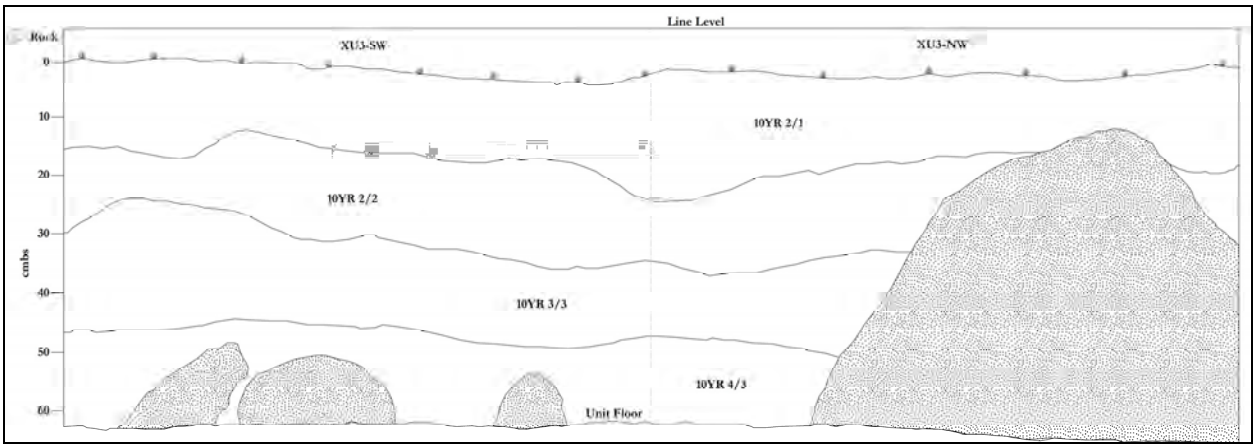


Figure 91. Soil stratigraphic profile, west wall, XU3, site 21LP11.

Geomorphology and Soils

Site 21LP11 is primarily situated on a landform classified as "erosional residual," though the easternmost portion of the site transitions to a "bar landform" (see Hudak and Hajic 1999). The site area lies just west of a large, exposed outcrop of granite bedrock in a catastrophic flood landscape carved by Glacial River Warren. The substantial exposures of bedrock typify the landscape in this portion of the valley.

The geomorphological investigation at site 21LP11 focused on soils exposed in shovel tests and excavation units. Soils were described using standard procedures and terminology outlined by Birkeland (1999) and Schoenenberger et al. (2002). Graphic profiles were constructed to visually convey soil and stratigraphic information for representative pedons. Also, grain-size distribution and organic matter content were determined on soils exposed in STs 3 and 6 and XUs 2 and 3. The grain-size distribution of the samples was determined using a slightly modified version of the pipette method (Gee and Bauder 1986), and included pretreatment with concentrated hydrogen peroxide to remove organic matter. Soil organic matter content was determined by loss on ignition analysis (Ball 1964). Also, an electronic Mettler Toledo pH meter was used to determine the pH of soil samples from STs 3 and 5.

Soils in all but the westernmost portion of the site area are mapped as Sinai silty clay loam (1–3 percent slopes) (Tufvesson 1997:74), and those associated with the westernmost site edge are mapped as Yellowbank-Rock outcrop complex (1–25 percent slopes) (Tufvesson 1997:92). The Sinai series consists of very deep, moderately well-drained and well-drained soils formed in glaciolacustrine sediments on uplands, and the Yellowbank series consists of very shallow to moderately deep, somewhat excessively drained soils that formed in a mantle of alluvium over granite and gneiss bedrock. Although the Yellowbank soil series is present in the western part of 21LP11 adjacent to the granite outcrop, the Sinai does not occur within the boundaries of the site. Instead, an alluvial soil is developed in a thin mantle of loam overlying coarse-grained alluvium on the bar landform in the eastern portion of the site.

The area of site 21LP11 that has yielded cultural deposits in a buried context is on the east side of a large mass of granite that occurs as an erosional remnant, or "residual," that rises above the valley floor. Slopewash has accumulated on the footslope and toeslope of the bedrock outcrop and may account for burial of the cultural deposits. The slopewash merges with alluvium on the relatively flat valley floor immediately east of the outcrop.

Most of the soils developed in the slopewash have A-Bw profiles above bedrock or alluvium. For example, in ST3 on the footslope, the A horizon (A1 + A2) is 45 cm thick and consists of very dark gray (10YR 3/1, dry) silt loam (Table

18). The Bw horizon is only 10 cm thick and consists of very dark grayish brown (10YR 3/2, dry) loam with weak, fine, subangular-blocky structure. Bedrock was intercepted at a depth of 55 cm. Organic matter (O.M.) content is high in the A1 and A2 horizons, ranging from 11.69 to 6.38 percent, respectively (Table 19; Figure 92). Although O.M. content decreases to 3.41 percent in the subsoil, it is high enough to qualify the Bw horizon as being mollic.

Table 18. Description of Shovel Test 3.

Landform: Erosional residual granite outcrop
Landscape position: Footslope
Slope: 2-3 percent
Land cover: Sumac

Depth (cm)	Soil Horizon	Description
0-23	A1	Very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; weak fine subangular blocky structure parting to moderate fine and medium granular; very friable; many worm casts and open worm and insect burrows; many fine and very fine and common medium and coarse roots; clear smooth boundary.
23-45	A2	Very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure parting to moderate medium and coarse granular; very friable; many worm casts and open worm and insect burrows; many fine and very fine and common medium and coarse roots; gradual smooth boundary.
45-55	Bw	Very dark grayish brown (10Y 3/2) loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; very friable; common fine and very fine and few medium and coarse roots; abrupt irregular boundary.
55+	2R	Granite.

Table 19. Grain Size and Organic Matter Data for Site 21LP11.

Depth (cm)	Soil Horizon	Total Sand	Silt C	Silt M	Silt F	Silt Total	Clay C	Clay F	Clay Total	O.M.	Textural Class
		----------	----------	----------	----------	----%----	----------	----------	----------		
Excavation Unit 2											
0-24	Ap	**51**	6	12	4	**22**	8	19	**27**	4.66	SCL
24-34	AB	**39**	17	14	7	**38**	12	11	**23**	2.53	L
34-55	Bw	**39**	25	13	6	**43**	10	8	**18**	0.62	L
55-70	2C	**73**	11	8	3	**22**	4	1	**5**	0.15	SL
Shovel Test 3											
0-23	A1	**23**	55	3	2	**60**	10	7	**17**	11.69	SiL
23-45	A2	**21**	68	4	1	**73**	3	4	**7**	6.38	SiL
45-55	Bw	**38**	13	16	6	**35**	10	17	**27**	3.41	L
55+	2R	--	--	--	--	--	--	--	--	----	--
Excavation Unit 3											
0-17	A1	**24**	57	3	3	**63**	8	5	**13**	10.44	SiL
17-32	A2	**23**	55	4	6	**65**	7	5	**12**	4.91	SiL
32-47	AB	**39**	15	15	4	**34**	12	15	**27**	3.86	L
47-62	Bw	**37**	17	18	2	**37**	10	16	**26**	3.31	L
62+	2C	--	--	--	--	--	--	--	--	----	--
Shovel Test 6											
0-22	A1	**21**	29	18	7	**54**	8	17	**25**	6.52	SiL
22-42	A2	**36**	18	13	7	**38**	12	14	**26**	5.17	L
42-52	AB	**38**	20	10	5	**35**	15	12	**27**	3.57	L
52-68	Bw	**28**	26	18	4	**48**	11	13	**24**	2.69	L
68+	2C	--	--	--	--	--	--	--	--	----	--

Abbreviations: C=Coarse, M=Medium, F=Fine; O.M.=Organic Matter; SiL=Silt loam; L=Loam; SCL=Silty clay loam

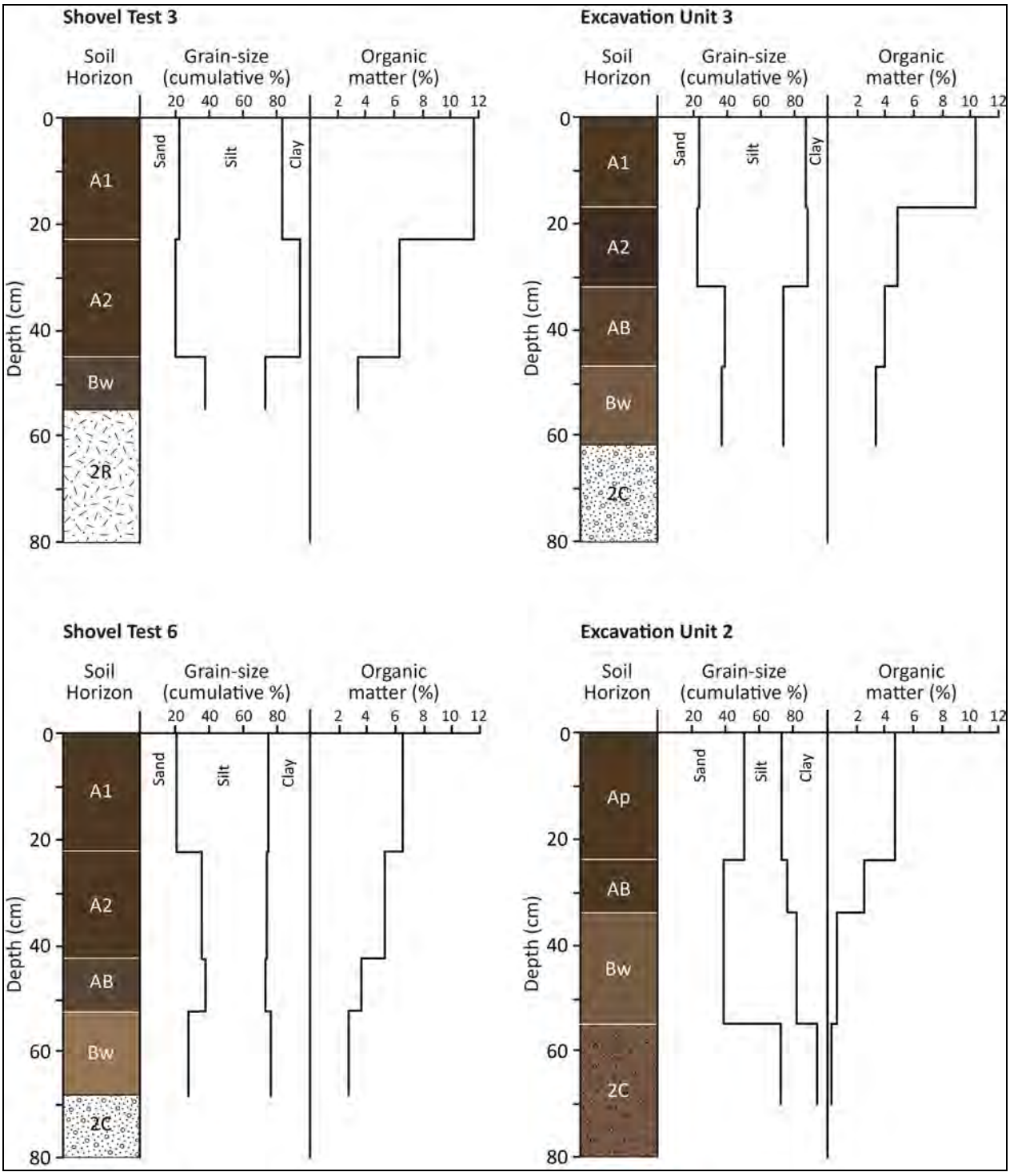


Figure 92. Diagram of the profiles from site 21LP11, depicting soil stratigraphy, horizonation, grain particle size, and organic matter content.

In XU1, which is downslope from ST3, the soil has an overthickened cumulic A horizon (A1+A2+A3) above gravelly alluvium (2C horizon) (Table 20). The A horizons have a loam texture and matrix colors ranging from very dark gray (10YR 3/1, dry) to dark grayish brown (10YR 3/2, dry). Weak subangular-blocky structure parts to moderate granular structure in the A horizons. An abrupt, irregular boundary separates the A3 horizon from the underlying cobble- and boulder-rich alluvium.

Table 20. Description of Excavation Unit 1.

Landform: Bedrock outcrop
Landscape position: Toeslope
Slope: 2 percent
Land cover: Sumac

Depth (cm)	Soil Horizon	Description
0-15	A1	Very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak fine subangular blocky structure parting to moderate fine and medium granular; very friable; many worm casts and open worm and insect burrows; many fine and very fine and common medium and coarse roots; clear smooth boundary.
15-25	A2	Very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure parting to moderate medium and coarse granular; very friable; many worm casts and open worm and insect burrows; many fine and very fine and common medium and coarse roots; gradual smooth boundary.
25-60	A3	Dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure parting to moderate medium and coarse granular; very friable; many worm casts and open worm and insect burrows; many fine and very fine and few medium and coarse roots; abrupt irregular boundary.
60+	2C	Subrounded cobbles and boulders in a coarse sandy matrix.

In XU3 and ST5 and ST6, all located on the boundary between the toeslope and valley floor, the soils are characterized by weakly expressed A-AB-Bw-2C profiles (Tables 21, 22 and 23; see Figure 92). The A horizon (A1+A2) is 32 to 49 cm thick and consists of very dark gray (10YR 3/1, dry) to very dark brown (10YR 2/2, dry) silt loam and loam. The Bw horizon is brown (10YR 4/3, dry) to yellowish brown (10YR 4/4, dry) loam with weak, fine, subangular-blocky structure. An abrupt, irregular boundary separates the Bw horizon from the underlying coarse-grained alluvium. In XU3 and ST6, the organic matter content is high in the A horizons, especially the A1, but steadily decreases with depth (see Table 19 and Figure 92).

In XU2, which was excavated on the relatively flat valley floor, the soil has a weakly expressed Ap-AB-Bw-2C profile developed in alluvium (Table 24). The plowzone (Ap horizon) is 24 cm thick and consists of very dark gray (10YR 3/1, dry) sandy clay loam. A 10-cm-thick transitional AB horizon consisting of very dark gray (10YR 3/1, dry) loam separates the Ap and Bw horizons. The Bw horizon is 21 cm thick and consists of brown (10YR 4/3, dry) loam. The underlying 2C horizon consists of subrounded cobbles and boulders in a brown (7.5YR 4/3, dry) and yellowish brown (10YR 5/4, dry) sandy loam matrix.

The results of the geomorphological investigation at 21LP11 point to several patterns at the site. First, soils developed on the footslope and toeslope of the granite outcrop tend to have thick A horizons, whereas the soil on the valley floor distal to the outcrop has a relatively thin A horizon. Also, the A horizons consistently have exceptionally high organic-matter contents. The thick, organic-rich A horizons may be products of cumulization, a process common on footslopes and toeslopes. Cumulic soils receive influxes of organic-rich parent material, in this case slopewash and alluvium, while pedogenesis is occurring, but the rate of sedimentation is so slow that soil development keeps up with deposition (Birkeland 1999:165; Nikiforoff 1949). In such soils, the A horizon builds up through time, and it not unusual for the A horizon to look stratified. Because cumulic soils have parent material continuously added to their surfaces, their features are partly sedimentologic and partly pedogenic (Birkeland 1999:165). The cumulization process is especially favorable for burial of cultural deposits, which may explain the concentration of artifacts at 40-60 cmbs at 21LP11.

Table 21. Description of Excavation Unit 3.

Landform: Boundary between bedrock outcrop and valley floor
Landscape position: Toeslope
Slope: 2 percent
Land cover: Sumac

Depth (cm)	Soil Horizon	Description
0-17	A1	Very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; weak fine subangular blocky structure parting to moderate fine and medium granular; very friable; many worm casts and open worm and insect burrows; many fine and very fine and common medium and coarse roots; clear smooth boundary.
17-32	A2	Very dark brown (10YR 2/2) silt loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure parting to moderate medium and coarse granular; very friable; many worm casts and open worm and insect burrows; many fine and very fine and common medium and coarse roots; gradual smooth boundary.
32-47	AB	Dark brown (10YR 3/3) loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; very friable; many worm casts and open worm and insect burrows; many fine and very fine and few medium and coarse roots; clear smooth boundary.
47-62	Bw	Brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure parting to weak fine subangular blocky; friable; common worm casts and open worm and insect burrows; common fine and very fine and few medium and coarse roots; abrupt irregular boundary.
62+	2C	Rounded and subrounded cobbles and boulders in a coarse sandy matrix.

Table 22. Description of Shovel Test 5.

Landform: Bar
Landscape position: Boundary between bedrock outcrop and valley floor
Slope: 1 percent
Land cover: Sumac

Depth (cm)	Soil Horizon	Description
0-22	A1	Very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; weak fine subangular blocky structure parting to moderate fine and medium granular; very friable; many worm casts and open worm and insect burrows; many fine and very fine and common medium and coarse roots; clear smooth boundary.
22-49	A2	Very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure parting to moderate medium and coarse granular; very friable; many worm casts and open worm and insect burrows; many fine and very fine and common medium and coarse roots; gradual smooth boundary.
49-59	AB	Very dark grayish brown (10Y 3/2) loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; very friable; many worm casts and open worm and insect burrows; common fine and very fine and few medium and coarse roots; gradual smooth boundary.
59-65	Bw	Brown (10YR 4/3) to dark yellowish brown (10YR 4/4) loam, dark brown (10YR 3/3) to dark yellowish brown (10YR 3/4) moist; weak fine subangular blocky structure; friable; common worm casts and open worm and insect burrows; common fine and very fine and few medium and coarse roots; abrupt irregular boundary.
65+	2C	Subrounded cobbles and boulders in a coarse sandy matrix.

Table 23. Description of Shovel Test 6.

Landform: Bar
Landscape position: Boundary between bedrock outcrop and valley floor
Slope: 1 percent
Land cover: Sumac

Depth (cm)	Soil Horizon	Description
0-22	A1	Very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; weak fine subangular blocky structure parting to moderate fine and medium granular; very friable; many worm casts and open worm and insect burrows; many fine and very fine and common medium and coarse roots; clear smooth boundary.
22-42	A2	Very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak medium and fine subangular blocky structure parting to moderate medium and coarse granular; very friable; many worm casts and open worm and insect burrows; many fine and very fine and common medium and coarse roots; gradual smooth boundary.
42-52	AB	Very dark grayish brown (10Y 3/2) loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure parting to moderate medium and coarse granular; very friable; common worm casts and open worm and insect burrows; common fine and very fine and few medium and coarse roots; gradual smooth boundary.
52-68	Bw	Yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; friable; common worm casts and open worm and insect burrows; common fine and very fine and few medium and coarse roots; abrupt irregular boundary.
68+	2C	Subrounded cobbles and boulders in a coarse sandy matrix.

Table 24. Description of Excavation Unit 2.

Landform: Bar
Landscape position: Terrace tread
Slope: 1 percent
Land cover: Grass (former cropland)

Depth (cm)	Soil Horizon	Description
0-24	Ap	Very dark gray (10YR 3/1) sandy clay loam, black (10YR 2/1) moist; weak fine subangular blocky structure parting to moderate medium and coarse granular; friable; many worm casts and open worm and insect burrows; many fine and very fine roots; abrupt smooth boundary.
24-34	AB	Very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak fine subangular blocky structure parting to weak very fine subangular blocky; friable; many worm casts and open worm and insect burrows; many fine and very fine roots; abrupt smooth boundary.
34-55	Bw	Brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; friable; common worm casts and open worm and insect burrows; common fine and very fine roots; clear irregular boundary.
55-70+	2C	Brown (7.5YR 4/3) and yellowish brown (10YR 5/4) very gravelly sandy loam, dark brown (7.5YR 3/3) and dark yellowish brown (7.5YR 4/4) moist; single grain; loose; 60-70 percent subrounded cobbles and boulders; few fine and very fine roots.

Also, the soils at 21LP11 are weakly developed regardless of whether they are on the footslope and toeslope of the granite outcrop or the tread of the broad valley floor. Such weak soil development can be attributed to several factors.

First, the veneer of loamy sediment that mantles the bedrock and gravelly alluvium may be very young, perhaps representing sedimentation over the past 1,000–2,000 years. If that is the case, all of the buried cultural deposits on the footslope and toeslope of the granite outcrop date to the Woodland period. Second, intensive bioturbation processes can inhibit the development of a well-expressed soil, such as one with an A-Bt profile that would be otherwise expected on a geomorphic surface that is more than 2,000 years old (Johnson 1992). With intensive bioturbation, the development of a biomantle often results in the burial of cultural deposits (Johnson 1990). Specifically, worm castings, combined with soil brought to the surface by ants and burrowing mammals, form a biomantle that may quickly conceal artifacts and cultural features on otherwise stable surfaces (Johnson 1990, 1992; Van Nest 2002). Biomantle formation eventually results in the gradual burial and "downward gravitational displacement" of materials that originally lay on the surface (Balek 2002:43). Several researchers have described the role that biomantle formation plays in the burial of archeological sites (e.g., Balek 2002; Bettis and Mandel 2002a; Johnson 2002; Johnson et al. 2005; Leigh 2001; Peacock and Fant 2002; Van Nest 2002). If cultural deposits at 21LP11 date to the Paleoindian period, evolution of a biomantle may account for occurrence in a buried context.

Resolution of site formation processes at 21LP11 will require a better understanding of the age of the sedimentary deposits and associated cultural materials. This will require the recovery of in situ charcoal and culturally diagnostic artifacts. Also, optically stimulated luminescence (OSL) dating may be used to determine the basal age of loamy deposits on the footslope and toeslope on the east side of the granite outcrop, though dating samples recovered at shallow depths (< 1 m) can be problematic with this method.

Interpretation and Recommendations

The results of subsurface testing at site 21LP11 affirmed the presence of undisturbed buried cultural deposits west of the previously cultivated field. Buried deposits were also identified in the eastern portion of the site in association with the mapped bar landform. In total, 11 shovel tests (STs 1–11), one 1-m-x-1-m unit (XU1), one 1-m-x-2-m block (XU2), one 2-m-x-2-m block (XU3), and one 1-m-x-50-cm expansion unit (XU3-SE-A) were excavated during the current study. STs 1, 9, and 11 were sterile. All other test excavations yielded prehistoric lithics.

Material recovered from test units excavated during the 1973 field season, as well as that recovered from ST7 and XU2 in the previously cultivated portion of the site, was confined to the plowzone. During the current study, artifacts recovered from buried contexts in the undisturbed portion of the site were discovered at depths ranging between 5 and 60 cmbs; however, the vast majority of this material was recovered from a 40–60 cmbs zone. Although cultural material was documented across a fairly large surface area at the site, results of testing and previous surface collecting suggest that the primary occupation area at 21LP11 was located along the western site margin below the outcropping granite bedrock. In terms of camp selection, this area would have afforded the greatest shelter from northwesterly winds during the fall and winter months.

The current excavations at site 21LP11 yielded a total of 242 artifacts; all of these items are lithics. Nine additional lithic items were recovered during previous investigations at the site, which brings the total inventory to 251 specimens. The majority of this material, nearly 85 percent (212 items), was recovered from the uncultivated area along the western edge of the site (Figure 93). By provenience, 7 items were surface-collected in 1973, 2 were recovered from the 1973 test units, shovel tests yielded 95 artifacts, XU1 yielded 86 items, XU2 yielded 8, and 53 were recovered from XU3. All of the artifacts recovered from the previously cultivated portion of the site, including ST7, XU2, and the nine specimens recovered during the 1973 investigation (n=39), derived from the surface or the plowzone. By contrast, over 82 percent (n=174) of specimens recovered from the uncultivated portion of the site were discovered within a zone between 40 and 60 cmbs; twelve of these items were documented in situ (Figure 94). The reason for the disparity in vertical artifact distribution between the plowed and unplowed site areas is geomorphological in nature (see below).

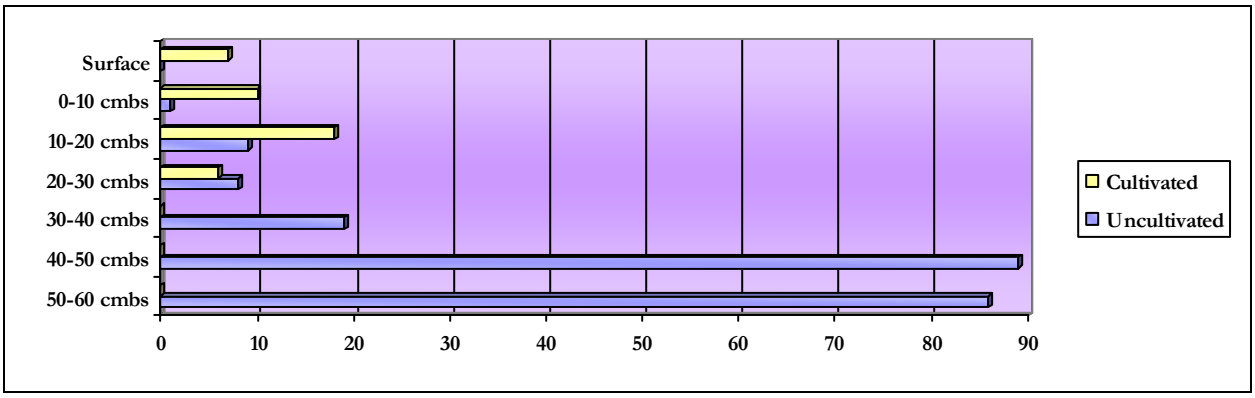


Figure 93. Dichotomy of recovered artifact counts (X-axis) by depth below surface (Y-axis) between the cultivated and uncultivated portions of site 21LP11.

Both artifact types and lithic material types recovered from the site are largely homogenous in nature. In terms of lithic materials identified, the assemblage is dominated by Swan River chert (n=197). Material types comprising the next highest quantities are quartz (n=14), Prairie du Chien chert (n=12), and unclassified cherts (n=12). The remaining materials identified within the assemblage are: unclassified chalcedonies (n=6); quartzite (n=1); jasper (n=2); gabbro (n=1); Burlington chert (n=3); and Tongue River silica (n=3). The above-listed material types are largely consistent with Bakken's (2011:79–80) regional model of lithic distribution and utilization for the Shetek subregion of the South Agassiz resource region. The three Burlington chert specimens represent the only overtly exotic lithic material types observed among the assemblage. Evidence indicates that occupants of site 21LP11 relied, almost exclusively, on local lithic raw materials for tool manufacture.

Identified artifact types are equally homogenous. When accounting for all specimens previously identified at the site (n=251), the assemblage consists of over 94 percent (236 items) debitage (either flakes or shatter). A typological breakdown of debitage specimens reveals that 19.5 percent (n=46) are shatter; the remaining 80.5 percent (n=190) consist of reduction flakes. Among the flake assemblage are 8 primary flakes, 38 secondary flakes, 142 tertiary flakes, and 2 microflakes. The remaining ca. 6 percent of site artifacts consist of reduction cores (n=6) and tools (n=9). Of the tools, one is a tertiary flake with unifacial retouch along one lateral margin. The suite of formal tools consists of two projectile points (one complete, triangular unnotched arrow point and one lanceolate, fluted spear point base), one spokeshave, three scrapers, and two biface fragments. The arrow and spear points are diagnostic of Late Prehistoric and early Paleoindian (possible) Clovis cultural/techno-complexes, respectively. The remaining formal tools are culturally/temporally ubiquitous. All of the formal tools identified at site 21LP11, with the exception of the arrow point, were recovered from the previously cultivated portion of the site during the 1973 investigations (Caine 1974). Among the entire lithic assemblage, 87 items (almost 35 percent) exhibit evidence of thermal alteration. Thermally altered specimens were recovered from all areas of the site and from depths ranging between the surface and 60 cmbs; vertical distribution is not particular to any specific depth within this range.

The majority of the 21LP11 artifact assemblage is not temporally/culturally diagnostic. Exceptions are the Late Prehistoric and fluted projectile points; however, the six overshot flakes recovered from between 40 and 60 cmbs are also quite interesting in this respect. Though the authors do not consider overshot flakes to be conclusively diagnostic of Clovis, their relative rarity among non-Clovis-aged artifact assemblages coupled with their repeated occurrence in clusters among multiple documented Clovis assemblages is circumstantially compelling (cf. Jennings 2013; Stanford and Bradley 2012:12; Waters et al. 2011:103–112; Waters and Jennings 2015:32–33). This, of course, is magnified by the presence of the fluted base discovered at the site during the 1973 investigations.

The weakly developed soils in the westernmost portion of the site present a conundrum for which an answer is not readily apparent. It is possible that they represent fairly recent deposits (1,000–2,000 years old); however, they may also represent a biomantle; forming as a result of extensive pedoturbation brought about by earthworms and other burrowing animals. A more definitive form of chronological control is needed for this site.

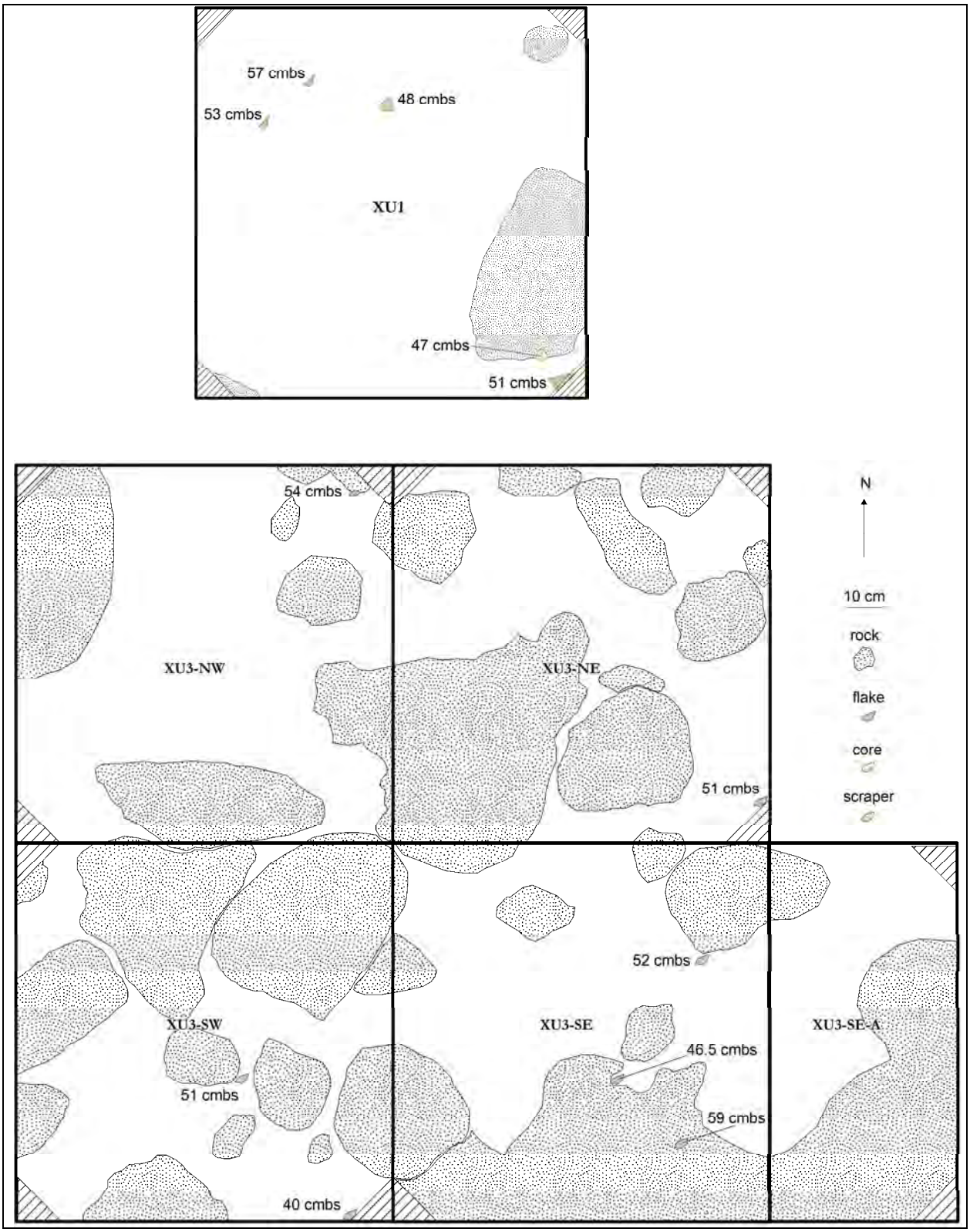


Figure 94. Composite plan view of Levels 5 and 6 (40–60 cmbs), XUs 1 and 3, site 21LP11, depicting the lateral distribution and depth of artifacts documented in situ. Distance between units not depicted to scale.

Site 21LP11 is a multicomponent lithic scatter with Late Prehistoric and early Paleoindian cultural affiliations; cultural affiliation is based on typological classification of the two recovered projectile points. Although the landscape position

of the site offers good shelter and viewsheds, as well as access to ample water, game, and lithic resources, no datable settlement features have been discovered, and additional diagnostic materials capable of clarifying other research questions associated with site function or cultural affiliation remain to be identified. The portion of the site located within the previously cultivated field lacks physical integrity as all material recovered from this locale derived either from the surface or the plowzone. However, buried cultural deposits identified along the western edge of the site exhibit no evidence of prior disturbance from agricultural practices and appear to retain stratigraphic integrity. The majority of artifacts from this portion of the site are associated with an intact zone between 40 and 60 cmbs. Among the artifacts recovered from this 40–60 cmbs zone are six overshot flakes, which have oftentimes been discovered in significant numbers among documented Clovis assemblages (see for example Jennings 2013; Stanford and Bradley 2012:12; Waters et al. 2011:103–112; Waters and Jennings 2015:32–33).

To date, no buried, intact Clovis-period sites have been documented in Minnesota. If the buried component at 21LP11 can be unequivocally tied to Clovis, an unprecedented opportunity to study one of Minnesota's earliest human groups would be realized. And in this case, the implications would reach beyond the study of the region's early occupants. Confirmation of such a habitation area in its present geographic position could also answer pressing questions related to both the timing and character of Glacial River Warren and the flow of water from Agassiz's southernmost outlet.

Site 21LP44

Site Number (Name): 21LP44	**Survey Parcel/Map Reference:** 2
Site Type/Function: Single Artifact/Unknown	**Legal Location:**
Landform Position: Erosional Residual	**Site Area (ac):** 0.01
Elevation Above Mean Sea Level (ft): 960	**Valley Section:** Upper
Cultural Affiliation: Unknown	**Site Condition:** Disturbed
USGS 7.5' Quadrangle(s): Ortonville (1971)	**Archaeological Subregion:** 2s

Research History

Site 21LP44 was not documented prior to the current study. Archeologists from the University of Minnesota did survey the site area in 1973, but no artifacts were observed at the time (Caine 1974). This is not necessarily surprising as the 1973 survey was largely surface-based and the Augustana field crew observed the artifact in the backdirt of a rodent burrow (see below).

Description

Site 21LP44 was recorded by Augustana on October 21, 2014. It was discovered in a cultivated beanfield in BSNWR. The field was designated Survey Parcel 2 (Figure 95; see Figure 19, above). Visibility in the field was 30 percent at the time of the investigation. The site, originally assigned field number MRV-LP-1, consists of a single lithic tertiary reduction flake of very dark gray (10YR 3/1) chert (Figure 96). It was discovered along the north edge of the field in the backdirt mound of a rodent burrow approximately 3 m south of the auto tour loop road (Figures 97 and 98). As the flake was discovered on a rodent backdirt mound and no additional material was observed across the surface of the field, it is likely that the specimen derived from a buried context.

Figure 95. Overview of Survey Parcel 2, Big Stone National Wildlife Refuge, Lac Qui Parle County, Minnesota.

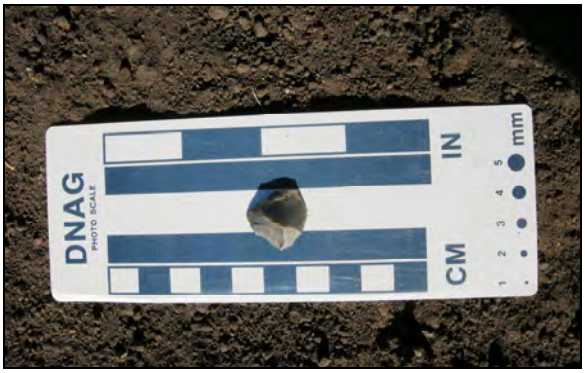


Figure 96. Lithic tertiary flake, site 21LP44.

Figure 97. Overview of site 21LP44.

site location information edit

Interpretation and Recommendations

Without subsurface testing, it is impossible to ascertain the extent of this site or whether buried diagnostic artifacts are present that may speak to its function or cultural affiliation. MN/Model classifies the landform sediment assemblage (LfSA) on which the site is located as *Erosional Residual*, or a "…remnant of a once larger stratigraphic unit or body of rock that has been mostly eroded" (MNDOT 2012:12). Given the position of this particular LfSA, the erosional mechanism alluded to is catastrophic flooding associated with the breaching of the Agassiz morainal dam. MN/Model GIS data designate the mapped LfSA containing site 21LP44 as having little to no chance of possessing paleosols and assign a landscape suitability rating (LSR) of *unsuitable* for harboring buried prehistoric archeological deposits. The site's landform was assigned a *low suitability* LSR for surface archeological deposits by MN/Model.

Despite the landform's low site locational probability as classified by MN/Model, site 21LP44 was discovered. Its direct association with the backdirt of a rodent burrow, coupled with the absence of additional observed material distributed across the surface of the field, strongly suggests an initial buried context. The MN/Model geomorphological data intimate that an intact, buried site deposit in this locality is unlikely and, while the model is probably accurate in this respect, the investigators recommend further subsurface investigation of the site area as a means of confirmation.

Site 21NL9

Site Number (Name): 21NL9	**Survey Parcel/Map Reference:** 12
Site Type/Function: Feature/Unknown	**Legal Location:**
Landform Position: Bluff Base	**Site Area (ac):** 0.48
Elevation Above Mean Sea Level (ft): 945	**Valley Section:** Lower
Cultural Affiliation: Unknown	**Site Condition:** Unknown
USGS 7.5' Quadrangle(s): St. Peter (1994)	**Archaeological Subregion:** 2n

Research History

Site 21NL9 is first mentioned in the state site files in a brief memo penned in February 1955 by Lloyd Wilford. The memo, which was based on information provided to Wilford by Elden Johnson, reads as follows: "On the John Hergert (?) farm – west of St. Peter…Said there were pits in terrace at SE corner of farm. Believed these were winter camp sites of Indians." It appears as though the site was reported to Johnson by the landowner as no information of a site visit by Johnson is recorded.

A second memo is included in the site file from May 16, 1956; it describes the results of a brief site visit. The site file does not identify to whom the memo is attributed; however, it notes that the account was transcribed from handwritten notes in January of 1979 by P. Anfinson. The memo, which is two paragraphs in length, is included below:

> Investigated pits on farm of John Hergert…The house is situated at the western edge of a flat prairie extending eastward to the Minnesota River about 2 miles away. Immediately west of the house a ridge or low escarpment extends north and south. The modern road is south of the house and rises to the top of the escarpment through a low draw. Near the base of the escarpment and immediately north of the road are three deep depressions from 10 to 20 feet across. The depth of the pits varies. One is almost open at the front, but about 10 feet deep on the uphill side. It looks like a __?__ dugout. Number 2 has the same steep wall at the back, but has a low wall on the open or downhill side. Number 3 is in a more level area, and is a shallow depression. There is a very large tree growing in number 1.
>
> Because of the distance from the river, it is unlikely that the pits are part of a former trading post. A trapper may have lived in such a pit but it seems unlikely that he would have constructed 3 pits. The pits have been here as long as any one remembers and there is no mention of them having been used by the earliest white settlers as dug-out houses. The well known trading post at Traverse-des-Sioux is two miles due east. Long before the establishment of the post this was the terminus of a famous Indian Trail, for which the spot was named. Here Indians going up the river often left their boats and proceeded overland to the upper leg of the river near the mouth of the Cottonwood River. It is likely that the Indian trail passed through the draw where the modern road is now located. The pits may have had a function in defense of the trail [21NL9 site file].

A further note in the site file mentions that 21NL9 was never mapped on a U.S. Geological Survey topographic quadrangle. Therefore, the site location as currently mapped in the state GIS database is a large, 63-acre box approximated from the above description as being "…immediately north of the road…" and "…at [the] SE corner of [the] farm" (see Figure 29, above). No testing was conducted at the site and the origin of the depressions was never ascertained.

Description

Augustana personnel investigated the majority of the mapped 21NL9 site area on October 7 and 8, 2015. A 9.47-acre area in the south-central portion of the mapped site was not investigated during the current study; this area is an abandoned, modern quarry pit for which access permission had not been obtained. The surveyed portion of the mapped site is located on a wide relict, high terrace/flood bar of the Minnesota River west of St. Peter. A line of bluffs extending into the uplands is located some 150 m west of the western edge of the mapped site area; a small farm lies below the bluffs and just west of the mapped site boundary. The area investigated is presently divided into two cultivated fields; the western field was harvested soybeans while the eastern field was harvested sweetcorn. Ground surface visibility in the beanfield averaged 40 percent; visibility averaged 80 percent in the cornfield (Figure 99; see Figure 29, above). No sites were identified in either field.

site location information edit
FIGURE 99
SURVEY PARCEL 19
AND SITE 21NL9
N
W
E
S
0
62.5
125
250
Meters
Legend
21NL9 Mapped Location
21NL9 Alternate Location
Survey Parcel 19

After completing the field survey, LiDAR imagery of the farm area was examined as inconsistencies in the original site description were noted. The pits are described as being dug into the hillside; however, the bluff base is south***west*** of the farm, not southeast as described in the site file. As a result, this location was examined first on the LiDAR. LiDAR data revealed two circular-shaped depressions measuring about 20 feet in diameter along the bluff base just southwest of the farm (Figure 100). A third pit was not conclusively visible. However, a smaller depression may be located between the larger two and the location is a far better match for the description provided. The area was not surveyed by Augustana due to lack of landowner permission.

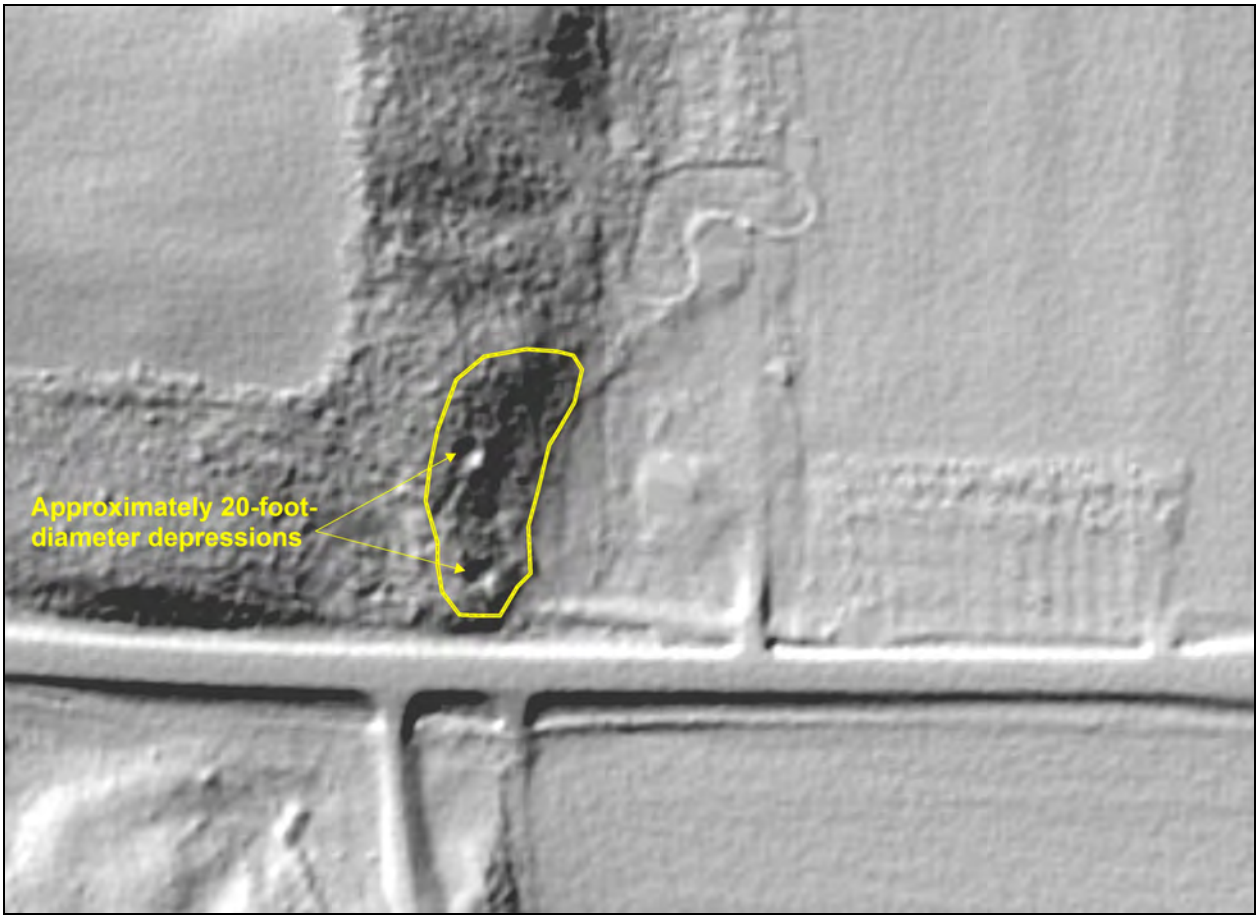


Figure 100. LiDAR hillshade model depicting two depressions in the hillside in an area believed to be a more likely location for site 21NL9, Nicollet County, Minnesota.

Interpretation and Recommendations

Site 21NL9 is a group of three depressions dug into the side of the bluffs just southwest of what used to be the John Hergert farm. The site was last visited in 1956; however, no artifacts were discovered in association with the depressions and no positive cultural affiliation could be ascertained at the time. Inconsistencies in the reporting of the location coupled with the lack of inclusion of a map in the site file resulted in a tenuously plotted site location in the state's GIS database. A field investigation of the plotted site locale yielded no evidence of site 21NL9 nor was the landform position consistent with that originally reported. Subsequent examination of high-resolution LiDAR data revealed the presence of two depressions set into the bluff slopes approximately 150 m west of the mapped 21NL9 site location. This area was not examined due to lack of access permission; however, its position is topographically consistent with the original account of the site area and the LiDAR data seem to corroborate this line of reasoning.

The 21NL9 alternative site location area should be field-verified when possible to ascertain the nature of the two visible depressions, search for a third feature, and attempt to determine specific associated historic contexts.

Site 21NL149

Site Number (Name): 21NL149	**Survey Parcel/Map Reference:** 6
Site Type/Function: Lithic Scatter/Unknown	**Legal Location:**
Landform Position: Alluvial Fan	**Site Area (ac):** 1.21
Elevation Above Mean Sea Level (ft): 835	**Valley Section:** Upper
Cultural Affiliation: Prehistoric	**Site Condition:** Disturbed
USGS 7.5' Quadrangle(s): Morgan NE (1982)	**Archaeological Subregion:** 2n

Research History

Site 21NL149 was not documented prior to the current study. The current property owner previously collected a series of ground/pecked-stone artifacts from the surface of the site when the field was under regular cultivation. The landowner subsequently brought material collected from 21NL149, together with artifacts from nearby site 21RN42 (also ground/pecked-stone specimens—see below), into the Brown County Historical Society Museum in New Ulm for identification. Museum personnel examined the artifacts from both sites and were made aware of their general locations; Augustana personnel were later informed of these sites by the same individuals (Bob Burgess, Museum Director and Jerry Weldy, landowner, personal communication 2015).

Description

Site 21NL149 in located northwest of Ft. Ridgely State Park in Nicollet County. It was documented by Augustana on June 9, 2015. The site is located on an alluvial fan that is currently in CRP (Figures 101 and 102; see Figure 23, above); the field was previously cultivated. Ground surface visibility was 0 percent at the time of the site visit, so the area was not subjected to a formal pedestrian survey. Instead, site boundaries and artifact types recorded are based on landowner information. The boundaries were mapped with GPS instruments after they were delimited by the landowner.

Figure 101. Overview of site 21NL149, Nicollet County, Minnesota, as reported by the current landowner. View is from the edge of the field across the site.

The collection of artifacts obtained from this site was examined during the site visit. Artifacts were in two boxes and mixed with specimens recovered from a separate site located on the bluffs overlooking the valley just northeast of 21NL149 (site 21RN42—see below). All of the artifacts collected were pecked/groundstone specimens (Figures 103 and 104); however, the landowner indicated that he was not otherwise familiar with different artifacts types. The collection consisted of 20 items, including multiple grooved mauls, hammerstones, and manos, as well as a celt and an axe or chopping tool. The landowner could not remember which items were recovered from which site, but noted that the distribution was fairly even between the two localities.

site location information edit
FIGURE 102
SITE 21NL149
N
W
E
S
0
50
100
200
Meters
Legend

Figure 103. Collection of ground/pecked-stone specimens from sites 21NL149 and 21RN42, Box 1 (undifferentiated).

Figure 104. Collection of ground/pecked-stone specimens from sites 21NL149 and 21RN42, Box 2 (undifferentiated).

Interpretation and Recommendations

Site 21NL149 consists of several pecked-/groundstone tools collected from the surface of a previously cultivated alluvial fan. The landform on which the site is located was mapped as high site potential by MN/Model. The site is presently in CRP and, due to reduced ground surface visibility, Augustana personnel were unable to identify additional artifacts during the current investigation. Despite this, the preponderance of heavy groundstone implements coupled with the relatively small size of the site suggests a habitation of some sort. Without subsurface testing, it is not possible to ascertain the extent of this site or whether buried diagnostic artifacts are present that may speak to its function or cultural affiliation. MN/Model GIS data designate the mapped LfSA containing site 21NL149 as commonly containing paleosols and assign a landscape suitability rating (LSR) of *high* for harboring buried prehistoric archeological deposits. The site's landform was assigned a *low suitability* LSR for surface archeological deposits by MN/Model.

Site 21NL149 is a relatively small prehistoric site consisting of multiple formal pecked/groundstone processing tools. The site is confined to an alluvial fan landform that possesses high potential for harboring buried cultural deposits. The artifact assemblage comprising site 21NL149, coupled with its geomorphological context, strongly suggests a prehistoric habitation with a high likelihood for hitherto undetected buried components. Augustana recommends further subsurface investigation of the site area as a means of exploring this assertion.

Site 21NL150

Site Number (Name): 21NL150	**Survey Parcel/Map Reference:** 12
Site Type/Function: Single Artifact/Unknown	**Legal Location:**
Landform Position: Bluff Base	**Site Area (ac):** 0.01
Elevation Above Mean Sea Level (ft): 930	**Valley Section:** Lower
Cultural Affiliation: Prehistoric	**Site Condition:** Disturbed
USGS 7.5' Quadrangle(s): St. Peter (1994)	**Archaeological Subregion:** 2n

Research History

Site 21NL150 was not documented prior to the current study. No previous investigations of the site area are mapped in the state GIS database.

Description

Site 21NL150 is located approximately 1.5 miles west-northwest of the community of St. Peter in Nicollet County. It was documented by Augustana personnel on October 7, 2015. The site is located just above the base of a stretch of north-south-oriented bluffs just above a relict, high terrace/flood bar of the Minnesota River. It was exposed on a bluff slope on one of a series of private walking trails maintained and utilized by the present property owners. The bluffs in the site area are wooded with a deciduous canopy and light understory. Ground surface visibility in the immediate vicinity of the site averaged 80 percent (Figures 105 and 106; see Figure 29, above). Further investigations in and around the site area failed to identify additional cultural material. The location of the site was mapped with a GPS instrument and photodocumented; topographically, it is situated near the mouth of a draw extending back into the bluffs.

Figure 105. Overview of site 21NL150, Nicollet County, Minnesota.

The site consists of a single lithic informal uniface tool (Figure 107). The specimen is manufactured from a piece of fairly poor quality, pale yellow-colored (2.5Y 7/4) fine-grained quartzite. It measures 6.2 cm in maximum length by 4.4 cm in maximum width; it measures 3.1 cm in maximum thickness. A portion of the cortical surface is present on the obverse face of the specimen; percussion flaking was accomplished on two margins of this face. The reverse face appears unworked. Minor damage observed along the flaked margin is likely the result of usewear. The specimen was returned to the property owner upon request.

site location information edit

Data are to be used for Reference purposes only

Source:
National Agricultural Imagery Program (2013)

Universal Transverse Mercator, NAD83
T110N, R26W

Path:
Manuscript Reports\Minnesota River Study\GIS Data

Author: ALAC
Date: October 2015

FIGURE 106
SURVEY PARCEL 16
AND SITE 21NL150

N
W E
S

0 50 100 200
Meters

Legend

Site (Isolate)
Section
Survey Parcel

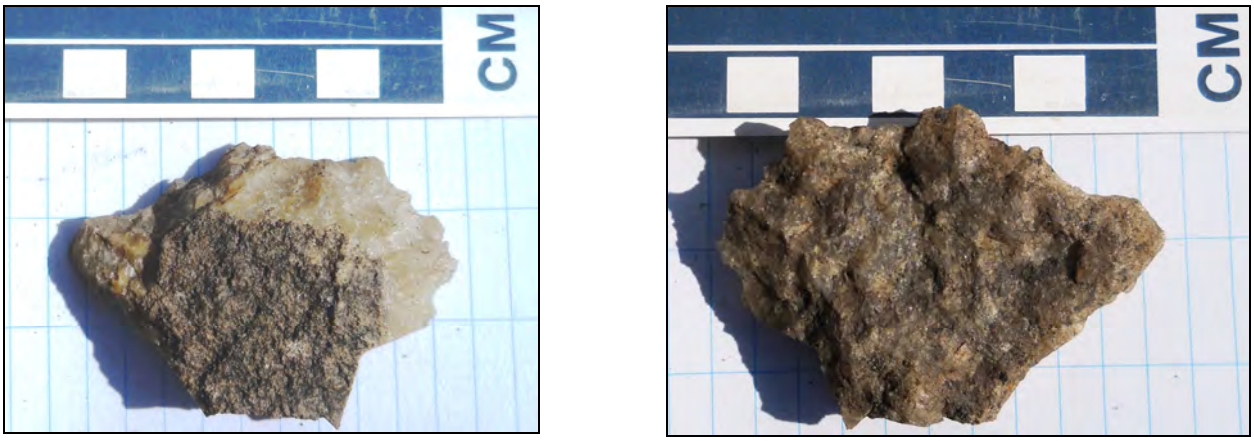


Figure 107. Lithic tool recovered from site 21NL150: obverse (left); reverse (right).

Interpretation and Recommendations

Site 21NL150 is an isolated prehistoric artifact located on a steeply sloped, erodible landform near the mouth of a draw. Its position on bluff slopes near the mouth of the draw suggests that it likely was redeposited from a location further upslope via sheetwash erosion. The artifact was almost certainly discovered out of its original depositional context and any additional cultural material that may be found in association with the specimen is also likely to have been redeposited. The ubiquity of the tool renders any cultural taxonomic assignment impossible. Landforms on which the site is located do not harbor paleosols and the LSR assigned to the site area is *unsuitable* for buried archeology; suitability is classified as *low* for surface manifestations.

Site 21NL150 consists of as single informal chipped stone tool located on steep bluff slopes near the mouth of a draw. The geomorphic setting suggests no potential for buried archeology in the immediate site vicinity and the artifact was likely redeposited from its original depositional context. The ubiquity of the tool precludes its assignment to a specific local or regional cultural tradition. The site is incapable of answering significant research questions related to the prehistory of the Minnesota River valley. No further work is recommended at site 21NL150.

Site 21RN42

Site Number (Name): 21RN42	**Survey Parcel/Map Reference:**
Site Type/Function: Lithic Scatter/Unknown	**Legal Location:**
Landform Position: Upland Bluffs	**Site Area (ac):** 18.27
Elevation Above Mean Sea Level (ft): 1,005	**Valley Section:** Upper
Cultural Affiliation: Prehistoric	**Site Condition:** Disturbed
USGS 7.5' Quadrangle(s): Morgan NE (1982)	**Archaeological Subregion:** 2n

Research History

Site 21RN42 was not documented prior to the present study. The current property owner collected a series of ground/pecked-stone artifacts from the surface of the site over a several year period. The landowner subsequently brought material collected from the site, together with artifacts from nearby site 21NL149 (also ground/pecked-stone specimens—see above), to the Brown County Historical Society Museum in New Ulm for identification. Museum personnel examined the artifacts from both sites and were made aware of their general locations; Augustana personnel were informed of these sites by the same individuals (Bob Burgess, Museum Director and Jerry Weldy, landowner, personal communication 2015).

Description

Site 21RN42 is located northwest of Ft. Ridgely State Park on bluffs overlooking the left bank of the Minnesota River along the southern Renville County line. It was documented by Augustana on June 9, 2015. At the time of the investigation, the site was located in a cultivated cornfield that afforded 90 percent ground surface visibility (Figures 108 and 109; see Figure 23, above). Soils within the site area were extremely light-colored, appearing quite deflated. The field contained a fair amount of noncultural stone and gravel, as well as numerous lithic artifacts. Hundreds of artifacts, including chipped stone, groundstone, and FCR, were observed and flagged while surveying the field; many others that were observed were not flagged. Although permission was not acquired for the 40-acre parcel immediately to the west, it is highly likely that the site extends into this area as well. The landowner had previously collected several pecked/groundstone artifacts from this field and from a field just below the bluffs to the southwest (see 21NL149 site description, above). Specimens in his collection included several manos and fully grooved mauls, as well as a celt and hammerstone. Although he was unable to recall exactly how many of the items were recovered from each site, he indicated that the distribution was fairly even between the two areas.

Figure 108. Overview of site 21RN42, Renville County, Minnesota. View is from the edge of the site.

During Augustana's survey of 21RN42, 103 lithic artifacts were formally inventoried; no faunal or ceramic specimens were observed. Numerous additional flakes, shatter pieces, and FCR fragments were observed that were neither flagged nor inventoried due to time constraints. Table 25 lists the documented material by type and count.

site location information edit

Data are to be used for Reference purposes only

Source:
National Agricultural Imagery Program (NAI)

Universal Transverse Mercator NAD83
T111N, R37W

Path:
Minnesota Reports\Minnesota River Study\GIS Data

Author: ALAC Date: February 2015

FIGURE 109
SURVEY PARCEL 8
AND SITE 21RN42

N
W E
S

0 62.5 125 250
Meters

Legend

Archeological Site
Section
Survey Parcel

At the request of the landowner, the documented tools, together with a sample of debitage that illustrated the various different lithic material types represented at the site, were removed from the field and given to him. Functionally diagnostic specimens were photodocumented (Figures 110 and 111). Among the observed chipped stone artifacts at the site, a large quantity—about 75 percent—exhibited evidence of thermal alteration. About 80 percent of the chipped stone artifacts observed consisted of either Swan River chert or oolitic Prairie du Chien chert.

Table 25. Type and Count of Lithic Artifacts Documented at Site 21RN42.

Artifact Type	Count (Inventoried)
Primary flake	3
Secondary flake	12
Tertiary flake	53
Shatter	11
Reduction core	3
Tested cobble	2
Hammerstone	1
Uniface	2
Biface fragment	2
Projectile point distal tip	1
Celt fragment	1
Mano	1
Grooved maul	1
Abrader	1
Discoidal	1
FCR	8
Total (Inventoried)	**103**

Artifacts were observed across the entire site area; however, two distinct localities with higher material concentrations were defined within the larger site boundaries. One area is in the easternmost portion of the site just north of the head of a draw that descends down the bluffs. The other concentration is in the approximate west-central site area. These concentrations are noted in Figure 109, above. Unfortunately, no clear artifact type patterns were discernable within the two localities and neither is associated with any area of particular topographic prominence. In fact, other than the increased artifact density within the two defined concentrations, no particular patterns (e.g., clusters of FCR or late-stage reduction detritus) were evident in artifact distribution across the site. Perhaps most noteworthy at site 21RN42 are two particular observations: first, the complete absence of faunal and ceramic specimens; and second, the preponderance of pecked/groundstone tools recovered. Augustana's survey recovered a mano, grooved maul, celt, and hammerstone from the site and the landowner's private collection included approximately 10 additional items of a similar nature (see 21NL149 description, above). The abundance and variety of these tools suggest that there was a substantial degree of processing occurring at 21RN42. The tools, coupled with the presence of numerous fragments of FCR, imply a habitation of at least short-term duration, which makes the absence of faunal material even more curious.

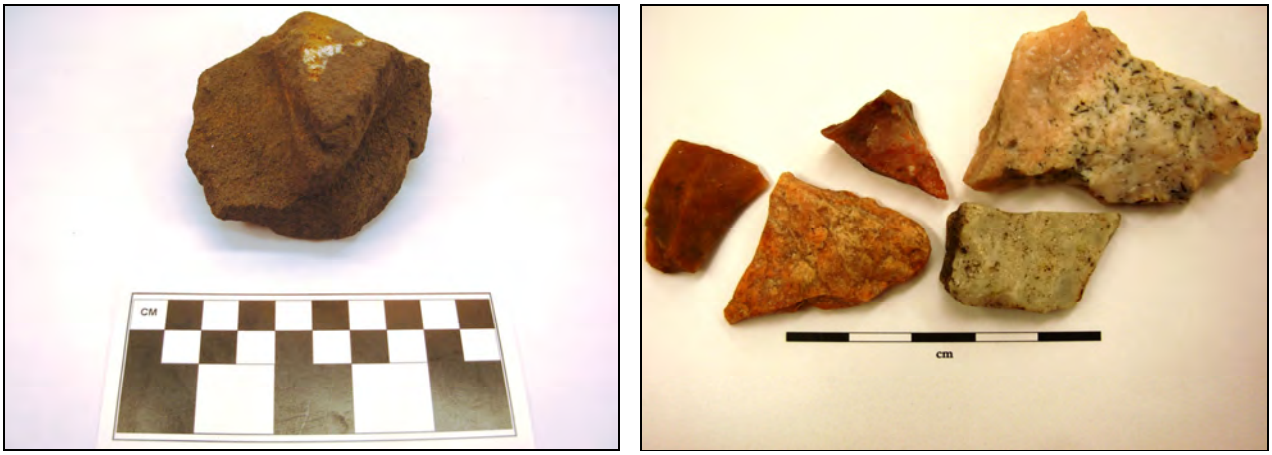


Figure 110. Sample of artifacts recovered from site 21RN42: sandstone shaft abrader with three grooves (left); debitage illustrating the predominant lithic material types present at the site—Swan River chert and Prairie du Chien chert (right).

Figure 111. Formal tools recovered from site 21RN42: granite mano and grooved maul (left); end scraper, two biface fragments, and celt fragment (right).

Interpretation and Recommendations

Site 21RN42 is a surficial lithic scatter located in a cultivated cornfield on upland bluffs overlooking the Minnesota River valley. The landform on which the site is located was mapped as high for surface archeological site potential by MN/Model. MN/Model GIS data does not classify site potential for the LfSA containing site 21RN42 because it lies beyond the walls of the Minnesota valley. However, upland landforms such as that containing the site do not harbor paleosols and although documented cases of archeological sites buried beneath biomantles in upland settings in the Plains and Midwest exist (see Johnson 1990, 1992; Van Nest 2002), their presence is considered the exception rather than the rule. As such, the 21RN42 site area would likely receive a LSR of *unsuitable* for harboring buried prehistoric archeological deposits. This supposition is further supported by the deflated appearance of the soils across the site area. The site's landform was assigned a *high* LSR for surface archeological deposits by MN/Model. Despite the presence of hundreds of artifacts, no diagnostics or datable features were identified during the site investigation. The deflated upland setting of the site, coupled with excellent ground surface visibility, suggests that any settlement feature remnants would have been detectable during the course of the survey. Though the setting and artifact assemblage are suggestive of a seasonal or temporary habitation, the absence of identified settlement features and faunal remains is curious.

Site 21RN42 is a prehistoric lithic scatter consisting of hundreds of chipped stone artifacts and multiple formal pecked/groundstone tools. The site is confined to a deflated upland landform that possesses little to no potential for harboring buried cultural deposits. The artifact assemblage comprising site 21RN42, coupled with its geomorphological context, strongly suggests a seasonal or temporary habitation; however, based on the deflated, upland setting and excellent ground surface visibility, it is likely that any surviving settlement features, or portions thereof, would have been detected during the surface investigation. Additional subsurface exploration is likely to yield little in the way of significant information concerning the inhabitants of this site. Augustana recommends no further work at site 21RN42.

Reported Sites

Five prehistoric site localities around the Le Sueur/Henderson area were reported to Augustana personnel by local historian Art Straub. Reported finds include unspecified projectile points, a lanceolate spear point, and a burial mound (see Figures 31 and 32, above). Mr. Straub accompanied the Augustana field crew and identified the location of each find; however, formal surveys were not conducted at four of the five localities because of either lack of access permission (one case) or no ground surface visibility (four cases). One of these reported areas corresponds with the location of recently documented site 21LE144 (Schirmer et al. 2015:172–173) but dense ground cover precluded a formal pedestrian survey within the mapped site boundary during the current study. The fifth reported locality, Allanson's Park in Henderson, was subjected to a pedestrian survey; however, no additional cultural material was observed. Because verification of four of these localities as sites was not possible during the current study, and because photographs or original specimens recovered from these areas were not available for examination, formal site numbers were not assigned.

5. The Effects of Late Quaternary Landscape Evolution on the Archeological Record of the Minnesota River Valley

Introduction

The record of human occupation in the Minnesota River valley (MRV) spans the past 13,500 years and may go further back in time. Although the number of recorded sites in the MRV that can be assigned to a cultural tradition is substantial (200 sites as of 2014), 147 of those sites (73.5 percent) are Woodland or younger occupations and, therefore, are less than approximately 2,000 years old. The paucity of recorded preceramic sites may be related to lower population densities in the MRV prior to 2000 RCYBP compared to population densities during later periods. However, the effects of geologic processes on the archeological record also must be considered.

The purpose of this section of the report is to describe the evolution and geomorphology of the MRV, and to address how geomorphic processes, especially erosion and deposition, have affected the temporal and spatial pattern and detection of archeological sites in the MRV. By combining information gleaned from the MN/Model (Hudak and Hajic 1999) and other sources, a simplified model of late-Quaternary landscape evolution is provided and can be used to resolve questions about the archeological record of the MRV. The model can serve as a guide to address such issues as where archeological deposits with specific cultural affiliations are likely to be preserved, where they were likely removed by erosion, where they are likely to be buried and undetectable using surface-oriented survey techniques, and how patterns in the sedimentary record might affect patterns in the archeological record.

Minnesota River

The Minnesota River is approximately 512 km long and drains an area of nearly 38,200 square km. It originates in Big Stone Lake immediately south of the Laurentian Divide in southwestern Minnesota and joins the Mississippi River in the Twin Cities of Minneapolis and St. Paul, near Fort Snelling. The Minnesota River trends southeast for 225 km from its head at Browns Valley to Mankato where it takes a sharp bend to the north. Although Wright (1972b) attributed this bend to bedrock control of the river, Jennings (2007) argued that it probably was inherited from the course of a north-trending stream that previously drained Lake Minnesota while the Des Moines Lobe was retreating. Regardless of the cause, the right-angle bend in the river at Mankato is unusual. Below Mankato, floodplain lakes are very common and typically occupy the middle of the valley floor.

Between Browns Valley and Mankato, the Minnesota River is cut into the Olivia and Blue Earth till plains to the north and south, respectively. Both till plains are products of the Des Moines Lobe, and the Minnesota River parallels the axis of this ice advance. Downstream from Mankato, the river flows generally north, and then gradually shifts to the northeast. Through this reach it initially crosses the Olivia and Blue Earth till plains, then cuts through the Owatonna Moraine before joining the Mississippi River.

As described below, meltwater outbursts from Glacial Lake Agassiz caused catastrophic floods that formed the entire MRV; hence, catastrophic flood landforms are common in the valley. Early phases of catastrophic outbursts also scoured the surrounding uplands and influenced the courses of lower ends of the Minnesota River's tributaries (Hudak and Hajic 1999). In the upper MRV, alluvial fans that aggraded at the mouths of large tributaries dammed the Minnesota River and formed a series of valley lakes, including Big Stone Lake. Below Big Stone Lake, catastrophic flooding widened the valley where resistant igneous and metamorphic rocks comprise the valley floor and forced the river to migrate laterally. The MRV gradually narrows as it approaches Mankato, but after abruptly turning north, the valley widens again and its walls are cut in a series of alternating arcs, probably because of turbulence introduced into flood flows as they made the sharp turn at Mankato (Hudak and Hajic 1999).

It is likely that the lower MRV adjusted to changes in the Mississippi River valley during the Pleistocene-Holocene transition. Back flooding of the lower Minnesota River in response to the damming that formed Lake Pepin in the Mississippi River valley created a large lake at the mouth of the Minnesota River that is an arm of Lake Pepin (Kolb 2013). This occurred sometime around 9500 RCYBP (10,750 cal. yr B.P.). Also at that time, the Minnesota River floodplain was aggrading and prograding as a delta into the flooded area at its mouth, possibly blocking the mouth at the head of ancestral Lake Pepin. Eventually, the aggradation stopped and the valley bottom stabilized into a pattern of

a single channel flowing among large floodplain lakes. Lakes in the lower MRV occupy a bedrock gorge infilled with glacial sediments (Wright et al. 1998), and these lakes may have been more extensive during the early Holocene than they are today (Kolb 2013).

EVOLUTION OF THE MINNESOTA RIVER VALLEY

The geomorphology of the MRV is mostly a product of one or more catastrophic floods emanating from Lake Agassiz, a large proglacial lake that occupied the Red River lowlands. By ca. 12,000 RCYBP, retreat of the Des Moines Lobe allowed the Red River Lobe to advance to the Big Stone Moraine located between present-day Browns Valley and Ortonville, Minnesota (Wright et al. 1998). The Big Stone Moraine is the modern continental divide between the Minnesota and Red rivers. As the Red River Lobe retreated from the Big Stone Moraine, meltwater was trapped behind the moraine, thereby forming Lake Agassiz (Clayton and Moran 1982; Elson 1967; Fisher 2003; Lepper et al. 2007; Upham 1890, 1895).

Lake Agassiz was one of the largest freshwater lakes in the world, reaching a maximum volume of 38,700 km^3 and covering about 350,400 square km (Jennings 2007; Leverington et al. 2000; Mann et al. 1999; Thorleifson 1996). Lake Agassiz fluctuated in size and covered parts of present-day Minnesota, North Dakota, South Dakota, Ontario, Saskatchewan, and Manitoba between ca. 11,800 RCYBP (13,600 cal. yr B.P.) and 7700 RCYBP (8550 cal. yr B.P.) (Clayton and Moran 1982; Lepper et al. 2007; Leverington et al. 2000), though it may have persisted until around 7500 RCYBP (8300 cal. yr B.P.) when its level dropped to that of the Tyrrell Sea (Teller 1987).

Several outlets were intermittently occupied through the course of Lake Agassiz's existence (Fisher 2003; Jennings 2007). An eastern outlet, which was active between ca. 10,900 and 10,300 RCYBP (13,750 and 12,070 cal. yr B.P.), carried water through Lake Nipigon and into Lake Superior (Clayton 1993; Teller and Thorleifson 1983; Thorleifson 1996). Between ca. 10,000 and 9600 RCYBP (11,950 and 10,920 cal. yr B.P.), an outlet to the northwest in the Fort McMurray area of Canada carried water through the Mackenzie River and into the Arctic Ocean (Fisher and Smith 1994; Fisher et al. 2002; Fisher and Souch 1998; Lowell et al. 2005; Smith and Fisher 1993). During its early stages, however, Lake Agassiz drained southward through a broad spillway cut in the Big Stone Moraine around 11,800 RCYBP (Fisher 2003; Teller 1985, 1990, 2001; Teller et al. 1983). Water emanating from the southern outlet formed Glacial River Warren, which carved the massive valley now occupied by the Minnesota River (Fenton et al. 1983; Ojakangas and Matsch 1982; Thorleifson 1996; Wright 1990).

The highly competent River Warren entrenched itself along a course previously occupied by a meltwater stream and continued to deepen and widen its valley as Lake Agassiz expanded (Matsch and Wright 1967). The channel bottom of River Warren was periodically armored with large boulders, which temporarily stabilized the stream (Matsch 1972; Wright 1990), but increases in competence renewed channel incision and the river eventually exposed the Precambrian bedrock that had been deeply buried by several till sheets. As the Des Moines Lobe retreated northward, the eastern and northwestern outlets for Lake Agassiz were exposed and activated in response to ice-margin fluctuations and isostatic adjustments, resulting in temporary abandonment of the southern outlet around 10,800 RCYBP (12,700 cal. yr B.P.) (Fisher 2003; Matsch 1983). By 9400 RCYBP (10,630 cal. yr B.P.), River Warren no longer received any glacial lake discharge through the southern outlet (Fisher 2003). Without its water supply from Lake Agassiz, the deep, wide channel carried only a small fraction of its former discharge; hence, the present-day Minnesota River is a classic example of an underfit stream (Matsch 1972).

There is strong geomorphic and sedimentologic evidence indicating that catastrophic flooding created the incised MRV (see Fisher 2004; Hudak and Hajic 1999; Johnson et al. 1998; Matsch and Wright 1967; Wiele and Mooers 1989). The valley shares many landforms characteristic of spillway valleys formed or modified by deglacial catastrophic floods (Kehew and Lord 1986). For example, River Warren produced an immense flood channel 1.5 km to 8 km wide and up to 80 m deep. Matsch (1983) estimated that a channel of this size involved the removal of from 50 x 10^9 m^3 to 75 x 10^9 m^3 of drift and bedrock in its reach across Minnesota. Also, southeast of Ortonville, the Minnesota River meanders between granite outcrops with scattered boulders resting directly on the bedrock. According to Fisher (2004), the boulders in the Big Stone National Wildlife Refuge are subangular to subrounded in shape and range in size from less than 1 m in each dimension to as large as 5.8 x 4.3 m and 3.1 m high (Fisher 2004). If the granite

boulders are corestones, as suggested by Patterson and Boerboom (1999), they were transported up to tens of kilometers before coming to rest in the spillway floor at Big Stone National Wildlife Refuge (Fisher 2004). However, if some of the boulders are not corestones, Fisher (2004) suggested that they probably were "redeposited from glacigenic sediment and their transport distances may range from tens of meters to 100 km, the length of the spillway upstream." He used boulders resting on meltwater-sculpted and striated granite near the head of the southern outlet spillway to generate paleodischarge calculations ranging between 0.364 and 0.102 Sv (364,000–102,000 m^3 per second). These discharges are consistent with flood discharges determined by modeling methodologies, and probably represent relatively brief, catastrophic flood events linked to episodic incision at the southern outlet and/or rapid inputs of meltwater to Lake Agassiz (Fisher 2004).

Other lines of evidence pointing to catastrophic floods in the southern spillway are associated with the sedimentological record. For example, Matsch (1983) and Patterson et al. (1999) described streamlined bars of gravel in the lee of bedrock knobs within the spillway east of Ortonville. Fisher (2004) interpreted these bars as erosional remnants of preexisting gravels, and noted that they are very common in spillways and often cited as evidence for catastrophic floods (e.g., Baker 1973; Fisher et al. 1995; Kehew and Lord 1986; O'Conner 1993). Johnson et al. (1998) presented evidence that significant filling, as well as cutting, occurred during major flood events in River Warren. They focused on a gravel pit excavated in a fill terrace near Kasota, Minnesota, in the lower MRV, where a 15-m-thick stratigraphic sequence containing sediments supposedly deposited by River Warren is exposed. Prominent features observed in the terrace fill include large-scale forest beds up to 15 m high that probably formed as part of a large, prograding bar on the bed of a swiftly moving stream that was at least 15 m deep (Johnson et al. 1998). Sometime later, during either the Lockhart Phase or the Emerson Phase, the terrace fill was incised by flooding, but not enough sediment was available in River Warren to allow a second filling event. Hence, based on the evidence at the Kasota section, there were two major periods of channel downcutting interrupted by one major filling episode, all attributed to catastrophic flooding (Johnson et al. 1998).

So when did the MRV form? Initial incision began in the MRV when Lake Agassiz began draining through the southern outlet cut in the Big Stone Moraine. Fisher (2003) determined the southern spillway chronology by dating plant macrofossils in two cores: the Browns Valley Fan core collected from a fan/delta complex that separated Traverse and Big Stone lakes sometime during the Holocene, and the Big Stone Lake core recovered further down the spillway, along the middle reach of Big Stone Lake. The age of initial catastrophic flooding through the southern outlet that carved the MRV is unknown because of the erosive nature of such flooding (Fisher 2003); however, it had to have occurred after the advance of the Grantsburg sublobe in the vicinity of the Twin Cities, or ca. 11,900 RCYBP (13,750 cal. yr B.P.) (Hudak et al. 2011).

According to sedimentological evidence and radiocarbon ages from the Browns Valley Fan core, the spillway through the Big Stone Moraine became inactive around 10,800 RCYBP (12,700 cal. yr B.P.), at the end of the Lockhart Phase in Lake Agassiz (Fisher 2003), and remained inactive until at least 9900 RCYBP (11,320 cal. yr B.P.). Evidence indicating that the spillway had formed sometime before ca. 10,400 RCYBP (12,275 cal. yr B.P.) comes from stratigraphic records and radiocarbon ages in the spillway bottom near New Ulm, Minnesota, where Hudak and Hajic (1999) reported ages of 10,410 ± 60 RCYBP (12,275 cal. yr B.P.) and 10,330 ± 60 RCYBP (12,175 cal. yr B.P.) determined on plant macrofossils recovered from within a valley bottom alluvial fan and from sandy alluvium beneath a valley bottom alluvial fan, respectively. In the Lake Agassiz basin near Moorhead, Minnesota, a deciduous parkland forest was in place between ca. 10,250 and 9900 RCYBP (Yansa and Ashworth 2005; Yansa et al. 2002), indicating that Lake Agassiz was north of Moorhead at a relative low stand during the Moorhead Phase (Fisher 2003; Fisher et al. 2008).

The stratigraphic record and radiocarbon chronology of Fisher's two cores indicate that spillway flooding resumed through the southern outlet sometime between ca. 9900 and 9400 RCYBP (11,300 and 10,630 cal. yr B.P.). It is likely that initiation of this second phase of discharge occurred during the last few centuries of this interval, with little, if any, further incision of the Big Stone Lake spillway (Fisher 2003). As previously noted, Hudak and Hajic (1999) documented the preservation of valley-bottom alluvial fans and terraces in the area of New Ulm and Mankato with ages of ca. 10,400–10,330 RCYBP (12,275–12,125 cal. yr B.P.). Those fans and terraces lack evidence of catastrophically carved paleochannels and, therefore, indicate that subsequent Holocene-aged flood discharges were likely orders of magnitude less than the earlier discharge that carved the MRV (Hudak et al. 2011). This latter phase of

flow(s) from Lake Agassiz must have been a relatively low discharge, perhaps with seasonal fluctuations (Hudak et al. 2011). According to Marchitto and Wei (1995) and Brown and Kennett (1998), little or no meltwater entered the Gulf of Mexico via the Mississippi River during Lake Agassiz's Emerson Phase (ca. 9900–9500 RCYBP; 11,300–10,750 cal. yr B.P.), a finding that supports the interpretation that the final occupancy of the southern outlet was short and non-catastrophic in nature. However, Licciardi et al. (1999) calculated a flood discharge of about 42,000 $m^3s^{2\ 1}$ with the last reopening phase of the southern outlet. Fisher (2003) suggests that either their estimate is too high or more than one outlet was operating at that time.

Based on the analysis of the Browns Valley fan and Big Stone Lake cores, Fisher (2003) concluded that final abandonment of the southern spillway occurred by 9400 RCYBP (10,630 cal. yr B.P.). Termination of Lake Agassiz's southern outlet at that time is consistent with the age of final abandonment proposed by Teller et al. (2000).

GEOMORPHOLOGY OF THE MINNESOTA RIVER VALLEY

Before the development of MN/Model's geomorphological component by Hudak and Hajic (1999), most studies that addressed the geomorphology of the MRV focused on the river's predecessor: Glacial River Warren. Matsch and Wright (1967) and Matsch (1972, 1983) linked the evolution of River Warren with various phases of Glacial Lake Agassiz. For example, Matsch (1983) interpreted strath (erosional) terraces in the upper reaches of the MRV, all with scatters of boulders on their surfaces, as former channel bottoms of Glacial River Warren and correlated them with lake stages as defined by the beach chronology of Upham (1895) and Elson (1967). Also, Kehew and Lord (1986) described various landforms created by catastrophic floods in River Warren, as did Fisher (2004). An exception to linking all geomorphic features in the MRV with Glacial Lake Agassiz was presented by Matsch (1972). He interpreted thick deposits of planar- and cross-bedded sand and cobbly gravel beneath high terraces as outwash deposited by the retreating Des Moines Lobe, before River Warren formed.

Johnson et al. (1998) conducted a detailed study of terraces of the MRV and concluded that boulder-strewn strath terraces cut in till are restricted to the upper third of the MRV, and that the portion of the valley below Granite Falls, Minnesota is characterized by fill terraces that aggraded while stream incision was occurring upstream. According to Johnson et al. (1998), each episode of valley incision was characterized by downcutting along the entire length of the MRV, probably initiated in the lower reaches of the valley, where a knickpoint formed. Knickpoints migrated upstream, probably at rapid rates in response to high-magnitude floods. As each wave of incision migrated upstream, the sediment removed would be transported downstream, where it would accumulate and form a fill terrace. The strath terraces in the upper reach of the valley were not covered with alluvium because the outflow from Lake Agassiz was not sediment-laden. Johnson et al. (1998) also concluded that: (1) below the southern outlet to Glacial Lake Agassiz, it is impossible to correlate terraces on the basis of elevation; (2) it is unrealistic to apply Glacial Lake Agassiz beach phase names to erosional events in the MRV, especially since the complex suite of strath and fill terraces could have been formed in as little as 400 years; and (3) the majority of the fill terraces are composed of sediments deposited by River Warren before the Moorhead Phase and that only a few may be pre-River Warren outwash terraces that formed as the Des Moines Lobe retreated.

Channel incision and concomitant terrace formation in the MRV is not limited to the terminal Pleistocene. For example, based on the results of optically stimulated luminescence (OSL) dating of sediments beneath a low terrace at the mouth of the Le Sueur River, a large stream that joins the Minnesota River on the west side of Mankato, Gran et al. (2009) determined that channel incision occurred in the MRV around 1540 cal. yr B.P. In addition to forming a low terrace, this incision may have initiated channel instability and an episode of channel migration in the MRV. Incision of the Minnesota River also triggered channel incision in its tributaries, which, in turn, promoted the development of alluvial fans in the MRV.

Recently, Gran et al. (2013) used light detection and ranging (LiDAR), topography, strath terrace chronology, and numerical modeling to determine knickpoint migration and incision history of the Le Sueur River. They determined that the Le Sueur River is best modeled as a detachment-limited channel, with downstream coarsening related to lag clasts from tills playing a critical factor in longitudinal profile development. Also, results show that post-settlement (modern) fine sediment contributions from sources associated with valley excavation are three times higher than modeled pre-settlement loads.

The most comprehensive study of the geomorphology of the MRV is that of Hudak and Hajic (1999), which was a component of the MN/Model geomorphological investigation. MN/Model is a predictive model for locating cultural deposits in Minnesota. Fifty-six cores were collected from the MRV, and a series of 17 cross-sections and one long-section were constructed from the cores. Also, two additional cross-sections showing three different core logs were modified after Hudak (1997) and included in Hudak and Hajic's 1999 report. The MN/Model geomorphological investigation yielded 12 radiocarbon ages from the MRV. Eleven additional ages were included from a previous study by Hudak (1997) of an alluvial fan in the MRV. These 23 combined radiocarbon ages and their associated stratigraphic data were used in the assessment of buried-site potential.

Hudak and Hajic (1999) defined and described a suite of landform-sediment assemblages (LfSAs) in the MRV. LfSAs are landforms and underlying genetically related packages of sediment and associated soils with predictable age relationships (Bettis et al. 1996; Rapp and Hill 2006). Each LfSA is associated with one of the following landscape sediment assemblages (LsSAs): *Upland, Catastrophic Flood*, *Paleo-Valley*, *Valley Terrace*, *Floodplain*, *Valley Margin*, and *Eolian*. Brief descriptions of these landscapes are as follows:

> *Upland Landscape*: Consists of undifferentiated upland areas isolated by Minnesota Valley LsSAs in several places and underlain by Des Moines Lobe till.
>
> *Catastrophic Flood Landscape*: Consists of erosional and depositional landforms created by one or more extremely large magnitude floods, including the one(s) that cut the MRV. *Catastrophic Flood* LfSAs are the highest and oldest geomorphic surfaces inset below the surrounding uplands and include bars, terraces, marginal channels, erosional residuals, paleochannels, and erosional straths.
>
> *Paleo-Valley Landscape*: An abandoned valley segment of the Blue Earth River south of Mankato. The valley floor is generally featureless, with the exception of tributary features, and is typically underlain by fine-textured deposits greater than 2 m thick. In some locations, overbank deposits are present. The absence of Blue Earth River paleochannels is curious and raises the possibility that the paleo-valley was cut when the MRV was cut during catastrophic flooding.
>
> *Valley Terrace Landscape*: There are two recognized valley terraces, VT1 and VT2, in the MRV (Figure 112). The VT2 LfSA probably represents the lowest level of the inner channel of catastrophic flooding and probably formed during the latest stages of catastrophic flood flows. VT2, however, is separated from the *Catastrophic Flood* landscape because it usually has thick younger deposits overlying the floor of the flood channel. There are no intervening paleosols, and sedimentation appears to have been more or less continuous from waning flood deposits to overbank deposits. The VT1 fill is laterally inset against VT2 fill and sometimes interfingers with alluvial fan deposits that mantle VT2 (see Figure 112). Also, modern floodplain deposits tend to be draped over VT1. Both terraces occur as intermittent remnants in the vicinity of Montevideo and downstream to the Mississippi valley confluence. LfSAs of both terraces are variable, with materials ranging from coarse to peat, and thickness ranging from little to no material to greater than 2 m. With VT2, coarser material probably represents late-stage catastrophic flood deposits or initial tributary valley-derived deposits. Finer material may also be late-stage catastrophic flood deposits in addition to both Minnesota River and tributary deposits. VT1 and VT2 valley fill sequences with peat are more common in the downstream reaches of the MRV. Basement material consists of glacial drift or bedrock. Surface modifications include one dune field in the lowest valley reach and overbank deposits, including post-Euroamerican settlement alluvium, either from the tributaries or flooding of the Minnesota River. Alluvial fans occur on both terraces, but are especially common on VT2.
>
> *Floodplain Landscape*: Four floodplain types, designated "w," "x," "y," and "z," occur in the MRV; designations are based on morphology and expression on aerial photographs. There are no explicit temporal relationships in the definitions of the different floodplain types; however, the age of the LfSAs probably increases from type "w" through types "x" and "y" to the oldest, type "z," particularly expressed in the age of their respective basal deposits. The floodplain LfSAs are greater than 2 m thick and laterally continuous over undifferentiated basement material. LfSAs recognized in the *Floodplain landscape* include natural levees, crevasse splays, point bars, islands in the Minnesota River, and delta lobes formed at the upstream end of riverine lakes.

Valley Margin Landscape: Consists of alluvial fans and colluvial slope deposits, which are common along the entire length of the MRV. Their geomorphic position indicates they formed after the incision of the valley by catastrophic floods. Both colluvial slope and early fan deposits incorporate mass-wasting products as the valley walls, freshly cut by catastrophic flooding, would have been susceptible to mass slope failures. This apparently was exaggerated in some valley reaches depending on what glacial drift stratigraphy was exhumed by valley cutting. Although there is a continuum between small alluvial fans and colluvial slope deposits, alluvial fans are distinguished by their fan shape and must be large enough to be mapped at a meaningful scale. Sedimentologically, fans exhibit better sorting than colluvial slope deposits, have upward-fining sequences, and may exhibit multiple buried soils at the top of upward-fining sequences. Colluvial slope deposits are extensive and well-developed in some reaches of the MRV, and associated sediments tend to be loams and loam diamictons, but are undifferentiated.

Eolian Landscape: This LsSA is represented by a single dune field, with interdunal depressions, in the downstream reach of the MRV. It is the stretch of valley oriented nearly west-east where westerly winds could be effective. Associated sediment is coarse and the deposits are generally greater than 2 m thick, but variable. The main part of the dune field postdates the *Catastrophic flood* landscape that it mantles and likely postdates the formation of the VT2 terrace that is mantled by some dunes downwind of the main dune field.

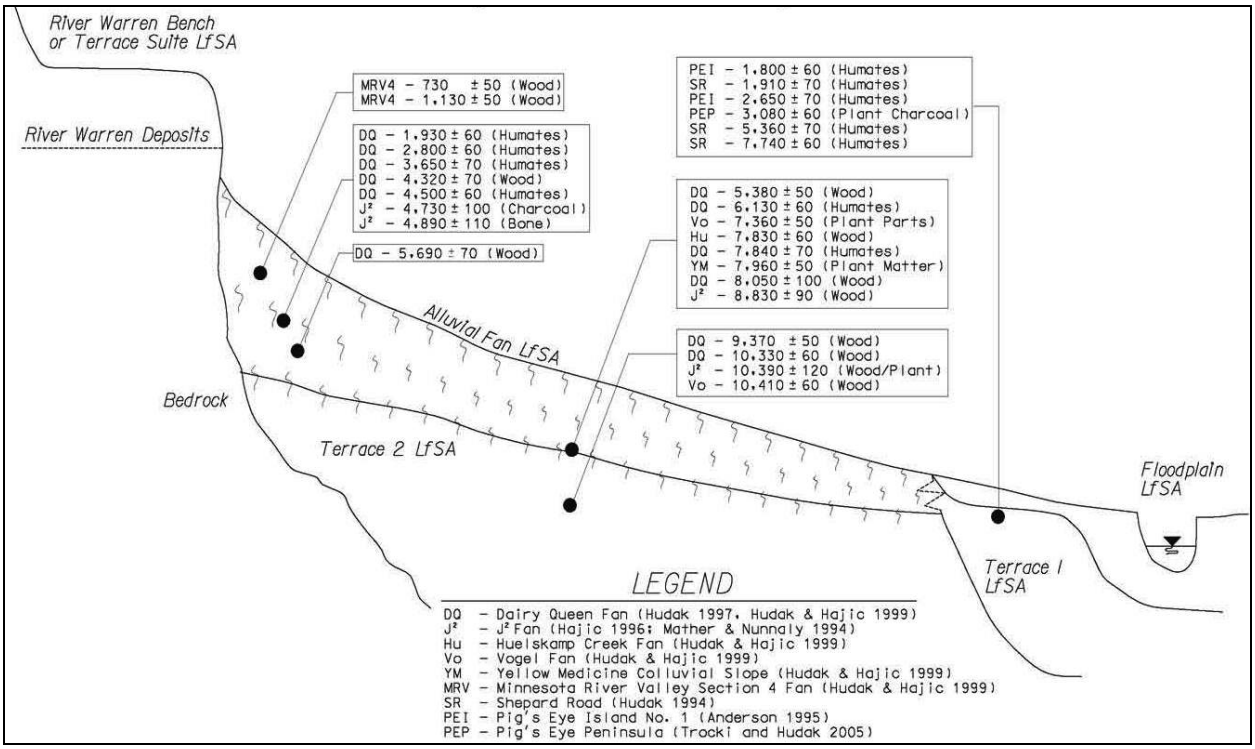


Figure 112. Generalized cross-section of the Minnesota River valley showing the stratigraphic relationships of the LfSAs and radiocarbon ages determined on materials from the deposits (from Hudak and Hajic 2005).

LANDSCAPE EVOLUTION AND ARCHEOLOGICAL SITE POTENTIAL

This section of the report addresses the effects of late-Quaternary landscape evolution on the archeological record of the MRV. Also, like the MN/Model, this section assesses the potential for cultural deposits associated with specific LfSAs, with emphasis on buried site potential. However, while the MN/Model ranks the potential for buried cultural deposits according to geologic time and depth below surface (0–1 m, 1–2 m, >2 m), in this report the potential for buried cultural deposits is designated by cultural affiliation (e.g., Paleoindian, Early Archaic, etc.) for the LfSAs that

are considered (Table 26). The impetus for considering LfSAs in an archeological context is the premise that the archeological record is a component of the sedimentary record; hence, physical processes that remove, modify, and bury sediments control the preservation and visibility of the record of the human past (Bettis and Mandel 2002b).

Table 26. Potential for Buried Prehistoric Cultural Deposits in Major LfSAs of the MRV.

Cultural Affiliation	Straths	Terraces VT2[1]	VT1[1]	Floodplain	Alluvial Fans[2]	Colluvial Aprons
Late Prehistoric	0	0	0	0–2	0	0
Woodland	0	0	2	0–2	3	3
Late Archaic	0	0	2	0	3	3
Middle Archaic	0	0	2	0	3	3
Early Archaic	0	0	2	0	3	3
Late Paleoindian	0	2	0	0	3	3
Middle Paleoindian	0	2	0	0	2	2
Early Paleoindian	0	1	0	0	2	2

Rankings: 0=No potential; 1=Low potential; 2=Moderate potential; 3=High potential.
[1] Fine-grained overbank facies only.
[2] Excluding small alluvial fans at the mouths of ephemeral streams.

In this study, determining the geologic potential for buried cultural deposits in the MRV involved consideration of four factors: (1) the soil stratigraphic record; (2) the age of sedimentary deposits; (3) the depositional environment (high-energy vs. low-energy); and (4) the drainage conditions (poorly drained vs. well-drained).

The presence/absence of terminal Pleistocene and Holocene-age buried soils, especially buried A horizons, is an important factor in evaluating site preservation potential (Holliday et al. 2016; Mandel 2006). Buried soils represent previous land surfaces that were stable long enough to develop recognizable soil profile characteristics (Mandel and Bettis 2001). If one assumes that the probability of human use of a particular landscape position was equal for each year, it follows that the surfaces that remained exposed for the longest time would represent those with the highest probability for containing cultural materials (Hoyer 1980). In the MRV, buried soils dating to the Holocene and terminal Pleistocene represent those surfaces, and evidence for human occupation would most likely be associated with them. However, prehistoric cultural deposits, even rich ones, also may be found in sediment that has not been modified by soil development (Hoyer 1980). Hence, the presence/absence of buried soils cannot be used as the sole criterion for evaluating the potentials for buried cultural materials. The mere presence of Holocene and terminal Pleistocene deposits beneath a geomorphic surface offers potential for buried cultural materials.

In the past, humans have been attracted to streams, often living on floodplains, terraces, or alluvial fans and exploiting the abundant resources available in alluvial settings. It is likely that prehistoric people were selective in choosing alluvial landforms for habitation, avoiding high-energy depositional environments, such as flood bars in zones of high-energy flooding and lateral accretion, but favoring relatively stable landforms that are elevated above the floodplain, such as terraces, alluvial fans and colluvial aprons. Although alluvial landscapes are conducive to the initial accumulation of artifacts, fluvial processes may restructure the artifact patterns (Rapp and Hill 2006:75). For example, where sites are situated on or near the banks of stream channels, high-energy floods tend to modify cultural deposits dramatically by displacing artifacts vertically and horizontally. In some cases, stream erosion may completely remove artifacts, cultural features, and even entire sites, thereby destroying evidence of human occupation (Mandel et al. 2016). On the other hand, vertical accretion, which is a relatively low-energy process compared to lateral accretion, can result in rapid burial and preservation of cultural material in floodplain deposits.

Drainage conditions also must be considered when assessing buried site potential. Wetlands, including bogs, marshes, shallow lakes, swamps, basins, and wet meadows, are very common on the valley floor of the Minnesota River, especially downstream from Mankato, and were present at various times over the past 13,000 years. Although people undoubtedly visited wetlands for hunting and gathering during that period, it is unlikely that they would have spent

much time in such wet environments, and ephemeral camps rarely produce an abundant material record. By contrast, well-drained LfSAs, such as alluvial fans and colluvial aprons, would have been attractive locations for long-term human occupations that tend to leave a rich archeological record.

In order to address the effects of late-Quaternary landscape evolution on the archeological record and assess the potential for buried cultural deposits in the MRV, the following discussion is divided into three periods: terminal Pleistocene; early through middle Holocene; and late Holocene. For the purpose of this report, the terminal Pleistocene begins at ca. 11,800 RCYBP (13,600 cal. yr B.P.) with the initial incision of the Big Stone Moraine and concomitant drainage of Lake Agassiz through the southern outlet, and ends at 10,000 RCYBP (11,500 cal. yr B.P.) with the onset of the Holocene. The early through middle Holocene spans the period 10,000 to 3800 RCYBP (11,500 to 4200 cal. yr B.P.), as defined by the Working Group of INTIMATE (Integration of ice-core, marine and terrestrial records) and the Subcommission on Quaternary Stratigraphy (SQS) of the International Commission on Stratigraphy (ICS) (Walker et al. 2012). The boundary between the middle and late Holocene is placed at 3800 RCYBP (4200 cal. yr B.P.) because it marks an aridification event (the 4.2 event) that is reflected in proxy records from North America and elsewhere.

Terminal Pleistocene

Deglacial events in the upper Midwest at the end of the Pleistocene were instrumental in shaping river valleys, as well as setting the stage for Holocene landscape evolution (Hudak et al. 2011). Some valleys were deeply scoured while others experienced massive accumulations of sediment. Recognizing the temporal and spatial pattern of erosion and alluviation during and immediately following deglaciation is crucial for understanding where archeological deposits may occur in surficial and buried contexts.

As previously noted, initial incision of the Big Stone Moraine began ca. 11,800 RCYBP (13,600 cal. yr B.P.) when Glacial Lake Agassiz started to drain through the southern outlet, causing catastrophic flooding via River Warren. The first phase of drainage was completed by ca. 10,800 RCYBP (12,700 cal. yr B.P.) and the southern outlet was temporarily abandoned until ca. 9900 RCYBP (11,320 cal. yr B.P.) The high-magnitude floods scoured the MRV and cut strath terraces primarily northwest of present-day Granite Falls, Minnesota, in the upper reaches of the drainage system. The catastrophic flooding and associated scouring would have removed Early Paleoindian cultural deposits that may have been present in the valley landscape, especially along the paths of flood channels (also referred to as marginal channels) and where strath terraces formed. Also, because the strath terraces are erosional surfaces cut across bedrock or glacial drift, they lack alluvial fill and, therefore, have no potential for containing buried cultural deposits. This does not, however, discount the possibility of sites buried beneath other LfSAs, such as fan or floodplain deposits, mantling a strath surface.

In addition to forming strath terraces, scouring by catastrophic floods created erosional residuals, which are streamlined lemniscate-shaped landforms. Clusters of erosional residuals occur northwest of Montevideo, in the area of New Ulm, and where igneous and metamorphic intrusions cross the valley (Hudak and Hajic 1999). Hundreds of erosional residuals also occur in the uplands on either side of the MRV northwest of Granite Falls. Areas of erosional residuals would have been stripped of cultural deposits predating catastrophic flooding and, like strath terraces, the erosional residuals have no potential for containing buried cultural deposits. Again, this does not preclude the potential for buried archeology in other LfSAs mantling this erosional surface.

The flood-driven incision of the valley landscape that occurred between ca. 11,800 and 10,800 RCYBP (13,600–12,700 cal. yr B.P.) was accompanied by the formation of catastrophic flood bars along the length of the MRV. In particular, streamlined mid-channel bars developed between flood channels, and alcove bars formed on the inside of flood channels that cut arcs or crescents into the preexisting landscape (Kehew and Lord 1986). Also, thick (>10 m) flood deposits aggraded on the valley floor downstream from Granite Falls and now comprise fill terraces (Johnson et al. 1998). The flood bars and terrace fills consist of coarse-grained alluvium, though they may be capped by fine-grained alluvium that accumulated during waning floods. However, according to Hudak and Hajic (1999), in most cases, fine-grained sediment on bars and fill terraces represents alluvium or sheetwash that postdates catastrophic flooding. Clearly, the catastrophic flood bars as well as the fill terraces that formed between ca. 11,800 and 10,800 RCYBP (13,600–12,700 cal. yr B.P.) are products of immense stream discharge, and such high-energy depositional

environments would have been unfavorable for human occupation and the preservation of cultural deposits. Excluding mantles of post-flood sediment, the bars and terraces formed by catastrophic flooding have no potential for containing *in situ* cultural deposits.

During the terminal Pleistocene and very early Holocene, fine-grained alluvium accumulated above coarse-grained catastrophic flood deposits on the valley floor of the Minnesota River. The fine-grained deposits represent low-energy depositional environments, largely floodplain overbank facies, and occur beneath the surface of the VT2 LfSA (see Figure 112). Plant macrofossils from these deposits have yielded radiocarbon ages ranging between ca. 10,400 and 9300 RCYBP (12,275–10,510 cal. yr B.P.). At the time of sedimentation, the fine-grained sediment assemblages may have been no better drained than the modern floodplain, as indicated by the common occurrence of peat, but now are better drained because of a slightly higher landscape position. Also, sedimentation appears to have been more or less continuous from waning flood deposits to overbank deposits, but aggradation of the fine-grained alluvium may have been periodically interrupted by soil development (Hudak and Hajic 1999). Taking these factors into account, the fine-grained sediment assemblages associated with the VT2 LfSA have moderate potential for containing Paleoindian cultural deposits.

Hudak and Hajic (1999) noted that in just a few cases in the downstream part of the MRV, silt interpreted as loess occurs on remnants of strath terraces formed by catastrophic flooding. The loess must postdate ca. 10,400 RCYBP (12,275 cal. yr B.P.), but its precise numerical age is unknown. Nevertheless, it has high potential for containing buried cultural deposits because the accumulation of loess is ideal for burial and preservation of archeological materials.

Deep incision by River Warren between ca. 11,800 and 10,800 RCYBP (13,600–12,700 cal. yr B.P.) lowered the local base level by as much as 80 m and triggered incision and head-cutting among its tributaries (Belmont 2011; Gran et al. 2009). At the beginning of this period of incision, most of the tributaries had low gradients and were poorly connected to the river channel. Hence, the wave of incision that moved up the tributaries generated large volumes of sediment and initiated the evolution of alluvial fans along the length of the MRV (Gran et al. 2009). Also, surface geology played a role in the development of alluvial fans and colluvial aprons along the margins of the valley floor. For example, in the lower MRV, the valley walls consist of soft, easily eroded Mesozoic bedrock or late-Wisconsinan drift of the Des Moines Lobe, but erosion-resistant Precambrian (Achaean) quartzite comprises the valley floor. The quartzite prevented channel (or valley) incision during catastrophic floods caused by outflows from Lake Agassiz, but the more erodible valley walls permitted horizontal expansion, which probably resulted in significant lateral erosion and helped retain relatively steep valley walls (Monaghan et al. 2006). It is likely that the steep walls accelerated colluviation and promoted development of alluvial fans soon after ca. 10,800 RCYBP (12,700 cal. yr B.P.) The valley walls, freshly cut by catastrophic flooding, would have been susceptible to mass slope failures, and mass-wasting products would have been incorporated into colluvial aprons and alluvial fans during their early stages of development (Hudak and Hajic 1999). Most of the alluvial fans and nearly all colluvial aprons formed on the valley terrace or catastrophic flood LfSAs.

Radiocarbon ages determined on plant macrofossils immediately below the contact between VT2 fill and alluvial fan deposits indicate that fans were forming soon after 10,400 RCYBP (12,275 cal. yr B.P.), if not earlier (Hudak and Hajic 1999). Initially, fan construction was rapid and only slowed when the tributary channels became adjusted to the lower base level and as aggradation occurred in the main valley as base level rose with back flooding from Lake Pepin at the mouth of the river. Colluvial aprons often merge with portions of alluvial fans near the valley wall, where deposits comprising both LfSAs are coeval.

Because it is likely that alluvial fans and colluvial aprons began to form soon after ca. 10,800 RCYBP (12,700 cal. yr B.P.) and continued to develop through the Pleistocene-Holocene transition, they have potential for containing deeply buried Paleoindian cultural deposits, including the material remains of Clovis and Folsom occupations. This potential is considered moderate, however, because aggradation of alluvial fan and colluvial apron deposits was initially rapid, and buried soils representing relatively stable geomorphic surfaces predating ca. 8100 RCYBP (9020 cal. yr B.P.) have not been recorded in these LfSAs. As described below, the potential for buried cultural deposits is greater in alluvial fan and colluvial slope deposits that accumulated after 10,000 RCYBP (11,950 cal. yr B.P.) compared to the earlier deposits.

Early and Middle Holocene

The southern outlet of Lake Agassiz was reoccupied between 9900 and 9400 RCYBP (11,300–10,630 cal. yr B.P.), causing more flooding in River Warren. Sedimentological evidence, however, suggests that flood magnitudes during the second phase of discharge through the southern spillway were not as great compared to the first phase, causing minimal additional modification of the MRV (Fisher 2003; Hudak and Hajic 1999).

Alluvial fans and colluvial aprons continued to form through the early and middle Holocene. During the early Holocene, development of fans probably was driven by waves of incision moving up the tributaries in response to incision and concomitant lowering of base level caused by catastrophic flooding in the main valley. Also, after the flooding, the vertical walls of the valley were unstable and conducive to mass-wasting and the development of colluvial aprons. However, during the middle Holocene, alluvial fans and colluvial aprons probably formed in response to climatically driven landscape instability. Warming and drying occurred in Minnesota during the mid-Holocene Altithermal climatic episode (Webb et al. 1983), causing high erosion rates in small streams and on hillslopes. Sediment derived from the erosion was transported to the mouths of the streams, where it formed alluvial fans, or to footslopes, where it formed colluvial aprons (Bettis and Mandel 2002b).

Sedimentologically, the alluvial fans that developed during the early and middle Holocene exhibit better sorting than colluvial aprons, are characterized by upward-fining sequences, and often have weakly to moderately developed soils at the top of the upward-fining sequences. Sediments are variable within those fans, becoming finer-grained going from the proximal to the distal end of the fan. Also, fan deposits consist of interstratified coarse and fine material, with coarser sediment deposited in the feeder channels, and the finer sediment deposited on the surfaces of the lobes by sheetflood or sheetwash processes. Among fans, the texture of alluvium varies depending on the sediment source in the contributory basin, and the size and age of fans tend to vary depending on the surface on which the fan rests. Fans associated with comparable tributary drainage areas tend to be larger where they overlie the catastrophic flood and valley terrace LfSAs, compared to where they overlie and interfinger with floodplain LfSAs (Hudak and Hajic 1999).

Two buried soil complexes have been identified in the alluvial fans of the MRV (Hudak and Hajic 1999). The youngest recorded complex ranges in age from 2000 to 4500 RCYBP (1950–5170 cal. yr B.P.), whereas the older complex ranges in age from 5400 to 8000 RCYBP (6240–8880 cal. yr B.P.)

Colluvial aprons dating to the early and middle Holocene are common and laterally extensive on footslopes and toeslopes in some reaches of the MRV. Nearly all of the aprons are on the valley terrace 2 (VT2) or catastrophic flood LfSAs. Depositional processes that formed the colluvial aprons include rainwash, sheetwash, landslides, and slow, continuous downslope creep. Hudak (personal communication 2015) believes that many of the alluvial fans and colluvial slopes have a "core" stratum developed as a result of a slope failure along the River Warren-cut valley walls. Colluvial aprons in the MRV consist mostly of loams and loam diamictons, and buried soils are common in this LfSA.

Alluvial fans and colluvial aprons that formed in the MRV during the early and middle Holocene have high potential for containing Late Paleoindian and Early through Late Archaic cultural deposits. The ranking is high because these LfSAs are moderately to well-drained, the sediments were deposited by relatively low-energy processes that favor preservation of cultural deposits, and buried soils are common. Based on observations at the Altman (21NL58) and Fritsche Creek II (21NL63) sites, which are associated with small alluvial/colluvial fans within the MRV, Terrell et al. concluded:

> The use of both of these fans as procurement and processing sites indicates that these landforms were attractive locations for such activities [during the Archaic period]. As both of these sites are located along the north edge of the river valley, it appears that the fans may have been selected in part as sheltered locations at the base of the river bluff. Furthermore, these sites provided ready access to water; and were proximate to game…the faunal assemblage indicates the hunting of individuals and may point to the harvesting of occasional animals that were coming to the water within the valley, or that were collected on the surrounding plains and subsequently processed at the site [Terrell et al. 2005:81–82].

The high potential for buried cultural deposits in alluvial fans has been realized at some of the most significant stratified sites in the MRV, including J Squared (21RW53), Fritsche Creek II (21NL63), Granite Falls Bison Kill (21YM47), Altman (21NL58), and 21CR155/21CR156.

At the J Squared site (21RW53), formerly known as the Jackpot Junction site, Hajic (1995) identified at least three archeological components at depths ranging from 70 to 300 cm below the land surface. Two of the components are associated with buried soils at depths of 150 and 300 cm. According to Hajic (1995), coalescing alluvial fans comprise the site. However, based on the results of deep testing, Bower et al. (1996) claimed that the archeological components are in a "colluvial fan" overlying a high terrace (VT2) of the Minnesota River. Hajic (personal communication 2015) stands by his interpretation, noting that deep cores collected at the site consist entirely of alluvial fan deposits, and that the "T2 terrace scarp" identified by Bower et al. (1996) is a road cut. Regardless of the controversy over the geomorphology of the site, a suite of radiocarbon ages indicates that the deepest archeological component dates to ca. 5000–4600 RCYBP (5700–5320 cal. yr B.P.); hence, it represents a Middle Archaic occupation.

The Fritsche Creek II site (21NL63), located just upstream from the city of New Ulm in Nicollet County (Roetzel et al. 1994), is a good example of a co-alluvial fan containing stratified cultural deposits. Co-alluvial fans are comprised of sediment transported by alluvial and colluvial processes (Cremeens et al. 2003). The Fritsche Creek site is on the north side of the Minnesota River, about 2 km upstream (west) of New Ulm, Minnesota. In 1994, at the conclusion of the limited Phase III fieldwork, the site was described as consisting of an extremely thin Woodland component within the upper 40 cm of the fan, and a "bone bed" at 85–150 cm below surface (21NL63 site file). Collagen from a bison bone yielded a radiocarbon age of 6080 ± 100 RCYBP (6960 cal. yr B.P.). This age, together with the archeological evidence, suggested that site 21NL63 was a Middle Archaic or earlier occupation. The site was most recently investigated in 2004 as part of the development of the MNDOT Deep Testing Protocol (Monaghan et al. 2006). The 2004 testing revealed that the bonebed recorded 85–150 cm below surface is a Middle Archaic occupation associated with bison butchering and processing, and dates to ca. 6500 RCYBP (7430 cal. yr B.P.) The bonebed rests on coarse-grained, early-Holocene alluvial fan deposits and is mantled by fine-grained colluvium that came down the Fritsche Creek ravine and accumulated on top of the fan. Also, artifacts and bone were recorded between 1.40 and 2.40 m below the land surface and are associated with a buried soil developed in alluvial fan deposits. The buried soil yielded a radiocarbon age of 8100 ± 40 RCYBP (9040 cal. yr B.P.); hence, there appears to be an Early Archaic component in the alluvial fan.

Prior to the excavations at the Fritsche Creek II site, the Granite Falls Bison Kill (21YM47) in Yellow Medicine County was the only well-dated Early Archaic site in the region and one of the few buried Archaic occupations in Minnesota (Anfinson 1997:36). This site contained a bed of butchered bison bone recorded 2.8 m below the surface of a co-alluvial fan, and the bonebed was associated with a buried soil. Radiocarbon ages from the bonebed range between ca. 6800 and 6400 RCYBP (7640–7340 cal. yr B.P.) (Lewis and Heikes 1990). A second cultural horizon represented by lithic debris and fire-cracked rock was identified at about 1.8 m below the surface and also is associated with a buried soil.

The Altman site (21NL58) is associated with a small secondary co-alluvial fan that formed at the mouth of an unnamed 2nd-order tributary of the Minnesota River in Nicollet County. Coring and deep testing revealed multiple buried soils in the fan, and a Middle Archaic component was recorded between 1.20 and 1.90 m below surface in a buried soil (Kolb 2005; Terrell et al. 2005). An abundance of faunal remains, combined with the artifact assemblage, suggests that the site was used as a faunal processing location. Carbonized samples from the buried archeological component yielded radiocarbon ages ranging from ca. 5000 to 5250 RCYBP (5720–5990 cal. yr B.P.) (Terrell et al. 2005).

Sites 21CR155 and 21CR156 are adjacent to each other at the base of the valley wall on the north side of the MRV in Carver County, across the river from the city of Shakopee, Minnesota. Both sites extend along the margin of a former floodplain lake on the valley floor. Site 21CR155 consists of three distinct areas: the eastern portion, which is associated with a fairly large alluvial fan that developed at the mouth of Bluff Creek; the central portion, which is associated with a small alluvial fan that formed at the mouth of an intermittent drainage; and the western portion, which consists of marshy (paludal) and lacustrine deposits at the surface and lacks alluvial fan deposits (Kolb 2013; Smith and Larson 2015). Site 21CR156 is about 500 m east of the Bluff Creek fan and is associated with a small co-alluvial fan.

At site 21CR155, the archeological deposits are primarily contained in a buried, cumulic, clay-rich soil that formed in a lacustrine deposit. This soil is deeply buried across the eastern portion of the site by paludal and alluvial fan deposits and occurs near the surface in the western portion of the site where alluvial fan deposits are absent and paludal deposits are thinner. Buried Early Archaic cultural deposits dating to ca. 6200–6000 RCYBP (7085–6840 cal. yr B.P.) occur in the soil formed in the lacustrine deposits. Also, Early Archaic cultural deposits dating to ca. 6300 RCYBP

were recorded 1.20–1.55 m below surface in colluvial deposits along the toeslope of the valley wall, and Early Archaic cultural deposits dating to ca. 7190 RCYBP (7975 cal. yr B.P.) occur 2.20–2.30 m below surface in alluvial fan deposits in the central portion of the site. In addition, Late Archaic and Late Woodland cultural deposits occur in buried contexts in lacustrine and paludal deposits, respectively, immediately adjacent to fan deposits at 21CR155.

The stratigraphy of site 21CR156 is complex and poorly understood. The co-alluvial fan consists of stratified alluvial fan deposits interbedded with colluvial deposits. Although it is difficult to distinguish between these deposits at the site, it appears that the alluvial fan deposits are dominant in the eastern portion of the site near the center of the fan, whereas the colluvium is more prevalent in the western portion of the site (Florin et al. 2013). Buried soils are common in the alluvium and colluvium, and the deepest buried soil, which yielded a radiocarbon age of 6710 ± 30 RCYBP (7580 cal. yr B.P.), contains a Middle Archaic component that is 1.80 to 2.00 m below surface. Also, within a different area of the site, a Late Paleoindian occupation was recorded at a depth of 1.30–1.40 m. Calcined animal bone recovered from the Late Paleoindian component yielded a radiocarbon age of 7040 ± 30 RCYBP (7890 cal. yr B.P.).

Based on his observations in Nicollet County, Kolb (2005) separated alluvial fans into two categories: primary and secondary. He concluded that primary fans likely formed soon after the catastrophic floodwater incised the valley for the final time about 9,600 years ago. In other words, the second series of floods created the valley surface to which the primary fans are graded. Radiocarbon ages indicate that development of secondary fans began 5,000–6,000 years ago during the warmest and driest part of the Holocene, and that sedimentation continued either episodically or at very slow rates in tandem with pedogenesis up to the present. Kolb (2005) noted that secondary fans often overlie a paleosol developed in slackwater deposits and that buried soils are common within the secondary fan deposits.

Some of the alluvial fans in the MRV merge with the lowest and youngest valley terrace LfSA: the VT1 (see Figure 112). VT1 represents a low-energy depositional environment, largely consisting of floodplain overbank facies (Hudak and Hajic 1999). At the time of sedimentation, VT1 probably was no better drained than the modern floodplain, but now is better drained because of a slightly higher landscape position. The presence of wetlands during aggradation of the VT1 fill was demonstrated by a geomorphological investigation in a segment of the lower MRV near Chaska, Minnesota. In that segment of the valley, Bettis and Thompson (1986) identified an alluvial terrace and referred to it as LSA 2. Their LSA 2 is equivalent to the VT1 LfSA. Deposits beneath the terrace consist of either peat/muck to 2.2 m or silt loam over peat or muck. The peat or muck overlies sandy and gravelly alluvium. Peat from three separate cores yielded the following radiocarbon ages: 5000 ± 80 RCYBP (5745 cal. yr B.P.), 2780 ± 50 RCYBP (2880 cal. yr B.P.), and 2370 ± 80 RCYBP (2445 cal. yr B.P.) (Bettis and Thompson 1986). Although wetlands were, and still are, common on VT1, aggradation of the terrace fill was punctuated by episodes of landscape stability and soil formation, as indicated by the occurrence of buried soils in this LfSA (Hudak and Hajic 1999). The numerical age of the sediment assemblage underlying VT1, however, is not clearly understood, especially in the downstream reaches of the MRV (C. M. Hudak, personal communication 2015). Based on the available data, aggradation of the VT1 fill was underway by at least ca. 7700 RCYBP (8485 cal. yr B.P.) and continued until ca. 1800 RCYBP (1730 cal. yr B.P.) (see Figure 112). Given its age, drainage conditions, and soil stratigraphy, the fine-grained component of VT1 has moderate potential for containing Early to Late Archaic cultural deposits.

Late Holocene

Late-Holocene deposits in the MRV are mostly confined to alluvial fans, colluvial aprons, and the modern floodplain of the Minnesota River. As noted above, the development of alluvial fans in the MRV extended into the late Holocene and the period of Euroamerican settlement. For example, late Holocene alluvium comprises fans at sites 21CR155 and 21CR156 in Carver County (Kolb 2013; Smith and Larson 2015), site 21NL147 in Nicollet County (Kolb 2014), and site 21CP16 in Chippewa County (this study). At site 21CR155 and other small fans in the MRV, major depositional events occurred during the early period of Euroamerican settlement. As the uplands were cleared of timber and tilled, significant erosion occurred, thereby generating large volumes of sediment and triggering the development of thick alluvial and co-alluvial fans on the valley floor at the mouths of streams and intermittent drainages in the MRV. For example, at site 21CR155, a thick Historic-age co-alluvial fan developed at the mouth of an intermittent drainage, resulting in the deep burial of a soil containing Early Archaic cultural deposits. Although modern fans have no potential for containing buried prehistoric cultural deposits, buried soils with high potential for Late Archaic and younger cultural deposits occur in fan deposits that aggraded between ca. 4200 RCYBP (4740 cal. yr B.P.) and the time of Euroamerican settlement. Site 21NL147 is a case-in-point.

At site 21NL147, a buried soil (Paleosol 2) was recorded 1.90–2.70 below the surface of a small alluvial fan (Kolb 2014). The high potential for cultural deposits in Paleosol 2 was realized with the discovery of Early Woodland materials. Charcoal from the Early Woodland component yielded two identical radiocarbon ages of 1550 ± 30 RCYBP (1465 cal. yr B.P.) (Kolb 2014).

As part of the current study of the MRV, two cores were taken at site 21CP16, which is located at the mouth of Spring Creek in the Chippewa River valley, about 1.5 km upstream from the Minnesota River. Although most of the valley floor has been artificially drained, a floodplain wetland is located on the northern edge of the alluvial fan, and Spring Creek tends to have continuous discharge because it is fed by springs. Cores 1 and 2 were taken on the upper midsection and distal end of the fan, respectively. Both cores exposed a surface soil with an overthickened (90 cm) cumulic A horizon above a stratified sandy and gravelly C horizon. Although a peaty muck occurs at a depth of 2.53–2.74 m and 1.20–1.35 m in Cores 1 and 2, respectively, buried soils were not observed in the cores (Table 27; Figure 113). The top of the peaty muck represents a buried floodplain wetland; hence, it marks the boundary between floodplain deposits and the overlying fan deposits.

Table 27. Description of Cores 1 and 2, Site 21CP16.

CORE 1
Landform: Alluvial Fan; upper midsection
Slope: 2–3 percent
Drainage: Well-drained
Land Cover: Cultivated field
Remarks: Peat from a sample of peaty muck collected at a depth of 2.63–2.69 cmbs yielded an age of 4160 ± 20 RCYBP; soil organic matter from a bulk soil sample collected at a depth of 80–88 cmbs yielded an age of 1635 ± 30 RCYBP.

Depth (cmbs)	Soil Horizon	Description
0–21	Ap	Very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak fine granular structure; very friable; many very fine and fine roots; abrupt boundary.
21–90	A	Very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; moderate medium and fine granular structure; friable; many worm casts and open worm burrows; many very fine and fine roots; gradual boundary.
90–115	AC	Dark gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) moist; very weak fine granular structure; friable; common worm casts and open worm burrows; common very fine and fine roots; gradual boundary.
115–217	C1	Stratified pale brown (10YR 6/3) and light yellowish brown (10YR 6/4) fine, medium and coarse sand interbedded with lenses of fine gravel; single grain; loose; abrupt boundary.
217–253	C2	Stratified (laminated) gray (10YR 5/1) loamy fine sand interbedded with pale brown (10YR 6/3) fine sandy loam; massive parting to single grain; friable to loose; abrupt boundary.
253–274	2Oab	Black (10YR 2/1) peaty muck; abrupt boundary.
274–310+	3Cb	Pale brown (10YR 6/3) medium and coarse sand interbedded with laminae of gray (10YR 5/1) loamy fine sand; single grain; loose.

CORE 2
Landform: Alluvial Fan; distal end
Slope: 1–2 percent
Drainage: Well-drained
Land Cover: Cultivated field

Depth (cmbs)	Soil Horizon	Description
0–20	Ap	Very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; weak fine granular structure; very friable; many very fine and fine roots; abrupt boundary.
20–90	A	Very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; moderate medium and fine granular structure; friable; many worm casts and open worm burrows; many very fine and fine roots; gradual boundary.

Table 27 (continued).

Depth (cmbs)	Soil Horizon	Description
90–98	AC	Dark gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) moist; very weak fine granular structure; friable; common worm casts and open worm burrows; common very fine and fine roots; gradual boundary.
98–120	C	Stratified pale brown (10YR 6/3) and light yellowish brown (10YR 6/4) fine, medium and coarse sand interbedded with lenses of fine gravel; single grain; loose; abrupt boundary.
120–135	2Oab	Black (10YR 2/1) peaty muck; abrupt boundary.
135–240+	3Cb	Pale brown (10YR 6/3) medium and coarse sand interbedded with laminae of gray (10YR 5/1) loamy fine sand; single grain; loose.

In Core 1, organic matter from the upper 10 cm of the peaty muck and lower 10 cm of the A horizon yielded AMS radiocarbon ages of 4160 ± 30 RCYBP (4710 cal. yr B.P.) and 1635 ± 30 RCYBP (1540 cal. yr B.P.), respectively (Table 28; see Figure 113 and Appendix A). Based on these ages, aggradation of the alluvial fan began soon after ca. 4100 RCYBP. Aggradation was initially rapid, but by ca. 1600 RCYBP sedimentation slowed, allowing formation of the nearly 1-m-thick cumulic A horizon of the surface soil.

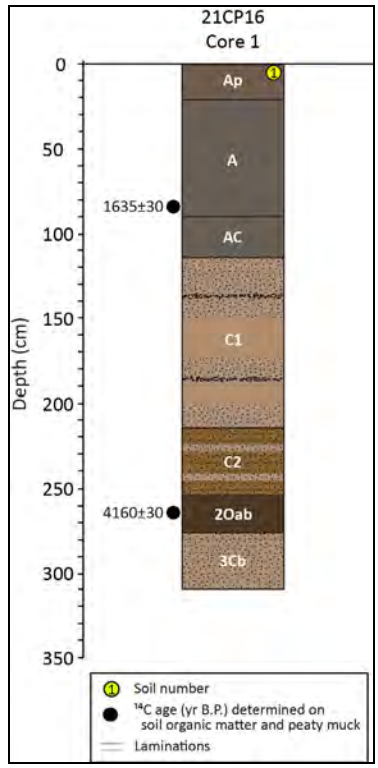


Figure 113. Diagram of Core 1, site 21CP16, depicting the stratigraphy, soil horizons, and radiocarbon ages.

Evidence gleaned from the cores suggests that there is moderate potential for buried Early to Late Woodland cultural deposits in the cumulic A horizon of the surface soil. Below a depth of 90 cm, however, the potential for cultural deposits is greatly diminished.

Also, a 1.95-m-long core was taken on the distal end of a large, low-angle alluvial fan in Minneopa State Park near Mankato. The fan developed on a broad strath terrace that is covered with many cobbles and boulders. A surface soil (Soil 1) with an A-AC-C profile occurs above an A horizon of a buried soil (Soil 2) at a depth of 1.68–1.95+ m (Table 29; Figure 114). Only the upper 27 cm of Soil 2 was penetrated; the core was refused at a depth of 1.95 m, perhaps by a cobble or boulder resting on the strath terrace. Organic matter from the upper 10 cm of the Ab Horizon of Soil 2 yielded an AMS radiocarbon age of 1695 ± 25 RCYBP (1595 cal. yr B.P.) (see Table 28, Figure 114, and Appendix A). Hence, Soil 2 was buried after ca. 1700 RCYBP (1600 cal. yr B.P.).

Based on the information gleaned from the core, there is high potential for cultural materials beneath the surface of the alluvial fan, and those materials are most likely to be associated with Soil 2. Unfortunately, the full thickness and age of Soil 2 is unknown. Nevertheless, given the minimum age of the Ab horizon (1700 RCYBP; 1600 cal. yr B.P.), Soil 2 has potential for containing Early Woodland and Late Archaic cultural deposits.

Sediment comprising the floodplain LsSA of the MRV aggraded during the late Holocene, and much of it accumulated over the past several hundred years (Bettis and Thompson 1986). Large volumes of sediment derived from upland erosion during the Historic period bypassed the alluvial fans and accumulated on the floodplain. Also, as a result of vertical accretion, floodplain alluvium was deposited on the VT1 surface in some reaches of the MRV (see Figure 112). With the exception of slightly elevated LfSAs, such as natural levees, floodplain ridges, and crevasse splays, the floodplain typically is poorly drained. As the climate became cooler and wetter during the late Holocene, wetlands developed and expanded on the floodplain. Based on its age and drainage conditions, most of the floodplain LsSA has low to no potential for containing buried cultural deposits. However, where the slightly elevated LfSAs occur, moderate potential exists.

Table 28. Radiocarbon Ages for Core 1, Site 21CP16 and Core 1, Minneopa State Park.

Locality	Material Dated	Sample Depth (m)	^{14}C Age (yr B.P.)[1]	Cal. Age (yr B.P.)[2]	Median Cal. Age (yr B.P.)	$\delta\ ^{13}C$	Laboratory No.
21CP16 Core 1	Peat	2.63–2.69	4160 ± 30	4828–4583	4710	-40.1	D-AMS014370
21CP16 Core 1	SOM[3]	0.80–0.88	1635 ± 30	1609–1416	1540	-40.0	D-AMS014369
Minneopa Core 1	SOM[3]	1.68–1.78	1695 ± 25	1617–1544	1595	-12.9	D-AMS014368

[1]All ages were determined by accelerator mass spectrometry (AMS).
[2]Calibration to calendar years (2 sigma) performed with CALIB 7.1 using calibration dataset intCal13 and Marine 13 (Reimer et al. 2013).
[3]SOM=Soil organic matter.

Table 29. Description of Core 1, Minneopa State Park.

Landform: Alluvial fan; distal end
Slope: 1–2 percent
Drainage: Well-drained
Land Cover: Native grasses
Remarks: The core barrel was refused at 195 cmbs. Soil organic matter from the upper 10 cm of the Ab horizon (168–178 cmbs) yielded a radiocarbon age of 1695 ± 25 RCYBP.

Depth (cmbs)	Soil Horizon	Description
0–42	A	Very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; weak fine granular structure; friable; many very fine and fine roots; gradual boundary.
42–63	AC	Dark grayish brown (10YR 4/2) loam and very fine sandy loam, very dark grayish brown (10YR 3/2) moist; very weak fine granular structure; friable; faint bedding; common worm casts and open worm burrows; many very fine and fine roots; gradual boundary.
63–145	C1	Laminated dark grayish brown (10YR 4/2), grayish brown (10YR 5/2), brown (10YR 5/3), and pale brown (10YR 6/3) silt loam, loam, very fine sandy loam, and loamy fine sand; massive; soft, very friable; very fine and fine roots; gradual boundary.
145–168	C2	Brown (10YR 5/3) very fine and fine sand, pale brown (10YR 6/3) moist; single grain; loose; abrupt boundary.
168–195	Ab	Very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; moderate fine and medium granular structure; friable; common worm casts; few very fine roots.

SUMMARY AND CONCLUSIONS

Previous geomorphological investigations have determined that the MRV was mostly shaped by events that occurred during the terminal Pleistocene and very early Holocene. Specifically, what is now the MRV served as the southern outlet of Lake Agassiz, a proglacial lake that formed during retreat of the Laurentide Ice Sheet. The southern spillway channel, Glacial River Warren, was active in two separate phases of high discharge: one at ca. 11,800–10,800 RCYBP (13,600–12,700 cal. yr B.P.) that was characterized by catastrophic flooding; and one at ca. 9600–9400 RCYBP (10,920–10,630 cal. yr B.P.) that involved lower-magnitude flooding compared to the first phase. The net effect of the two phases of flooding was formation of a valley up to 8 km wide and 80 m deep. Also, as River Warren incised its channel and migrated laterally, it formed strath terraces, especially in the upper reaches of the drainage. Sediment transported downstream by the floods accumulated on the valley floor and formed fill terraces in the lower MRV.

At a few localities in the lower MRV, silty sediment that appears to be loess occurs on remnants of strath terraces formed by catastrophic flooding. The loess postdates ca. 10,400 RCYBP (12,275 cal. yr B.P.), but its numerical age is unknown.

Incision of River Warren lowered the local base level and triggered channel incision in tributaries. Consequently, the tributaries produced large volumes of sediment that initially accumulated as alluvial fans on strath and fill terraces in the MRV. Throughout the Holocene, alluvial and co-alluvial fans and colluvial aprons developed along the entire length of the MRV. Aggradation of these LfSAs, which probably began soon after 10,800 RCYBP, was punctuated by periods of stability that account for buried soils in the sedimentary sequences of the fans and aprons. Two buried soil complexes occur in the alluvial fans: one dating to 2000–4500 RCYBP (1950–5170 cal. yr B.P.); and the other dating to 5400–8000 RCYBP (6240–8880 cal. yr B.P.).

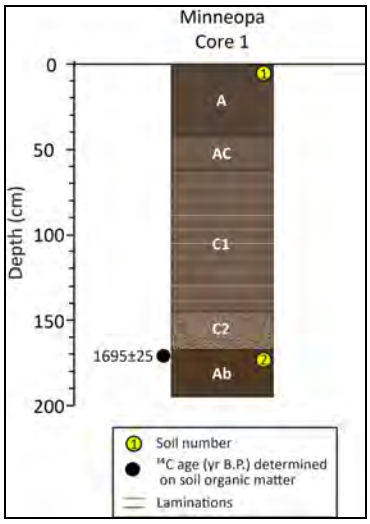


Figure 114. Diagram of Core 1, Minneopa State Park, depicting the stratigraphy, soil horizons, and radiocarbon age.

Soon after 10,800 RCYBP (12,700 cal. yr B.P.) and continuing into the early Holocene, fine-grained overbank deposits accumulated on top of coarse-grained catastrophic flood deposits underlying VT2, one of two valley terraces identified by Hudak and Hajic (2005). There are no intervening paleosols, and sedimentation appears to have been more or less continuous from waning flood deposits to overbank deposits. In some segments of the MRV, lacustrine and paludal deposits dating to the early, middle, and/or late Holocene accumulated on the surface of VT2. Alluvium beneath a younger and slightly lower valley terrace, VT1, is laterally inset against VT2 fill and sometimes interfingers with alluvial fan deposits that mantle VT2. Also, modern floodplain deposits are often draped over VT1 (see Figure 112). Radiocarbon ages indicate that aggradation of the VT1 fill was underway by at least ca. 7700 RCYBP (8485 cal. yr B.P.) and continued until ca. 1800 RCYBP (1730 cal. yr B.P.). As is the case with VT2, lacustrine and paludal deposits dating to the early, middle, and late Holocene may be associated with VT1. Valley fill beneath the modern floodplain accumulated during the very late Holocene, with most of the aggradation occurring during the Historic period.

The past 150 years have witnessed rejuvenation of the streams in the Minnesota River basin. Entrenchment, channel widening, and active channel migration have occurred because of increases in sediment and water discharge and flood peak height resulting from land clearing and cultivation. The initial response of streams to accelerated soil erosion caused by land use in the Upper Midwest has been extensive overbank sedimentation (Knox 2006). In the MRV, increased sedimentation during the Historic period has resulted in burial of low geomorphic surfaces, such as VT1 and the distal ends of alluvial fans, as well as the formation of Historic-age secondary alluvial fans like the one at site 21CR155.

Based on the history of late-Quaternary landscape evolution, most of the prehistoric archeological record of the MRV is likely to occur in a buried context. Geomorphic, chronostratigraphic, and soil stratigraphic data were used in this study to predict where buried cultural deposits associated with different cultural affiliations are likely to occur in the valley landscape, as summarized below and presented in Table 26, above.

Alluvial fans in the MRV have moderate to high potential for buried cultural resources, though the potential varies with fan size. Large fans typically are composed of terminal Pleistocene through late Holocene sedimentary deposits with multiple buried soils, and they are elevated, well-drained landforms. Initially, aggradation of the large fans was rapid and uninterrupted by soil development until soon before ca. 8000 RCYBP (8880 cal. yr B.P.). However, between ca. 8000 RCYBP (8880 cal. yr B.P.) and the Historic period, sedimentation on the fans was punctuated by soil development, thereby forming stratigraphic sequences with multiple buried soils. Hence, the large fans have moderate potential for containing Early and Middle Paleoindian cultural deposits, but high potential for containing buried Archaic and Woodland cultural deposits. Because these fans have been relatively stable for the past 500 years, they are not likely to contain buried Late Prehistoric cultural deposits. Small fans at the mouths of ephemeral streams, however, often consist mostly or entirely of Historic-age sedimentary deposits, and, therefore, have little or no potential for containing prehistoric cultural deposits.

Many of the colluvial aprons on footslopes and toeslopes in the MRV are coeval with the large alluvial fans, are moderately to well-drained, and contain buried soils. Also, like the large fans, the aprons rapidly aggraded during their

early stage of development, but experienced multiple episodes of landscape stability and concomitant soil development between ca. 8000 RCYBP (8880 cal. yr B.P.) and the Historic period. Hence, the colluvial aprons have moderate potential for containing Early and Middle Paleoindian cultural deposits, but high potential for containing buried Archaic and Woodland cultural deposits.

There also is potential for buried cultural resources in alluvial deposits beneath the two valley terraces, VT1 and VT2, but compared to the alluvial fans and colluvial aprons, the potential is not as high. Given its age, drainage conditions, and soil stratigraphy, the fine-grained component of VT1 has moderate potential for containing Early to Late Archaic cultural deposits. Considering the same factors, the fine-grained component of VT2 has low potential for containing buried Early Paleoindian cultural deposits, but moderate potential for containing buried Middle and Late Paleoindian cultural deposits. Also, lacustrine and paludal deposits associated with VT1 and VT2 have at least moderate potential for containing Archaic and Woodland cultural deposits. During protracted droughts and the warm, dry mid-Holocene Altithermal climatic episode, floodplain lakes and wetlands temporarily dried up and became suitable settings for human occupation. This conclusion is supported by the results of investigations at site 21CR155, where buried Early and Late Archaic cultural deposits were found in lacustrine deposits, and buried Late Woodland archeological materials were recorded in paludal deposits (Florin et al. 2013; Kolb 2013; Smith and Larson 2015).

The LfSAs comprising the modern floodplain of the Minnesota River have moderate to no potential for containing buried prehistoric cultural resources. The fine-grained floodplain deposits accumulated during the very late Holocene, and much of it postdates Euroamerican settlement in the region. Low areas of the floodplain are wetlands with no potential for buried archeological deposits. However, slightly elevated and better drained floodplain LfSAs, such as natural levees, crevasse splays and floodplain ridges, formed over the past 2,000 years and have moderate potential for containing Woodland and Late Prehistoric cultural deposits.

It is important to note that some of the processes that drove late-Quaternary landscape evolution in the MRV probably removed part of the archeological record. For example, the high-magnitude catastrophic floods that scoured the MRV between ca. 11,800 and 10,800 RCYBP (13,600–12,700 cal. yr B.P.) would have removed Early Paleoindian cultural deposits that may have been present in the valley landscape, especially along the paths of flood channels and where strath terraces formed. Because the strath terraces are erosion surfaces cut across bedrock or glacial drift, they lack alluvial fill and, therefore, have no potential for containing buried cultural deposits. However, archeological materials with Middle Paleoindian through Late Prehistoric affiliations may occur on the strath terraces. Also, lateral channel migration of the Minnesota River has resulted in significant erosion of the riverbank; hence, evidence for prehistoric occupations that may have focused along the channel would have been destroyed by erosion. Similarly, where the channel has shifted close to a valley wall, it is likely that alluvial fans and associated cultural deposits were removed.

In sum, the material remains of human occupation in the MRV have passed through a geologic filter to become the archeological record. Understanding the nature of the temporal and spatial patterns that this filter has imposed on the archeological record is the first task in identifying archeological patterns that reflect human choices versus the effects of geomorphic processes. Previous geoarcheological investigations have accomplished this task and have led to the development of a predictive model: the MN/Model. MN/Model is a powerful predictive tool, but it remains to be fully tested.

6. Synthesis and Recommendations

Research Objectives and Investigation Results

The objective of the current study, as defined on page 1 of the project RFP, is "…to help determine where prehistoric sites are located within the Minnesota River trench, to determine what statewide historic contexts are present, and to suggest productive directions for future archaeological research within the trench." Three primary tasks comprised the project:

1) Assess what is known about the prehistoric human occupation of the Minnesota River trench by reviewing the region's pertinent archeological, geological, geomorphological, paleoenvironmental, ethnographic, and historic literature. Data obtained from this review should allow for the generation of a predictive locational model for prehistoric sites in the study area. The model will assist in the identification of likely site locations for each of the major prehistoric cultural traditions in the valley.

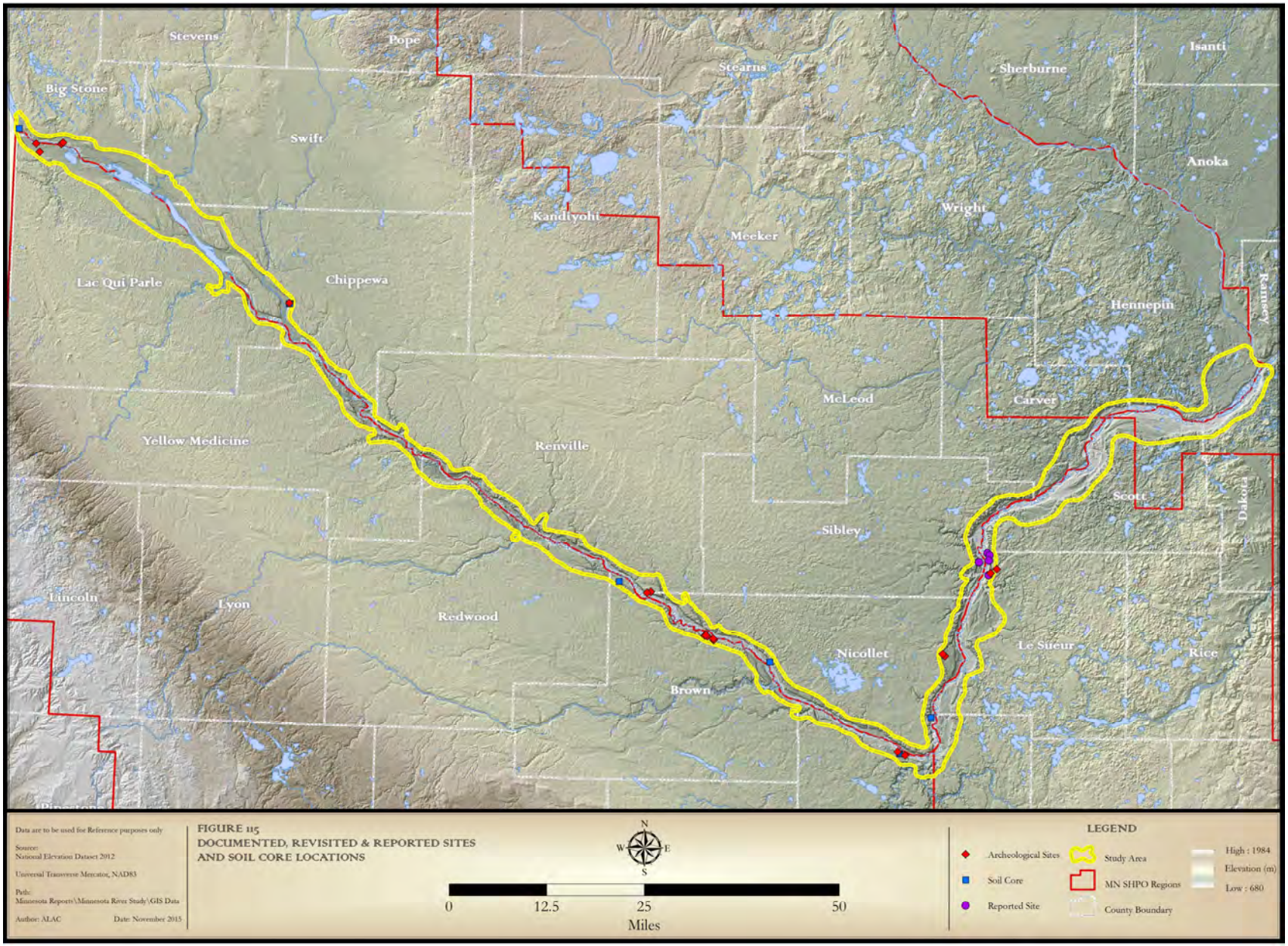
2) Conduct a joint archeological/geomorphological field survey of select localities identified in the research design that are felt to reflect a good sample of varying landform settings with high site potential. The archeological component will focus on pedestrian reconnaissance of fields with good surface visibility and high surface/near-surface site potential; the geomorphological component will be directed towards the mechanical deep-testing of landforms identified as having high buried site potential (alluvial fans, fill terraces, colluvial slopes, etc.).

3) Complete an analytical and descriptive report that summarizes the literature search, field survey, geomorphology, paleoecology, and absolute dating results. The report should address the reconstruction of the study area's late Pleistocene and Holocene environmental history, summarize the prehistoric archeological contexts present or likely to be present there, construct a justifiable site locational model for such sites, and suggest productive avenues for future research.

As a secondary objective, the RFP called for evaluative test excavations to be undertaken at site 21LP11 in the study area. Results of this evaluation were to be presented as part of the larger analytical and descriptive report defined in Task 3, above.

In addressing Task 1, site records and reports were reviewed at the OSA and SHPO, and meetings were held with MHS, OSA, and MNDOT staff concerning various aspects of the project. Archived records from the U-of-M and IMA were also consulted, as were resources available at the CWS, Augustana University and Minnesota State University, Moorhead. In addition to reviewing the literature for site distribution and settlement patterns, previously constructed site locational models, such as Minnesota's MN/Model (Hudak et al. 2002), were utilized. Augustana personnel also visited the Brown County Historical Society Museum in New Ulm, the Chippewa County Historical Society Museum in Montevideo, and the Joseph R. Brown Minnesota River Center in Henderson. Relevant collections housed in these facilities were examined. Private artifact collections from Brown, Chippewa, Le Sueur, Nicollet, and Renville counties were minimally documented and limited interviews were conducted with the collection owners and with other local residents knowledgeable about the history and prehistory of the study area. Five newly identified archeological sites and five additional reported artifact localities were documented as a direct result of these consultations.

With regard to Task 2, complementary archeological and geomorphological field investigations were conducted throughout the study area. The priority of the archeological field investigations was to maximize site discovery. Because of this, and because the parameters governing the archeological survey component largely limited it to a pedestrian surface reconnaissance, cultivated fields located above the present floodplain were the focal point. Thirty individual parcels, comprising 1,446.24 acres, were surveyed. Seven previously unrecorded sites were identified and documented. In addition, 10 previously recorded sites were revisited during the course of the study and five reported site areas were mapped (Figure 115).


Stevens
Pope
Stearns
Sherburne
Isanti
Big Stone
Swift
Anoka
Kandiyohi
Wright
Meeker
Lac Qui Parle
Chippewa
Hennepin
Ramsey
McLeod
Carver
Yellow Medicine
Renville
Scott
Dakota
Sibley
Lincoln
Lyon
Redwood
Nicollet
Le Sueur
Rice
Brown
Data are to be used for Reference purposes only
Source:
National Elevation Dataset 2012
Universal Transverse Mercator, NAD83
Path:
Minnesota Reports\Minnesota River Study\GIS Data
Author: ALAC
Date: November 2015
FIGURE 115
DOCUMENTED, REVISITED & REPORTED SITES
AND SOIL CORE LOCATIONS
N
W
E
S
0
12.5
25
50
Miles
LEGEND
Archeological Sites
Soil Core
Reported Site
Study Area
MN SHPO Regions
County Boundary
High : 1984
Elevation (m)
Low : 680

The geomorphological field component involved reconnaissance of the project area and limited subsurface exploration. An effort was made to locate natural exposures of late Pleistocene and Holocene alluvium in stream cutbanks; however, the lack of adequate exposures along the river necessitated the sampling of landforms with a Giddings hydraulic soil probe. Eight soil cores were ultimately extracted from six localities during the geomorphological component (see Figure 115, above). Bulk soil samples were collected from paleosols at different localities for radiocarbon assay (see Appendix A). Samples were also obtained for stable carbon isotope and phytolith analyses. Findings from the stable carbon isotope and phytolith studies are currently in preparation. Additionally, the walls of two test units at 21LP11 were described and sampled by the project geomorphologist. Samples from two of the profiles were analyzed for grain-size distribution and organic matter content.

As part of Task 3, a synthesis of previous geomorphological and geoarcheological investigations was completed (see Chapter 5). This represents the first compilation of such information and provides the basis for assessing how geomorphic processes, especially erosion and deposition, have affected the spatial and temporal pattern and detection of archeological sites in the Valley. Also, by combining information gleaned from the MN/Model and other sources, a simplified model of late-Quaternary landscape evolution is provided. The model can serve as a guide to address such issues as where archeological deposits with specific cultural affiliations are likely to be preserved, where they were likely to be removed by erosion, where they are likely to be buried and undetectable using surface-oriented survey techniques, and how patterns in the sedimentary record might affect patterns in the archeological records.

The following discussion summarizes the results of the investigation and provides a narrative site locational predictive model as well as recommendations for future research in the Minnesota River trench.

Site 21LP11 Evaluative Testing

As a subcomponent of Task 2, limited test excavations were conducted at site 21LP11. Efforts culminated in the excavation of 11 shovel tests (STs 1–11), one 1-m-x-1-m unit (XU1), one 1-m-x-2-m block (XU2), one 2-m-x-2-m block (XU3), and one 1-m-x-50-cm expansion unit (XU3-SE-A). STs 1, 9, and 11 were sterile. All other test excavations yielded prehistoric lithics.

A total of 251 lithic artifacts have been recovered from 21LP11 to-date. The majority of this material, nearly 85 percent (212 items), was recovered from the uncultivated area along the western edge of the site. By provenience, 7 items were surface-collected in 1973, 2 were recovered from the 1973 test units, shovel tests yielded 95 artifacts, XU1 yielded 86 items, XU2 yielded 8, and 53 specimens were recovered from XU3. All of the artifacts recovered from the previously cultivated portion of the site (n=39) derived from the surface or the plowzone. By contrast, over 82 percent (n=174) of specimens recovered from the uncultivated portion of the site were discovered within a zone between 40 and 60 cmbs.

The 21LP11 lithic assemblage is dominated by Swan River chert (n=197). Other material types present within the assemblage include quartz (n=14), Prairie du Chien chert (n=12), unclassified cherts (n=12), unclassified chalcedonies (n=6), quartzite (n=1), jasper (n=2), gabbro (n=1), Burlington chert (n=3), and Tongue River silica (n=3). These data suggest that occupants of site 21LP11 relied, almost exclusively, on local lithic raw materials for tool manufacture (see Bakken 2011:79–80).

Over 94 percent (236 items) of the complete 21LP11 artifact assemblage (n=251 items) is debitage (either flakes or shatter). Shatter comprises 19.5 percent (n=46) of the debitage; the remaining 80.5 percent (n=190) consists of reduction flakes. The flake assemblage consists of 8 primary flakes, 38 secondary flakes, 142 tertiary flakes, and 2 microflakes; 6 of the flakes were identified as overshot specimens. The artifacts comprising the remaining ca. 6 percent of the site assemblage are reduction cores (n=6) and tools (n=9). Tools consist of 1 tertiary flake with unifacial retouch, 2 projectile points (one complete, triangular unnotched arrow point and one lanceolate, fluted spear point base), 1 spokeshave, 3 scrapers, and 2 biface fragments. The tools are nondiagnostic except for the arrow and spear points, which are indicative of Late Prehistoric and early Paleoindian (possible) Clovis cultural/techno-complexes, respectively. All of the formal tools identified at site 21LP11, with the exception of the arrow point, were recovered from the previously cultivated portion of the site during the 1973 investigations (Caine 1974). The arrow point was recovered from XU3-SE-A at a depth of 20 cmbs. Nearly 35 percent of the site lithics (n=87) exhibit evidence of thermal alteration. Thermally altered specimens were recovered from all areas of the site and from depths ranging between the surface and 60 cmbs.

No intact, datable settlement features were discovered at the site and only two of the recovered artifact specimens (the projectile points) are considered temporally/culturally diagnostic. However, the six overshot flakes recovered from 40–60 cmbs may provide additional insight. Isolated overshot flakes have been discovered among site assemblages at various times throughout prehistory. The occurrence of these artifacts among non-Clovis-aged assemblages is relatively rare. However, at several different Clovis sites, overshot flakes have repeatedly been documented in clusters, and multiple analyses of Clovis bifacial reduction strategy have concluded that the removal of overshot flakes during the thinning stages of biface manufacture was both intentional and a hallmark of the cultural tradition (cf. Jennings 2013; Stanford and Bradley 2012:12; Waters et al. 2011:103–112; Waters and Jennings 2015:32–33).

The weakly developed soils in the westernmost portion of the site are perplexing. It is possible that they represent fairly recent deposits (1,000–2,000 years old); however, they may also represent a biomantle, forming as a result of extensive pedoturbation brought about by earthworms and other burrowing animals. Resolution of site formation processes at 21LP11 will require a better understanding of the age of the sedimentary deposits and associated cultural materials. This will require the recovery of in situ charcoal and culturally diagnostic artifacts. Alternatively, in the absence of diagnostics and intact datable features, optically stimulated luminescence (OSL) dating may represent a possible means of acquiring some degree of chronological control. OSL dating could be used to determine the basal age of loamy deposits on the footslope and toeslope on the east side of the granite outcrop; however, dating samples recovered at shallow depths (< 1 m) can be problematic with this method.

The landscape position of site 21LP11 offers good shelter and viewsheds, as well as access to ample water, game, and lithic resources; however, no datable settlement features have been discovered, and additional diagnostic materials capable of clarifying site function or cultural affiliation remain to be identified. The portion of the site located within the previously cultivated field is confined to the heavily disturbed plowzone. However, the westernmost margin of the site was not previously cultivated and disturbance in this area, primarily root-action from a dense sumac grove, is largely confined to the upper 20 cmbs. The majority of artifacts from this portion of the site are associated with an intact zone between 40 and 60 cmbs. As noted above, among the artifacts recovered from this 40–60 cmbs zone are six overshot flakes, which have oftentimes been discovered in significant numbers among documented Clovis assemblages (see for example Jennings 2013; Stanford and Bradley 2012:12; Waters et al. 2011:103–112; Waters and Jennings 2015:32–33).

To date, no buried, intact Clovis-period sites have been documented in Minnesota. If the buried component at 21LP11 can be unequivocally tied to Clovis, an unprecedented opportunity to study one of Minnesota's earliest human groups would be realized. And in this case, the implications would reach beyond the study of the region's early occupants. Confirmation of such a habitation area in its present geographic position could also answer pressing questions related to both the timing and character of Glacial River Warren and the flow of water from Agassiz's southernmost outlet. Because of these unique circumstances and the research potential inherent in the site, the investigators recommend that further archeological investigations within the undisturbed portion of 21LP11 are warranted.

Survey Parcels and Distribution of Investigated Sites

The current pedestrian survey investigated 30 individual parcels totaling 1,446.24 acres (see Chapter 4, Figures 18–35, above). Parcel distribution incorporates portions of 10 counties: Big Stone; Brown; Carver; Chippewa; Lac Qui Parle; Le Sueur; Nicollet; Renville; Scott; and Sibley. Additionally, sites were revisited and a core was extracted from Minneopa State Park in Blue Earth County; however, a formal survey parcel was not assigned to this area due to poor ground surface visibility. All of the investigated parcels are located in the Prairie Lake Archaeological Region. Of these, 571.67 acres (39.53 percent) are in Archaeological Subregion 2n (Parcels 4–5, 8, 12–13, 16–20, 23–24, and 27–28); 270.57 acres (18.70 percent) are in Subregion 2s (Parcels 1–3, 6–7, and 9–11); and 604.00 acres (41.77 percent) fall within Subregion 2e (Parcels 14–15, 21–22, 25–26, and 29–30). Soil cores were extracted from Parcels 1, 5, 7, 12, and 13 (see Mandel, this report). Archeological sites were documented or revisited in Parcels 2, 4–6, 8–11, 16, 19, and 26; a site reported in Parcel 28 was not verified despite a pedestrian survey of the area.

Surveyed parcels span nine different mapped LfSAs and range topographically from high upland bluffs overlooking the trench to low floodplains along the valley floor (Figure 116; see Chapter 4, Table 10, above). Terraces were the most thoroughly investigated of the LfSAs, comprising 21.71 percent of the total survey acreage. Fans (19.21 percent), bars (19.11 percent), and bluffs (17.44 percent) represent the next most frequently investigated landforms, followed by marginal

channels (7.66 percent), floodplains (7.51 percent), and erosional residuals (5.97 percent). Colluvial slopes (1.26 percent) and meander belts (0.13 percent) comprise the lowest acreage totals, representing 18.29 and 1.87 acres, respectively.

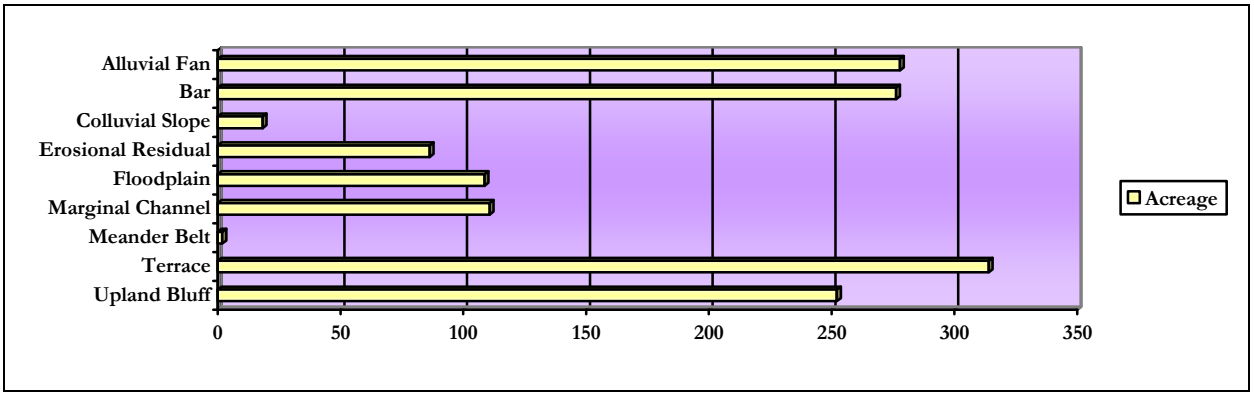


Figure 116. Graphic illustration of mapped LfSAs investigated (X-axis) by total acreage (Y-axis).

Twenty-two archeological sites were investigated by Augustana during the current study, including seven newly recorded properties, 10 revisited sites, and five localities reported by an informant. These areas are associated with six of the nine LfSAs listed in Figure 116, above. A numerical breakdown of the 22 investigated site areas by mapped LfSA is provided in Table 30. The majority of the 22 investigated site areas (n=15, or 68 percent) are affiliated with upland and fan landforms; this is not altogether surprising considering that these two LfSAs comprise nearly 37 percent of the total surveyed acreage. Sites were not identified in association with colluvial slope, marginal channel, or meander belt LfSAs during the current investigation. This is also not particularly revealing as these landforms represent just over 9 percent of the total area investigated during the study. Relative to the entire Minnesota Valley study area, this small sample size—both in terms of identified sites and surveyed acreage—renders an analysis of site distribution by landform statistically insignificant. Identification of meaningful patterns in landform site distribution will require a more robust dataset (see below).

Table 30. Investigated Sites by Landform.

Mapped LfSA	Site Count (Percent)
Alluvial Fan	6 (27.0)
Bar	1 (4.5)
Erosional Residual	2 (9.0)
Floodplain	1 (4.5)
Terrace	3 (14.0)
Upland	9 (41.0)
Total	**22 (100.0)**

In evaluating the distribution of investigated sites relative to modeled site location potential, site centroids were superimposed over a MN/Model GIS layer generated for the Minnesota River valley study area. Results indicate that the majority of investigated sites (over 77 percent) are located in areas of *high* modeled site potential. The remaining sites are associated with areas of *moderate* (n=2), *low* (n=1), and *unknown* (n=2) modeled site potential, respectively. Table 31 illustrates these data. Results fall within the accepted range of MN/Model's projected performance (Hudak et al. 2002); but, again, the sample size is too low to be statistically significant.

Table 31. Investigated Sites by Modeled Site Location Potential.

Modeled Site Potential from MN/Model	Site Count (Percent)
High	17 (77.3)
Medium	2 (9.1)
Low	1 (4.5)
Unknown	2 (9.1)
Total	**22 (100.0)**

Due to limitations inherent in analyzing small sample sizes, it was decided that the above-listed topics should be addressed using site location, LfSA, and site potential data from the entirety of the study area rather than the current investigation alone. To accomplish this, prehistoric site centroids from the whole of the Minnesota Valley were evaluated relative to a MN/Model generated for the study area (Figure 117; Table 32). Subsequently, data concerning the distribution of prehistoric cultural components by primary mapped landform setting, previously compiled by Anfinson, were reevaluated (see Chapter 2, Tables 2–8 and Figures 4 and 5). These data were compared with LfSA information from MN/Model and data derived from geomorphological investigations conducted as part of the current study to gain a clearer understanding of both surface and buried site potential for a given landform setting.

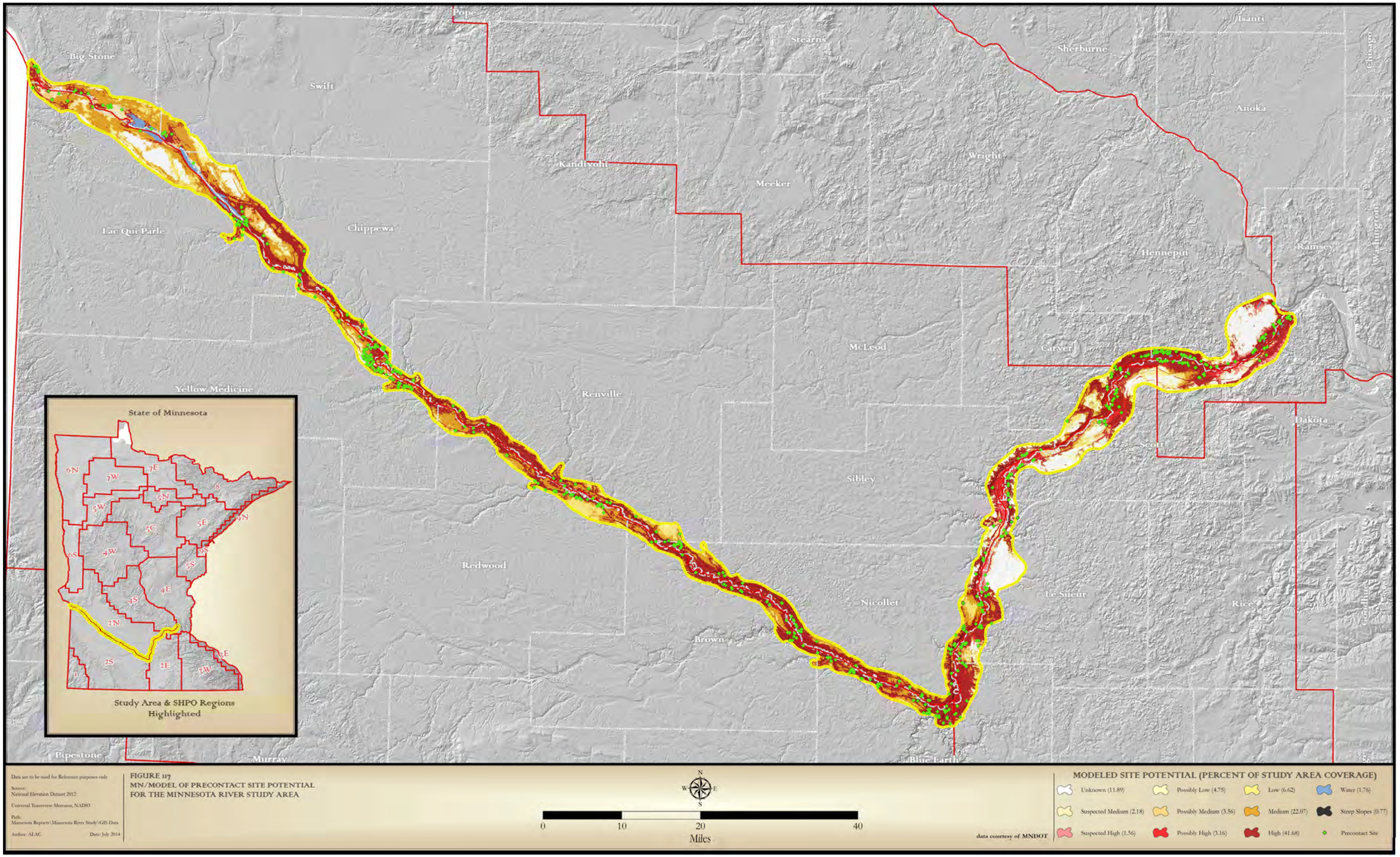

Pope
Stearns
Sherburne
Isanti
Chisago
Big Stone
Swift
Anoka
Kandiyohi
Wright
Meeker
Lac Qui Parle
Chippewa
Hennepin
Ramsey
Washington
McLeod
Carver
Yellow Medicine
Renville
Dakota
Scott
Sibley
Redwood
Nicollet
Le Sueur
Rice
Brown
Pipestone
Murray
Blue Earth
State of Minnesota
6N
7W
7E
8
5W
5N
5E
9N
5C
6S
4W
9S
5S
4E
4S
2N
3E
2S
2E
7W
Study Area & SHPO Regions Highlighted
Data are to be used for Reference purposes only
Source:
National Elevation Dataset 2012
Universal Transverse Mercator, NAD83
Path:
Minnesota Reports\Minnesota River Study\GIS Data
Author: ALAC
Date: July 2014
FIGURE 117
MN/MODEL OF PRECONTACT SITE POTENTIAL
FOR THE MINNESOTA RIVER STUDY AREA
N
W
E
S
0
10
20
40
Miles
data courtesy of MNDOT
MODELED SITE POTENTIAL (PERCENT OF STUDY AREA COVERAGE)
Unknown (11.89)
Possibly Low (4.75)
Low (6.62)
Water (1.76)
Suspected Medium (2.18)
Possibly Medium (3.56)
Medium (22.07)
Steep Slopes (0.77)
Suspected High (1.56)
Possibly High (3.16)
High (41.68)
Precontact Site

Table 32. MN/Model Data Relative to Previously Recorded Precontact Sites in the Study Area.

Probability Code/ Map Label	Land Surface Area (acres)	Percent of Total Study Area	Site Count Distribution by Map Label (percent)*
Unknown	64,533.25	11.89	4 (0.76)
Low	35,930.20	6.62	5 (0.95)
Possibly Low	25,780.73	4.75	1 (0.19)
Medium	119,785.43	22.07	63 (11.91)
Possibly Medium	19,321.98	3.56	12 (2.27)
Suspected Medium	11,832.00	2.18	10 (1.89)
High	226,219.15	41.68	413 (78.06)
Possibly High	17,150.97	3.16	6 (1.13)
Suspected High	8,466.94	1.56	3 (0.57)
Water	9,552.44	1.76	1 (0.19)
Steep Slopes	4,179.19	0.77	11 (2.08)
Totals	**542,752.28**	**100.00**	**529 (100.00)**

*** Although the boundaries of some sites overlap more than one mapped probability label, the counts reported here are based on site center-points, or centroids; only a single probability value was assigned for each site. Site count based on MNDOT records as of the fall of 2014. Sites newly recorded during this study are not included as MN/Model excludes all single artifact sites from its modelling process.**

In initially examining Figure 117, one is struck by the substantial amount of red-shaded—or *high* site potential—land surface area within the trench. This makes sense given the previously noted close correlation between potable water and site locations; however, it does not appear, on the surface, to be particularly revealing with respect to site prediction for a given set of landforms in the valley and is generally contradictory for site prediction models (see Hobbs et al. 2002). It was, therefore, decided that a formal assessment of the model should be undertaken. Such an assessment revolves around the calculation of the *gain statistic*. Hobbs et al. (2002) succinctly describe the use of the gain statistic in assessing MN/Model's ability to accurately predict site locations for a given study area beyond the level of random chance:

> A perfect model would include very little area in high and medium site potential classes, but would accurately predict 100 percent of sites. The gain statistic for that model would be very close to one. In a poor model, that provided no improvement over chance alone, the percent area classified as high and medium site potential would equal or even exceed the percentage of sites predicted. The gain statistic for such a model would be very close to zero.
>
> Gain is calculated as
>
> 1 – (percent area/percent sites)
>
> where percent area is the percentage of the region in the high or high and medium site potential areas and percent sites is the percentage of known sites of the type modeled actually found in the same area [Hobbs et al. 2002].

Based on this information and the data presented in Table 32,[1] above, the gain statistic for the current study area can be calculated by the following equation:

$$1 - (74.21/95.83) = 0.23.$$

The low gain value for MN/Model in the current study area implies a very limited degree of utility. Other avenues must be explored in order to more accurately identify trends in site distribution and predicted settlement locations for the different landforms in the valley. This is particularly true if one hopes to identify settlement patterns among specific defined cultural traditions. This led to the reevaluation of Anfinson's prehistoric site distribution by landform setting data in conjunction with MN/Model's Landscape Suitability Rankings (LSRs) for each landform and recently extracted soil cores, which address both surface and buried site potential. MN/Model defines LSR as: "A ranking used

[1] In this instance, fields from Table 32 with the *High*, *Possibly High*, and *Suspected High* descriptors were combined to obtain a single percentage of high probability areas and corresponding sites. The same was done with fields containing the *Medium* and *Low* descriptors.

to evaluate the potentials for the land surface and subsurface intervals to have and preserve in situ cultural deposits based upon stratigraphic ages and either postdepositional or depositional environments. This ranking does not predict archaeological site locations, it predicts landscapes and paleolandscapes that could contain or not contain in situ sites" (Hudak et al. 2002). It employs a simple probability scale that ranges from 0 to 3, where 0 equals *Unsuitable*, 1 equals *Low*, 2 equals *Moderate*, and 3 equals *High*. In examining Anfinson's data (Chapter 2, Tables 2–8 and Figures 4 and 5) independent of mapped site potential by LSR, Michlovic (Chapter 2, pp. 21–22) offered the following initial observations:

1) For the earliest sites in the database, Paleoindian and Archaic, there are no components listed in the floodplain of the river. Sites from the later periods on the other hand, are represented in floodplain deposits. Any of several factors may be responsible for this. Perhaps water levels in the river were too high to accommodate any occupations from this early time period. Or, maybe early sites were eroded by the river. Also possible is that early sites were deeply buried by later alluvium and do not appear in near surface contexts.

2) Almost 90 percent of single finds are on elevated landforms, including bluffs and terraces. None are on the floodplain. Earthworks are likewise found on elevations with only a single instance of an earthwork on the floodplain and none represented on islands. If single finds reflect travel routes or incidental passage, the pattern of abundance suggests that this off-site debris was commonly deposited by pedestrian travel that may have been preferable outside the valley bottoms. High ground might also have been preferable since the terrace positions may have been more heavily populated, while the floodplain was either heavily wooded or more likely to feature settlements that might curtail overland travel.

3) Artifact scatters, that is, sites with both lithic and ceramic remains were located on all topographic positions. Since sites with ceramics are also sites from the periods post-dating the Archaic, this finding dovetails with the conclusion reached in Observation 1, above.

4) Roughly 10–20 percent of the sites from all cultural periods are represented on fan deposits. It is unlikely that alluvial fans comprised a comparable fraction of the area within the Minnesota Valley, so it may be surmised that alluvial fans were favored localities for situating settlements in the prehistoric period.

5) The favored locations for sites of all types and cultural periods seem to be blufftops and low terraces. Even though about 57 percent of the components are Woodland, Table 8 seems to suggest that these landscape positions were preferred areas throughout the prehistoric period and for several different types of sites. Do note, however, that the high incidence of sites on blufftops is skewed by the very high number of earthworks rather than habitations. The lithic scatters common on blufftops may be primarily from earlier or preceramic periods. The single finds situated mostly on blufftops, mentioned in item 2 above, may have been preceramic items representing off-site debris from these early periods, or perhaps indicators of upland travel during the ceramic period, when a higher number of sites are located on lower elevations.

6) Earthworks are not found on the floodplain or islands but almost entirely on blufftops and terraces. Mounds were placed in locations where they could be seen. This is one of the most obvious of all the implications of the data presented in the tables.

7) The Minnesota River region is probably best known in archeology as the geographic center of the Cambria culture. Cambria is here classified as part of the Plains Village tradition, which in the database also includes Great Oasis and Big Stone phase sites. However, if we examine the tables we find that Plains Village sites are actually relatively rare, and furthermore that only a portion of those classified in this category actually comprise Cambria sites. Most Cambria is found at a few sites near Mankato. Plains Village sites clustered around Big Stone Lake are listed in the tables as Big Stone phase, but Saienga and Harbo Hill may be Cambria (Anfinson 1997:103; see also Holley and Michlovic 2013:83ff) [Michlovic, Chapter 2, pp. 21–22].

In Tables 7 and 8, Michlovic (Chapter 2, pages 19–20) presents Anfinson's compiled data on site type and cultural component distribution by six primary landforms in the study area. The six tabulated landforms are: *alluvial fan*; *blufftop*; *floodplain*; *high terrace*; *island*; and *low terrace*. The mapped LSR for each of these landforms was examined in MN/Model for potential trends in surface and buried site potential (Table 33) and this was then compared to the initial findings. The LSRs for the *Blufftop* landform are based on MN/Model's *Undifferentiated Uplands* category as no Blufftop category exists in the MN/Model. As a result, the LSR for upland surface sites in Table 33 is likely lower than it would be if it was calculated only for upland sites in bluff settings. Additionally, MN/Model does not segregate terrace landforms in the study area by elevation (*high* or *low*); rather, it differentiates them as either strath (erosional) or fill. Therefore, the LSRs for terrace landforms in Table 33 are not necessarily analogous to those presented in Anfinson's data.

Table 33. Landscape Suitability Ranking by Primary Landform, Minnesota River Valley.

Primary Landform	Landscape Suitability Ranking (LSR) Surface	0–1 mbs	1–2 mbs	2–5 mbs
Alluvial Fan	Low	High	High	High
Blufftop (Uplands)	Low	Unsuitable	Unsuitable	Unsuitable
Floodplain	Unsuitable to Low	Unsuitable to Moderate	Unsuitable to Moderate	Unsuitable to Moderate
Strath Terrace*	Low	Unsuitable to Moderate	Unsuitable	Unsuitable
Island	Low	Moderate	Moderate	Low
Terrace*	Unsuitable to Low	Unsuitable to High†	Unsuitable to High†	Unsuitable to Moderate

*** Anfinson's data includes *High* Terrace and *Low* Terrace designations; however, MN/Model classifies terraces as either *Strath* Terraces or *Terraces* (*Fill* Terraces), so no direct correlation can be drawn between these landforms.**
† LSRs for the majority of these terraces are classified as *Low* to *Moderate*.

A brief examination of the table reveals that, regardless of landform, prehistoric sites are relatively unlikely to manifest surficially in the study area. This is somewhat surprising with respect to strath terrace and blufftop settings, as these likely represent the oldest surfaces with the least chance for deep soil development of the above-listed landforms. However, as was previously noted, a specific *Blufftop* category did not exist in the model and the probability was assigned, instead, to an *Undifferentiated Upland* setting. This setting presumably encompasses upland environments well-removed from permanent water sources, which would account for the lower modeled probability for surface sites. Buried sites are modeled to be highly probable in all alluvial fan settings between 0 and 5 mbs. However, all upland settings and almost all strath terraces are modeled completely unsuitable for harboring buried archeology. It bears mention that, while this is almost always the case, several studies have documented buried archeological deposits in supposedly stable upland settings as a result of earthworm activity (see for example Atkinson 1957; Balek 2002; Darwin 1881; Johnson 1990, 1992; Johnson and Watson-Stegner 1990; Rolfsen 1980; Van Nest 2002; Wood and Johnson 1978). Rolfsen (1980), for example, demonstrated that earthworms bury items to a depth of 45 cmbs in about five years. Hence, worm castings, combined with soil brought to the surface by ants, burrowing mammals and uprooted trees, may form a biomantle that could quickly conceal artifacts and cultural features on "stable" upland surfaces (Johnson 1990, 1992; Van Nest 2002). The potential for buried archeology in upland settings must not be wholly discounted. Islands are predictably modeled to have low probability for deeply buried sites; however, models suggest that they possess moderate potential for buried sites up to 2 mbs. Floodplains and fill terraces exhibit the greatest degree of variability in modeled potential for buried sites, though neither is modeled to possess high potential for deeply buried deposits.

NARRATIVE SITE PREDICTIVE MODEL

In the United States, the use of archeological predictive modeling began occurring with some frequency during the 1970s and its application became increasingly widespread throughout the 1980s and 1990s (Judge and Sebastian 1988; Kvamme 1995:3; Wheatley and Gillings 2002:165; Whitley 2003:1). The subsequent introduction of GIS allowed a greater degree of flexibility and utility in applying these models across much larger areas (Dalla Bona 1994). In theory, well-constructed models can be effective planning tools for managing cultural resources and understanding prehistoric land utilization (Kvamme 1990:289). Land use could potentially encompass topics such as settlement practices, travel and trade routes, hunting and foraging areas, and locales for lithic and other resource procurement. General backgrounds on predictive modeling in archeology can be found in the above-listed sources, as can discussions concerning the merits and shortcomings of such constructs (cf. Wheatley and Gillings 2002:165; Whitley 2003:2). While it is not the intention to debate the merits and shortcomings of predictive models here, it should nevertheless be understood that these models do not provide definitive answers in terms of where sites will and will not be located, nor are they 'magical' dowsing instruments; they should not be utilized as such.

Previous archeological work in the Minnesota Valley has clarified where we might expect to find prehistoric sites. The results of predictive surveys dating back to the early 1980s, and culminating in 2002 with the publication of the MN/Model, give broadly similar results. Sites are found near water sources. Lake perimeters, river and stream embouchures at lakes, and stream confluences are all high in site potential. Elevated positions overlooking permanent water are high site potential areas as well, whereas uplands distant from water are low in site potential. Two exceptions are mounds, which tend to be on elevated positions, often overlooking waterbodies, and single artifact finds, which appear to be the most common archeological deposit removed from a water source.

The cultural historical periods represented in previously discovered archeological sites in the Minnesota Valley present an interesting pattern; in some ways predictable, in others anomalous. Late Prehistoric sites (including Plains Village and Oneota manifestations) are fairly uncommon; however, they seem clearly to mimic the distribution and characteristics of sites from the early Historic period. Sites from the preceding period, usually called the Late Woodland, are the most common pre-village ceramic-bearing sites in the Valley. The earlier portion of the Woodland is not well-represented. Curiously, documented Archaic-period sites are as common as identified Plains Village and Oneota sites combined in the Valley. Least well-represented are Paleoindian sites, currently known only by the presence of isolated artifact finds or poorly documented sites. In other words, the sites furthest back in time are the least available for study. This is unsurprising, but it does raise the question of whether there are fewer early sites because there were fewer and smaller populations, or whether the geomorphic processes operating in the Valley either buried earlier sites, or voided them altogether through erosional processes. The possibility of buried early sites must be seriously entertained.

From the outset, it was felt that modelling site locations necessitated the consideration of a combination of land use patterns among prehistoric peoples and cultural/geological filtering mechanisms within the Trench. In other words, we want to be able to predict not only which landform settings in the valley were likely to be utilized prehistorically for specific activities, but also the likelihood of a given landform to retain evidence of these activities archeologically. Based on a given site's function, we can expect to recognize certain trends associated with the selection of its location, the frequency with which it was occupied, the number of similar sites present on the landscape, and the way in which it manifests archeologically. It was ultimately hoped that we would be capable of identifying patterns between specific site types and landform settings, as well as which site types had the greatest potential to be discovered in relatively undisturbed contexts.

Defined Site Types

In modelling prehistoric site distribution in Red Lake County, Buhta et al. (2012:167–168) defined four primary functional site-types that could reasonably be expected to be identified among prehistoric archeological assemblages in the county: *habitation*; *resource procurement*; *mortuary*; and *unclassified*. Because these site-types are expected to be compatible with the prehistoric occupation of the Minnesota River trench, they are discussed below.

- **Habitation** sites include semi-permanent and permanent living areas such as villages or basecamps, single-use camps, and temporary seasonal or satellite camps. Basecamps are large sites located in areas with both abundant and predictable resources such as the confluences of major waterways and their tributaries. These areas likely provided access to known herd migration corridors and/or high elevation observation localities. The different types of camps were occupied for different durations; larger basecamps were occupied repeatedly for extended periods while smaller, satellite camps were only utilized seasonally or even less frequently. The smaller camps would be found in similar settings to those described for the basecamps or in close proximity to a predictable potable water supply. These sites may be discovered in buried contexts throughout the valley. In the absence of intact settlement features, these site-types are most likely to manifest in the archeological record as artifact scatters and, to a lesser extent, lithic scatters. In rare instances, earthworks in the form of ditch and embankment fortifications may also be associated with such sites.

- **Resource Procurement** sites include lithic quarries or procurement localities, as well as kill/processing areas and other foraging sites where resource gathering activities occurred. Quarries/lithic procurement sites are utilized for the very specific function of obtaining workable lithics for tool manufacture. These sites provide a reliable resource and would likely be revisited fairly regularly, albeit for very brief periods. In the study area, most knappable lithic sources are likely to be located near the margins of the valley and/or up tributaries

where outcrops have been exposed. However, strath terraces and flood bar landforms likely harbored quality lithic resources and upland till cobbles were presumably also frequently utilized sources. Kill/processing areas are, for the most part, medium- to large-sized sites representative of a single hunting event. However, certain sites that include herding and trapping components like drivelines, arroyo traps, and jumps, may have been utilized multiple times. These sites can represent the taking, butchering, and/or caching of one or more animals and will typically be found in a variety of settings across the landscape. Some of these settings common to the study area include the heads of steep-sided tributaries adjacent to major waterways, the base of cliffs or gullies, the edge of marshes or watering holes, and shallow river crossings. Such sites are almost always identified in buried contexts and, as such, very few are likely to be detected except through deep testing in geographic areas of high probability or by chance (e.g., an erosional event exposing a bonebed in a cutbank). Resource procurement sites are most likely to be detectable in the archeological record as lithic scatters (sometimes extensive) associated with nearby source outcrops or artifact scatters comprised largely of human-modified faunal remains, such as a bonebed. Foraging sites are even more difficult to identify archeologically than kill/processing sites simply because the footprint of human activity is negligible insofar as it relates to the surviving archeological record. Although foraging was presumably a frequent practice prehistorically, and one that likely occurred in relatively close proximity to habitation sites, no foraging sites are likely to be positively identifiable in the archeological record.

- **Mortuary** sites serve a very specific function, both ceremonially and practically. Sites of this type have been reported and documented in the study area and it is likely that other such properties remain unrecorded within the valley. Most of these sites are probably affiliated with the Woodland tradition and will be identified as earthen burial mounds or the remnants of such features. They are most likely to be located in areas of greater topographic relief, such as prominent bluffs or high terraces overlooking the valley or stream confluences. This is not always the case, however, as burials may also be associated with larger habitation areas.

- **Unclassified** sites are far more ephemeral in nature and are expected to exist in far greater numbers on the landscape compared to the other three site-types. Though such site areas are more abundant, they are not necessarily more predictable in that they could represent any number of different activities. These sites may represent small, single-use camps, specialized function areas that may have been reused at various times throughout the year (e.g., fishing or foraging areas, overlooks/animal herd observation areas), a brief rest area where a tool was resharpened or discarded, or an unintended, chance occurrence (e.g., a lost tool). This site type is likely to occur with the greatest frequency in the region and is also most likely to occur in a wide variety of landscape positions. In the archeological record, these site-types typically consist of isolated artifacts or ephemeral lithic scatters.

Cultural Tradition Models

Paleoindian Sites

Very little may be said about the Paleoindian occupation of the Minnesota Valley except perhaps that these pioneer occupants were certainly present, as indicated by their diagnostic artifacts in collections. There are few issues more pressing in relation to the culture history of the Minnesota Valley than the location and study of a Paleoindian occupation. One of the prevailing opinions is that after the recession of the glaciers and the formation of Lake Agassiz north of Big Stone Lake, Paleoindians would have been able to use the Valley, and their settlements may have been scattered throughout the high positions overlooking glacial river Warren. Periodic heavy outflows through Lake Agassiz's southern outlet may have voided these earliest human occupations, which would account for the paucity of Paleoindian remains. The occasional discovery of fluted points in the region does suggest the potential for sites of this earliest period, and the discovery of one of these would be a major accomplishment.

Paleoindian sites in the study area could conceivably manifest as any of the above-listed site-types; however, their antiquity and ephemeral nature suggests that the majority will be identified as *unclassified* types consisting of single artifacts or ephemeral lithic scatters. Habitation sites, where present, are predicted to be ephemeral, short-term camps for small, highly mobile groups. Paleoindian mortuary sites are exceedingly rare in North America and such sites are predicted to be equally rare in the study area. However, the Browns Valley site (21TR5), a 9,000-year-old burial in

Traverse County (Jenks 1937), indicates that there are, indeed, Paleoindian mortuary sites in the immediate vicinity of the trench.

Anfinson's data identify only 16 Paleoindian sites in the study area (see Chapter 2, Table 3, above). Of these, nearly half (n=7) are associated with low terrace landforms; none have been documented in floodplain settings (see Chapter 2, Table 8, above). Unfortunately, the sample size is much too small to draw any definitive conclusions about site distribution by particular landform. It is, however, interesting to note that, with the exception of low terraces, a fairly even distribution of these sites by landform is apparent. In a previous model for early Paleoindian sites in Minnesota, Buhta et al. (2011:93–97) concluded that, for riverine environments, stream confluences were likely to be the most desirable as both habitation areas and for the procurement of a range of different resources. However, sites located along the valley margins (e.g., alluvial fans and colluvial slopes) are more likely to avoid geologic filtering mechanisms provided that these landforms aggraded at a sufficiently early time to harbor sites of this age. Results of the present geomorphological study support these findings (see Table 26, above). The portion of Table 26 relevant to Paleoindian sites is presented here as Table 34. Of particular interest is the lack of buried site potential in VT1 settings, where seven of the 16 previously recorded Paleoindian sites have been identified to-date. This implies that, while Paleoindian sites are present in these settings, they will not manifest as intact, buried deposits there. The floodplain and strath terraces also lack the potential to harbor buried sites of this age. Valley margin settings offer the highest probability for intact, buried Paleoindian sites; however, Late and Middle Paleoindian sites are also fairly likely to be preserved in VT2 settings (see Mandel, this report, pp. 148–149).

Table 34. Potential for Buried Paleoindian-aged Cultural Deposits in Major LfSAs of the MRV.

Cultural Affiliation	Straths	Terraces VT2[1]	VT1[1]	Floodplain	Alluvial Fans[2]	Colluvial Aprons
Late Paleoindian	0	2	0	0	3	3
Middle Paleoindian	0	2	0	0	2	2
Early Paleoindian	0	1	0	0	2	2

Rankings: 0=No potential; 1=Low potential; 2=Moderate potential; 3=High potential.
[1] Fine-grained overbank facies only.
[2] Excluding small alluvial fans at the mouths of ephemeral streams.

Archaic Sites

Regarding Archaic period occupations, a clearer picture is emerging on the nature of the assemblages and the dimensions of the adaptation from excavations at sites such as the one at Granite Falls. This site shows a Middle Holocene adaptation and toolkit broadly similar to others from the region, including Itasca, Cherokee and Rustad. All show a heavy focus on bison hunting. Other Archaic sites in the Valley, such as Hildahl, possibly Runck, and the Minneopa State Park sites near Mankato illustrate later Archaic adaptations, including a broad spectrum resource use at Hildahl, the possible elaboration of burial ceremonialism at Runck, and evidence of more eastern influences as seen in the projectile point assemblages at Minneopa State Park.

Similar to documented Paleoindian sites, the majority of Archaic sites in the study area are of the *unclassified* type, most of which manifest as ephemeral lithic scatters. However, Archaic sites of all of the above-listed types have been documented in the trench. Those identified as Archaic-period habitations are likely to exhibit similarities to predicted Paleoindian habitations (i.e., ephemeral, short-term camps for small, nomadic bands) with a greater likelihood of settlement feature presence and material preservation as compared to Paleoindian camps. To-date, Archaic-period resource procurement sites documented in the trench are kill or butchery localities associated with extinct forms of bison; it is predicted that most Archaic resource procurement sites documented in the future will be of a similar nature. The burial at the Runck site was assigned to the Archaic period based on projectile point typology (Valentine 1969); however, no radiocarbon dates were obtained. It is anticipated that very few Archaic mortuary sites are present in the trench; indeed, few have been identified in the Plains and Upper Midwest. Those that are present can be compared to the Runck burial, as well as the Middle Archaic burial from the Turin site in western Iowa (Fisher et al. 1985).

One of the more interesting revelations among the data compiled by Anfinson (see Chapter 2, Table 3, above), limited sample size notwithstanding, is that there are as many identified Archaic sites in the study area as there are Late Prehistoric sites (including Plains Village and Oneota components combined). Certainly this contradicts preconceived expectations for the relative abundance of cultural traditions in the study area; one would expect more Late Prehistoric sites than Archaic sites in the archeological record because previous evidence suggests a time-transgressive population increase and more recent site deposits should, therefore, be both more numerous and have a greater likelihood of surviving the myriad geologic and anthropogenic filtering mechanisms due to substantially less time exposure to said mechanisms. The question then becomes "why the disparity?" Anfinson (1997:39) notes that rivers may have been preferred by Archaic people due to many lake basins drying up during the Altithermal. Regional paleoclimatic evidence is supportive of this hypothesis; however, it is also possible that Archaic lake habitation sites are less visible in the archeological record because they are now inundated.

Thirty-seven Archaic sites are identified in the study area (see Chapter 2, Table 3, above). Like Paleoindian sites, data indicate that the majority of Archaic sites (n=17) are associated with low terrace landforms; none have been documented on floodplains or islands (see Chapter 2, Table 8, above). Archaic sites were also documented in blufftop (n=9), alluvial fan (n=6), and high terrace (n=5) settings. In the Central Plains, previous research has detected a pattern of Archaic sites buried deep in alluvial fan and terrace deposits along the margins of stream valleys that are tributaries to primary watercourses (cf. Kruse et al. 2010, 2011, 2012). Broadly similar patterns are anticipated in the study area. Mandel's geomorphological study classified buried site potential for Archaic sites in the MRV's major LfSAs (see Table 26, above). Table 35 presents the Archaic-specific portion of Table 26. As is evident, a quite strong dichotomy exists between buried Archaic site potential and LfSA association. In the MRV, buried Archaic sites will be in valley margin settings or in the VT1 (see Mandel, this report, pp. 148–149); Archaic sites may manifest surficially throughout the Valley. Additionally, recent work in the lower reaches of the trench has uncovered a series of stratified sites with Archaic and Woodland components buried beneath lacustrine and paludal deposits associated with the Valley Terrace LfSA (Frank Florin, personal communication 2015). One of these sites, 21CR155, includes multiple Archaic components and has been the subject of extensive excavations (Florin et al. 2013).

Table 35. Potential for Buried Archaic-aged Cultural Deposits in Major LfSAs of the MRV.

Cultural Affiliation	Terraces			Floodplain	Alluvial	Colluvial
	Straths	VT2[1]	VT1[1]		Fans[2]	Aprons
Late Archaic	0	0	2	0	3	3
Middle Archaic	0	0	2	0	3	3
Early Archaic	0	0	2	0	3	3

Rankings: 0=No potential; 1=Low potential; 2=Moderate potential; 3=High potential.
[1] Fine-grained overbank facies only.
[2] Excluding small alluvial fans at the mouths of ephemeral streams.

Woodland Sites

During the latter part of Anfinson's Middle Prehistoric period, or the Woodland, there appears to be a curious transition from southerly influences in the Fox Lake timespan, when ceramics resemble types such as Black Sand and extend into Iowa and to the east. Roughly contemporaneous with this period in time are the Havana-style ceramics from Heyman's Creek and Minneopa Bison Pasture East. This also reflects an earlier Woodland, or Middle Prehistoric, cultural influence from the southeast. In the Lake Benton span, ceramics appear to be more similar to those of the central Minnesota and Wisconsin woodlands than to those of the prairie peninsula in Iowa (see Johnson 2014:101). Whether there were historical forces operating to work a transformation in the direction of cultural development in the Minnesota River valley is an open question. More careful comparative study of the ceramic assemblages in Minnesota and Iowa may show that the present notion of Late Woodland Minnesota Valley affiliations to the north are exaggerated. Even so, the issue remains.

As with the other traditions, *unclassified* site types dominate the Woodland assemblage in the study area; such sites typically consist of single artifacts or ephemeral lithic scatters and artifact scatters. Woodland habitation and mortuary

sites are also not uncommon; the former consists, largely, of small- to large-scale artifact scatters (sometimes with associated features) while the latter consists of earthen mounds or mounds with accompanying lithic/artifact scatters. Sites of the resource procurement type are rarer. In 1990, Anfinson (1990) published a synthesis of known and predicted Woodland sites by archeological region. In the Prairie Lake Region, large river valleys near woods are predicted to be preferred winter camp settings; resource procurement sites are predicted to be near water as well (Anfinson 1990:155). Mound sites are predicted to be on higher ground, such as terraces or uplands, and near basecamps (Anfinson 1990:157). It is expected that Woodland sites in the study area will follow a similar pattern of distribution to those outlined by Anfinson. However, substantial habitations located in close proximity to mound groups are, thus far, uncommon in the study area. This may be more a product of our failure to identify and document these sites than their actual absence, though the phenomenon is nevertheless interesting.

Previous research has demonstrated that, among later Woodland-period sites in west-central Minnesota, distribution patterns overwhelmingly favor lakeshore habitations where both lacustrine and riverine environments were available (Buhta et al. 2014:135). Despite this, in an entirely riverine study area, Woodland sites still dominate the cultural component assemblage, accounting for over 55 percent (n=110) of all identified components (see Chapter 2, Table 3, above). Woodland sites are documented in association with all six of the primary landforms identified in Table 8 (see Chapter 2, above). Fully two-thirds of these sites are associated with low terrace (n=48) and blufftop (n=24) landforms; site distribution among floodplain (n=10), alluvial fan (n=12), and high terrace (n=12) settings is fairly even, albeit significantly lower frequency relative to low terraces and bluffs. Two Woodland sites are documented on islands in the trench. Not surprisingly, most of the blufftop sites attributable to this tradition are mounds. The present geomorphological study reveals that VT2 and strath terrace settings have no potential to harbor buried Woodland sites; however, such sites are highly likely to be buried in the fill of valley margin LfSAs (Table 36; see Table 26, above) (see Mandel, this report, pp. 148–149). Buried Late Woodland deposits were also recently discovered in paludal deposits associated with the Valley Terrace LfSA at site 21CR155 (Florin et al. 2013).

Table 36. Potential for Buried Woodland-aged Cultural Deposits in Major LfSAs of the MRV.

Cultural Affiliation	Terraces			Floodplain	Alluvial	Colluvial
	Straths	VT2[1]	VT1[1]		Fans[2]	Aprons
Woodland	0	0	2	0–2	3	3

Rankings: 0=No potential; 1=Low potential; 2=Moderate potential; 3=High potential.
[1] Fine-grained overbank facies only.
[2] Excluding small alluvial fans at the mouths of ephemeral streams.

Late Prehistoric Sites

Perhaps the Late Prehistoric, by virtue of documented similarities with early Historic settlements, is the best known of any archeological unit in the Valley. The early part of the Historic period presents a clear picture of Dakota control over most of the Minnesota Valley. Larger settlements were on what would later be the more navigable portions of the stream north of Mankato toward St. Paul. A second cluster of heavy occupation is indicated in documents and on early maps near Big Stone Lake. Dakota settlements were apparently not present around modern-day Mankato, possibly due to the nearby presence of the Iowa in that vicinity. Also, by early historic times the Traverse des Sioux was in use and there was a Sisseton village at Swan Lake, along this traverse from the area west of St. Peter and toward New Ulm. The "elbow" in the Minnesota River is not much mentioned as an area used by the Dakota until prompted to move there by Le Sueur. It is likely that others besides the Dakota inhabited the area.

Another possible parallel between the Historic period Dakota and the prehistoric village cultures relates to the variety of sites typically found. Johnson (1991) described several types of Cambria sites, including large villages, smaller nearby villages, small habitations and burial sites. There is a rough correspondence with the Historic Dakota pattern described by Spector (1993) of Dakota summer planting villages, late summer ricing sites, deer hunting sites, and ceremonial activity areas.

The Cambria sites are northwest of Mankato in the great southern bend of the Minnesota. The significant villages on the Minnesota 400–500 years prior to the contact period were located in an area that, in the Historic period, may have been a borderland between ethnic groups. Certainly this portion of the Minnesota River valley near Mankato was the scene of some cultural dynamism, at least in the Late Prehistoric and early Historic periods. One of the interesting parallels between the early Historic period and the Late Prehistoric period is that the larger villages seem to cluster on the Lower Minnesota River in both periods while the major portion of the middle valley, north of New Ulm, features few large settlements or evidence of large villages. The headwaters area around Big Stone Lake, known in the Historic period for a large concentration of Teton settlements, and later those of the Sisseton, in the Late Prehistoric is the focus of heavy settlement, including a variety of semi-permanent ditched occupations such as Hartford Beach, Tenney, Bunker Hill and Shady Dell. This collection of sites has been classified by some as the Big Stone phase. These Late Prehistoric villages reflect an intensity of occupation different from those in the upper Minnesota Valley south and east of Big Stone.

Whether dealing with Cambria, Big Stone phase or even Oneota, pottery diagnostic of these village occupations is found scattered widely in the Valley, but it is nowhere very common outside the Lower Valley and Bend area, and the Minnesota River headwaters. Gibbon's claim that the pattern of life set in the Valley in the early period of the villages continued through the earlier portion of the Historic period seems confirmed.

If we combine the historical record and its documentation, it is very clear that the Dakota settled the Minnesota Valley, but there was concomitant occasional use of the region by other groups. This intermittent use of the Valley was sometimes peaceful, as with the trade fair held on the Blue Earth, and sometimes hostile, as with the Meskwaki or Mascoutin intruders. Furthermore, the Dakota themselves were divided into distinct bands or villages that maintained their own identity. It may be that the ethnic diversity we witness in the Valley in the early Historic period was a persistent pattern that extends centuries into the past. Syms (1977) described such a pattern of regional use on the Northern Plains for the entire ceramic period, with some groups using an area intensively, while others occasionally intruded and quite possibly left their ethnic signatures in the material remains found at archeological sites.

Anfinson's data identify a total of 37 Late Prehistoric sites in the study area; 23 of these are attributable to the Plains Village tradition while 14 are classified as Oneota (see Chapter 2, Table 3, above). Of the Plains Village sites, nine are single-component; five of these are typed as unclassified, and four are designated habitations. Most are affiliated with Cambria. Two of the Oneota sites are designated as single-component sites; they are both of the unclassified type. In keeping with a decided trend, most of the Late Prehistoric sites are associated with low terrace and blufftop landforms. No Late Prehistoric sites have been documented in association with islands; however, a quite even distribution is noted among the remaining landforms (see Chapter 2, Table 8, above). According to the results of the current geomorphological study, floodplains are the only LfSA with any potential to harbor intact, buried sites of the Late Prehistoric period (Table 37; see Table 26, above) (see Mandel, this report, pp. 148–149). However, this does not imply that buried Late Prehistoric sites are not present in association with other landform settings. For instance, Late Prehistoric sites positioned on the surface of the VT1 may have been subsequently buried under a mantle of fan or floodplain deposits that aggraded during the historic period.

Table 37. Potential for Buried Late Prehistoric-aged Cultural Deposits in Major LfSAs of the MRV.

Cultural Affiliation	Terraces			Floodplain	Alluvial	Colluvial
	Straths	VT2[1]	VT1[1]		Fans[2]	Aprons
Late Prehistoric	0	0	0	0–2	0	0

Rankings: 0=No potential; 1=Low potential; 2=Moderate potential; 3=High potential.
[1] Fine-grained overbank facies only.
[2] Excluding small alluvial fans at the mouths of ephemeral streams.

DISCUSSION AND RECOMMENDATIONS FOR FUTURE RESEARCH

The Minnesota River valley represents an immense study area with a diverse settlement history and complex geomorphological composition. Through time, both changing environmental conditions and individual preferences among the various cultural groups have influenced the locales where certain sites-types for each tradition might be

expected. The scope of prehistoric habitation in the study area coupled with the intricate geological filtering mechanisms at work has complicated our understanding of settlement patterns among the earliest inhabitants of the Trench. Nevertheless, archeological, historic, and geomorphological research offers some important clues as to where we may begin looking.

Research detailing the late-Quaternary landscape evolutionary history of the Minnesota River valley suggests that most of the prehistoric archeological record of the Trench is likely to be buried. Implicit in this is the realization that traditional pedestrian surface survey is *not* an adequate methodological approach for archeologists to employ in the majority of the Minnesota Valley's landscape settings. Future archeological investigations in the Trench should incorporate deep testing methodology, similar to that outlined by Monaghan et al. (2006), as a means of augmenting traditional surface investigation techniques. Some form of subsurface testing protocol may even be necessary for landforms deemed to have no potential for harboring buried archeology, such as strath terraces and erosional residuals. Although the landforms themselves are incapable of harboring buried cultural deposits, they may, in many areas, be mantled by more recent alluvial deposits capable of burying sites.

In the Minnesota Valley, the actual determination of site placement shows a surprising lack of sites of certain types, and from certain periods, in the floodplain of the river valley. Only Woodland and Late Prehistoric sites are predicted to be present in this setting in a buried context and, where present, these sites are most likely be found only through deep testing protocols. This setting represents the only landform predicted to have the potential to harbor buried Late Prehistoric-aged sites; investigations for these sites should target this landform. Many of the oldest sites in this setting were removed via erosional mechanisms of flooding, lateral stream migration, and the like; sites of this age identified on the floodplain are predicted to have been removed from their original context and are likely to be isolated artifacts.

The two primary fill terraces in the Trench, VT1 and VT2, vary greatly in their buried site potential depending on cultural tradition. The VT1 has moderate potential for harboring buried Woodland and Archaic sites but no potential to contain Late Prehistoric or Paleoindian deposits. The VT2 has no potential for harboring sites that postdate the Paleoindian period; however, it possesses moderate potential to contain buried Late and Middle Paleoindian sites and low potential for Early Paleoindian sites. It is important to note that, in many areas of the Trench, the VT1 and VT2 surfaces are entirely mantled by more recent floodplain, fan, or colluvial slope deposits (see Figure 112, above). Sites buried in terrace deposits in these areas will likely require deep testing equipment to reach.

The valley margin landforms (alluvial fans and colluvial slopes) offer the greatest overall potential for harboring buried prehistoric sites. Both landforms possess high potential for containing Woodland, Archaic, and Late Paleoindian deposits and moderate potential for Early and Middle Paleoindian sites. Late Prehistoric sites are not predicted to be buried in these settings; however, small, Historic-period fans—often located at the mouths of ephemeral streams—may have buried Late Prehistoric-aged surface deposits on the valley floor in certain locations throughout the Valley. Again, deep testing is likely to be the only feasible manner of identifying prehistoric sites buried in these landform settings.

Another pressing issue related to the prehistory of the Minnesota River trench is chronological control. In terms of geomorphological chronology, additional dates are needed to help clarify the age of terrace fills and floodplain deposits throughout the Valley. Although previous efforts have established a relatively sound chronology for alluvial fan aggradation (see for example Hudak and Hajic 1999), a better understanding of the timing of terrace and floodplain formation would afford a clearer picture of prehistoric land use strategies for a much larger portion of the Trench area. Also critical, particularly with respect to Early Paleoindian sites, is a better understanding of the timing and character of Lake Agassiz's draining episodes via the southern outlet subsequent to the initial catastrophic burst during the Lockhart phase. Some researchers have suggested that catastrophic flooding had ceased through the southern outlet prior to the Emerson phase (ca. 9900–9500 B.P.) (see for example Hudak 2005; Lowell 2011) and possibly the latter stages of the Lockhart phase as well. Major archeological implications are inherent in the timing of Glacial River Warren and any associated potential catastrophic flood events. If catastrophic flooding ceased prior to the end of the Lockhart phase, then intact Folsom- and/or Clovis-aged sites may exist in the higher valley terraces.

A final topic for further research is paleoenvironmental reconstruction. As outlined earlier by Grimm (this report, pp. 23–32), no accurate pollen records have been obtained from within the Trench. In general, it is notoriously difficult to obtain accurate records for river valleys. Oxbow and other backwater lakes are often short-lived and are alternately

scoured out by floods or receive episodic dumps of flood sediments from unknown locations further upstream, which presents a range of taphonomic difficulties for interpretation. In addition, pollen source areas are typically much larger than the thin river valley. As a result, pollen is typically not very useful for such environments, at least for any level of great detail (Eric Grimm, personal communication 2015). Other regional sites for which pollen data have been acquired are, with few exceptions, poorly dated. As a result, the timing and character of climatic and vegetational change within the study area are poorly understood.

Although well-dated pollen sequences are not available from within the study area, paleoenvironmental reconstruction may still be attainable through two alternate avenues. The first avenue involves assembling a suite of faunal and macrobotanical remains from dated archeological sites in the Trench. Each assemblage analyzed will provide a snap-shot of paleoenvironmental conditions on a localized level, both spatially and temporally. The more sites identified with these assemblages, the clearer the picture becomes. The advantage of this approach is that, when preservation is good, a quite high-resolution microenvironmental reconstruction is possible. The drawback is that, because the spatial and temporal window is so locally narrow, numerous assemblages would be necessary from a range of different timeframes throughout the valley in order to obtain a complete picture of the vegetational change through time. Additionally, sites dating to the Pleistocene-Holocene transition may not exist.

The second, more pragmatic, approach involves the acquisition of additional deep sediment cores from strategic locations within the valley. High-powered hydraulic drill rigs are necessary to extract sediment cores that penetrate the full extent of both alluvial fan and valley terrace deposits. From these cores, suites of AMS dates may be obtained that span the full extent of human occupation of the Trench. Acquired dates can be paired with stable carbon isotope studies of the deposits, which can detect changes in C^3- and C^4-dominant plant regimes. These, in turn, offer insight into the general climatic makeup at a given point in time as C^4-dominant plant communities—which are more drought-resistant—imply more arid conditions. The stable carbon isotope studies cannot offer the same, high-resolution results as good lakebed pollen records; however, they can still provide a general idea of prevalent vegetation patterns through time. Vegetational resolution issues can be addressed, in part, through the recovery and analysis of phytolith samples from these deep soil cores. To this end, a 7-m-long core extracted from an alluvial fan in the valley near Franklin, Minnesota is presently being dated and analyzed for stable carbon isotopes and phytoliths. Results of this study will be made available in a separate report. Unfortunately, this core did not penetrate the entirety of the fan and terrace deposits and may not, therefore, provide data for the earliest Holocene or terminal Pleistocene. To achieve a complete paleoenvironmental reconstruction, additional cores would need to be extracted from similar landforms in the valley with larger drill rigs that are capable of acquiring samples from the full range of the valley's history.

7. REFERENCES CITED

Advisory Council on Historic Preservation
2012 Section 106 Regulations: Text of ACHP's Regulations, "Protection of Historic Properties" (36 CFR Part 800) (incorporates amendments effective August 5, 2004). Electronic document, http://www.achp.gov/regs-rev04.pdf, accessed September 26, 2012. Advisory Council on Historic Preservation, Washington, D.C.

Anderson, G. C.
1984 *Kinsmen of Another Kind: Dakota–White Relations in the Upper Mississippi Valley, 1650–1852*. University of Nebraska Press, Lincoln.

Anfinson, S. F.
1979 *A Handbook of Minnesota Prehistoric Ceramics*. Occasional Publications in Minnesota Anthropology No. 5. The Minnesota Archaeological Society, St. Paul.

1987 The Prehistory of the Prairie Lake Region in the Northeastern Plains. Unpublished Ph.D. dissertation, Department of Anthropology, University of Minnesota, Minneapolis.

1990 Chapter 10: Archaeological Regions in Minnesota and the Woodland Period. In *The Woodland Tradition in the Western Great Lakes: Papers Presented to Elden Johnson*, edited by G. E. Gibbon, pp. 138–166. University of Minnesota Publications in Anthropology No. 4. University of Minnesota, Minneapolis.

1997 *Southwestern Minnesota Archaeology: 12,000 Years in the Prairie Lake Region*. Minnesota Prehistoric Archaeology Series No. 14. Minnesota Historical Society, St. Paul.

2011 *State Archaeologist's Manual for Archaeological Projects in Minnesota*. Minnesota Office of the State Archaeologist, Ft. Snelling History Center, St. Paul.

2014 Minnesota River Valley Archaeological Site Database. Office of the State Archaeologist, St. Paul.

Artz, J. A., E. L. D. Bristow, and W. E. Whittaker
2013 *Mapping Precontact Burial Mounds in Sixteen Minnesota Counties using Light Detection and Ranging (LiDAR)*. Contract Completion Report No. 1976. Office of the State Archaeologist, University of Iowa, Iowa City. Submitted to Minnesota Historical Society, St. Paul, Minnesota.

Arzigian, C., and M. Kolb
2011 *2010 Archaeological Reconnaissance Survey of Olmstead County, Minnesota*. Mississippi Valley Archaeology Center, University of Wisconsin-La Crosse and Strata Morph Geoexploration, Milwaukee, Wisconsin. Submitted to Minnesota Historical Society, St. Paul, Minnesota.

Ashworth, A. C., D. P. Schwert, W. A. Watts, and H. E. Wright, Jr.
1981 Plant and Insect Fossils at Norwood in South-central Minnesota: A Record of Late-glacial Succession. *Quaternary Research* 16:66–79.

Atkinson, R. J. C.
1957 Worms and Weathering. *American Antiquity* 31:219–233.

Aulwes, G., A. Jenkins, A. Hruby, D. Maul, C. Miller, R. Mohapatra, G. Schmid, F. Wilkerson, and D. Friend
2013 *Investigating Poorly Known Areas of Minnesota: An Archaeological Survey of McLeod County*. Bolton & Menk, Inc., Burnsville, Minnesota. Submitted to Minnesota Historical Society, St. Paul, Minnesota.

Baker, V. R.
1973 *Paleohydrology and Sedimentology of Lake Missoula Flooding in Eastern Washington*. Special Paper 144. Geological Society of America, Boulder, Colorado.

Bakken, K. E.
2011 Lithic Raw Material Use Patterns in Minnesota. Unpublished Ph.D. dissertation, Department of Anthropology, University of Minnesota, Twin Cities. Electronic document, http://www.tc.umn.edu/~bakk0029//, accessed March 11, 2011.

Balek, C. L.
2002 Buried Artifacts in Stable Upland Sites and the Role of Bioturbation: A Review. *Geoarchaeology: An International Journal* 17:41–51.

Ball, D. E.
1964 Loss-on-ignition as an Estimate of Organic Matter and Organic Carbon in Non-calcareous Soils. *Journal of Soil Science* 15:84–92.

Beissel, D., K. Brown, M. E. Brown, and K. P. Zimmerman
1984 *Cultural Resources Investigation of the Upper Minnesota River (639) Project, Deuel and Grant Counties, South Dakota and Lac qui Parle and Yellow Medicine Counties, Minnesota*. Contract No. DACW37-82-M-1508. University of South Dakota Archaeology Laboratory, Vermillion, South Dakota. Submitted to U.S. Army Corps of Engineers, St. Paul District.

Belmont, P.
2011 Floodplain Width Adjustments in Response to Rapid Base Level Fall and Knickpoint Migration. *Geomorphology* 128:92–102.

Benn, D. W. (editor)
1990 *Woodland Cultures on the Western Prairies: The Rainbow Site Investigations*. Office of the State Archaeologist, Iowa City.

Bergman, C. A., and M. H. Newcomer
1983 Flint Arrowhead Breakage: Examples from Ksar Akil, Lebanon. *Journal of Field Archaeology* 10:238–243.

Bettis, E. A. III, and R. D. Mandel
2002a Geomorphology and Geoarchaeology. In *Archaeology in the Eisele's Hill Locality: Phase III Data Recovery Excavations at 13MC134, U.S. Highway 61, Muscatine County, Iowa*, edited by D. W. Benn, pp. 6–16. BCA Report No. 628/629. Bear Creek Archaeology, Inc., Cresco, Iowa.

2002b The Effects of Temporal and Spatial Patterns of Holocene Erosion and Alluviation on the Archaeological Record of the Central and Eastern Great Plains, U.S.A. *Geoarchaeology: An International Journal* 17:141–154.

Bettis, E. A., III, D. J. Quade, and T. J. Kemmis
1996 *Hogs, Bogs, and Logs: Quaternary Deposits and Environmental Geology of the Des Moines Lobe*. Guidebook Series No. 18. Iowa Department of Natural Resources, Geological Survey Bureau, Iowa City.

Bettis, E. A., III, and D. M. Thompson
1986 *Geomorphological Investigations of the Minnesota River Flood Control Project at Chaska*. Unpublished report prepared for the U.S. Army Corps of Engineers, St. Paul District.

Birkeland, P. W.
1999 *Soils and Geomorphology*. 3rd ed. Oxford University Press, Oxford.

Bourne, E. G.
1906 The Travels of Jonathan Carver. *The American Historical Review* 11(2):287–302

Bower, J. R. F., Z. Jing, G. Rapp, Jr., S. C. Mulholland, S. H. Valppu, S. L. Mulholland, and J. K. Huber
1996 *Limited Phase II Investigations at the J Squared Site (21RW53) Redwood County, Minnesota*. Report No. 96–16. Archaeometry Laboratory, University of Minnesota, Duluth. Submitted to Minnesota Department of Transportation, St. Paul, Minnesota.

Bray, K. M
n.d. Le Sueur, the Oglala Sioux, and the Beginnings of the Buffalo Robe Trade. Unpublished manuscript.

1994 Teton Sioux: Population History, 1655–1881. *Nebraska History* 75:165–188.

Bray, E. C., and M. C. Bray
1976 *Joseph N. Nicollet on the Plains and Prairies*. Minnesota Historical Society, St. Paul.

Brown, P. A., and J. P. Kennett
1998 Megaflood Erosion and Meltwater Plumbing Changes During Last North American Deglaciation Recorded in Gulf of Mexico Sediments. *Geology* 26:599–602.

Buhta, A. A., J. L. Hofman, E. C. Grimm, R. D. Mandel, and L. A. Hannus
2011 *Investigating the Earliest Human Occupation of Minnesota: A Multidisciplinary Approach to Modeling Landform Suitability & Site Distribution Probability for the State's Early Paleoindian Resources*. Archeological Contract Series No. 248. Archeology Laboratory, Augustana College, Sioux Falls, South Dakota. Submitted to the Minnesota Historical Society, St. Paul, Minnesota.

Buhta, A. A., C. M. Johnson, E. C. Grimm, L. A. Hannus, and T. V. Gillen
2014 *On the Periphery?: Archeological Investigations of the Woodland Tradition in West-Central Minnesota*. Archeological Contract Series No. 269. Archeology Laboratory, Augustana College, Sioux Falls, South Dakota. Submitted to the Minnesota Historical Society, St. Paul, Minnesota.

Buhta, A. A., R. D. Mandel, L. Palmer, and L. A. Hannus
2012 *Red Lake County, Minnesota: An Archeological & Geomorphological Resources Inventory & Appraisal*. Archeological Contract Series No. 258. Archeology Laboratory, Augustana College, Sioux Falls, South Dakota. Submitted to the Minnesota Historical Society, St. Paul, Minnesota.

Caine, C. A. H.
1974 *Archaeological Survey in the Big Stone Refuge Area, Minnesota for the United States Department of the Interior National Park Service*. Contract No. CX-4000-3-0033. Department of Anthropology, Archaeology Laboratory, University of Minnesota, Minneapolis.

Camill, P., C. E. Umbanhowar, Jr., R. Teed, C. E. Geiss, J. Aldinger, L. Dvorak, J. Kenning, J. Limmer, and K. Walkup
2003 Late-glacial and Holocene Climatic Effects on Fire and Vegetation Dynamics at the Prairie–forest Ecotone in South-central Minnesota. *Journal of Ecology* 91:822–836.

Clayton, L.
1983 Chronology of Lake Agassiz Drainage to Lake Superior. In *Glacial Lake Agassiz*, edited by J. T. Teller and L. Clayton, pp. 291–307. Special Paper No. 26. Geological Association of Canada, St. John's, Newfoundland.

Clayton, L., and S. R. Moran
1982 Chronology of Late-Wisconsinan Glaciation in Middle North America. *Quaternary Science Reviews* 1:55–82.

Cremeens, D. L., D. H. MacDonald, and J. C. Lothrop
2003 Holocene Colluvial Soils and Geoarchaeology in the Unglaciated Appalachian Plateau: Two Examples from West Virginia, USA. *Geoarchaeology: An International Journal* 18:799–826.

Curry, B. B., M. E. Konen, T. H. Larson, C. H. Yansa, K. C. Hackley, H. Alexanderson, and T. V. Lowell
2010 The DeKalb Mounds of Northeastern Illinois as Archives of Deglacial History and Postglacial Environments. *Quaternary Research* 74:82–90.

Dalla Bona, L.
1994 *Volume 3: Methodological Considerations*. Center for Archaeological Resource Prediction, Lakehead University, Thunder Bay, Ontario. Submitted to the Ontario Ministry of Natural Resources, Thunder Bay, Ontario. Electronic document, http://modelling.pictographs.com/method.htm, accessed March 10, 2011.

Darwin, C.
1881 *The Formation of Vegetable Mould Through the Action of Worms*. Appleton, New York.

Delisle, G.
1717 *Carte de la Louisiane et du cours du Mississipi*. Geography and Map Division, U.S. Library of Congress, Electronic document, http://www.loc.gov/resource/g4042m.ct001245/, accessed April 14, 2015.

Dobbs, C. A.
1989 *A Phase One Archaeological Survey of the Cottonwood, Redwood and Yellow Medicine Drainages in Southwestern Minnesota*. Report 15. Institute for Minnesota Archaeology, Minneapolis.

Dyke, A. S., A. Moore, and L. Robertson
2003 *Deglaciation of North America*. Open File 1574, Geological Survey of Canada.

Elson, J. A.
1967 Geology of Glacial Lake Agassiz. In *Life, Land and Water*, edited by W. J. Mayer-Oakes, pp. 37–96. Proceedings of the 1966 Conference on Environmental Studies of the Glacial Lake Agassiz Region, University of Manitoba Press, Winnipeg.

Eren, M. I., R. J. Patten, M. J. O'Brien, and D. J. Meltzer
2014 More on the Rumor of 'Intentional Overshot Flaking' and the Purported Ice-Age Atlantic Crossing. *Lithic Technology* 39(1):55–63.

Fenton, M. M., S. R. Moran, J. T. Teller, and L. Clayton
1983 Quaternary Stratigraphy and History in the Southern Part of the Lake Agassiz Basin. In *Glacial Lake Agassiz*, edited by J. T. Teller and L. Clayton, pp. 49–74. Special Paper 26. Geological Association of Canada, St. John's, Newfoundland.

Fisher, A. K., W. D. Frankforter, J. A. Tiffany, S. J. Schermer, and D. C. Anderson
1985 Turin: A Middle Archaic Burial Site in Western Iowa. *Plains Anthropologist* 30(109):195–218.

Fisher, T. G.
2003 Chronology of Glacial Lake Agassiz Meltwater Routed to the Gulf of Mexico. *Quaternary Research* 59:271–276.

2004 River Warren Boulders, Minnesota, USA: Catastrophic Paleoflow Indicators in the Southern Spillway of Glacial Lake Agassiz. *Boreas* 33:349–358.

Fisher, T. G., H. M. Jol, and D. C. Smith
1995 Ground-penetrating Radar Used to Assess Aggregate in Catastrophic Flood Deposits, Northeast Alberta, Canada. *Canadian Geotechnical Journal* 32:871–879.

Fisher, T. G., and D. G. Smith
1994 Glacial Lake Agassiz: Its Northwest Maximum Extent and Outlet in Saskatchewan (Emerson Phase). *Quaternary Science Reviews* 13:845–858.

Fisher, T. G., D. G. Smith, and J. T. Andrews
2002 Preboreal Oscillation Caused by a Glacial Lake Agassiz Flood. *Quaternary Science Reviews* 21:873–878.

Fisher, T. G., and C. Souch
1998 Northwest Outlet Channels of Lake Agassiz, Isostatic Tilting and a Migrating Continental Drainage Divide, Saskatchewan, Canada. *Geomorphology* 23:57–73.

Fisher, T. G., C. H. Yansa, T. V. Lowell, K. Lepper, I. Hajdas, and A. Ashworth
2008 The Chronology, Climate, and Confusion of the Moorhead Phase of Glacial Lake Agassiz: New Results from the Ojata Beach, North Dakota, USA. *Quaternary Science Reviews* 27:1124–1135.

Fite, E. D., and A. Freeman
1969 *A Book of Old Maps Delineating American History from the Earliest Days to the Close of the Revolutionary War*. Dover Publications, New York.

Florin, F., J. Lindbeck, and B. Wergen
2013 *Phase I Archaeological Survey and Phase II Evaluation of Sites 21CR154, 21CR155, and 21CR156 for the TH101/CSAH 61 Southwest Reconnection Project in Scott and Carver Counties, Minnesota*. Florin Cultural Resource Services, LLC, Boyceville, Wisconsin. Submitted to Minnesota Department of Transportation, St. Paul, Minnesota.

Gee, G. W., and J. W. Bauder
1986 Particle-size Analysis. In *Methods of Soil Analysis, Part I: Physical and Mineralogical Methods*, 2nd ed., edited by A. Klute, pp. 383–411. Agronomy Monograph No. 9. American Society of Agronomy/Soil Science Society of America, Madison, Wisconsin.

Geiss, C. E., C. E. Umbanhowar, P. Camill, and S. K. Banerjee
2003 Sediment Magnetic Properties Reveal Holocene Climate Change Along the Minnesota Prairie-forest Ecotone. *Journal of Paleolimnology* 30:151–166.

Gibbon, G. E.
2012 *Archaeology of Minnesota: The Prehistory of the Upper Mississippi Region*. University of Minnesota Press, Minneapolis.

Gonzales, L. M., J. W. Williams, and E. C. Grimm
2009 Expanded Response-surfaces: A New Method to Reconstruct Paleoclimates from Fossil Pollen Assemblages that Lack Modern Analogues. *Quaternary Science Reviews* 28:3315–3332.

Gran, K. B., P. Belmont, S. S. Day, N. Finnegan, C. Jennings, and J.W. Lauer
2011 Landscape Evolution in South-Central Minnesota and the Role of Geomorphic History on Modern Erosional Processes. *GSA Today* 21:7–9.

Gran, K. B., P. Belmont, S. S. Day, C. Jennings, A. Johnson, L. Perg, and P. R. Wilcock
2009 Geomorphic Evolution of the Le Sueur River, Minnesota, USA, and Implications for Current Sediment Loading. In *Management and Restoration of Fluvial Systems with Broad Historical Changes and Human Impacts*, edited by L. A. James, S. L. Rathburn, and G. R. Whittecar, pp. 119–130. Special Paper 451. Geological Society of America, Boulder, Colorado.

Gran, K. B., N. J. Finnegan, A. L. Johnson, P. Belmont, C. Wittkop, and T. M. Rittenour
2013 Landscape Evolution, Valley Excavation, and Terrace Development Following Abrupt Postglacial Base Level Fall. *Geological Society of America Bulletin* 125:1851–1864.

Grimm, E. C.
1983 Chronology and Dynamics of Vegetation Change in the Prairie-Woodland Region of Southern Minnesota, U.S.A. *New Phytologist* 93:311–350.

1984 Fire and Other Factors Controlling the Big Woods Vegetation of Minnesota in the Mid-nineteenth Century. *Ecological Monographs* 54:291–311.

2011 Vegetation & Climate of Southwestern Minnesota During the Paleoindian Period. In *Investigating the Earliest Human Occupation of Minnesota: A Multidisciplinary Approach to Modeling Landform Suitability & Site Distribution Probability for the State's Early Paleoindian Resources*, by A. A. Buhta, J. L. Hofman, E. C. Grimm, R. D. Mandel, and L. A. Hannus, pp. 75–88. Archeological Contract Series 248. Archeology Laboratory, Augustana College, Sioux Falls, South Dakota. Submitted to Minnesota Historical Society, St. Paul, Minnesota.

Grimm, E. C., J. J. Donovan, and K. J. Brown
2011 A High-resolution Record of Climate Variability and Landscape Response from Kettle Lake, Northern Great Plains, North America. *Quaternary Science Reviews* 30:2626-2650.

Grimm, E. C., L. J. Maher, Jr., and D. M. Nelson
2009 The Magnitude of Error in Conventional Bulk-sediment Radiocarbon Dates from Central North America. *Quaternary Research* 72:301-308. doi:10.1016/j.yqres.2009.05.006.

Gronhovd, A., K. E. Bakken, D. Simpson, and N. Scholl
2013 *Archaeological Survey of Steele County, Minnesota*. 10,000 Lakes Archaeology, Inc., South St. Paul, Minnesota and AMEC Environment and Infrastructure, Inc., Louisville, Kentucky. Submitted to Minnesota Historical Society, St. Paul, Minnesota.

Hajic, E. R.
1995 *Evaluation of Site Limits and Geological Context of the Jackpot Junction Site (21RW52), Redwood Co., Minnesota*. Foth & Van Dyke, Eden Prairie, Minnesota. Submitted to Minnesota Department of Transportation, St. Paul, Minnesota.

Hart, J. F., and S. S. Ziegler
2008 *Landscapes of Minnesota*. Minnesota Historical Society, St. Paul.

Hashizume, J.
2009 Paleoindian Projectile Point Breakage and Reshaping. In *Hell Gap: A Stratified Paleoindian Campsite at the Edge of the Rockies*, edited by M. L. Larson, M. Kornfeld, and G. C. Frison, pp. 274–284. The University of Utah Press, Salt Lake City.

Haug, J. K.
1983 Early Plains Village Sites in Northeastern South Dakota. Paper presented at the 41st annual Plains Anthropological Conference, Rapid City, South Dakota.

Henning, D. R., and D. L. Toom
2003 Cambria and the Initial Middle Missouri Variant Revisited. *Wisconsin Archaeologist* 84(1&2):197–217.

Hobbs, E., C. M. Johnson, and G. E. Gibbon
2002 Model Development and Evaluation. In *Mn/Model: A Predictive Model of Precontact Archaeological Site Location for the State of Minnesota*, edited by G. J. Hudak, E. Hobbs, A. Brooks, C. Sersland, and C. Phillips, Section 7.5.1.2.3. Gain Statistic. Minnesota Department of Transportation, St. Paul. Electronic document, http://www.dot.state.mn.us/mnmodel/P3FinalReport/chapter7.html#ch75, accessed November 24, 2015.

Hobbs, H. C., and J. E. Goebel
1982 *Geologic Map of Minnesota: Quaternary Geology*. State Map Series S-1. Minnesota Geological Survey, Minneapolis, Minnesota. Scale 1:500,000, 1 sheet.

Holley, G. R., and M. G. Michlovic
2013 *The Prehistoric Village Cultures of Southern Minnesota*. Department of Anthropology and Earth Science, Minnesota State University, Moorhead, Minnesota. Submitted to Minnesota Historical Society, St. Paul, Minnesota.

Holley, G. R., M. G. Michlovic, and R. A. Dalan
2011 *Archaeological Survey of Swift County, Minnesota*. Archaeology Laboratory, Minnesota State University, Moorhead, Minnesota. Submitted to Minnesota Historical Society, St. Paul.

Holliday, V. T., R. D. Mandel, and T. Beach
2016 Soil Stratigraphy. In *Encyclopedia of Geoarchaeology*, edited by A. S. Gilbert. Springer Press, New York, in press.

Hoyer, B. E.
1980 The Geology of the Cherokee Sewer Site. In *The Cherokee Excavations: Holocene Ecology and Human Adaptations in Northwestern Iowa,* edited by D. C. Anderson and H. A. Semken, Jr., pp. 21–66. Academic Press, New York.

Huckell, B. B.
2014 But How Do We Know If It's Clovis? An Examination of Clovis Overshot Flaking of Bifaces and a North Dakota Cache. In *Clovis Caches: Recent Discoveries and New Research*, edited by B. B. Huckell and J. D. Kilby, pp. 133–152. University of New Mexico Press, Albuquerque.

Hudak, C. M.
1997 *Phase 1 Geomorphological Investigation of the T. H. 169 Corridor Between North Mankato and St. Peter, Minnesota (S.P. 5211-45).* Minnesota Department of Transportation, St. Paul, Minnesota.

2005 Landscape Evolution of the Minnesota River Valley. Paper presented at the 39th Annual Meeting of the North-Central Section of the Geological Society of America, May 19–20, 2005, Minneapolis, Minnesota.

Hudak, C. M., and E. R. Hajic
1999 Landscape Suitability Models for Geologically Buried Precontact Cultural Resources: Minnesota River Model, with Contributions by P.A. Trocki and R. A. Kluth. In *Mn/Model: A Predictive Model of Precontact Archaeological Site Location for the State of Minnesota*, edited by G. J. Hudak, E. Hobbs, A. Brooks, C. Sersland, and C. Phillips, Chapter 12, and Appendix E. Minnesota Department of Transportation, St. Paul, Minnesota. Web version published in 2002. Electronic document, http://www.mnmodel.dot.state.mn.us/pages/final_report.html, accessed January 21, 2014.

2005 Landscape Evolution of the Minnesota River Valley. *Geological Society of America Abstracts with Programs* 37(5):8.

Hudak, C. M., E. R. Hajic, and J. J. Walsh
2011 Interpreting Origins of Landform Sediment Assemblages within the Upper Mississippi River Valley and Tributaries in the Twin Cities Area of Minnesota. In *Archean to Anthropocene: Field Guides to the Geology of the Mid-Continent of North America*, edited by J. D. Miller, G. J. Hudak, C. Wittkop, and P. I. McLaughlin, pp. 525–544. Field Guide 24. Geological Society of America, Boulder, Colorado.

Hudak, G. J., E. Hobbs, A. Brooks, C. Sersland, and C. Phillips (editors)
2002 *Mn/Model: A Predictive Model of Precontact Archaeological Site Location for the State of Minnesota*. Minnesota Department of Transportation, St. Paul. Electronic document, http://www.mnmodel.dot.state.mn.us/pages/final_report.html, accessed January 21, 2014.

Jelgersma, S.
1962 A Late-glacial Pollen Diagram from Madelia, South-central Minnesota. *American Journal of Science* 260:522–529.

Jenks, A. E.
1937 *Minnesota's Browns Valley Man and Associated Burial Artifacts*. Memoir No. 49. American Anthropological Association, Menasha, Wisconsin.

Jennings, C. E.
2007 Chapter 2: Overview of the Quaternary Geologic History of the Minnesota River. In *Native Plant Communities and Rare Species of the Minnesota River Valley Counties,* pp. 2.1–2.12. Biological Report No. 89. Minnesota County Biological Survey, Division of Ecological Resources, Minnesota Department of Natural Resources, St. Paul, Minnesota.

Jennings, T. A.
2013 The Hogeye Clovis Cache, Texas: Quantifying Lithic Reduction Signatures. *Journal of Archaeological Science* 40:649–658.

Johnson, C. M.
2014 Ceramic Analysis. In *On the Periphery?: Archeological Investigations of the Woodland Tradition in West-Central Minnesota*, by A. A. Buhta, C. M. Johnson, E. C. Grimm, L. A. Hannus, and T. V. Gillen, pp. 77–102. Archeological Contract Series No. 269. Archeology Laboratory, Augustana College, Sioux Falls, South Dakota. Submitted to the Minnesota Historical Society, St. Paul, Minnesota.

Johnson, D. L.
1990 Biomantle Evolution and Redistribution of Earth Materials and Artifacts. *Soil Science* 149:84–102.

1992 Biomechanical Processes and the Gaia Paradigm in a Unified Pedo-Geomorphic Pedo-Archaeologic Framework: Dynamic Denudation. In *Proceedings of the First International Conference on Pedo-Archaeology*, edited by J. E. Foss, M. E. Timpson, and M. W. Morris, pp. 41–67. The University of Tennessee Agricultural Experiment Station, Knoxville.

2002 Darwin Would Be Proud: Bioturbation, Dynamic Denudation, and the Power of Theory in Science. *Geoarchaeology* 17(1):7–40.

Johnson, D. L., J. E. J. Domier, and D. N. Johnson
2005 Reflections on the Nature of Soil and its Biomantle. *Annals of the Association of American Geographers* 95(1):11–31.

Johnson, D. L., and D. Watson-Stegner
1990 The Soil Evolution Model as a Framework for Evaluating Pedoturbation in Archaeological Site Formation. In *Archaeological Geology of North America,* edited by N. P. Lasca and J. Donahue, pp. 541–560. Centennial Special Volume 4. Geological Society of America Boulder, Colorado.

Johnson, E.
1991 Cambria and Cahokia's Northwestern Periphery. In *New Perspectives on Cahokia: Views from the Periphery*, edited by J. B. Stoltman, pp. 307–318. Prehistory Press, Madison.

Johnson, M. D., D. M. Davis, and J. L. Pederson
1998 Terraces of the Minnesota River Valley and the Character of Glacial River Warren Downcutting. In *Contributions to Quaternary Studies in Minnesota*, edited by C. J. Patterson and H. E. Wright, Jr., pp. 121–130. Report of Investigations No. 49. Minnesota Geological Survey, St. Paul, Minnesota.

Judge, J., and L. Sebastian (editors)
1988 *Quantifying the Present and Predicting the Past: Theory, Method, and Application of Archaeological Predictive Modeling*. U.S. Department of the Interior, Bureau of Land Management, Denver, Colorado.

Kees, G.
2008 *Using Subsoiling to Reduce Soil Compaction*. Technology Development Program, U.S. Department of Agriculture, Forest Service, Missoula, Montana. Electronic document, http://www.fs.fed.us/t-d/pubs/pdfpubs/pdf08342828/pdf08342828dpi72.pdf, accessed August 25, 2015.

Kehew, A. E., and M. L. Lord
1986 Origin and Large-scale Erosion Features of Glacial Lake Spillways in the Northern Great Plains. *Geological Society of America Bulletin* 97:162–177.

Knox, J. C.
2006 Floodplain Sedimentation in the Upper Mississippi Valley: Natural Versus Human Accelerated. *Geomorphology* 79:286–310.

Kolb, M. F.
2005 Appendix A: Geomorphological Investigations in Conjunction with the Phase I Archaeological Survey of the Proposed Corridors for the Re-Construction of Minnesota Trunk Highway 14 and the Phase II Excavations at the Altman Site (21NL58) Nicollet County, Minnesota. In *Trunk Highway 14-New Ulm to North Mankato Archaeological Survey Nicollet County Minnesota Phase I Archaeological and Geomorphological Survey and Phase II Archaeological Testing of 21NL58, 21NL59 and 21NL134*, by M. M. Terrell, J. A. Kloss, D. J. Eigenberger, and M. F. Kolb. Two Pines Resource Group, Shafer, Minnesota. Submitted to Minnesota Department of Transportation, St. Paul, Minnesota.

2013 *Phase I Geomorphological Investigation for the TH101/CSAH 61 "Y" Study in Scott and Carver Counties, Minnesota.* Report of Investigation No. 233. Strata Morph Geoexploration, Inc., Sun Prairie, Wisconsin. Submitted to Florin Cultural Resource Services, LLC, St. Paul, Minnesota.

2014 *Phase I and II Geomorphological Investigations for Improvements to Sections of Trunk Highway US 169 in Nicollet County, Minnesota.* Strata Morph Geoexploration, Inc., Sun Prairie, Wisconsin. Submitted to Minnesota Department of Transportation, St. Paul, Minnesota.

Kruse, J. M., A. A. Buhta, and R. D. Mandel
2010 *An Archeological and Geomorphological Survey of Select Lands along the Platte River Bluffs and along Silver and Wahoo Creeks, Saunders County, Nebraska.* Archeological Contract Series No. 240. Archeology Laboratory, Augustana College, Sioux Falls, South Dakota. Submitted to Nebraska State Historical Society, Lincoln, Nebraska. Contract No. NE-31-09-032.

2011 *An Archeological and Geomorphological Survey of Select Lands along the Platte River Bluffs, South Bend Locality, Cass and Sarpy Counties, Nebraska.* Archeological Contract Series No. 247. Archeology Laboratory, Augustana College, Sioux Falls, South Dakota. Submitted to Nebraska State Historical Society, Lincoln, Nebraska. Contract No. NE-31-10-016.

Kruse, J. M., A. A. Buhta, L. Palmer, and R. D. Mandel
2012 *An Archeological and Geomorphological Survey of Select Lands in Sarpy, Washington, and Burt Counties, Nebraska*. Archeological Contract Series No. 256. Archeology Laboratory, Augustana College, Sioux Falls, South Dakota. Submitted to Nebraska State Historical Society, Lincoln, Nebraska. Contract No. NE-31-11-021.

Kvamme, K. L.
1990 The Fundamental Principles and Practice of Predictive Archaeological Modeling. In *Mathematics and Information Science in Archaeology: A Flexible Framework*, edited by A. Voorips, pp. 257–295. Studies in Modern Archaeology, Holos-Verlag, Bonn.

1995 A View from Across the Water: The North American Experience in Archaeological GIS. In *Archaeology and Geographic Information Systems: A European Perspective*, edited by G. Lock and Z. Stančič, pp. 1–14. Taylor and Francis, London.

Landes, R.
1968 *The Mystic Lake Sioux*. University of Wisconsin Press, Madison.

Leigh, D. S.
2001 Buried Artifacts in Sandy Soils: Techniques for Evaluating Pedoturbation Versus Sedimentation. In *Earth Sciences and Archaeology*, edited by P. Goldberg, V. T. Holliday, and C. R. Ferring, pp. 269–293. Kluwer Academic/Plenum, New York.

Lepper, K., T. G. Fisher, I. Hajdas, and T. V. Lowell
2007 Ages for the Big Stone Moraine and the Oldest Beaches of Glacial Lake Agassiz: Implications for Deglaciation Chronology. *Geology* 35:667–670.

Leverington, D. W., J. D. Mann, and J. T. Teller
2000 Changes in the Bathymetry and Volume of Glacial Lake Agassiz Between 11,000 and 9300 ^{14}C yr BP. *Quaternary Research* 54:174–181.

Leverington, D. W., and J. T. Teller
2003 Paleotopographic Reconstructions of the Eastern Outlets of Glacial Lake Agassiz. *Canadian Journal of Earth Sciences* 40:1259–1278.

Lewis, S. E., and P. M. Heikes
1990 A Preliminary Report on a Paleo-Indian Bison Kill Site (21YM47) Near Granite Falls, Minnesota. *Occasional Papers in Paleobiology* 111(6):1–2.

Lewis, T. H.
1883 Field Notes for August 3, 1883. Fortified Site at Odessa. Notebook No. 8. Manuscript on file, Minnesota Historical Society, St. Paul.

1898 *The Northwestern Archaeological Survey*. Pioneer Press Company, St. Paul.

Licciardi, J. M., J. T. Teller, and P. U. Clark
1999 Freshwater Routing by the Laurentide Ice Sheet During the Last Deglaciation. In *Mechanisms of Global Climate Change at Millennial Time Scales*, edited by P. U. Clark, R. S. Webb, and L. D. Keigwin, pp. 177–201. Geophysical Monograph 112. American Geophysical Union, Washington, D.C.

Lowell, T. V.
2011 The Moorhead Low: The First Prairie Drought? Paper presented at the Annual Meeting of the Geological Society of America, October 9–12, 2011, Minneapolis, Minnesota.

Lowell, T. V., N. Waterson, T. Fisher, H. Loope, K. Glover, G. Comer, I. Hajdas, G. Denton, J. Schaefer, V. Rinterknecht, W. Broecker, and J. Teller
2005 Testing the Lake Agassiz Meltwater Trigger for the Younger Dryas. *EOS (Transactions, American Geophysical Union)* 86:365–373.

McAndrews, J. H.
1968 Pollen Evidence for the Protohistoric Development of the "Big Woods" in Minnesota (U.S.A). *Review of Palaeobotany and Palynology* 7:201–211.

McDonald, J. N.
1981 *North American Bison: Their Classification and Evolution*. University of California Press, Berkeley.

Mandel, R. D.
2006 The Effects of Late Quaternary Landscape Evolution on the Archaeology of Kansas. In *Kansas Archaeology*, edited by R. J. Hoard and W. E. Banks, pp. 46–75. University Press of Kansas, Lawrence.

Mandel, R. D., and E. A. Bettis, III
2001 Use and Analysis of Soils by Archaeologists and Geoscientists: A North American Perspective. In *Earth Science in Archaeology*, edited by P. Goldberg, V. T. Holliday, and C. R. Ferring, pp. 173–204. Kluwer Academic/Plenum, New York.

Mandel, R. D., P. Goldberg, and V. T. Holliday
2016 Site Formation Processes. In *Encyclopedia of Geoarchaeology*, edited by A. S. Gilbert. Springer Press, New York, in press.

Mann, J. D., D. W. Leverington, J. Rayburn, and J. T. Teller
1999 The Volume and Paleobathymetry of Glacial Lake Agassiz. *Journal of Paleolimnology* 22:71–80.

Marchitto, T. M., and K. Y. Wei
1995 History of Laurentide Meltwater Flow to the Gulf of Mexico During the Last Deglaciation, As Revealed by Reworked Calcareous Nannofossils. *Geology* 23:779–782.

Marschner, F. J.
1930 *The Original Vegetation of Minnesota: Compiled from U.S. General Land Office Survey Notes*. Office of Agricultural Economics, U.S. Department of Agriculture, Washington, D.C.

Matsch, C. L.
1972 Quaternary Geology of Southwestern Minnesota. In *Geology of Minnesota: A Centennial Volume*, edited by P. K. Sims and G. B. Morey, pp. 548–560. Minnesota Geological Survey, St. Paul, Minnesota.

1983 River Warren, the Southern Outlet of Lake Agassiz. In *Glacial Lake Agassiz*, edited by J. T. Teller and L. Clayton, pp. 232–244. Special Paper 26. Geological Association of Canada, St. John's, Newfoundland.

Matsch, C. L., and H. E. Wright, Jr.
1967 The Southern Outlet of Lake Agassiz. In *Life, Land and Water*, edited by W. J. Mayer-Oakes, pp. 121–140. Proceedings of the 1966 Conference on Environmental Studies of the Glacial Lake Agassiz Region, University of Manitoba Press, Winnipeg, Manitoba.

Michlovic, M. G.
1985 The Problem of the Teton Migration. In *Archaeology, Ecology and Ethnohistory of the Prairie-Forest Border Zone of Minnesota and Manitoba*, edited by J. Spector and E. Johnson, pp. 131–145. J&L Reprints, Vol. 31, Lincoln.

Michlovic, M. G., G. R. Holley, R. A. Dalan, and E. Gooding
In press The Cheyenne Migration and the Biesterfeldt Site Revisited. *Plains Anthropologist*.

Midoshima, T.
1994 Effects of Trampling on Lithic Artifacts. *Palaeolithic Archaeology* 48:43–55.

Minnesota Department of Transportation (MNDOT)
1998 *Model for Sites Excluding Single Artifacts: Minnesota River Prairie Subsection*. Electronic document, http://environment.transportation.org/documents/mn_model/figures/Fig8203.pdf, accessed June 25, 2014.

2012 *Map Unit Field Code Key Table for Mn/Model v. 7.0: Geomorphic Field Codes*. Electronic document, http://www.dot.state.mn.us/mnmodel/geomorphology/UpdatedCodeKeyTable.pdf, accessed March 4, 2015.

Minnesota Historical Society (MHS)
1981 *Minnesota Statewide Archaeological Survey – Summary: 1977–1980*. Minnesota Historical Society, St. Paul.

Mitchell, M.
2012 The Origins and Development of Farming Villages in the Northern Great Plains. In *Oxford Handbook of North American Archaeology*, edited by T. Pauketat, pp. 359–373. Oxford University Press, New York.

Monaghan, G. W., K. C. Egan-Bruhy, M. J. Hambacher, D. R. Hayes, M. F. Kolb, S. R. Kuehn, S. Peterson, J. A. Robertson, and N. R. Schaffer
2006 *Minnesota Deep Test Protocol Project*. Commonwealth Cultural Resources Group, Inc., Jackson, Michigan. Submitted to Minnesota Department of Transportation, St. Paul, Minnesota.

Mott Wedel, M.
1974 Le Sueur and the Dakota Sioux. In *Aspects of Upper Great Lakes Anthropology: Papers in Honor of Lloyd A. Wilford*, edited by E. Johnson, pp. 157–171. Minnesota Prehistoric Archaeology Series No. 11. Minnesota Historical Society, St. Paul.

Mulholland, S. C., S. L. Mulholland, J. Hamilton, and S. Stark
2011 *Points and Pits: Archaeological Investigations in Minnesota's Region 9, The Lake Superior Shore, Carlton, Cook, Lake, and St. Louis Counties, Minnesota*. Duluth Archaeology Center, Duluth, Minnesota. Submitted to Minnesota Historical Society, St. Paul, Minnesota.

Munsell® Color
2000 *Munsell Soil Color Charts*. GretagMacbeth, New Windsor.

Nasatir, A. P.
1990 *Before Lewis and Clark, Documents Illustrating the History of the Missouri, 1785–1804*. Vol 1. University of Nebraska Press, Lincoln.

Neill, E. D.
1882 *Outline of the State of Minnesota*. Minnesota Historical Company, Minneapolis.

Nickerson, W. B.
1988 Archaeological Evidences in Minnesota: Explorations of the Minnesota Historical Society in the Years 1913 and 1916 in the Valley of the Minnesota River by William B. Nickerson Under the Direction of Newton H. Winchell and Warren Upham. *Minnesota Archaeologist* 47(2):4–40.

Nicollet, J. N.
1843 *Hydrographical Basin of the Upper Mississippi River from Astronomical and Barometrical Observations, Surveys, and Information*. W. J. Stone, Washington, D.C. Geography and Map Division, U.S. Library of Congress. Electronic document, http://www.loc.gov/resource/g4042m.ct001419/, accessed April 14, 2015.

Nielsen, A. E.
1991 Trampling the Archaeological Record: An Experimental Study. *American Antiquity* 56(3):483–503.

Nikiforoff, C. C.
1949 Weathering and Soil Evolution. *Soil Science* 67:219–223.

O'Connor, J. E.
1993 *Hydrology, Hydraulics and Geomorphology of the Bonneville Flood*. Special Paper 274. Geological Society of America, Boulder, Colorado.

Ojakangas, R. W., and C. L. Matsch
1982 *Minnesota's Geology*. University of Minnesota Press, Minneapolis.

Patterson, C. J., and T. J. Boerboom
1999 The Significance of Preexisting, Deeply Weathered Crystalline Rock in Interpreting the Effects of Glaciation in the Minnesota River Valley, U.S.A. *Annals of Glaciology* 28:53–58.

Patterson, C. J., A. R. Knable, S. E. Gran, and S. Phippen
1999 *Regional Hydrologic Assessment of the Upper Minnesota River Basin, Minnesota*. Minnesota Geological Survey, RHA-4, Part A, Plate 1, scale 1:100,000. St. Paul, Minnesota.

Peacock, E., and D.W. Fant
2002 Biomantle Formation and Artifact Translocation in Upland Sandy Soils: An Example from the Holly Springs National Forest, North-Central Mississippi, U.S.A. *Geoarchaeology* 17(1):91–114.

Perkl, B.
1998 *Cucurbita pepo* from King Coulee, Southeastern Minnesota. *American Antiquity* 63(2):279–288.

Pond, S. W.
1986 [1908] *The Dakota or Sioux in Minnesota as They Were in 1834*. Minnesota Historical Society Press, St. Paul.

Radford, D. S.
2015 *Cultural Resource Reconnaissance Survey for a Bison Pasture Project and Intensive Archaeological Testing of Sites 21BE303 and 21BE304, Minneopa State Park, Blue Earth County, Minnesota*. Letter report, Minnesota Department of Natural Resources, St. Paul. Submitted to Minnesota Historical Society, State Historic Preservation Office, St. Paul, Minnesota.

Radle, N. J.
1981 Vegetation History and Lake-level Changes at a Saline Lake in Northeastern South Dakota. Unpublished Master's thesis, Department of Earth Sciences, University of Minnesota, Minneapolis.

Rapp, G., and C. L Hill
2006 *Geoarchaeology: The Earth Science Approach to Archaeological Interpretation*. 2nd ed. Yale University Press, New Haven.

Reimer, P. J., E. Bard, A. Bayliss, J. W. Beck, P. G. Blackwell, C. Bronk Ramsey, C. E. Buck, H. Cheng, R. L. Edwards, M. Friedrich, P. M. Grootes, T. P. Guilderson, H. Haflidason, I. Hajdas, C. Hatté, T. J. Heaton, A. G. Hogg, K. A. Hughen, K. F. Kaiser, B. Kromer, S. W. Manning, M. Niu, R. W. Reimer, D. A. Richards, E. M. Scott, J. R. Southon, C. S. M. Turney, and J. van der Plicht
2013 IntCal13 and MARINE13 Radiocarbon Age Calibration Curves 0–50,000 Years cal BP. *Radiocarbon* 55:1869–1887.

Riley, M. A., J. A. Artz, W. E. Whittaker, R. M. Lillie, and A. C. Sorenson
2010 *Archaeological Prospection for Precontact Burial Mounds Using Light Detection and Ranging (LiDAR) in Scott and Crow Wing Counties, Minnesota*. Contract Completion Report 1768. Office of the State Archaeologist, University of Iowa, Iowa City. Submitted to Minnesota Historical Society, St. Paul, Minnesota.

Robinson, D.
1904 *A History of the Dakota or Sioux Indians*. South Dakota Historical Collections, Vol .2. State Historical Society, Pierre. News Printing Co., Aberdeen.

Roetzel, K., R. Strachan, and C. Broste
1994 *An Archaeological Report of a Limited Phase III Mitigation of the Fritsche Creek Bison Kill Site in Nicollet County, Minnesota*. Impact Services, Incorporated, Mankato, Minnesota.

Rolfsen, P.
1980 Disturbance of Archaeological Layers by Processes in the Soils. *Norwegian Archaeological Review* 13(2):110–18.

Schirmer, R. C., C. A. Wittkop, J. B. Anderson, J. C. Anderson, A. A. Brown, E. B. Evenson, C. P. Nowak, K. M. Reinhardt, and J. A. Reichel
2015 *Archeological Survey of Le Sueur County*. Department of Anthropology, Minnesota State University, Mankato. Submitted to Minnesota Historical Society, St. Paul, Minnesota.

Schoeneberger, P. J., D. A. Wysocki, E. C. Benham, and W. D. Broderson
2002 *Field Book for Describing and Sampling Soils.* National Soil Survey Center, U.S. Department of Agriculture, Lincoln, Nebraska.

Scullin, M.
2012 *Ceramics from the Price Site 21BE36*. Midwest Ethnohorticulture, Indianola, Iowa.

n.d. Nelson Site (21BE24) Ceramics. Unpublished manuscript.

Smith, C. A., and P. Larson
2015 Appendix A: Geomorphological Investigation at 21CR155. In *Phase III Data Recovery at Site 21CR155 for the TH101/CSAH 61 Southwest Reconnection Project in Carver County, Minnesota*, by F. Florin, K. Bakken, J. Lindbeck, and B. Wergin. Florin Cultural Resource Services, Boyceville, Wisconsin. Submitted to Minnesota Department of Transportation, St. Paul, Minnesota.

Smith, D. G., and T. G. Fisher
1993 Glacial Lake Agassiz—The Northwestern Outlet and Paleoflood. *Geology* 21:9–12.

Spector, J.
1993 *What This Awl Means*. Minnesota Historical Society, St. Paul.

Stanford, D. J., and B. A. Bradley
2012 *Across Atlantic Ice: The Origins of America's Clovis Culture*. University of California Press, Berkeley.

Syms, E. L.
1977 Cultural Ecology and Ecological Dynamics of the Ceramic Period in Southwestern Manitoba. *Plains Anthropologist Memoir* 12.

Teller, J. T.
1985 Lake Agassiz and Its Influence on the Great Lakes. In *Quaternary Evolution of the Great Lakes*, edited by P. F. Karrow and P. E. Calkin, pp. 1–16. Special Paper 30. Geological Association of Canada, St. John's, Newfoundland.

Teller, J. T. (continued)

1987 Proglacial Lakes and the Southern Margin of the Laurentide Ice Sheet. In *North America and Adjacent Oceans during the Last Deglaciation*, edited by W. F. Ruddiman and H. E. Wright, Jr., pp. 39–69. Vol. K-3, Geology of North America. Geological Society of America, Boulder, Colorado.

1990 Volume and Routing of Late-glacial Runoff from the Southern Laurentide Ice Sheet. *Quaternary Research* 34:12–23.

2001 Formation of Large Beaches in an Area of Rapid Differential Isostatic Rebound: The Three-outlet Control of Lake Agassiz. *Quaternary Science Reviews* 20:1649–1659.

Teller, J. T., and D. W. Leverington

2004 Glacial Lake Agassiz: A 5000 yr History of Change and Its Relationship to the $\delta^{18}O$ Record of Greenland. *Geological Society of America Bulletin* 116:729–742.

Teller, J. T., J. Risberg, G. Matile, and S. Zoltai

2000 Postglacial History and Paleoecology of Wampum, Manitoba, a Former Lagoon in the Lake Agassiz Basin. *Geological Society of America Bulletin* 112(6):943–958.

Teller, J. T., and L. H. Thorleifson

1983 The Lake Agassiz–Lake Superior Connection. In *Glacial Lake Agassiz*, edited by J. T. Teller and L. Clayton, pp. 261–290. Special Paper 26. Geological Association of Canada, St. John's, Newfoundland.

Teller, J. T., L. H. Thorleifson, L. A. Dredge, H. C. Hobbs, and B. T. Schreiner

1983 Maximum Extent and Major Features of Lake Agassiz. In *Glacial Lake Agassiz*, edited by J. T. Teller and L. Clayton, pp. 43–45. Special Paper 26. Geological Association of Canada, St. John's, Newfoundland.

Terrell, M. M., J. A. Kloss, D. J. Eigenberger, and M. F. Kolb

2005 *Trunk Highway 14-New Ulm to North Mankato Archaeological Survey Nicollet County Minnesota Phase I Archaeological and Geomorphological Survey and Phase II Archaeological Testing of 21NL58, 21NL59 and 21NL134*. Two Pines Resource Group, Shafer, Minnesota. Submitted to Minnesota Department of Transportation, St. Paul, Minnesota.

Thorleifson, L. H.

1996 Review of Lake Agassiz History. In *Sedimentology, Geomorphology and History of the Central Lake Agassiz Basin*, edited by J. T. Teller, L. H. Thorleifson, G. Matile and W. C. Brisbin, pp. 55–84. Field Trip Guidebook B2. Geological Association of Canada, St. John's, Newfoundland.

Toom, D. L.

2004 Northeastern Plains Village Complex Timelines and Relations. *Plains Anthropologist* 49(191):281–297.

Tufvesson, D.

1997 *Soil Survey of Lac Qui Parle County, Minnesota*. U.S. Department of Agriculture, Natural Resources Conservation Service, in cooperation with the Minnesota Agricultural Experiment Station. U.S. Government Printing Office, Washington, D.C.

Umbanhowar, C. E., Jr., P. Camill, C. E. Geiss, and R. Teed

2006 Asymmetric Vegetation Responses to Mid-Holocene Aridity at the Prairie-Forest Ecotone in South-central Minnesota. *Quaternary Research* 66:53–66.

Upham, W.
1890 *Report of Exploration of the Glacial Lake Agassiz in Manitoba.* Annual Report 1888–1889, Part E, Geological Survey of Canada, Ottawa, Canada.

1895 *The Glacial Lake Agassiz.* U.S. Geological Survey Monograph 25. U.S. Government Printing Office, Washington, D.C.

2001 *Minnesota Place Names.* 3rd ed. Minnesota Historical Society, St. Paul.

Valentine, J. H.
1969 An Archaic Burial and a Workshop Site Near New Ulm. *Minnesota Archaeologist* 30(3):72–75.

Van Nest, J.
2002 The Good Earthworm: How Natural Processes Preserve Upland Archaic Sites of Western Illinois, U.S.A. *Geoarchaeology: An International Journal* 17:53–90.

Waddington, J. C. B.
1969 A Stratigraphic Record of the Pollen Influx to a Lake in the Big Woods of Minnesota. *Geological Society of America Special Paper* 123:263–282.

Walker, M. J. C., M. Berkelhammer, S. Björck, L. C. Cwynar, A. Fisher, A. J. Long, J. J. Lowe, R. M. Newnham, S. O. Rasmussen, and H. Weiss
2012 Formal Subdivision of the Holocene Series/Epoch: A Discussion Paper by A Working Group of INTIMATE (Integration of Ice-core, Marine and Terrestrial Records) and the Subcommission on Quaternary Stratigraphy (International Commission on Stratigraphy). *Journal of Quaternary Science* 27:649–659.

Waters, M. R., and T. A. Jennings
2015 *The Hogeye Clovis Cache.* Texas A&M University Press, College Station.

Waters, M. R., C. D. Pevny, and D. L. Carlson
2011 *Clovis Lithic Technology: Investigation of a Stratified Workshop at the Gault Site, Texas.* Texas A&M University Press, College Station.

Watts, W. A., and R. C. Bright
1968 Pollen, Seed, and Mollusk Analysis of a Sediment Core from Pickerel Lake, Northeastern South Dakota. *Geological Society of America Bulletin* 79:855–876.

Webb, T., E. J. Cushing, and H. E. Wright, Jr.
1983 Holocene Changes in the Vegetation of the Midwest. In *Late-Quaternary Environments of the United States: The Holocene,* edited by H. E. Wright, Jr., pp. 142–165. University of Minnesota Press, Minneapolis.

Wheatley, D. W., and M. Gillings
2002 *Spatial Technology and Archaeology: The Archaeological Applications of GIS.* Taylor Francis, London.

Whitley, T. G.
2003 Causality and Cross-Purposes in Archaeological Predictive Modeling. Paper presented at the Computer Applications in Archaeology Conference, Vienna, Austria, April 8–12, 2003. Electronic document, http://www.brockington.org/research/papers/Whitley-2003-Causality.pdf, accessed March 2, 2011.

Wiele, S., and H. D. Mooers
1989 Glacial River Warren: Steady-State and Peak Discharge. *Program with Abstracts*, p. A60. Geological Survey of America Annual Meeting, St. Louis.

Williams, J. W., B. Shuman, and P. J. Bartlein
2009 Rapid Responses of the Prairie-Forest Ecotone to Early Holocene Aridity in Mid-continental North America. *Global and Planetary Change* 66:195–207. doi:10.1016/j.gloplacha.2008.10.012.

Winchell, N. H.
1911 *Aborigines of Minnesota*. Minnesota Historical Society, St. Paul.

Wood, W. R., and D. L. Johnson
1978 A Survey of Disturbance Processes in Archaeological Site Formation. In *Advances in Archaeological Method and Theory*, Vol. 1, edited by M. B. Schiffer, pp. 315–381. Academic Press, New York.

Woolworth, A. R.
1974 *Ethnohistorical Report on the Yankton Sioux*. Garland Publishing Inc., New York.

Wright, H. E., Jr.
1972a Physiography of Minnesota. In *Geology of Minnesota: A Centennial Volume*, edited by P. K. Sims and G. B. Morey, pp. 561–578. Minnesota Geological Survey, University of Minnesota, St. Paul.

1972b Quaternary History of Minnesota. In *Geology of Minnesota: A Centennial Volume*, edited by P. K. Sims and G. B. Morey, pp. 515–547. Minnesota Geological Survey, St. Paul, Minnesota.

1990 *Geologic History of Minnesota Rivers*. Educational Series 7. Minnesota Geological Survey, University of Minnesota, St. Paul, Minnesota.

Wright, H. E., Jr., K. Lease, and S. Johnson
1998 Glacial River Warren and the Environmental History of Southeastern Minnesota. In *Contributions to Quaternary Studies in Minnesota*, edited by C. J. Patterson and H. E. Wright, Jr., pp. 131–140. Report of Investigations 49. Minnesota Geological Survey, University of Minnesota, St. Paul, Minnesota.

Wright, H. E., Jr., C. L. Matsch, and E. J. Cushing
1973 Superior and Des Moines Lobes. *Geological Society of America Memoir* 136:153–185.

Wright, H. E., Jr., T. C. Winter, and H. L. Patten
1963 Two Pollen Diagrams from Southeastern Minnesota: Problems in the Regional Late-glacial and Postglacial Vegetational History. *Geological Society of America Bulletin* 74:1371–1396.

Yansa, C. H., and A. C. Ashworth
2005 Late Pleistocene Palaeoenvironments of the Southern Lake Agassiz Basin, USA. *Journal of Quaternary Science* 20(3):255–267.

Yansa, C. H., A. C. Ashworth, and T. G. Fisher
2002 Early Holocene Plant and Animal Colonization of the Southern Basin of Glacial Lake Agassiz. In *Abstracts of the International Association of Great Lakes Research*, p. 126. University of Manitoba, Winnipeg, Manitoba.

APPENDIX A

LABORATORY RESULTS OF AMS-DATED CHARCOAL SAMPLES

DirectAMS | Radiocarbon Dating Services

Dr. Ugo Zoppi
Director, Accelerator Mass Spectrometry Lab

22 December 2015

Rolfe D. Mandel
Kansas Geological Survey
Geoarcheology and Quaternary Geology
Odyssey Research Program
1930 Constant Avenue
Lawrence, KS 66047-3724

Dear Rolfe,

Your samples submitted for radiocarbon dating have been processed and measured by AMS. Following results were obtained:

DirectAMS code	Submitter ID	$\delta(^{13}C)$	Fraction of modern		Radiocarbon age	
		per mil	pMC	1σ error	BP	1σ error
D-AMS 014368	RDM-MINNE0PA-168	-12.9	81.00	0.26	1693	26
D-AMS 014369	RDM-21CP16-80-88	-40.1	81.59	0.27	1634	27
D-AMS 014370	RDM21CP16-263-269	-40.9	59.58	0.20	4160	27

All results have been corrected for isotopic fractionation with $\delta^{13}C$ values measured on the prepared graphite using the AMS spectrometer. These $\delta^{13}C$ values provide the most accurate radiocarbon ages but cannot be used to investigate environmental conditions.

Best regards,

Ugo Zoppi

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