THE PHASE I ARCHEOLOGICAL RESEARCH PROGRAM FOR THE KNIFE RIVER INDIAN VILLAGES NATIONAL HISTORIC SITE

PART I: OBJECTIVES, METHODS, AND SUMMARIES OF BASELINE STUDIES

NATIONAL PARK SERVICE
MIDWEST ARCHEOLOGICAL CENTER

THE PHASE I ARCHEOLOGICAL RESEARCH PROGRAM FOR THE KNIFE RIVER INDIAN VILLAGES NATIONAL HISTORIC SITE, PART I: OBJECTIVES, METHODS, AND SUMMARIES OF BASELINE STUDIES

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS USED

The following abbreviations/acronymns appear in the four parts of this volume:

BP	before the present (calculated from AD 1950)
C-14:	carbon-14, or radiocarbon
IASP	Interagency Archeological Salvage Program
KNRI	Knife River Indian Villages National Historic Site
KRF	Knife River Flint
MWAC	Midwest Archeological Center
MNI	minimum number of individuals
NARS	National Archives and Records Service
NISP	number of identified specimens
NPS	National Park Service
RCYBP	radiocarbon years before present (calculated from AD 1950)
SHSND	State Historical Society of North Dakota
SIRBS	Smithsonian Institution River Basin Surveys
SMU	Southern Methodist University
TL	thermoluminescence
TRSS	Tongue River Silicified Sediment
UGA	University of Georgia
UND	University of North Dakota
WU	Washington University

PREFACE

In 1974, the Congress of the United States authorized the establishment of the Knife River Indian Villages National Historic Site in Mercer County, North Dakota, to preserve archeological vestiges of the Hidatsa and Mandan Indians and to commemorate the cultural history and lifeways of those important native peoples of the Northern Plains. Starting in 1976, the National Park Service undertook an extensive program of archeological and ethnohistorical research designed to illuminate the archeological and historical resources of the newly-authorized park. This research, which was termed the Phase I research program for the park, was cooperatively carried out by the Service's Midwest Archeological Center and the Department of Anthropology of the University of North Dakota, as well as by researchers at other academic institutions in the United States, most notably the Department of Anthropology of the University of Missouri-Columbia.

This volume of the Midwest Archeological Center's *Occasional Studies in Anthropology* series reports the results of that decade-long research program. It is issued in four parts, each of which deals with a particular aspect of the research. Part I (Chapters 1-10) describes the overall program in general, particularly emphasizing the objectives and methodology employed in the research. Part II (Chapters 11-16) recapitulates a series of ethnohistorical studies that complements the archeological research and provides an ethnohistorical backdrop against which the archeological record of Hidatsa culture change can be interpreted. Part III (Chapters 17-21) summarizes the analysis of various classes of material remains recovered during the research program, principally the pottery, lithics, modified and unmodified fauna, and Euroamerican trade goods. Part IV (Chapters 22-27) broadly interprets the park's archeological record and offers a revised culture-historic taxonomy for what is proposed as the Knife region of the Middle Missouri subarea.

Most of the chapters contained in this volume were completed circa 1985-1986. Some effort has been made to update aspects of the data and conclusions offered in them by referencing certain key published and unpublished studies which have appeared since that time, but the lack of time and funds has precluded a comprehensive revision of the entire corpus of papers contained herein. Nevertheless, it is believed that this summary of the Knife River Indian Villages Phase I research program will be of substantial interest to Plains scholars and considerable utility in telling the story of the Hidatsa and Mandan Indians to the public.

CHAPTER 1

A HISTORY AND OVERVIEW OF THE KNIFE RIVER INDIAN VILLAGES NATIONAL HISTORIC SITE PHASE I RESEARCH PROGRAM[1]

F. A. Calabrese

INTRODUCTION

The Knife River Indian Villages National Historic Site is located in central North Dakota near the confluence of the Knife and Missouri Rivers, just north of the modern town of Stanton. The park lies within the area between the Garrison Dam to the north and the Oahe reservoir to the south, the last remaining unflooded segment of the Missouri River valley in the Dakotas. The valley is comprised of several distinct environmental zones, including floodplain, terraces, and dissected breaks with adjacent rolling uplands. Forests occur on the floodplain, lower terraces, and in draws cutting through the breaks, with a variety of native and exotic grasses found on higher terraces and in the breaks and uplands.

Many relatively undisturbed archeological sites exist along this stretch of river valley, an area which historically was home to both the Hidatsa and Mandan Indians. Several of these village sites—primarily relating to the Hidatsas—are preserved at the Knife River Indian Villages National Historic Site, a park authorized in 1974 for that purpose. The park's archeological record represents an occupational sequence spanning more than seven centuries of occupation of the Missouri River valley by horticultural peoples uniquely adapted to the rigorous Northern Plains environment. Even today, the region is considered only marginally suited for most forms of agriculture, yet the success of these peoples in exploiting a varied resource base was such that the population of the area in late prehistoric times was probably twice what it is today. The strategic location of the historic Hidatsa and Mandan villages provided their occupants with an unparalleled opportunity to prosper as middlemen traders between the Euroamericans to the north and east and Indian groups to the west and south, expanding upon a tradition which developed from centuries of prehistoric trading with nomadic neighbors.

The villages are rich in associations with prominent figures in the history of the westward expansion of the American nation as well as the earlier fur trade which derived from Canada, Spanish Louisiana, and the United States. There is a wealth of historical data pertaining to the Lewis and Clark presence at the villages (1804 and 1806) as well as fabulous pictorial documentation by the later artists George Catlin and Karl Bodmer (1832-1834). Throughout the historic period the Hidatsas and Mandans were affected dramatically by a variety of influences stemming from Euroamerican culture, resulting in unparalleled changes in both material culture and social organization. Contact with Euroamericans also tragically led to the decimation of the Hidatsa and Mandan populations through repeated outbreaks of smallpox and other epidemic diseases. The sum of these influences forever altered the culture of these peoples.

ADMINISTRATIVE BACKGROUND

Archeological interest in the Knife River Indian Villages dates back more than a century. Shortly after establishment of the town of Stanton, North Dakota, an archeologist from Minneapolis, Theodore Lewis, visited the villages clustered about the mouth of the Knife River and drew sketch maps of them (Wood 1986a:49). Prior to World War I, the State Historical Society of North Dakota employed a local surveyor to make detailed maps of the same villages, and in the 1920s the Society entertained the idea of acquiring the sites to set them aside as archeological preserves. Unfortunately, the Society was not able to accomplish this. Today we owe a great debt to the foresight of local landowners who have conscientiously preserved these archeological sites over the years, making it possible for ourselves and future generations to appreciate them as an historical and scientific resource.

[1] This is an updated and expanded version of a paper published in 1987 (F. A. Calabrese, "Knife River Indian Villages Archeological Program: An Overview," in *Perspectives on Archeological Resources Management in the Great Plains*, edited by Alan J. Osborn and Robert C. Hassler, pp. 135-157. I & O Publishing Company, Omaha, Nebraska).

Inclusion of the Knife River village sites in the National Park System was considered as early as the mid-1960s. The Big Hidatsa village, which is today one of the primary resources of the Knife River Indian Villages National Historic Site, was declared a National Historic Landmark in 1966. By 1968 a "feasibility study" was underway by the National Park Service, which subsequently resulted in a "Master Plan" document that ultimately guided the early development of the park as recommended by the study (National Park Service n.d.). This study, completed in 1968, was submitted to Washington by early 1970. The legislative package prepared for Congress subsequently passed both the House and Senate and was signed into law as Public Law 93-486 on October 26, 1974 (88 Stat. 1461). This enabling legislation authorized a sum of $600,000 for land acquisition and $2,260,000 for development at Knife River Indian Villages National Historic Site. The law authorized establishment of the only unit in the National Park Service designed specifically to commemorate the culture and history of Plains Indians. Explicitly recognized in the legislative history of P.L. 93-486 were three purposes which the park was to serve: *preservation* and *interpretation* of the park's archeological resources as well as *study* of those resources.

In November of 1974, a news release announcing the authorization of the new National Historic Site met with little enthusiasm from within the National Park Service. At that time the Service was suffering cuts in both budget and personnel. Managers were more worried about how they were going to meet current funding and staffing demands for existing parks in the face of pending reductions, than about stretching diminished resources to cover new additions to the National Park System, such as the Knife River Indian Villages.

At that time also, the Midwest Archeological Center was undergoing major changes. The Center developed out of the Smithsonian Institution, River Basin Surveys office in Lincoln, Nebraska. That office, called the Missouri Basin Project, was originally established in 1946 under a cooperative agreement between the National Park Service and the Smithsonian Institution, to accomplish archeological "salvage" work in conjunction with massive Federal reservoir construction planned for the Missouri River basin (Lehmer 1971:1-7). When the River Basin Surveys program was discontinued in 1969, the Missouri Basin Project office was transferred to the National Park Service and renamed the Midwest Archeological Center. Initially, many of the Smithsonian personnel remained and the National Park Service, through the Center, continued its salvage archeology responsibilities in the Missouri River basin as well as elsewhere in the Service's ten-state Midwest Region. As during the days of the Smithsonian program, much of this work focused on the Missouri River valley in the Dakotas, a region called by archeologists the Middle Missouri subarea (Lehmer 1971:28-29).

In 1973 the National Park Service initiated major changes in both the mission and the funding of its archeological programs. Heavy emphasis was placed on contracting to accomplish archeological objectives. As a result, the Center's internal salvage capability (Center personnel had been conducting major salvage projects in the Middle Missouri for several years) was eliminated after 1973. The following year, in conjunction with passage of the 1974 Archeological and Historic Preservation Act, the "external" (i.e., reservoir salvage) contract archeological program was centralized into three newly-established offices in San Francisco, Denver, and Atlanta. Ten positions were taken from the Midwest Archeological Center and allocated to other offices administering the external archeological program. The Center's salvage funds were terminated, but line-item National Park Service funding for the Center began in Fiscal Year 1975. The Center was left to build an "internal" archeological program devoted exclusively to the archeological resource management needs of national park areas. The total scope of Center programs at that time was small, based on only five permanent, full-time positions with very limited base and project funds. The total scope of the Center's responsibilities was expanded in 1974 when the Rocky Mountain Region was created from six states formerly administered by the Midwest Region, and six additional states east of the Mississippi River were added to the Midwest Region. Consequently, the Center found itself serving two Regions and about 75 park areas. These changes required the Center to reconfigure dramatically to serve the needs of geographically far-flung national parks despite the Center's historical focus and experience in Plains archeological studies. Establishment of the Knife River Indian Villages National Historic Site offered an opportune way for the Center to both meet internal National Park Service needs and utilize its unique capabilities for research in the Plains.

In November of 1974 the Midwest Archeological Center identified the need for a multi-disciplinary archeological, ethnohistorical, and magnetic survey research program designed to identify and evaluate the archeological resources of the Knife River Indian Villages National Historic Site. However, very little money was available for a program of such ambitious scope. The Center initiated a "Form 10-238," the National Park Service document required to program funds, requesting $137,000 per year for five years to carry out an extensive archeological program which would be directed by the Center. Earlier attempts to secure funds and positions through the normal programming channels had met with little success. There were simply not enough resources to meet all of the Service's needs, and funds were not immediately forthcoming for the five-year research program recommended by the Center.

In July, 1975, shortly after the park's enabling legislation was passed, the Rocky Mountain Region assigned an Area Manager to the new Knife River Indian Villages National Historic Site. It was recognized then that the eroding, nearly vertical bank at the Sakakawea Village was a serious problem and stabilization measures were needed as soon as possible. In response to this, the Center outlined an archeological program to salvage archeological information along the cutbank at Sakakawea. Only $3,000 were made available for this archeological work in contrast to $30,000 for *planning* the stabilization work. However, the planning money was of a year-ending nature, meaning that it must be spent or obligated by the end of the fiscal year in which it is received. Consequently, the Rocky Mountain Region elected to transfer these funds to the Center to augment the amount available for the archeological work. This provided the initial funding for the Knife River Indian Villages research program.

THE COOPERATIVE RELATIONSHIP WITH THE UNIVERSITY OF NORTH DAKOTA

At that time (January and February, 1976) the Center still faced the dilemma of accomplishing its goals at Knife River within the constraints of the Center's budget and personnel ceilings, and with year-ending funds. It was clear that the available $33,000 were not going to be sufficient to meet all foreseeable needs for Knife River. It was also evident that the Center would not be able to directly conduct all of the needed research in light of growing demands placed upon it to meet the needs of the seventy-odd other parks in the Midwest and Rocky Mountain Regions. The Chairman of the Department of Anthropology and Archaeology at the University of North Dakota expressed a willingness to participate in a joint archeological program at Knife River. It was proposed that the University of North Dakota would provide a position and matching funds necessary to support a Principal Investigator for the Knife River project. The possibility of a formal cooperative relationship with the University of North Dakota appeared to be a logical and flexible way to accomplish a long-term program of research at Knife River, particularly in view of the uncertainty of funds beyond Fiscal Year 1976.

A proposal for a joint University of North Dakota and National Park Service research effort was verbally presented to the Deputy Regional Director of the Rocky Mountain Region in March, 1976, at a Regional Superintendents Conference in Denver. With his concurrence on the concept of a cooperative program, a trip was made in early April to the University of North Dakota to discuss specific arrangements with the University's President and Dean of the College of Arts and Sciences. By late April a memorandum of agreement between the Service and the University had been drafted and submitted to the Department of the Interior Solicitor. The Solicitor considered the proposed memorandum of agreement to be an improper instrument for the kind of relationship we wished to establish with the University, which anticipated the payment of funds to the University. Consequently, the agreement was redrafted into a contract (May 5), again reviewed by the Solicitor (May 5-June 11), submitted to the Rocky Mountain (June 15) and Midwest Regions (June 18) for review and signature, and finally sent to the University of North Dakota for final endorsement (June 28).

The general objectives of Contract No. CX-6000-6-A061 were designed to provide flexibility for a long-term research program that could change priorities and directions as new research results and shifting management needs and funding levels warranted. In brief, they were:

1) To undertake a cooperative archeological research program for the upper Missouri River basin designed to provide an understanding of regional prehistory, ethnohistory, and history of American Indian populations within and adjacent to the area; and

2) To conduct an integrated, interdisciplinary program including (but not restricted to) archeological, historic, prehistoric, and other scientific research needed to understand Hidatsa prehistory and history and the relationship of the Hidatsas to surrounding tribes.

The ultimate purpose of this research, of course, was to illuminate the archeological story of the Knife River Indian Villages National Historic Site.

Investigation of the Sakakawea Village cutbank was initiated during the summer of 1976 by a Midwest Archeological Center field crew working under the direction of Robert K. Nickel. By 1977, the University of North Dakota had hired Dr. Stanley A. Ahler to fill the jointly-funded research position for the Knife River Indian Villages program. Fieldwork at Sakakawea Village was continued in 1977 under the joint direction of Nickel and Ahler, and was completed in 1978 by Ahler. Throughout this period funding for the project was, at best, minimal and insecure. It was not until Fiscal Year 1979 that funds for the five-year research program recommended in 1974 began to become available, which thus assured fiscal continuity for the program.

However, Contract No. CX-6000-6-A061 was written to last for a period of five years, while the five-year funding cycle did not begin until three fiscal years into the life of the contract. Consequently, this lack of synchronization between the contractual and funding cycles was corrected by the award of a second contract, CX-6000-1-0045, to the University of North Dakota after the first contract expired in 1981. The second contract continued the cooperative relationship that was established by the first and allowed the successful completion of the program's goals. The research carried out through these two contracts was augmented by several other instruments that were subsequently created for related research or management purposes at Knife River Indian Villages. These additional studies, which effectively augmented the cooperative relationship between the National Park Service and the University of North Dakota, were conducted by means of separate contracts or purchase orders as well as by transfer of funds to another Service office. They included remote sensing studies to be conducted by the Remote Sensing Division of the Chaco Archeological Center (now part of the Southwest Regional Office of the National Park Service); mapping and analysis of magnetic survey data at the University of Nebraska, as well as identification and analysis by that institution of a portion of the faunal data recovered from sites in the park; and several ethnohistorical studies conducted by W. Raymond Wood and his students at the University of Missouri; as well as other fieldwork projects conducted by the University of North Dakota for various development-related purposes.

Phase I field research was conducted at the Knife River Indian Villages each summer from 1976 through 1981. Following that, additional field investigations of differing scope were conducted at various times after 1981 for planning and construction purposes. A calendar of Phase I and post-Phase I field investigations within the park through 1988 is presented in Table 1.1. Some of the development-related, post-Phase I field investigations were completed under the terms of the second research contract (CX-6000-1-0045) and later cooperative agreements entered into by the Midwest Region of the National Park Service and the University of North Dakota. Both research contracts and the subsequent cooperative agreements were administered through the Midwest Archeological Center. The development-related investigations accomplished after the formal end of Phase I fieldwork have also contributed substantially to our understanding of the archeological record at the Knife River Indian Villages National Historic Site.

From an administrative standpoint, the research program for the Knife River Indian Villages did not always proceed smoothly. Originally conceived as a twelve-year program encompassing three distinct phases of research, funding limitations restricted the scope of the program to accomplishment of only the first phase, primarily consisting of the gathering of baseline information about the archeological resources of the park. The program always received solid support from the Chief Anthropologist in the Washington office of the National Park Service, but was often viewed critically by personnel in the Rocky Mountain Regional Office and, to a lesser extent, by some of the managers who superintended the park during the life of the Phase I research. This lack of enthusiasm for archeological research at Knife River was fostered in large part by a traditional bias toward Southwestern archeology in the National Park Service. It was, and continues to be, difficult for some managers to understand the wisdom of expending extremely finite funds on nearly invisible Plains archeological sites while highly visible Southwestern prehistoric ruins are eroding away at a frightful rate. In short, there is always intense competition for the Service's few archeological research dollars, most of which have traditionally been directed to the many parks in the Southwest which contain spectacular ruins to be interpreted to visitors and for which the Service has long held management responsibilities. Research at Knife River simply did not stack up as a high priority in the eyes of officials in Denver.

By Fiscal Year 1980, discontent with the program had reached full blossom, to the extent that the successful attainment of Phase I goals was in question. The Knife River Indian Villages research was criticized as being "too costly" and not meeting the management needs of the new park. Because the Regional Office saw higher priorities which had to be met in the southwestern parks of the Region, the Center was informed that funding would be terminated in mid-project at the end of Fiscal Year 1980. A meeting between representatives of the Midwest Archeological Center, the Rocky Mountain Regional Office, the Washington Office, and the University of North Dakota was held at Denver in December, 1980, to discuss the future of the Knife River Indian Villages program. At the meeting it was decided that it would not be in the Service's best interest to discontinue the project without completing analysis and reports of the work accomplished to date. It was agreed that funding would be provided to bring the project to completion at the end of Phase I as defined in the research plan. It was also agreed to go beyond the strict scope of Phase I by analyzing and interpreting all data available at that point in time, i.e., the goal was set of meeting Phase II and Phase III interpretive objectives as much as possible using data sources from Phase I research as well as out-of-park research.

Table 1.1. Archeological investigations at Knife River Indian Villages National Historic Site, 1976-1988.

Year and brief description of investigation	Documentation
1976	
Salvage excavations and cutbank profile recording were initiated at Sakakawea Village (32ME11) under direction of R. Nickel, MWAC.	Ahler et al. 1980
Magnetic survey was initiated under the direction of R. Nickel, MWAC, and and J. Weymouth, University of Nebraska.	Nickel 1977 Weymouth and Nickel 1977
A major portion of the effort was devoted to the Sakakawea Village (32ME11), but small areas of the Buchfink (32ME9), Amahami (32ME8), Sakakawea Cemetery (32ME493), and Ramble (32ME496) sites were surveyed as well.	Weymouth 1978, 1988
Remote sensing activities were initiated under the direction of T. Lyons, Division of Remote Sensing, Chaco Archeological Center. Black-and-white vertical aerial photographs to a scale of 1:1800 were made of selected sites within the park. These subsequently were used to photogrammetrically produce 0.5 foot contour maps to a scale of 1 inch equals 30 feet, of the Sakakawea Village (32ME11), the Lower Hidatsa Village (32ME10), the Big Hidatsa Villages (32ME12), and the Sakakawea Cemetery site (32ME493).	Photographs and maps on file, MWAC
Contract No. CX-6000-6-A061 was awarded on June 13, 1976, to the University of North Dakota for a five-year program of archeological research in the park. S. Ahler was designated Principal Investigator.	
1977	
W. R. Wood, University of Missouri, completed a report entitled "Historic Resources of the Knife River Indian Villages National Historic Site." This document outlined several anthropological and ethnohistorical investigations ancillary to the archeological research program for the park.	Wood 1977b
Investigations continued at the Sakakawea Village (32ME11) under the joint direction of S. Ahler, UND, and R. Nickel, MWAC including test excavations, cutbank profile recording, and controlled surface collection.	Ahler et al. 1980 Ahler and Benz 1980 Goulding 1980

Table 1.1. Continued.

Year and brief description of investigation	Documentation
<u>1977 (cont.)</u>	
Magnetic survey was continued at the Sakakawea Village (32ME11) under the direction of R. Nickel.	Weymouth 1979a, 1988
Magnetic survey was initiated at the Lower Hidatsa Village (32ME10) and the Big Hidatsa Village (32ME12) under the direction of R. Nickel.	Weymouth 1979a, 1979b, 1988
Magnetic survey was conducted at the Poly site (32ME407) under the direction of R. Nickel.	Weymouth 1988
A limited, controlled surface collection was made at the Lower Hidatsa Village (32ME10) under the direction of S. Ahler.	Ahler and Benz 1980
Limited surface collections were made at the Poly (32ME407), Stanton Ferry (32ML6), and Stiefel (32ME202) sites under the direction of S. Ahler.	Ahler and Swenson 1980
Remote sensing activities continued under the direction of T. Lyons. Color infrared vertical aerial photographs were taken of the entire park at a scale of 1:6000.	Original transparencies are on file with the Southwest Regional office, NPS; one set of copies is in KNRI collection
<u>1978</u>	
Ahler completed "A Research Plan for Investigation of the Archeological Resources of the Knife River Indian Villages National Historic Site," which outlined a three-phase, twelve-year program of archeological investigations relating to the park.	Ahler 1978a
Ahler and Swenson devised a preliminary format for analysis of ceramics from sites in the park and nearby vicinity.	Swenson and Ahler 1978
Cutbank profile recording was completed at the Sakakawea Village (32ME11) under the direction of S. Ahler.	Ahler et al. 1980
A limited experiment in earth resistivity surveying was conducted at the Sakakawea Village (32ME11) under the direction of R. Nickel.	
Test excavations were made in the Lower Hidatsa Village (32ME10), Poly (32ME407), Scovill (32ME409), and Elbee (32ME408) sites under the direction of S. Ahler. Work at the Elbee site was intended to mitigate the adverse effects resulting from construction and use of a temporary access road to an equipment staging area during construction of the stabllization berm at the Sakakawea site. Much of this work also served to provide preliminary information on the archeological remains present in proposed development areas.	Ahler 1978b Ahler and Weston 1981 Goulding 1980
Systematic surface reconnaissance was initiated under the direction of S. Ahler for the 1980 purpose of Identifying the archeological resources of the park.	Ahler 1978b; Ahler and Weston Ahler et al. 1979 Lovick and Ahler 1982
Geomorphological investigations were initiated in the park by J. Reiten under the direction of L. Clayton and S. Ahler.	Reiten 1980, 1983
Magnetic survey was continued at the Big Hidatsa Village (32ME12) and completed at the Sakakawea Village (32ME11) under the direction of R. Nickel. In addition, a small amount of magnetic surveying was conducted In development areas, including the Elbee site (32ME408).	Weymouth 1979b, 1988

Table 1.1. Continued.

Year and brief description of investigation	Documentation
1978 (cont.)	
Remote sensing activities were completed. KBM, Inc., of Grand Forks, North Dakota, made black-and-white vertical aerial photographs of the entire park, from which was photogrammetrically produced the 22-sheet park basemap with a contour interval of 50 centimeters and a scale of 1:1000. This map subsequently served as the archeological basemap of the park.	Original negatives on file with Denver Service Center; prints on file, MWAC
Construction-related test excavation was dug in the Taylor Bluff Village (32ME366) under the direction of J. Taylor of the KNRI staff.	Ahler 1988
1979	
Extensive magnetic survey and test excavations were conducted under the direction of S. Ahler in three proposed alternative locations (A/B and C) for eventual development of a visitor facility.	Ahler 1979 Toom et al. 1985
Test excavations were conducted under the direction of S. Ahler in the Buchfink (32ME9), Hotrok (32ME412), and Forkorner (32ME413) sites.	Ahler 1979 Ahler and Mehrer 1984
Geomorphological investigations were completed by J. Reiten under the direction of L. Clayton and S. Ahler.	Reiten 1980, 1983
Systematic surface reconnaissance was continued under the direction of S. Ahler.	Ahler 1979; Lovick and Ahler 1982
1980	
Test excavations were made at the Big Hidatsa Village (32ME12) and the Running Deer site (32ME383) under the direction of S. Ahler.	Ahler and Swenson 1985a Ahler and Mehrer 1984
Systematic surface reconnaissance was completed under the direction of S. Ahler.	Lovick and Ahler 1982
Magnetic survey of the Big Hidatsa (32ME12) was continued under the direction of R. Nickel.	Weymouth 1988
W. R. Wood completed "The Origins of the Hidatsa Indians: A Review of Ethnohistorical and Traditional Data," a document which provided important guidance for future research.	Wood 1986b
1981	
Test excavations were conducted at the Youess (32ME415), Forkorner (32ME413), Hump (32ME414), Buchfink (32ME9), Lower Hidatsa Village (32ME10), and Sakakawea Village (32ME11) sites under the direction of S. Ahler for the purpose of collecting datable charcoal and ceramic samples.	Ahler and Mehrer 1984
Magnetic survey activities in the park were completed under the direction of R. Nickel, with emphasis directed to the Lower Hidatsa Village (32ME10) and lesser effort devoted to the Sakakawea (32ME11) and Big Hidatsa (32ME12) Villages.	Weymouth 1988
Contract No. CX-6000-1-0045 was awarded on June 15, 1981 to the University of North Dakota for a three-year research program to complete Phase I investigation. S. Ahler was designated Principal Investigator.	

Table 1.1. Concluded.

Year and brief description of investigation	Documentation
1982	
The report of the parkwide archeological reconnaissance was completed.	Lovick and Ahler 1982
Test excavations were conducted on the Taylor Bluff site (32ME366) under the direction S. Ahler. These investigations were designed to evaluate resources that would be affected by installation of a new pump and water line, as well as a coal chute and a sign.	Ahler et al. 1983
1983	
Excavations were conducted at the Taylor Bluff Village (32ME366) under the direction of S. Ahler and D. Toom. This work was for the purpose of mitigating the impact of riverbank stabilization measures.	Ahler 1988
1985	
Construction-related test excavations were conducted at the Taylor Bluff Village (32ME366), Buchfink site (32ME9), Madman's Bluff site (32ME312), and Scovill site (32ME409), and additional areas in the park were investigated by means of auger probing. This work was under the direction of S. Ahler and D. Toom.	Toom and Ahler 1985
1987	
Test excavations were conducted in the expanded area B visitor center location under the direction of S. Ahler, UND and S. De Vore, MWAC.	Toom 1989
1988	
The plowzone was stripped from the entire area B visitor center location under the direction of S. Ahler and D. Toom.	Toom 1989

ARCHEOLOGICAL OBJECTIVES

As noted earlier, the Midwest Archeological Center was previously involved in research within the Dakotas. Consequently, establishment of the Knife River Indian Villages National Historic Site offered an opportunity to test a series of hypotheses which had evolved from ongoing research in the Middle Missouri subarea by a number of researchers affiliated with the Center and the University of Missouri. Immediate objectives facing the Knife River Indian Villages researchers were to 1) develop an overall research plan to guide the project; 2) define studies needed to illuminate voids in our current understanding of the area's prehistory and ethnohistory; and 3) initiate a comprehensive program of field research to acquire baseline data on the extent and nature of the park's archeological resources.

As his first task in the newly-established research position at the University of North Dakota, Ahler was to prepare a research plan to guide the Knife River Program. Such a plan was to draw upon ideas and methodologies developed by researchers-principally at the Midwest Archeological Center and the University of Missouri-who had earlier conducted work at related sites in the Middle Missouri. A parallel plan for ethnohistorical, ethnographic, and cultural-ecological studies was to be prepared by Dr. W. Raymond Wood of the University of Missouri. These efforts resulted in two important documents-the research plans written by Ahler (1978a) and Wood (1977b)-which have provided overall direction and guidance to the Knife River Indian Villages research program. The latter work by Wood will be discussed in some detail later.

In his archeological research plan, Ahler (1978a) provided a brief overview of the region's archeology, defined a series of major archeological problems, and outlined a three-phase research program (see Chapter 3). Primary objectives for the Knife River Indian Villages research program included: 1) development of an inter- and intra-village chronology; 2) identification of village occupants to distinguish between the Mandan and Hidatsa occupations in the region; 3) evaluation of the evolution of cultural sub-systems operative in Hidatsa society (e.g., trade, technologies, subsistence, etc.); and 4) management and preservation of the park's resources.

Once the basic temporal and spatial aspects of the park's archeological resources were understood, the plan called for the resolution of higher-level anthropological problems, including: 1) delineating the basic parameters of local subsistence systems including identification of changing patterns and strategies; 2) defining the native stone, bone, and ceramic technologies and understanding changing patterns in these technological sub-systems; and 3) understanding changing patterns and strategies in the native settlement system.

To resolve these problems a three-phase research design was proposed to span a twelve-year period. Phases II and III were only conceptually described in Ahler's research plan, as specific objectives and methodologies would necessarily be based on the results of Phase I and earlier research.

Phase I (years 1-3) of the proposed program emphasized collecting basic data to locate, identify, and inventory all cultural resources at Knife River Indian Villages National Historic Site. Concomitant with this was the development of research methods grounded in the physical and natural sciences to attack major problems outlined for Phase II. Because of the urgency to prepare for eventual stabilization of the Sakakawea Village, components of Phase I were already well underway at the time the research plan was completed (i.e., early 1978).

Phase II would emphasize extensive test excavations within and outside of the park area to resolve chronological and ethnic identity problems, define within-site activity areas, and continue collection of baseline data (years 4-7).

Phase III would involve large-scale excavations to collect comparative information on architectural changes through time and to reconstruct spatial patterns of tool manufacture, use, and discard within the major villages. Also within the scope of Phase III would be continued study of existing collections and the development of public interpretive programs, including living history (years 8-12).

Ahler's plan proposed eleven subprograms that would each contribute toward the accomplishment of Phase I objectives. These include: 1) remote sensing and mapping; 2) magnetic survey; 3) Executive Order 11593 resource inventory; 4) controlled, within-site surface collection; 5) problem oriented test excavations; 6) reconnaissance and testing in development areas; 7) out-of-park reconnaissance; 8) environmental and paleoenvironmental studies; 9) chronometric studies; 10) analysis of existing collections in various repositories outside the park; and 11) rodent control and site preservation. Most of these subprograms have been implemented with some success. These accomplishments are summarized below, and details of the results of individual subprograms are given in the chapters that follow. A few Phase I research objectives have not been satisfactorily completed because of insufficient funding, emphasis on other priorities, or other reasons that will be explained below.

RESEARCH SUBPROGRAMS

Magnetic Survey

While the Midwest Archeological Center was struggling with various ways to resolve administrative problems with limited personnel and funds, it was also pursuing new approaches to archeology which fit a conservation model of cultural resource management which was then evolving (Lipe 1974; Grady and Lipe 1976; Calabrese 1976). Simply stated, the Center's mission is the preservation and protection of archeological resources in the parks while obtaining data for both scientific and management needs. To this end, Center staff were exploring new methods of data recovery, one of which was the non-destructive exploration of archeological sites through the use of proton magnetometers.

Magnetic survey had been used for archeological purposes in Europe for a number of years, yet the kind and size of sites where it was employed there differ significantly from those in North America. Experimentation in North America was underway in the 1960s and the Midwest Archeological Center was fortunate to be able to collaborate with a University of Nebraska physicist interested in applying such research techniques to Plains archeology. John W. Weymouth began teaching magnetic survey techniques in University of Nebraska archeological courses and archeological field schools in the early 1970s. Weymouth's work looked promising for the resolution of certain problems in the Middle Missouri subarea, where Center investigators had long been working. The Center arranged for Weymouth to magnetically survey a portion of the Walth Bay site near Mobridge, South Dakota, in 1974. The results of this initial application in the Middle Missouri (Weymouth 1976) revealed great potential for magnetic survey techniques to be successfully employed on earthlodge village sites at the Knife River Indian Villages.

The Knife River Indian Villages offered a virtually unique opportunity for magnetic survey because 1) the surface expression of former earthlodge structures was generally easily identifiable; 2) anticipated archeological excavations would allow the investigation of magnetic field anomalies believed to provide clues to the location and nature of subsurface archeological features; and 3) the magnetic survey data could be easily related to the data from the remote sensing aerial photography subprogram.

In the summer of 1976 a proton magnetometer survey of portions of the Sakakawea, Buchfink, and Amahami Villages was conducted as a joint effort by the Midwest Archeological Center and University of Nebraska (Weymouth and Nickel 1977; Nickel 1977). The results were remarkable. In the area covered, the magnetic "signatures" of twelve earthlodges were apparent. When compared to available aerial photo coverage and contour maps, not only did the features match and correlate but additional structures, not apparent in the photos or on the maps, were observable on the magnetic contour maps (Weymouth and Nickel 1977:11).

In sum, in a matter of a few days, a wealth of information was obtained about subsurface features, including the identification of houses with no visible surface expression. In addition, the magnetic survey detected fire hearths, cache pits, and house entryways. All of this information was acquired with no alteration or diminishment of the in-the-ground archeological record.

Until this time the Midwest Archeological Center had used equipment and expertise borrowed from the University of Nebraska. The Center was dependent upon magnetometers obtained on loan from the University of Nebraska physics and geology departments. The success of the magnetic survey work at Sakakawea Village soon impressed National Park Service management officials (Calabrese 1977). The directorate of the Midwest Regional office was quick to grasp the utility of magnetic surveying as a cost-efficient means of evaluating subsurface remains without sacrificing irreplaceable archeological resources. Consequently, the Midwest Region made funds available to purchase two proton magnetometers for the Midwest Archeological Center, which were subsequently used during the 1977 and later field seasons. With its own equipment and under the direction of Robert K. Nickel, one of Weymouth's students and colleagues, the Center continued magnetic surveys at Sakakawea, Big Hidatsa, and Lower Hidatsa Villages as well as at other sites both within and outside of the park (Weymouth 1978, 1979a, 1979b, 1986, 1988; Weymouth and Nickel 1977; Nickel 1977).

Magnetic survey was used to map villages, locate archeological features in plowed fields, and evaluate sites with little or no surface evidence present (such as the Buchfink Village). It was also extensively used to evaluate areas proposed for development within the park. It guided the placement of test trenches and test units, where subsequent excavations were generally able to evaluate the cause of the anomalies reported by magnetic survey.

The Data Logger Project

One aspect of the magnetic survey subprogram resulted in a unique experience for the Midwest Archeological Center. As the Knife River Indian Villages research evolved, the magnetic survey subprogram progressed in sophistication, not only in the nature of its archeological applications but also in the development of field and laboratory procedures. The mapping and magnetic survey techniques in use up to the summer of 1977 consisted of survey measurements taken within a 20 m grid, with two magnetometers producing readings simultaneously. A stationary, reference magnetometer was used to measure diurnal variation in the magnetic field and another magnetometer was moved over the grid to record differences in the field that were caused by archeological or other subsurface features. Each pair of simultaneous readings from the magnetometers was recorded by hand, and the resultant data matrix was carried or mailed back to Weymouth's office at the University of Nebraska, where it was keypunched and entered into the University's mainframe computer for data mapping using the SYMAP program

(Weymouth 1976; Weymouth and Nickel 1977). A later innovation, in 1977, consisted of the use of a remote terminal, where data collected during the day were transmitted from the field by keyboard in the evening. Preliminary analysis with limited data matrix feedback was then returned to the field research team within a day. This relatively rapid return of processed information to the field researchers allowed adjustment of survey strategy, detection of instrument malfunction, or resurvey of areas yielding dubious measurements.

However, even with use of the remote terminal, the process was still slower than ideal and data were returned only in the form of a list of differences between the value of paired readings. It still remained for the field researcher to construct crude maps by hand in order to understand the significance of the data that he or she was collecting. If the technique was to be of more efficient use to the archeologist, who often worked under difficult and primitive field conditions and generally had only limited time at any given site, he or she must have the collected data in map form almost immediately to assist with on-the-spot decision making and project redirection. It soon became clear that in order to manipulate large sets of figures (over 400 pairs of five-digit numbers are recorded for each 20 m by 20 m magnetic survey unit and as many as six such units could be surveyed in a single day) a computer was needed *in the field* to record and process data on-site. No commercial computers suitable for such use were then available on the market. Then too, in those days of incipient computer awareness, the purchase of a computer in the federal government was extremely difficult, if not impossible. To meet the Center's needs an electrical engineering graduate student, Ken L. Burgess, was hired to design and build a field computer to record digital data directly from the magnetometers. Burgess was also given the task of devising software to enable the computer to process and map magnetic survey data in the field.

Working through the winter of 1976-1977, Burgess had a prototype ready for field testing in May of 1977. After experimentation, this unit was fully operational in August of 1977 (Burgess 1978). This "data logger" was capable of receiving data directly from the pair of magnetometers (both reference and moving), record it on tape, and provide digital hard (i.e., paper) copy in the field. The computer also had the capability of allowing the operator to display and print arithmetic differences between values obtained from the two magnetometers and provide maps of these data. The end result was a system which totally eliminated manual manipulation of field data, thus reducing error and increasing efficiency by cutting field time 50 percent or more. In addition, the computer in the field was capable of acting as a terminal for the transfer of data from the field to a mainframe computer and it accepted graphic or numeric data in return.

In January of 1978 the Washington office of the National Park Service learned about the existence of the Center's computer, and, because computer use in the Service's field offices was tightly controlled in those days, sent a team to Lincoln to investigate. When finished, they agreed that it was indeed a "special use" computer and allowed the Center to continue using it.

Since those early "pioneering" days of the Center's magnetic survey program, which evolved from the Knife River Indian Villages archeological research program, advances in computer hardware and software technology, as well as in magnetic surveying equipment, have allowed archeological applications of magnetic survey methodology to be performed with greatly increased efficiency. Today, the "data logger," once a boon to the research program for the Knife River Indian Villages, seems a primitive and cumbersome research tool indeed.

Mapping and Remote Sensing

Midwest Archeological Center staff members have long been aware of the potential benefits of aerial photographs in archeological research. Important early applications of aerial photo interpretation were done in the Plains by the State of Kansas (Stallard and Witty 1966) and the combined efforts of the National Park Service and the Smithsonian Institution (Itek Corporation 1965a, 1965b). Donald J. Lehmer and W. Raymond Wood extensively used aerial photos to identify archeological sites in the upper Knife-Heart region. Recently, the archeological use of aerial photographs throughout the Plains has been comprehensively reviewed in a publication that draws in part on the remote sensing work at the Knife River Indian Villages (Wood et al. 1984).

In May of 1975 Thomas R. Lyons spoke to a group of Center archeologists about his use of remote sensing techniques at archeological sites in the Southwest, primarily at and near Chaco Culture National Historical Park. The utility of aerial photography for research at the Knife

River Indian Villages was immediately apparent. Meeting with Lyons in February, 1976, I outlined our needs at Knife River, which included 1) aerial photography and mapping of the major villages at 0.5 ft contour intervals; 2) identification of individual archeological features, such as fortification ditches, house depressions, and trails; and 3) location of burial pits and cemetery areas. Tom had never worked on the Plains before and was unfamiliar with the local topography and vegetation. He questioned me unbelievingly when we requested maps with 0.5 ft contours. Nonetheless, he agreed to assist. Chief Anthropologist Douglas Scovill and the Washington office were interested in having the techniques of remote sensing applied outside of the Southwest and agreed to fund aerial photography and photogrammetric topographic mapping of the village sites. The aerial overflights were made and photos were produced in the summer of 1976 to a scale of 1:1,800. Map production began that fall and continued through the winter of 1976-1977. By the summer of 1977 good quality topographic maps of Sakakawea and Lower Hidatsa Villages had been completed. Ground control problems had to be resolved before completion of the Big Hidatsa maps, which, however, was accomplished that summer.

Meanwhile, in July, 1977, aerial false color infrared photographs of the Knife River Indian Villages National Historic Site were made to a scale of 1:6,000. These photos have provided researchers with an additional tool for evaluating surface features. The result is a complete set of large format, infrared transparencies covering the entire park, as well as photogrammetrically-produced contour maps of each of the three major Knife River Villages at a scale of one inch equals 30 feet. The latter have been particularly useful for plotting archeological data and they served as basemaps for mapping the extent and location of magnetic surveys as well (Weymouth and Nickel 1977). In addition, complete stereoscopic coverage of the entire park was also obtained during overflights made in 1978, from which a series of topographic maps was photogrammetrically produced at a scale of 1:1,000 with a 50 cm contour interval. These detailed maps serve as the basis for the park's archeological basemap and also provide a useful tool for managers and planners concerned with the development and operation of physical facilities within the park. Together, these extensive series of black-and-white and infrared photos offer the opportunity to identify and evaluate subtle archeological features on the ground. There is yet a wealth of information to be obtained from further study of these aerial photographs (Obenauf n.d.).

Surface Reconnaissance and Executive Order Inventory

One of the immediate tasks facing the newly developing park was to systematically inventory and evaluate all archeological resources within its boundary, as required by Executive Order 11593. The surface reconnaissance program was initiated in 1978 using a modified version of a point-quarter sampling procedure (Ahler 1978b:4-8, 16-22; Ahler et al. 1979:16-24; Ahler and Weston 1980), a technique borrowed from the biological sciences. The technique, using random points in a defined survey tract (grid), allows a statistically-based estimate of artifact density to be calculated per given unit of surface area, and results in some definition of differences in the artifactual content of the surveyed tracts as well. Large land tracts which were in pasture or which had been recently cultivated, both in the northern and southern portions of the park, were covered in this manner in 1978. The resulting artifact density values were graphically displayed by computer mapping programs such as SYMAP. These maps were subsequently consulted by planners in the selection of alternative locations within the park where the permanent visitor center might eventually be placed in order to minimize impact to the park's archeological resources. Later, the same data were also instrumental in determining field investigative needs and procedures to be followed in evaluating archeological resources in the specific area that was ultimately selected as the site of the new visitor center. Additional point-quarter survey continued through the summer of 1979.

Point-quarter sampling survey was only one of several techniques by which the parkwide cultural resource reconnaissance was conducted. The full range of techniques employed included systematic subsurface exploration with a powered auger and traditional pedestrian visual examination of the ground surface, as well as two varieties of point-quarter survey, one for cultivated tracts of land and the other adapted to pasture tracts. By this combination of techniques, 93 percent of all lands within the park (and its adjacent easement on the west) was systematically surveyed for archeological sites, a level of compliance with Executive Order 11593 that few other national park areas can match. The seven percent that was not surveyed lay exclusively on privately-owned land adjacent to the park, covered only by a National Park Service easement to insure continued agricultural use of the land; permission to survey these easement lands could not be obtained from the landowners.

The Executive Order or cultural resource reconnaissance was conducted between 1976 and 1980 to identify, locate, and evaluate all surface archeological and historical sites. The original feasibility study of the proposed park (i.e., the 1968 "master plan") had recognized the existence of only four major sites within the suggested boundary of the park. The intensive, parkwide Executive Order reconnaissance has expanded the park's archeological resource inventory to include a total of 56 archeological sites lying wholly or partly within the park's fee or easement lands (Lovick and Ahler 1982). These sites span a temporal range extending back to Early Archaic times possibly as old as eight thousand years ago.

Problem Oriented Test Excavations

Several of the archeological sites in the park, including the major villages as well as some of the less prominent sites, were subjected to limited test excavations designed to acquire basic stratigraphic and chronological information or to answer other, more specific questions. These investigations started with the initial fieldwork at the Sakakawea Village in 1976 and continued intermittently through 1985. The work at Sakakawea (Ahler et al. 1980), Big Hidatsa (Ahler and Swenson 1985a), and Lower Hidatsa Villages (Ahler and Weston 1981) was a high priority for the archeological program because of the need for information about the depth, age, and complexity of the deposits at these sites, which are primary interpretive resources of the park. However, test excavations also took place at several of the less visible sites in the park, including Hotrok, Running Deer, Buchfink, Poly, Scovill, Forkorner, Hump, and Youess (Ahler and Mehrer 1984); Elbee (Ahler 1984); and Taylor Bluff Village (Ahler 1988). Much of this work was for the sake of acquiring baseline resource and interpretive information, but imminent construction activities provided the impetus for some of the excavations (such as construction of the earthen berm below the Sakakawea Village, which necessitated work at both that site and the Elbee site; and shoreline stabilization measures along the Knife River, which required mitigative excavations at the Taylor Bluff Village). The results of these excavations are presented in a series of technical reports and are summarized in the chapters that follow.

The benefits of these excavations, some extremely minor in scale, have been immeasurable. They have provided detailed information about the chronology and content of the deep and complex cultural deposits at each of the park's three major villages, Sakakawea, Big Hidatsa, and Lower Hidatsa. They have contributed to a major reevaluation and revision of the culture-history of the northern portion of the Middle Missouri subarea (see Chapter 25). They have allowed recognition of a previously unknown prehistoric cultural expression in the region, the Scattered Village complex, which is represented at several of the sites in the park. They have resulted in the identification of yet another, highly-important Hidatsa village in the park, the Taylor Bluff Village, where the Awatixa Hidatsas lived following the 1834 destruction of their homes at Sakakawea Village and their movement to Like-A-Fishhook Village in 1845. This village was likely the birthplace of Buffalo Bird Woman, to whom so much of our present understanding of Hidatsa ethnography is owed. Excavations at sites in the park as well as at a traditional Mandan site, the On-A-Slant Village below Mandan, North Dakota, have permitted archeologists for the first time to distinguish between the material culture of the Mandans and Hidatsas and to begin to trace the cultural history of the separate Hidatsa subgroups (Breakey and Ahler 1985). Truly, the story of Hidatsa cultural development is emerging from the ground at Knife River Indian Villages.

Evaluation of Potential Development Sites

As in any newly established park, selection of a location for the visitor center is of paramount concern to management. At Knife River Indian Villages, the problem was complicated by the fact that virtually the entire park, and particularly the southern end of the park where a visitor center was desired, is a complex of archeological sites, the very resources which the park was established to preserve. Final selection of the permanent visitor center location proved to be a challenge, and some of the archeological work conducted in the park was carried out for that very purpose. Park management selected a number of possible locations for the visitor center and directed that those locations be evaluated archeologically to determine the presence or absence of archeological resources on or in them. Consequently, magnetic survey crews from the Midwest Archeological Center and archeological survey crews from the University of North Dakota investigated these locations for that purpose; all were found to contain archeological remains. Finally, with input from archeologists, planners, and managers, a final set of five alternative development loci was identified. Four of these clustered in the southwestern portion of the park, ranging from immediately west of the Sakakawea Village southward to the southwest corner of the park (National Park Service

1980). The fifth location was adjacent to the north edge of the town of Stanton, but primary attention was directed to the other four locations, which were considered more advantageous. There were arguments between the archeologists, planners, and managers, with the Midwest Archeological Center advocating the southwestern corner of the park (area "A"), the park management advocating the location west of Sakakawea Village (area "D"), planners from the Denver Service Center promoting location "B" north of the "A" alternative in the southwest corner of the park, and Rocky Mountain Regional Office personnel perferring a location a short distance west of the Lower Hidatsa Village (alternative "C"). Each location offered a combination of advantages and disadvantages which appealed in different ways to the interests of one or another of these various parties. None of the alternatives satisfied everyone concerned-locations were viewed as being too near the major villages of the park, or too distant from the villages, or not being on high enough ground, or having too much potential to disturb archeological sites or native burials, etc.

At length, the range of viable alternatives was narrowed to two: area "C" on the Lower Hidatsa West archeological site west of the Lower Hidatsa Village and area "B" south of "C," which slightly overlapped two of the park's less prominent archeological sites but which was thought to have relatively little potential for adverse impact to significant resources. In the summer of 1979, as part of the Phase I archeological research program, archeologists from the University of North Dakota dug extensive test trenches in both locations to evaluate their suitability from the standpoint of impact to archeological resources (Ahler 1979; Toom et al. 1985). The results supported area "B" as the location where impact would be less. Despite the archeological findings, park management officials generally preferred area "C," until Native Americans who attended a public meeting on the visitor center alternatives protested the likely disturbance of graves in area "C." From that point, park management supported area "B," which was subsequently selected by Regional Director Lorraine Mintzmyer. Denver Service Center planners later extended the location a short distance eastward to take advantage of higher ground and provide more area for physical facilities.

Archeologists were twice more called upon to work in the selected visitor center area. In 1987, a University of North Dakota field crew working under the direction of a Midwest Archeological Center archeologist dug test trenches to investigate the eastern portion of the expanded area "B" location in a fashion similar to the 1979 investigation of the original area "B." Little of significance was found and a recommendation was made that the former plowzone be mechanically stripped from the entire visitor center development zone to record and excavate any subsurface features that might yet be intact, such as fire hearths, lodge floors, cache pits, burials, and the like. That work was performed during the summer of 1988, and the essentially negative results of the project cleared the entire zone for subsequent development (Toom 1989). Construction of the visitor center began in May, 1990, and was completed in the winter of 1991-1992; the new facility was formally dedicated on June 27, 1992.

Environmental and Paleoenvironmental Studies

Until the Knife River project was initiated, geomorphological studies of the Knife River area were limited. A preliminary assessment of geomorphological study needs of the newly-established park was made in 1976 by Lee Clayton of the Department of Geology at the University of North Dakota (Clayton 1976). This had been preceded by more general studies by Clayton and his associates (Clayton et al. 1976) which were instrumental in understanding local terrace stratigraphy.

Clayton suggested that the area's poorly understood Holocene stratigraphy and chronology should be the subject of an intensive study. Such research was subsequently conducted by Jon Reiten of the University of North Dakota as part of the park's archeological research program. Reiten's research, completed as a Master of Science thesis in the Department of Geology at the University of North Dakota, was designed to 1) date the succession of local terraces; 2) core and evaluate subsurface deposits; and 3) map surface sediments and geomorphic units (Ahler 1979:8-9, 45; Reiten 1980, 1983). The results of this work have provided important clues as to which of the terrace formations in the park may be likely to contain pre-Plains Village archeological remains.

Information about the park's biotic (zoological and botanical) resources would certainly be needed to interpret the park's archeological record and formal study of such resources was considered important from the outset of the Phase I research. However, program funding was too limited to sponsor this research, and such investigations were deferred from the Phase I program.

Controlled Within-site Surface Collection

This subprogram was initiated in 1977 with intensive surface collections made within five-meter squares covering approximately 25 percent of the uncultivated portions of Sakakawea Village (Ahler 1978a:43). The ultimate objective of this subprogram was to systematically record and collect artifacts from the entire surface of each of the three major village sites within the park. However, rapid vegetative growth that occurred once the land was no longer pastured, coupled with more pressing problems and needs in other subprograms, resulted in discontinuance of this program after one season of fieldwork at the Sakakawea and Lower Hidatsa Villages (Ahler and Benz 1980).

Chronometric Studies

Two preliminary evaluatory studies were made to seek alternative methods of obtaining absolute dates for the archeological sites at the Knife River Indian Villages. Estimated dates for occupation of the three late sites at Knife River (Sakakawea, Big Hidatsa, and Lower Hidatsa), based upon historical records and "guesstimates" made on the basis of what little was known about the archeology of these sites prior to the Phase I research, ranged from the seventeenth to the mid-nineteenth century. Because of "fossil fuel" contamination of the atmospheric radiocarbon reservoir stemming from the Industrial Revolution, radiocarbon dating procedures are not useful for developing an accurate chronology for the later span of these village occupations.

The late David W. Zimmerman of Washington University evaluated the potential of thermoluminescence (TL) dating of pottery sherds from Knife River sites (Zimmerman n.d.). On the basis of preliminary tests on several sherds he indicated that the quartz "high temperature" and quartz "predose" methods should yield acceptable dates with a tolerable 7 to 8 percent error factor (plus or minus one standard deviation). He concluded that the possibility of establishing relatively fine-scale intra- and inter-site chronologies was good. A total of 44 sherds from sites within the park was submitted for dating to the Washington University Center for Archeometry between 1977 and 1980 (Zimmerman n.d.; Sutton n.d.; Ross and Sutton 1980, 1981). In addition, nine more sherds from sites within the park were later submitted to another TL dating laboratory, Alpha Analytic, Inc. Sherds were taken from the major villages as well as some of the less prominent sites. Despite problems with dating some of these samples, the results of the TL dating project are encouraging and have suggested considerably longer occupation of the major villages in the park than previously thought (see Chapter 8).

At the same time as Zimmerman's initial assessment of the utility of TL dating for the Knife River Indian Villages research, Daniel Wolfman (1978) provided a preliminary assessment of the utility of archeomagnetic dating at Knife River Indian Villages. He noted that the potential for establishing a useful archeometric chronology for Knife River between 1675 and 1845 is dependent upon 1) our ability to date sites of the same time period independently of the archeological data; 2) availability of datable material; and 3) ranges of change in the geomagnetic field and configuration of the polar curve. Historically dated local declination and inclination information for the Knife River area is simply not available, precluding the possibility of developing a master polar curve with which to date archeological deposits there. Nine samples of earth were collected from a hearth in House 16 at Sakakawea Village in 1981. Analysis of them is pending further developments in the construction of a master inclination/declination curve for the region.

Although the limitations of radiocarbon dating might not permit establishment of a relatively "fine-grained" chronology for the Knife River research program, nevertheless, the technique holds great promise for constructing a chronology of the earlier occupations at Knife River. An extensive series of radiocarbon dates from a variety of sites at the Knife River Indian Villages and surrounding area was obtained. In the early 1970s there were few dates from sites in the upper Knife-Heart region (Calabrese 1972). Today, well over 100 radiocarbon dates are available (see Chapter 8), making the cluster of sites at Knife River one of the most abundantly radiocarbon-dated areas within the Middle Missouri. These samples date sites from the Late Archaic through post-contact occupation of the area (see Chapter 4).

Analysis of Existing Collections

Archeological research at any given site or in any given locale does not proceed in a void. Comparative analysis has always been a hallmark of the discipline, and, in fact, is necessary to provide a cross-cultural perspective for the study of cultural process.

One of the subprograms of the Knife River Phase I program was directed toward analysis of existing collections from archeological sites which are located outside the park but which are important to understanding Hidatsa/Mandan culture history and the archeology of the Knife-Heart region. These peoples did not always live at Knife River, and to understand their origins and subsequent movements, it is essential to examine in detail archeological collections from village sites that they occupied at various times and places in the prehistoric and early historic past. The Phase I analysis of existing collections particularly focused on the study of pottery because from a stylistic and technological standpoint, pottery is a relatively fine-grained indicator of cultural changes. One of the Phase I program goals was to distinguish between the material culture assemblages left by the Hidatsas and their neighbors, the Mandans. Fine-scale distinctions between related ceramic assemblages are especially important if one views Hidatsa and Mandan material culture assemblages as the product of several largely autonomous subgroups who may have coalesced and splintered from one another at various times during their history.

As research on the Knife River collections proceeded, ceramic assemblages from 34 archeological sites were examined in accordance with an analytical methodology developed early in the Phase I research program (Swenson and Ahler 1978) and later refined (Ahler and Swenson 1985b). These collections were housed at the Smithsonian Institution, the University of Montana, the South Dakota Archaeological Research Center, the State Historical Society of North Dakota, the University of Missouri, and the Illinois State Museum. The results of this work have not been separately reported, but are incorporated into the final research program results summarized in the present volume. As a result of this work, we are beginning to be able to distinguish between the ceramic traditions of the Hidatsas and Mandans (Breakey and Ahler 1985; see also Chapter 17, this volume).

Rodent Control Subprogram

From the outset of the Phase I research program it was recognized that the burrowing activities of rodents have implications for the long-term preservation of the archeological deposits at the Knife River Indian Villages, and a subprogram was proposed specifically to find ways to reduce or eliminate rodent populations from the major archeological sites in the park (Ahler 1978a:48). Controlled surface collection activities at the Sakakawea and Lower Hidatsa Villages in 1977 attempted to measure the volume of rodent backdirt piles on the surface at that time and compare that volume to the calculated total volume of the archeological deposits at each site. That effort resulted in estimates that 0.84 percent of the total volume of the deposits at the Sakakawea Village, and 0.31 percent of the total volume of the Lower Hidatsa Village deposits, had been displaced to the surface (Ahler and Benz 1980:35, 41). Considering that the rodent backdirt piles visible in 1977 represent only a synchronic view of a continuous cycle of rodent backdirt pile creation and erosion, the threat that faunalturbation from rodent burrowing activities poses for the disturbance of archeological deposits is great indeed. Unfortunately, little progress was made on the goal of this subprogram beyond this point because of higher funding priorities elsewhere in the Phase I program. The problem, however, continues to be recognized by park management as serious and it is addressed in the park's natural resource management plan (National Park Service 1984).

Ethnohistorical Studies

An essential adjunct to the Phase I archeological research was a series of ethnohistorical studies of the wealth of historical records that relate to the Knife River Indian Villages National Historic Site. These studies described below grew out of the personal, long-standing interest of W. Raymond Wood in the native peoples of the Northern Plains, particularly the three semi-sedentary, horticultural tribes that lived along the Missouri River valley, the Mandans, Hidatsas, and Arikaras. Wood stimulated many of his students and colleagues to pursue ethnohistorical research that would ultimately contribute to the interpretation of the archeological record that was being revealed by the Phase I archeological research at Knife River. Direction for these studies was provided by the ethnohistorical and ethnographic research plan that Wood prepared in 1977 (Wood 1977b), and the studies continued typically with minimal or no funding throughout the life of the Phase I archeological research. These studies were conducted primarily by researchers at the University of Missouri and the Midwest Archeological Center. Important new historical perspectives on native culture change, participation in the fur trade, and response to introduced epidemic diseases have resulted. The results of this research have been indispensable for interpretation of that part of the Knife River Indian Villages archeological record that relates to the historic period.

As mentioned above, the first of these studies was an assessment of the historical resource base of the Knife River Indian Villages National Historic Site, prepared early in the Phase I research program by W. Raymond Wood (1977b). The study was commissioned to 1) identify pertinent historical documentation and related resource material and evaluate the reliability of the various sources of information; 2) define studies needed to complement the existing historical and ethnographic record relating to the Hidatsas and Mandans; 3) outline the procedures and time necessary to implement the recommended studies; and 4) identify qualified individuals to carry out this research.

Investigation of the archeological resources in the park was considered a high priority throughout the Phase I program. Consequently, it was not possible to support the ethnohistorical and other studies recommended by Wood to the degree anticipated at the outset of the research program. Fortunately, several historical studies of great relevance to the Knife River Indian Villages were undertaken in the 1970s and 1980s by researchers working independently of the National Park Service. As a result, important new studies have been completed, such as Barry M. Gough's new edition of Alexander Henry's journal (Gough 1988), and others are still underway, such as Gary E. Moulton's important new edition of the Lewis and Clark journals and the translation of Prince Maximilian's journals that is in preparation at the Center for Western Studies at Joslyn Art Museum. W. Raymond Wood stimulated talented students at the University of Missouri to conduct research relating to the Knife River Indian Villages, such as Chomko's (1986) year-by-year reconstruction of tribal movements and changing native settlements in the upper Knife-Heart region during the historic period. When possible, limited funding assistance was provided to several students pursuing relevant archeological and ethnohistorical problems for graduate degree requirements (cf. Goulding 1980, Hanson 1987, Trimble 1986). In these various ways, considerable new information has strengthened the ethnohistorical and ethnological data base for the Knife River Indian Villages National Historic Site.

One of the most important Phase I ethnohistorical studies was Wood's (1986b) review of ethnohistorical, traditional, and archeological data bearing on the origins of the three Hidatsa subgroups. Completed in 1980, this monograph was published in 1986 in response to demand from a variety of researchers and others who found its content useful and interesting.

Another major product of the ethnohistorical research is Wood's (1986a) study of the historical cartography of the upper Knife-Heart region. Wood evaluated Missouri River maps dating from the late 1700s through the early 1900s. Wood's study is laced with information pertinent to interpretation of the upper Knife-Heart region archeological and historical records. It offers one of the most complete resources for the beginning researcher to ground himself in the information available in the cartographic record. Several other in-depth studies of early Missouri River maps were also produced by Wood during the term of the Phase I research (Wood 1981, 1983; Wood and Moulton 1981).

Another contribution of the ethnohistorical aspect of the Phase I research program is the analysis of the Sitting Rabbit 1907 map of the Missouri River in North Dakota (Thiessen et al. 1979). This study reviewed the authorship of a map prepared between 1906 and 1907 by a Mandan Indian at the request of the secretary of the State Historical Society of North Dakota. The Sitting Rabbit map, annotated in Hidatsa orthography, is important because it provides a glimpse of Mandan and Hidatsa geography as viewed by members of those societies, and also preserves a number of Hidatsa linguistic forms which are not otherwise recorded.

Support from the Midwest Archeological Center was provided for Michael K. Trimble's (1986) ethnohistorical interpretation of the spread of smallpox in the Northern Plains utilizing concepts of disease ecology, completed in 1979 as an M.A. thesis at the University of Missouri and later published. Trimble successfully argues that the smallpox epidemic at Fort Clark in 1837, which virtually destroyed the Mandan tribe and culturally shattered the Hidatsas and Arikaras as well, was probably introduced to the native populations by three Arikara women who disembarked at Fort Clark from the steamboat *St. Peters*. His ecological approach, or what he calls "disease ecology," concentrates on mutual relationships between organisms and their environment while considering the complicating effects of human actions which alter the relationship between diseases and their environment. Trimble also essentially negates the hypothesized dissemination of smallpox to the Upper Missouri Indians through distribution of a contaminated blanket. Trimble further developed his ideas about epidemic diseases among the natives of the Upper Missouri region in a doctoral dissertation completed at the University of Missouri (Trimble 1985).

Jeffery R. Hanson (1987) conducted a study of the factors underlying Hidatsa culture change (adaptive adjustment) between 1780 and 1845, a period when native culture experienced major changes. His research was completed in 1983 as a doctoral dissertation at the University of Missouri and was subsequently published in 1987. Besides contagious disease epidemics, Hanson has shown that the Hidatsas faced major social and economic changes stemming from the introduction of the horse and long-term participation in the fur trade, as well as intensified warfare in the historic period.

Wood and Thiessen collaborated in reviewing the primary historical sources relating to the fur trade at Knife River, particularly those relating to trading visits by Canadian and British traders. They produced new transcriptions of several manuscripts which were previously unavailable or were available only in flawed editions (e.g., Wood 1979; Thiessen 1980a, 1980b, and 1981). Most of these historical documents were subsequently published (Wood 1977a, 1984; Wood and Thiessen 1985). Their research has placed the Knife River fur trade in an important new historical perspective (cf. Wood and Thiessen 1985:3-74).

A wealth of important new information has resulted from the several ethnohistorical studies conducted in conjunction with the Phase I archeological research for the Knife River Indian Villages. This fruitful research was conducted with only meager financial support.

CONCLUSION

An archeologist's responsibility for his resource base does not end with the excavation, analysis, and interpretation of data. The artifacts, specimens, and associated records gathered as a result of meticulously systematic methods are a unique and irreplaceable resource and must be preserved under controlled conditions to insure their availability for future research. To this end and in view of the fact that research was one of the purposes that the Knife River Indian Villages National Historic Site was authorized to serve, it was decided early in the Phase I program that all collections and records resulting from Phase I research should ultimately repose at the park. Accordingly, suitable facilities were incorporated into the design plans for the park's permanent visitor center. The collections in storage at the University of North Dakota were reorganized by University of North Dakota personnel (Ahler 1987a, 1987b) and cataloged into the National Park Service's Automated National Catalog System by park personnel working on the University's campus. They subsequently were transferred to the park's recently completed permanent visitor center and administrative headquarters.

A large series of technical reports exists to document the objectives, methods, and results of the many separate investigations that comprise the archeological and ethnohistorical research program for the Knife River Indian Villages, and the resulting collections and records are ready for permanent curation at the park. Beyond that, however, the research program results need to be communicated to the general public, whom, after all, this research is most intended to benefit. A children's book (Ward et al. 1989), based on an Hidatsa oral story and combined with the results of the archeological research program to insure the accuracy of illustrations, has been jointly prepared by the University of North Dakota and the Midwest Archeological Center and published by the Theodore Roosevelt Nature and History Association, which exists, in part, to assist the interpretive needs of the Knife River Indian Villages National Historic Site. Another, heavily-illustrated book (Ahler et al. 1991) was also jointly prepared to interpret the results of the Phase I archeological and ethnohistorical research to the general public. Information resulting from the Phase I research provided the basis for an educational teaching lesson plan focused on the Knife River Indian Villages that was jointly produced by the National Park Service and the National Trust for Historic Preservation (Metcalf n.d.). It is hoped that in the future the results of the archeological and ethnohistorical research program will be further utilized to produce yet other means of communicating the park's story to the public; the possibilities for meaningful interpretation are virtually limitless.

The Knife River archeological project was born out of a common interest in the prehistory and early history of North Dakota shared by researchers at several institutions and offices. The research program was initiated at a time when major shifts were occurring in the organization and mission of the cultural resource management functions of the National Park Service, on both the national and local levels. The Midwest Archeological Center was in the process of reorienting itself to greatly expanded responsibilities for management of the archeological resources in the parks of two of the Service's regions. The incipient Knife River research program reflected this new orientation and fortuitously drew upon the valuable experience that the Center's staff had acquired during the office's role in the Interagency Archeological Salvage Program, particularly the Center's work at sites along the shoreline of the upper Oahe Reservoir in northern South Dakota. At that time also, archeologists began to give greater consideration to the concept of conserving the archeological resource base, an ethic which increasingly took root in the professional community following William Lipe's explication of it in a paper published in 1974.

These changes stimulated the creation of a research program for the Knife River Indian Villages that employed innovative field methodology and analytical concepts developed during earlier research at related sites that had been occupied by peoples with a lifeway that was very similar to the Hidatsas and Mandans at Knife River. The research was conducted in accordance with a rigorous and detailed plan that emphasized the preservation of the park's resources by prescribing the use of non-destructive investigative technques such as remote sensing and magnetic surveys, and minimizing the need for traditional excavation techniques. The beginning of an important new understanding has emerged from the Phase I research program conducted for the Knife River Indian Villages National Historic Site. The ultimate success of that research program is summarized in the pages that follow.

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CHAPTER 2

ARCHEOLOGICAL STUDY PREVIOUS TO THE KNRI PROGRAM

Stanley A. Ahler

INTRODUCTION

This chapter provides a review of archeological investigations within and in the vicinity of the Knife River Indian Villages National Historic Site (KNRI) which occurred from the closing decades of the nineteenth century up until about 1976, the time when National Park Service-sponsored work actively began in the KNRI. This review consists of two parts. One is a general overview, arranged chronologically, of various studies which have been conducted in the KNRI and vicinity. The second is a more detailed review of the development of explanatory frameworks for Mandan and Hidatsa culture-history which have been proposed over the years to account for the complexities and patterns, regularities and irregularities recognizable in the prehistoric and historic archeological record in Plains Village sites. The latter review is intended to be particularly pertinent to the reassessment of the culture-historical scheme for the upper Knife-Heart region presented in Chapter 25 based on the latest available data developed in large part from the KNRI Phase I archeological program.

GENERAL OVERVIEW OF PREVIOUS STUDIES

Archeological studies in the upper Knife-Heart region and within the KNRI proper prior to initiation of the NPS program in 1976 can easily be discussed according to four general periods of activity. These can be termed the *mapping period*, which began with the earliest archeological study in 1883 and continued until the late 1920s; the *pioneer excavation period*, which ran from the late 1920s through the mid-1940s; the *Interagency Archeological Salvage Program* (IASP) period, which continued from the late 1940s through the early 1960s; and the *revitalized excavation period*, which began in the mid-1960s and continued through the mid-1970s.

Mapping Period

As implied by the term "mapping period" applied to the earliest episode of archeological study in the KNRI area, the focal point of the earliest studies consisted largely of surveying and mapping major village sites throughout the region. It should be remembered that this activity took place much less than a century after abandonment of some of the villages being studied, and also prior to much of the agricultural and industrial development which was eventually to come to the Missouri River trench. With these considerations in mind, some appreciation can be gained for the clarity of the archeological record which was readily visible on the ground surface to the early researchers, and also for the value of the village plans and other archeological maps which were developed at that time. Much of the detail of these early village site mapping expeditions has been cogently summarized by Wood (1986a) in his review of the cartographic resources for the upper Knife-Heart region, and we have drawn heavily on his work for the summary provided here. Much of the remainder of this section is taken directly with only minor editing from the overview of pre-1974 archeological investigations presented by Lovick and Ahler (1982:85-93).

The earliest documented visit by a professional archeologist to the KNRI area was that of Theodore H. Lewis in October of 1883. At that time, he sketched a number of crude maps with notes on Big Hidatsa Village (32ME12) and Sakakawea Village (32ME11), now within the KNRI, as well as Amahami Village (32ME8), Fort Clark (32ME2), Hensler (32OL18), Greenshield (32OL17), and Bagnell (32OL16) downstream. Copies of these notes and associated maps are on file in the Minnesota Historical Society (Hill-Lewis Manuscripts, S. Notebook No. 2; Wood 1986a:49). Lewis also made a detailed map of the Molander site (32OL7) (Hill-Lewis Manuscripts, Box 7, Folder 2; Wood 1986a:49); this map was later reprinted in Will (1924:Figure 3).

During the period from 1896 to 1904, Judge J. V. Brower from Minneapolis and the Minnesota Historical Society conducted archeological explorations of a sort in the Missouri valley in North Dakota (Brower 1904). His work consisted primarily of extracting large artifact collections from various village sites for purposes of display and curation. In 1904 his collection contained some 30,000

Plains Village artifacts (Brower 1904:xi, xiii). In about 1903 he solicited the help of Ernst R. Steinbrueck of Mandan and the State Historical Society of North Dakota (SHSND) in his artifact collection endeavors (Brower 1904:131-133). Steinbrueck (1904) published a description of 20 village sites he had visited by that time along the Missouri River, but it appears that he had not yet visited sites farther upstream than Deapolis Village (32ME5, Bullberry Bush Camp site) a few kilometers south of the KNRI. Steinbrueck apparently continued his investigations of village sites for a few years under the direction of Orin G. Libby of the SHSND; by 1907 he had produced a map showing the locations of 35 village sites on the Missouri River (Wood 1986a:51), and by sometime prior to 1924 (Will 1924:332-334) he had generated a list of 32 village sites and their legal descriptions which included all three major village sites in the KNRI. We can probably safely assume that the Steinbrueck/Libby work produced artifact collections from these same sites (possibly from uncontrolled excavations) for deposit in the SHSND.

The summer of 1905 saw one of the first truly systematic archeological excavations in the Middle Missouri subarea, conducted by two Harvard University undergraduate students, George F. Will and Herbert J. Spinden, at the Burgois or Double Ditch site a few miles north of Bismarck on the left bank of the Missouri River. They partially excavated several of the large refuse mounds which prominently mark the site, as well as portions of two lodges, three cache pits, and a portion of one of the fortification ditches. They believed the site to have been occupied by the Mandans in prehistoric times, and their report (Will and Spinden 1906) describes their investigation and the collected artifacts and summarizes Mandan ethnography and linguistics as understood at the time.

The period from about 1906 to 1913 was a time of intensive village site mapping activities directed by personnel at the SHSND (Wood 1986a:49-54). Several projects resulted in plan maps of individual sites (e.g., the 1906 Kiebert-Libby maps; the 1909 Stout et al. maps; the 1909 Kiebert map and site notes; and the 1911 Will-Spinden maps) (Wood 1986a:51-54). Other projects resulted in general site location maps generated by both Native Americans and archeologists, for example, the Sitting Rabbit maps of 1906 (Libby 1906) and 1907 (Thiessen et al. 1979); the various maps drawn by native informants and recorded by Gilbert Wilson (Wood 1986a:54-55); and the 1902-1907 maps of E. R. Steinbrueck.

Of particular interest here are maps of sites and features specifically within the KNRI. These include a map of Big Hidatsa Village (32ME12; published in Libby 1908:Plate 4; Bushnell 1922:Figure 12; Bowers 1965:Map 3), maps of Sakakawea Village (32ME11; published in Bowers 1965:Map 5 and Will 1924:Figure 9), maps of Lower Hidatsa Village (32ME10; published in Bowers 1965:Map 4; Will 1924:Figure 10; and Ahler et al. 1991:104), maps of a "soldiers fort" in the southern part of the KNRI (Ahler and Mehrer 1984:Figure 15), and a map of the fortified waterfront site, apparently a late village site (32ME366; Ahler et al. 1983:Figure 3; Ahler 1988:Figures 3 and 4; and Ahler et al. 1991:97). All of these maps are highly significant because they provide descriptive data on many of the prominent archeological features in the KNRI at a time when they were little affected by cultivation, uncontrolled excavation, and other types of disturbance which have occurred at an accelerated pace during the past 75 years.

Of particular relevance to the KNRI program is the Stout 1909 map of village sites and other archeological features at the mouth of the Knife River. This map was drawn by A. B. Stout and a party from the SHSND with information provided by three Mandan-Hidatsas from Fort Berthold (Libby 1910:82). This map encompasses an area very much the same as the KNRI today (Figure 6 in Lovick and Ahler 1982:88). Four major villages clearly shown on the map include Big Hidatsa (designated as Main Village), Sakakawea (Middle Hidatsa), Lower Hidatsa (A-wa-ti-ka), and Amahami (Awach-ha-we). An extensive system of trails is shown connecting the four villages and leading to points outside the area. No traces of many parts of these trails are visible today due to intensive cultivation within parts of the KNRI. Two separate cemetery areas are shown west of Sakakawea Village and northwest of Lower Hidatsa Village, undoubtedly distinguished in 1909 by burial pits visible on the ground surface. Two "Tepee Circle" locations are probably lodge locations or other architectural features. Artifact concentrations exist in those locations today, but no architectural remains are visible, probably due to the effects of cultivation. Of particular note is the "Water Front-Fortified" location at the edge of the Knife River, near but separate from Big Hidatsa Village. This site (32ME366) might not be recognized today as separate from Big Hidatsa Village without the existence of the early maps and notes describing this feature. Another interesting feature is the "Soldiers' Fortification" on the terrace edge a short distance north of Amahami Village. Today this area is totally disturbed by gravel mining activity, and no separate site number has been given to this particular feature. This feature may in fact have been historic in age, or it may have been a part of a fortification system associated with the Buchfink site (32ME9) recognized in the general area.

In 1911 and 1919 George F. Will and Herbert J. Spinden conducted additional reconnaissance efforts in the Missouri River valley (Will 1924), concentrating on collection of analyzable sherd samples as well as mapping and describing certain sites. The major significance of their work and subsequent analysis is that Will was able to provide the beginnings of chronological ordering of several sites into two units which today would be comparable to the Fort Yates phase and the Heart River phase. This distinction was based largely on pottery attributes. In particular, Will was able to distinguish between what we would today call Fort Yates ware and Le Beau S-Rim ware based on the spacing between individual cord impressed decoration lines (Will 1924:341-344); this is still the major distinction recognized between those wares (Lee 1980:166-170, 181). Will's publication provides descriptions of Amahami, Lower Hidatsa, Sakakawea, and Big Hidatsa Villages and new maps of Sakakawea and Lower Hidatsa (Will 1924:323-325, Figures 9 and 10), and generally provides an update on archeological knowledge of the region to that date.

Pioneer Excavation Period

The period of pioneer excavation in Plains Village sites in the upper Knife-Heart region was ushered in, except for Will and Spinden's brief work at the Double Ditch site in 1905, by work in the late 1920s and early 1930s by the Logan Museum of Beloit, Wisconsin, under the direction of Alfred W. Bowers. During that period, Bowers also conducted ethnographic work with the Mandans and the Hidatsas at Fort Berthold Reservation. His archeological work in the area was conducted primarily to test or supplement hypothetical models of the history of the two tribes derived largely from native oral traditions. Bowers' ethnographic work is summarized in his books dealing with Mandan (1950) and Hidatsa (1965) social and ceremonial organization, and his archeological investigations and interpretations are described in his unpublished doctoral dissertation (1948) and in a few other unpublished manuscripts which for the most part have subsequently been lost. Bowers' contributions to an understanding of the culture-history of the region will be summarized in the second part of this chapter. It can be noted that Bowers' archeological field investigations as well as his ideas on the culture-history of the region, while considered by this author to be of some significance, have generally received little positive attention from the remainder of the archeological community (e.g., Will 1933:152; Will and Hecker 1944:110).

In the period 1929 through 1931 Bowers conducted major excavations at several sites in the Missouri valley including Lower Sanger (32OL11), Greenshield (32OL17), and Hensler (32OL18) in the upper Knife-Heart region. He apparently did not excavate in any of the sites in the KNRI, but used surface collections from Big Hidatsa and Lower Hidatsa along with collections from 33 other village sites in the valley in his assessment of the prehistory of the area. His (1948) analysis of rim form, rim decoration attributes, and body sherd surface treatments provides one of the earliest quantitative studies aimed at solving culture-historical problems.

In 1938 a test excavation program was conducted in the KNRI area by a team from Columbia University under the direction of W. Duncan Strong. Strong's crew of graduate students placed five test units in Big Hidatsa Village and four units each in Sakakawea and Lower Hidatsa Villages for the purpose of obtaining ceramic collections and investigating site stratigraphy. They also obtained a surface collection from Amahami Village and tested the Lyman Aldren site (32ME3) outside the KNRI. In 1938 Strong also conducted a large-scale excavation at the Slant Village site (32MO26) at Fort Abraham Lincoln State Park in cooperation with the SHSND; at least one circular house and several burials and cache pits were excavated at Slant. Strong never formally wrote up any of his excavations in North Dakota, but he did use the ceramic data in a summary article on the prehistory of the area (1940). The large ceramic collection from Slant Village was also used extensively in Will and Hecker's (1944) synthesis of regional archeology.

In the late 1930s and early 1940s George F. Will and Thad. C. Hecker of the SHSND conducted test excavations at a large number of village sites in North Dakota (at Menoken [32BL2], Sperry [32BL4], Larson [32BL9], Ward [32BL3], Huff [32MO11], downstream from the KNRI, and at High Butte [32ME13] and White Earth Creek [32MN2] upstream from KNRI) and made surface collections from an even larger number in order to obtain ceramic data for developing a cultural chronology for some 120 sites in the valley. In 1941 Will and Hecker (1944:9) tested a midden dump at Lower Hidatsa Village in the KNRI, finding two distinct house floors, one some 9 ft (2.7 m) below the surface and centered beneath the dump. They estimated a duration of occupation of at least 100 years for Lower Hidatsa with a date of establishment prior to AD 1740 (1944:114).

In addition to providing a location and description of some 120 village sites in the Missouri valley above the Grand River in South Dakota, the primary contribution of Will and Hecker (1944) is their formulation of a culture-historical framework for village sites thought to be associated with the Mandans and Hidatsas. This framework will be discussed in greater detail in a following section.

IASP Period

In the twenty year period from the end of World War II to the mid-1960s, most archeological investigations in the Missouri valley in North Dakota were federally sponsored surveys, testing, and salvage excavations in the Oahe Reservoir south of Bismarck and in the Garrison Reservoir upstream from the KNRI. This research was conducted under the auspices of the Interagency Archeological Salvage Program (IASP), an intensive, multi-agency federal, state, and local effort to salvage information from some of the many archeological and historic sites scheduled for inundation beneath several major reservoirs being constructed by the federal government along the Missouri River mainstem (see the summary of this program in Lehmer 1971). The IASP research was carried out by the Smithsonian Institution's River Basin Surveys (SIRBS) program, the National Park Service, and various cooperating state and local museums, historical societies, and universities. During this IASP period, archeological investigations were conducted at a fast-paced tempo in many parts of the Missouri valley. Field studies nearly ground to a standstill in the upper Knife-Heart region, however, since it was one of the few areas not programmed for destruction by inundation. Major data contributions flowed forth from the Cannonball region to the south and the Garrison region to the north. Major excavations (cf. Lehmer 1971:193-200) south of Bismarck were almost exclusively at prehistoric sites placed within Lehmer's Middle Missouri tradition, including Fire Heart Creek (32SI2; Lehmer 1966), Paul Brave (32SI4; Wood and Woolworth 1964), Havens (32EM1; Sperry 1982), Ben Standing Soldier (32SI7; not yet reported), Tony Glas (32EM4; Howard n.d.), Bendish (32MO2; Thiessen 1976), South Cannonball (32SI19; Griffin 1984), Shermer (32EM10; Sperry 1968), and Huff (32MO11; Howard 1962; Wood 1967). With one exception (Grandmother's Lodge, 32ME59; Woolworth 1956), excavations at villages in the Garrison region were in historic period sites associated with the Arikaras (Star Village, 32ME16; Metcalf 1963), Hidatsas (Rock Village, 32ME15, and Nightwalker's Butte, 32ML39; Hartle 1960 and Lehmer et al. 1978), or the combined Mandans/Hidatsas/Arikaras (Fort Berthold, 32ML2; Smith 1972).

While inundation did not reach the upper Knife-Heart region, the villages there were not immune to destruction. Ralph Thompson, a dedicated lay archeologist, monitored the destruction through gravel mining of Deapolis Village (32ME5), a nineteenth-century Mandan village below Knife River, and amassed a sizeable artifact collection from the site (Thompson 1961). This collection has figured prominently in subsequent research (Lehmer et al. 1978; Chapter 7, this volume).

One of the most significant publications to come from the IASP period is W. Raymond Wood's (1967) study of the Huff site and his assessment of Mandan culture-history which brings together a variety of data, primarily from south of the Heart River, derived largely from IASP investigations. A second major publication developed directly out of IASP studies is Donald J. Lehmer's (1971) review and summary of the federal salvage program and synthesis of knowledge on Middle Missouri archeology near the end of that program. Lehmer's work, in particular, sets forth a revised, comprehensive model of the culture-history of the entire Middle Missouri subarea; this model has for some time been the accepted standard for the subarea. Details of this taxonomic model of particular relevance to KNRI archeology are discussed below.

Revitalized Excavation Period

The year 1965 marked the beginning of a new episode of investigations in the upper Knife-Heart region under the direction of W. Raymond Wood and Donald J. Lehmer. This period of study is here called the revitalized excavation period owing to the fact that some of the largest excavations yet conducted in Plains Village sites in the region were conducted during this time. Wood and Lehmer's interests were focused particularly on the upper

Knife-Heart region because, following the completion of the federal dam construction program, it remained the last major unflooded segment of the Missouri River valley in all the Dakotas. In 1965 Lehmer conducted test excavations at Lower Hidatsa Village and Sakakawea Village within the KNRI, placing two test units in each site. This work was aimed largely at gathering stratigraphic and ceramic data, and on the basis of what was learned, Lehmer (1967) wrote a synopsis of Knife River archeological resources for the NPS. This document was in turn used by the NPS as a data source for planning the creation and development of the National Historic Site a few years later. The artifacts from these tests are described in several reports (Lehmer et al. 1978; Ahler et al. 1980; Ahler and Weston 1981).

In 1968 Wood and Lehmer collaborated on a test excavation program which collected moderate-sized samples from 16 village sites in the upper Knife-Heart region between Sanger and Stanton in Oliver and Mercer Counties. While all data from these tests have not been completely reported, studies of some chipped stone materials (Schneider 1972) and ceramics (Lippincott 1970) have been completed. The ceramic and lithic artifacts from many of these tested sites-a significant part of the data base deriving from sites outside the KNRI-are addressed in Chapters 17 and 18. This testing program also led to a more refined picture of the cultural taxonomy of the upper Knife-Heart region (Wood 1986b), as will be reviewed in the following section of this chapter.

The 1968 Wood/Lehmer testing program provided impetus for several larger-scaled projects, most notably at the Ice Glider (32OL110), Cross Ranch (32OL14), Upper Sanger (32OL12), and Bagnell (32OL16) sites, all on the Cross Ranch near Sanger. Work at Ice Glider, an historic period Dakota winter camp, and the nearby Greenshield (32OL17) and Washburn Ferry (32OL102) sites is reported by Wood (ed. 1986). Lehmer eventually spent four seasons excavating several complete houses at Bagnell Village, but this work has been only partially reported (Lehmer et al. 1973; Angus 1975; Pepperl n.d.). The Bagnell Village collection is one of the most significant for understanding the archeology of the area, including that within the KNRI, and the analysis of these materials, interrupted by Lehmer's untimely death in 1975, remains an important research topic for the future. Two houses were excavated at the Cross Ranch site and analysis of these data yielded the definition of the Nailati phase assigned to the Extended variant of the Middle Missouri tradition (Calabrese 1972). Tests at Upper Sanger have also been reported (Stoutamire 1973).

The next major excavation in the immediate vicinity of the KNRI was the salvage work conducted in 1970 and 1971 by the SHSND and in 1972 by Dana College at a small portion of Amahami Village (32ME8) immediately south of the KNRI where construction of a new courthouse was planned by the town of Stanton. Artifacts from this study constitute the only controlled sample from the site which is now largely destroyed; research there was reported by Dill (1975) and was later summarized by Dill (1977) and Lehmer et al. (1978). An early, prehistoric component at Amahami, thought perhaps to be a part of the larger Buchfink site (32ME9) in the area, was also encountered in the Amahami excavations and has been described in the above reports.

A contribution based on data developed during this and previous periods is the report by Lehmer et al. (1978) which defined the Knife River phase as the culture-historic unit which encompasses virtually all of the Mandan and Hidatsa villages in the upper Knife-Heart and Garrison regions dating from AD 1780 onwards. This report describes the archeology of the Night-Walkers's Butte site (32ML39) and Rock Village (32ME15), discusses excavations at Amahami Village (32ME8), Sakakawea Village, and Lower Hidatsa Village within the KNRI, and provides a detailed summary of data on pottery and trade artifacts found in components assigned to the Knife River phase. The report is particularly useful to the current research in the KNRI program for its definition of Knife River ware and other pottery groups found in the post-contact period sites and in its discussion and hypotheses concerning cultural change evident in Mandan and Hidatsa villages in the late contact period.

Two additional studies serve to illustrate the continuing focus in the 1970s of archeological studies in the vicinity of the KNRI. One is the excavation of the High Butte site (32ME13) (Wood and Johnson 1973) which served to document a Woodland period origin for the site as suspected by Will and Hecker some years earlier (1944:36); the other is the survey of several linear mound groups, apparently also of Woodland origin, by Chomko and Wood (1973).

CULTURE-HISTORIC SCHEMES FOR THE UPPER KNIFE-HEART REGION

Plains Village tradition sites are often, but not always, large and prominent and marked by large midden piles, earthlodge depressions, and fortification ditches. Because of this, such sites have been the focus of most of the previous archeological research in the area, with this work going back to the seminal study by Will and Spinden (1906) at the Double Ditch site near Bismarck. The emphasis on research in Plains Village sites has not been restricted to the Knife-Heart region, but rather, this has been the rule throughout the subarea. This is particularly so in areas to the south now inundated beneath the Oahe, Big Bend, and Fort Randall Reservoirs where major salvage excavations were conducted in the 1950s and 1960s by the IASP (Lehmer 1971:193-200). One product of this research has been the accumulation of a tremendous amount of data on village archeology of the Middle Missouri subarea, particularly from regions south of the Knife-Heart where village sites were most dense and where the effects of inundation have been most severe.

Although the Plains Village tradition exhibits remarkable stability and uniformity in its general characteristics and basic adaptation through time (cf. Wood 1967, 1974), the tradition is not without recognizable internal changes, growth, and developments. Consequently, the Plains Village tradition is internally complex from an archeological point of view, and the 800-900 year period of archeology represented by the tradition has been the subject of considerable effort aimed at chronological ordering, spatial ordering, and development of culture-historical models which allow some explanation of the historic and prehistoric development of the three major tribal groups resident in the area at the historic level. Four such efforts at culture-historic classification have occurred which encompass archeological sites within the upper Knife-Heart region and which are based on data available prior to the NPS/KNRI program.

The earliest such effort was by Will and Hecker (1944), based primarily on excavated and surface collected information from some 120 archeological sites in the Missouri River valley. Geographically, their synthesis was based on sites extending along the trench from South Dakota to the cluster of sites at the mouth of the Knife River, but the focus of the model is on sites in a smaller area in the vicinity of the Heart River in what we might call today the lower Knife-Heart region and the upper end of the Cannonball region (cf. Lehmer 1971:Figure 21). Many of the village sites in this focal area can be linked by oral tradition and historic references to the Mandan tribe, and the culture-historic model developed by Will and Hecker is intended to be a model of Mandan culture-historic developments in the Dakotas. The Hidatsas are collectively considered by Will and Hecker to be latecomers to the valley, and no explicit recognition is afforded them in the prehistoric archeological record. Will and Hecker concluded (1944:33,48) that the material culture of the Mandans, Hidatsas, and "Amahami" (i.e., the Awaxawi subgroup of the Hidatsas) is indistinguishable, attributing this to the close association of these groups over a considerable period of time.

Will and Hecker devised a four-period chronological and developmental scheme for organizing village sites belonging to the Mandan (and Hidatsa) cultural tradition, as outlined in Table 2.1. The chronological sequence was based largely on pottery types and architectural information. Rectangular house forms are associated with the first two units, the Archaic Mandan period and the Middle Mandan period, and circular houses are associated with the Later Heart River period and the Decadent Mandan period. The Later Heart River period reflects the peak in Mandan cultural development as seen in the major traditional Mandan villages near the mouth of the Heart River. Control of chronology in Will and Hecker's time was minimal, but it is interesting to note that they considered the Later Heart River period to have begun at least as early as AD 1650 and possibly much earlier, but definitely in pre-contact times. The Decadent Mandan period was distinguished by a loss of the finely decorated S-rim pottery and use of other straight or braced rim forms. This process was considered by Will and Hecker to have occurred primarily after AD 1800, after the Mandans had vacated the Heart River area and had settled near the Knife River. Virtually all pottery collections from that area which were not dominated by fine S-rim wares were classified by Will and Hecker as belonging to the Decadent Mandan period.

The work by Will and Hecker was soon followed by a yet more comprehensive study of the cultural taxonomy of the Middle Missouri subarea conducted by Alfred W. Bowers. His study was developed in his unpublished doctoral dissertation (1948) and has been only partially published in later works on the Mandans (1950) and Hidatsas (1965). Bowers approached the archeology of the subarea through use of the direct historical approach, a research method well established in the Central

Table 2.1. Outline of the Will and Hecker (1944) culture-historic scheme as it applies to Plains Village sites in the upper Knife-Heart region.

Periods	Tribal Identification	Approx. Time
Decadent	Mandan Hidatsa Arikara	
		ca. AD 1800-1825
Later Heart River	Mandan Hidatsa	post-contact & pre-contact
		AD 1650 or earlier
Middle Mandan	assumed Mandan	
		?
Archaic Mandan	assumed Mandan	
		?

and Northern Plains (Strong 1932, 1940; Wedel 1938). Bowers worked from a wide variety of known data at the historic horizon, developed a hypothetical model for the prehistory of the subarea, and worked backwards in time to organize the differences and similarities of archeological manifestations into units conforming to the hypothesized model of prehistoric cultural development. Bowers mustered a wide range of available data in his research including extensive ethnological information gathered from Mandan and Hidatsa informants on the Fort Berthold Reservation. Extensive data on oral histories played a very significant role in the model for the culture-history developed by Bowers. We can note that Bowers' research was conducted prior to the availability of carbon-14 dating for the subarea.

Bowers began his assessment of the prehistory of the subarea with the recognition that the Mandan and Hidatsa tribal groups as recognized today each at one time consisted of two or more distinctive subgroups with each, according to tribal traditions, apparently having its own history and prehistory (Bowers 1948:15-24; also see Chapter 12, this volume). Working from ethnographically collected oral traditions of the Mandans, Bowers suggested the existence of two major internal subdivisions (what we might call co-traditions) during the prehistory of the Mandans. These were based on an early subdivision of the tribe into two relatively geographically isolated subgroups shortly after their arrival on the Missouri River in South Dakota, sometime prior to AD 1300 (Table 2.2). The northern subgroup eventually settled in the vicinity of the mouth of the Heart River in North Dakota. Bowers (1948:80-95) recognized three archeological foci or chronological subunits for this northern subgroup of the Mandans, from earliest to latest, the Cannonball, Huff, and Heart River foci. Cannonball and Huff focus peoples built rectangular lodges, while Heart River focus peoples built circular lodges.

Oral traditions (Bowers 1948:20-24) indicate that simultaneously with the Mandan settlement in the Heart River area, the southern subgroup of the Mandans remained far to the south, eventually moving westward along the tributary streams draining from the Black Hills. After a period of isolation from the northern Mandan group, these southern Mandans moved back onto the

Table 2.2. Outline of the Bowers (1948) culture-historic scheme as it applies to Plains Village sites in the upper Knife-Heart and Garrison regions.

Northern (Heart River) Mandan Tradition	Southern Mandan Tradition	Hidatsa Tradition	Approximate Time
Heart River Focus (Nuitadi) (Nuptadi)	Heart River Focus (Awigaxa)	Heart River Focus (Hidatsa-proper) (Awatixa) (Awaxawi)	post-contact & pre-contact
			ca. AD 1650
Huff Focus	Upper Grand Focus	Painted Woods Focus (Awatixa) (Awaxawi)	
			ca. AD 1450-1500
Cannonball Focus	Lower Grand Focus		
			ca. AD 1300-1350

Missouri River establishing villages at the mouths of the Cheyenne, Moreau, and Grand Rivers. Bowers suggested that this occurred by circa AD 1500 (1948:96), and that the southern Mandans had by this time adopted the use of circular lodges and made pottery with predominantly tool-impressed decorations. After about AD 1500, the southern Mandan group moved far up the Missouri valley and settled in the Knife-Heart region, among and north of the Heart River Mandan group and south of the Knife River. These southern Mandan groups took with them the distinctive cultural traits of tool-incised ceramics and circular house plans. Eventually, during the period from AD 1500 to contact, the northern and southern subgroups of Mandans blended with each other and merged into the single generalized Mandan cultural pattern known from the historic era (Bowers 1948:95-106; 1950:16-17). Bowers placed the sites of the southern Mandans in three chronologically distinct foci, the Lower Grand, the Upper Grand, and the Heart River foci (Table 2.2). The Lower Grand focus is represented only by sites in South Dakota; the Upper Grand focus is represented both by South Dakota sites and several sites in the Knife-Heart region established after the migration of these peoples to the north (e.g., Lyman Aldren, Motsiff), and the Heart River focus is comprised of early and late post-contact age villages throughout the Knife-Heart region.

At about the time that the southern Mandan group moved into the upper Knife-Heart region from far to the south, the first of the Hidatsa groups, the Awatixas, moved onto the Missouri River from the east, also settling in the upper Knife-Heart region near the Knife River (Bowers 1948:107-133, 219). Shortly thereafter, a second subgroup of Hidatsas, the Awaxawis, also moved onto the Missouri from the east and established a series of settlements near the Mandan villagers in the upper Knife-Heart region with whom they interacted closely from this time on. The third Hidatsa subgroup, the Hidatsas-proper, arrived quite late on the Missouri River, settling at the Big Hidatsa Village which was apparently the only major village established by these people in the region. Bowers places the Hidatsa village sites in two chronologically sequential foci, the prehistoric Painted Woods focus, and the post-contact Heart River focus. The Painted Woods focus accounts for the pre-contact age villages of the Awaxawis and Awatixas in the region, chronologically equivalent to and sometimes geographically very near the Upper Grand focus Mandan groups who settled in the same area at about the same time (Table 2.2). This was a period of intensive borrowing and sharing of cultural traits, with the Hidatsas rapidly adopting ceramic decorative practices from the Mandans in the area, and eventually dropping such distinctive traits as pottery check-stamping which they had brought with them.

The Bowers scheme recognizes the strong role that the processes of borrowing and assimilation played during the late prehistoric and historic periods among all Mandan and Hidatsa groups in the area. Bowers gives recognition to the process by placing all such later groups in the single Heart River focus.

At face value, it appear that Bowers' scheme for the culture-history of the area offers the flexibility for accomodating broad diversity of archeological complexes in the Knife-Heart region. Recent work in the KNRI has in fact documented such diversity, with prehistoric-age sites which contain essentially "South Dakota" cultural elements occurring there in some numbers. Limitations of Bowers' scheme have to do primarily with definition of the individual taxonomic units, or foci, many of which would now probably be redefined as containing one or more phases based on more refined dating and analytic procedures. It is likely that the overall picture captured by Bowers in his view of the culture-history of the area may in fact be valid, while the internal details of his model need to be refined using new techniques and the latest available data.

The culture-historic model set forth by Bowers has received neither wide recognition nor much acceptance by Middle Missouri archeologists. This is attributable in part to the lack of publication of either the 1948 dissertation or the primary data upon which it is based. Bowers' model was soon to be eclipsed by another model first set forth by Donald Lehmer in 1954, later explained in much more detail in Lehmer's 1971 *Introduction to Middle Missouri Archeology*, which has come to be viewed as the basic overview and syn-thesis of Plains Village cultural development in the Dakotas.

Before examining the details of Lehmer's synthesis of Middle Missouri prehistory, we should mention a major work produced by W. Raymond Wood (1967) following Lehmer's early (1954) synthetic statement and just prior to Lehmer's final overview (1971) of all Middle Missouri archeology. Wood's work focuses specifically on the culture-history of the Mandan tribe, based in large part on primary data from the Huff site just below the Heart River. He does not attempt to address details of Hidatsa prehistory or cultural developments in the upper Knife-Heart region. For that reason we will not review it in detail here. Wood elaborates upon and adds considerable chronological detail or other facts to the model of Mandan cultural development set forth in Will and Hecker (1944). He also addresses ancestral Arikara intrusions in the lower part of the Missouri valley and the idea of a coalescence between ancestral Arikaras and ancestral Mandans as set forth by Lehmer (1954). Few new data were available to Wood in 1967 from the upper Knife-Heart region, and prehistoric cultural developments in the Knife River area remained largely unexplained in detail in Wood's study and were assumed to conform to general models developed from data gathered farther to the south.

Returning now to the contributions of Lehmer (1954, 1971), we can note that the views of Lehmer and Bowers (1948) are somewhat contrastive due to the differing perspectives and methods followed by each scholar. Lehmer (1971) approached the problem of Plains Village culture-history and taxonomy geographically and conceptually from South Dakota where he did his original fieldwork in the subarea (1954). He immersed himself in the wealth of data and artifacts generated by the IASP, mostly from sites south and downstream from Bismarck. Lehmer developed a model of culture-history which strongly emphasized processes of environmental change, migration, and diffusion, with the latter two having origins in areas to the south and southeast. Lehmer worked with the aid of chronometrically-dated sites and generated a model of culture change and development which conceptually proceeded from the prehistoric data base to the historic record. He first used the archeological data to organize the prehistoric complexes into temporal and spatial units, and he then used the historic records of early Euroamerican explorers to bridge the gap between prehistory and history and to provide the linkage between his archeological complexes and the scene as documented during the waning years of the Plains Village period.

One can note that the approach taken by Bowers, working from history to prehistory, was essentially the opposite of that applied by Lehmer who worked from prehistory to history. Even though Bowers' contributions (1948, 1950, 1965) were largely available to Lehmer at the time of his last synthesis of the archeology (1971), Lehmer apparently chose not to use or comment on most of the historical data and the culture-historical model set forth in Bowers' work.

Lehmer's (1971) scheme of events recognizes the coexistence of two separate traditions within the more general Plains Village tradition or pattern in the Middle Missouri subarea. The earliest of the two is the Middle Missouri tradition which accounts for the initial influx of villagers into the area and which encompasses the early part of the prehistoric record of the Mandan and possibly the Hidatsa tribal groups. People belonging to the Middle Missouri tradition moved into the Missouri valley from the southeast, rapidly spread throughout the whole of the subarea, and lived under relatively stable conditions for several hundred years. The hallmarks of the Middle Missouri tradition are use of dwellings with rectangular floor plans and use of pottery with a relatively porous fabric and with straight and S-shaped rim profiles and tool- and coarse cord-impressed decorations.

The second major tradition recognized by Lehmer in the subarea is the Coalescent tradition. The Coalescent tradition first appears in the subarea perhaps 300 years later than the Middle Missouri tradition, and the appearance of this cultural unit reflects actual migrations of peoples having a different culture and language stock from the Central Plains into the southern half of the subarea in South Dakota. Specifically, Lehmer would equate the Coalescent tradition, at least in its "Initial" and "Extended" variants, with the ancestors of the Caddoan-speaking Arikaras. The Coalescent tradition, at least prior to AD 1675, is characterized by earthlodges with circular floor plans and by thin-walled pottery with compact paste and often with straight to outflared rims and a high incidence of tool decorations. In its early form, Lehmer (1971:124-128) conceives of the Coalescent tradition as a blending of ideas and cultural traits from the Central Plains with preexisting traits and slightly different ideas already in the area in the form of the Middle Missouri tradition.

For a period of time (AD 1400-1675) peoples bearing the Coalescent and Middle Missouri traditions coexisted in the respective southern and northern parts of the Middle Missouri subarea (Lehmer 1971:124-128). For uncertain reasons, at about the time of historic contact (estimated to be AD 1675 by Lehmer) the two traditions began another period of "coalescing" (1971:163-179), this time with the northern Middle Missouri tradition peoples losing much of their distinctiveness expressed in terms of ceramic decorative procedures and rectangular house types. They supposedly borrowed the circular house form from their neighbors to the south and also eventually made most of their pottery with outflared, thickened rim forms in keeping with their more southerly neighbors. By the time that historic documents began to be recorded for the area, the Mandans, Hidatsas, and Arikaras had all undergone the ravages of smallpox and had coalesced even more, bearing a material culture which was very similar across all three tribal groups.

Lehmer uses the concept "variant" to further organize chronological and spatial subunits within each of the two major traditions. Thus, the Middle Missouri tradition exhibits Initial, Extended, and Terminal variants, reflecting primarily periods of time during which the Middle Missouri peoples (ancestors of the Mandans and possibly Hidatsas) 1) made their initial penetration into the subarea; 2) extended their dominance throughout the subarea; and finally, 3) retracted to the north under conflict and territorial competition with their Coalescent tradition neighbors to the south. The Coalescent tradition exhibits Initial, Extended, Post-Contact, and Disorganized variants, reflecting periods of 1) initial intrusion from the south; 2) expansion upriver at the expense of the proto-Mandans and proto-Hidatsas; 3) sharing of ideas with northern neighbors and eventual absorption of these neighbors into the same tradition during the period of early historic contact; and finally, 4) cultural collapse under pressures from Euroamerican disease and trade systems during the fully historic period.

Table 2.3 presents a summary of the Lehmer model as applied directly to sites in the upper Knife-Heart region. Lehmer was reluctant to discuss individual phase definitions for the Extended Middle Missouri variant in any region in the subarea (1971:97), due largely to a lack of detailed studies of individual site assemblages. The lack of information for the Extended Middle Missouri variant was particularly acute in the upper Knife-Heart region, and Lehmer declined to suggest any phase names which might be applied to components of that variant in that part of the valley. In an appendix to his 1971 work, Lehmer (1971:201-206) did present summary information and in some cases original definitions for phases which he assigned to the Post-Contact and Disorganized variants of the Coalescent tradition throughout the subarea. For regions in South Dakota this included several phases thought to be linked to early and historic Arikara occupations in that part of the valley. In the Knife-Heart region in North Dakota Lehmer defined both the Heart River phase which was thought to date in the early part of the contact period (Post-Contact Coalescent variant) and the Knife River phase which was dated as following the disastrous smallpox epidemic of AD 1780-1782 (Disorganized Coalescent variant) (Table 2.3). Both phases are characterized by houses with circular floor plans and fairly compact, nucleated villages which in some cases are fortified. The major distinctions between the two phases lie in material culture, with the Heart River phase characterized by Le Beau S-Rim ware pottery, and with the Knife River phase characterized by straight, braced rim ware pottery, eventually classified as Knife River ware (Lehmer et al. 1978).

Lehmer (1971:203-204) defined subphases 1 and 2 of the Heart River phase, based largely on geographic distributions of sites, with the former subphase sites being concentrated near the mouth of the Heart River and with the latter subphase sites scattered upstream from Square Buttes to the Knife River. Historic documentation can be used to demonstrate that many of the subphase 1 villages were occupied by the Mandans, while Lehmer hypothesized that the subphase 2 sites may have been Hidatsa in origin, based primarily on their locations and the absence in those villages of a central plaza characteristic of Mandan villages. In a similar fashion, Lehmer identified subphases 1 and 2, respectively, for the Knife River phase, which are linked to respective historically documented occupations by the Mandan and Hidatsa tribes. Lehmer does acknowledge (1971:204-205) that Bowers had studied and taxonomically classified some of the same sites, but he incorrectly interpreted Bowers' classification system, suggesting that Bowers' Heart River focus and Painted Woods focus were both equatable with Lehmer's Heart River phase (cf. Table 2.2).

A key difference in the Lehmer and Bowers approaches to the ordering of the culture-history of the subarea lies in 1) the definition of the Extended Coalescent variant on the part of Lehmer as representing Caddoan-speaking immigrants into the area, versus 2) the identification by Bowers of the Lower Grand and Upper Grand foci, applied to some of the same sites, as early manifestations of a Mandan subgroup. That is, Bowers explains much of the archeological diversity of the Missouri valley from the Cheyenne River northward as a reflection of movements and interactions among various subparts of the Mandan cultural tradition, while Lehmer would account for these same archeological phenomena as documenting a confrontation between the Mandan-based culture to the north and the Caddoan, Central Plains-origi-

Table 2.3. Outline of the Lehmer (1971) culture-historic classification as it applies to Plains Village sites in the upper Knife-Heart and Garrison regions.

Tradition	Variant	Phase	Subphase	Approx. Time
				AD 1862
	Disorganized Variant	Knife River Phase	1 (Mandan) 2 (Hidatsa)	
Coalescent Tradition				AD 1780
	Post-Contact Variant	Heart River Phase	1 (Mandan) 2 (Hidatsa)	
				post-contact AD 1675 pre-contact
Middle Missouri Tradition	Extended Variant	Not Named		
				AD 1100

nating cultures to the south. A major deficiency in Lehmer's cultural taxonomy is that it does not anticipate or allow for archeological complexes with "Coalescent-like" traits (tool-incised pottery and circular houses) at any location north of the Caddoan-speakers' migration front until a period quite late in time, that is, not until during the second episode of coalescence during the post-contact period. However, Bowers clearly recognized the existence of anomalous sites such as Lyman Aldren on a prehistoric time level and located far to the north of the traditional Mandan homeland at the mouth of the Heart River. The existence of such sites can be accounted for in the oral traditions of the Mandans which Lehmer apparently ignored, but which Bowers utilized in development of his culture-historical model for the sub-area.

A second major difference in the two models is that Bowers' model suggests the existence of an Hidatsa cultural tradition, separate from that of the Mandans, recognizable in the prehistoric archeological record and embodied in the Painted Woods focus (Table 2.2). The Lehmer model, in contrast, follows the lead set by Will and Hecker and allows little recognition in the pre-contact period archeological record for distinctly Hidatsa archeological manifestations. This difference is probably directly attributable to the relative importance the respective scholars have afforded the historic records and oral traditions of the Mandans and Hidatsas in developing their culture-historic models. If cultural developments and migrations documented in oral traditions in fact leave some recognizable imprint on the archeological record, then the Lehmer model, actually based at its core on broad language distributions recorded at the historic time level, may ultimately prove too simple to serve adequately as an explanatory framework for the archeological record.

A potentially serious flaw in the Lehmer model is the identification of a Coalescent *tradition* when in fact no such tradition may have actually existed. Lehmer may have correctly recognized the *process* of coalescence, and there may be as many as three examples of this process having occurred during the prehistory of the area: 1) when Caddoan-speaking villagers moved out of the Central Plains and established themselves as a new, culturally distinctive village group in South Dakota; 2) when the southern Mandan group borrowed architectural and ceramic traits from elsewhere while living in the vicinity of the Black Hills; and 3) when the two groups of Mandans and three groups of Hidatsas interacted in the Knife-Heart region. These three episodes of the process of coalescence were not necessarily chronologically sequential and did not necessarily involve the same group of people or their direct descendents in all three cases. Hence, these processes, while occurring repeatedly in the Plains Village period in the subarea, do not necessarily constitute a cultural "tradition" in the sense that Willey and Phillips (1958:37) defined it as a "(primarily) temporal continuity represented by persistent configurations in single technologies or other systems of related forms." For this reason, the use of the unit "Coalescent tradition" as one of the primary integrative units for Lehmer's taxonomy for the subarea is subject to serious question.

We can further note that based on data currently available, neither scheme appears to serve particularly well in unmodified form as the final model for the culture-history of the Knife-Heart region. Limitations in Lehmer's model seem to stem in part from difficulties in his use of the concept "tradition," and in part from the southerly origin of most of his data base. In the latter regard, he simply did not take into account the complexity of the archeological record or the richness of the oral histories for the northern part of the Middle Missouri subarea and in the Knife-Heart region. It is probably fair to say that the model Lehmer developed simply fits better in the south than in the north. In the years following publication of *Introduction to Middle Missouri Archeology*, Lehmer focused his interests on the Knife-Heart region, and, to his credit, he apparently began to appreciate the complexity of the region and its significance for the understanding of the subarea in general. On the other hand, Bowers' research (partly because of the period in which it was conducted) suffers from lack of good chronological control, from lack of good contextual data for some multicomponent sites, and to some extent from lack of large enough data samples, particularly from sites in the southern end of the trench. Bowers tended to see the prehistory of the trench from a northern perspective, and some of his generalizations are perhaps strongly biased by that perspective.

In a recent paper W. Raymond Wood (1986b) has set forth yet another fairly detailed cultural taxonomy developed specifically for the upper Knife-Heart region. This is discussed here rather than later in this volume because, like the previous models, it is grounded in data available prior to initiation of the NPS/KNRI program in 1976. The major data source for this work is in fact the artifact collections derived from the Wood-Lehmer testing program conducted in 1968 in the region and data developed in many of the spin-off investigations during the late 1960s and early 1970s at sites in the Sanger Bend area, as discussed in the previous section. Data from these sources were augmented by Wood's reexamination of early artifact collections from many upper Knife-Heart region sites housed in the State Historical Society of North Dakota.

Wood's (1986b) model is essentially an update of the broad Lehmer model for the entire Middle Missouri subarea, refined and applied specifically to sites in the upper Knife-Heart region. Thus it retains the concept that archeological components there can be organized according to two major, sequential cultural traditions, the Middle Missouri and the Coalescent (Table 2.4). Wood retains Lehmer's (1971:203-205) Heart River phase of the post-contact Coalescent variant. Likewise, Wood also retains Lehmer's (1971:205-206) Disorganized Coalescent variant Knife River phase (also defined in Lehmer et al. 1978) with the respective Mandan (I) and Hidatsa (II) subphases. The most significant addition in Wood's model is its recognition of two additional phases, the Nailati and the Clark's Creek phases, which are assigned to the prehistoric age, Middle Missouri tradition (Table 2.4). The Nailati phase was originally defined by Calabrese (1972) based on research at Cross Ranch Village (32OL14), and the earlier, Clark's Creek phase is newly defined by Wood in the 1986 paper. The Wood model shares with that of Lehmer and that of Will and Hecker a lack of distinction between Mandan and Hidatsa sites in the absence of historic documentation confirming an ethnic association for a particular village. Insofar as the Lehmer model is subject to criticism on the basis of an unclear usage of the concept of tradition and a potentially inadequate accounting of events documented in oral traditions, Wood's model for the upper Knife-Heart region is subject to the same potential limitations.

The two earlier phases described by Wood and assigned to the Extended Middle Missouri variant share

Table 2.4. Outline of the Wood (1986b) culture-historic classification as it applies to Plains Village sites in the upper Knife-Heart and Garrison regions.

Tradition	Variant	Phase	Subphase	Approx. Time
				AD 1862
Coalescent Tradition	Disorganized Variant	Knife River Phase	I (Mandan) II (Hidatsa)	
				AD 1780
	Post-Contact Variant	Heart River Phase	I (Mandan) II (Hidatsa)	
				post-contact AD 1675 pre-contact
Middle Missouri Tradition	Extended Variant	Nailati Phase		
				AD 1300
		Clark's Creek Phase		
				AD 1200

many cultural traits. Both are characterized by use of long-rectangular house structures apparently oriented northeast-southwest, dispersed settlements lacking fortifications, and manufacture of S-rim and straight, unbraced-rim pottery wares. Check stamped surface treatment in pottery occurs at sites of both phases, and is most common in and distinctive of Nailati phase sites. Clark's Creek phase houses appear to have been constructed in shallow pits, while Nailati phase houses were constructed near the present ground surface. The Nailati phase is thought to have developed directly from the Clark's Creek phase; the Nailati phase is also characterized as a transitional link to the subsequent Heart River phase.

The reader is referred to Table 2.5 for a summary of the similarities and contrasts in the respective culture-historic classifications which have been developed for the study area over the past half-century. This table contains a listing of most of the previously recognized Plains Village sites in the upper Knife-Heart and nearby Garrison regions along with the culture-historic classifications assigned to them by various researchers. The taxonomic unit identification is given for each site and, where such has been offered or clearly implied by a researcher, the specific tribal unit or subunit identification is also noted for each village. Note that many sites are recognized as multicomponent in nature and are classified as belonging to multiple taxonomic units.

Table 2.5. Summary of previous taxonomic classifications of major Plains Village tradition sites in the upper Knife-Heart and Garrison regions, North Dakota.

Region and Site		Will and Hecker 1944	Bowers 1948	Lehmer 1971	Wood 1986b
Garrison Region					
Like-A-Fishhook	32ML2	DEC (M,H,A)	HRF,MF	DCV	ARIK
Star	32ME16	ARIK	MF	DCV	ARIK
Night-Walker's Butte	32ML39		?	KRP2	KRPII
Rock	32ME15		HRF(HP)	KRP2	KRPII
Grandmother's Lodge	32ME59			EMMV	
Upper Knife-Heart Region - Sites within the KNRI					
Big Hidatsa	32ME12	LHR (H)	HRF(HP)	HRP2, KRP2	HRP,KRPII
Sakakawea	32ME11	DEC (H)	HRF(AT)	KRP2	KRPII
Lower Hidatsa	32ME10	LHR (H)	PWF,HRF(AT)	HRP2, KRP2	HRP,KRP
Buchfink	32ME9	MM	PWF(AT)	EMMV	NP
Amahami	32ME8	DEC (A)	PWF,HRF(AX)	KRP2	KRPII
Upper Knife-Heart Region - Sites outside the KNRI					
Black Cat	32ME5	LHR (M)	HRF(M)		KRPI
Stiefel	32ME202			EMMV	CCP
Stanton Ferry	32ML6	AM	PWF	EMMV	CCP
White Buffalo Robe	32ME7	LRH	HRF	HRP	HRP
Boller	32ME6	DEC (M)	?	KRP1	KRP
Sagehorn	32ME101			EMMV	CCP
Deapolis	32ME5	DEC (M)	HRF(M)	KRP1	KRPII
Alderin Creek	32ME4			HRP	HRP
Big White	32ME203	LHR (M)	HRF(M)		
Lyman Aldren	32ME3	AM	UGF		EMMV
Fort Clark	32ME2	DEC (M)	HRF(M),MF		KRPI,ARIK
Clark's Creek	32ME1	AM	CF	EMMV	CCP
Mahhaha	32OL22	LHR (A)	PWF	HRP,EMMV	NP,NRP,KRP
Shoreline	32OL103				CCP
Mandan Lake	32OL21	AM,MM,LHR	PWF,HF,HRF	HRP2,EMMV	HRP

Table 2.5. Concluded.

Region and Site		Will and Hecker 1944	Bowers 1948	Lehmer 1971	Wood 1986b
Upper Knife-Heart Region-(cont.)					
Connolly	32OL20	AM	?		
Dennison	32OL19	MM	HRF	HRP	HRP
Hensler	32OL18	MM	HRF(M)	HRP	HRP
Greenshield	32OL17	ARIK	MF		ARIK
Flaming Arrow	32ML4	LHR (M)	PWF(AT)		
Bagnell	32OL16	MM	PWF(AX),MF	HRP,EMMV	NP,HRP
Unnamed	32OL15	MM	PWF		
Cross Ranch	32OL14	AM	PWF	EMMV	NP
Mile Post 28	32OL13	MM	PWF	EMMV	NP
Upper Sanger	32OL12	MM	PWF	HRP,EMMV	EMMV,HRP
Lower Sanger	32OL11	MM	HRF(M)	HRP	EMMV,HRP
Wildwood	32OL10	AM	?		CCP
Smith Farm	32OL9	LHR	HRF	HRP2	HRP
Pretty Point	32OL8	AM,MM	CBF,HRF	EMMV	EMMV,HRP
Molander	32OL7	ARIK	HF		KRF
Price	32OL6	MM		EMMV	

Explanation:

Will and Hecker 1944 -	DEC	=	Decadent Period
	LRH	=	Late Heart River Period
	MM	=	Middle Mandan Period
	AM	=	Archaic Mandan Period
	ARIK	=	Historic Arikara
	(M)	=	Mandan
	(H)	=	Hidatsa
	(A)	=	Amahami (Awaxawi Hidatsa)
Bowers 1948 -	MF	=	Meyers Focus (Arikara)
	HRF	=	Heart River Focus
	PWF	=	Painted Woods Focus (Awaxawi and Awatixa)
	UGF	=	Upper Grand Focus (Southern Mandan)
	CF	=	Cannonball Focus (Northern Mandan)
	HF	=	Huff Focus (Northern Mandan)
	(HP)	=	Hidatsa-Proper
	(AT)	=	Awatixa
	(AX)	=	Awaxawi
	(M)	=	Mandan
Lehmer 1971 -	EMMV	=	Extended Middle Missouri Variant
	HRP, HRP1, HRP2	=	Heart River Phase, Subphase 1, Mandan Subphase 2, Hidatsa
	KRP, KRP1, KRP2	=	Knife River Phase, Subphase 1, Mandan Subphase 2, Hidatsa
	DCV	=	Disorganized Coalescent Variant
Wood 1986b -	EMMV	=	Extended Middle Missouri Variant
	CCP	=	Clark's Creek Phase
	NP	=	Nailati Phase
	HRP, HRPI, HRPII	=	Heart River Phase, Subphase I, Mandan Subphase II, Hidatsa
	KRP, KRPI, KRPII	=	Knife River Phase, Subphase I, Mandan Subphase II, Hidatsa
	ARIK	=	Historic Arikara

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CHAPTER 3

THE ARCHEOLOGICAL RESEARCH DESIGN FOR THE KNRI

Stanley A. Ahler

Early in the development of the archeological program at the KNRI it was established that the research should be conducted according to a comprehensive research plan. Elements of that plan were already in place when the Midwest Archeological Center (MWAC) initiated salvage excavations at the Sakakawea Village site (32ME11) in the summer of 1976. When S. A. Ahler joined the staff of the University of North Dakota (UND) in the fall of 1976, filling the position created through the joint agreement between UND and the National Park Service (see Chapter 1), his first task was to work with the MWAC staff to fully develop a detailed plan for all subsequent archeological research to be conducted in the KNRI.

This plan was available in draft form by the time of the 1977 field season, and it was finalized early in 1978 (Ahler 1978). Since that time it has provided general guidance and specific research problem orientation for virtually all aspects of archeological research sponsored by the NPS in the KNRI.

The 1978 research plan consists of three parts. First is background information on what was at the time the current state of knowledge about archeological resources and archeological problems relevant to the KNRI archeological program (Ahler 1978:1-31). This includes a summary of previous and ongoing archeological programs in the region and a summary of data on existing archeological collections available for study and of some pertinence to the archeological program within the KNRI. Much of that information has been reiterated in even more detail in Lovick and Ahler (1982:85-98) or will be repeated in one way or another in updated form in this report, and it need not be repeated here.

The second part of the 1978 KNRI research plan consists of a delineation of major archeological problems or information needs which should be addressed in the KNRI archeological program (Ahler 1978:32-39). These problem statements form the background against which virtually all subsequent archeological work in the KNRI has been conducted, and they bear repeating here. Five major problem areas are identified: 1) the need for accurate site locational and inventory data; 2) the need to establish a detailed Plains Village site chronology for sites in the KNRI and in the surrounding region; 3) the need to develop a refined culture-historic statement which assesses and, if possible, distinguishes between Mandan and Hidatsa culture-historical developments in the archeological record; 4) the need to isolate and study various cultural systems and subsystems and the changes in such systems during, particularly, the post-contact period; and 5) the need to provide detailed archeological data and recommendations to KNRI management personnel for purposes of developing sound management decisions affecting the preservation of significant archeological sites in the KNRI. Each of these points can be briefly elaborated upon.

(1) The need for accurate site locational data for the entire KNRI is of paramount concern for proper management and development of the KNRI. Executive Order 11593 (1971) and Section 110 of the National Historic Preservation Act as amended in 1980, direct all federal agencies to develop inventories of archeological sites on lands under their management, and such data are absolutely essential to developing any viable long-term research program in the KNRI. At the time that the KNRI was authorized by Congress in 1974, four archeological sites were known to exist within the designated boundary. Even cursory surface examination indicated this to be a gross underestimate of the full inventory of archeological properties within the KNRI, and compilation of accurate data on this subject was a high priority for research, development, and management within the KNRI.

(2) Refined chronological information was essentially lacking for virtually all sites in the KNRI as well as in the surrounding region at the time of the initiation of the KNRI archeological program. Several sites within the KNRI were dated to the post-contact period on the basis of historic documentation and presence of artifacts of Euroamerican origin, and sites and components dating to the prehistoric, pre-contact era were thought to exist there as well. In 1976, none of these sites was well dated by chronometric means, and only two sites in that entire

region of the Missouri valley had been dated by radiocarbon analysis. Lacking such information, only a very general culture-historic scheme had been developed for the region, based on broad parallels in material culture between KNRI site samples and samples from outside the region. Detailed chronological data were necessary before any accurate interpretation of historical developments in the KNRI could occur.

(3) Most of the major village sites in the KNRI, whose preservation and interpretation was to occur through creation of the KNRI by Congress, were thought to be attributable to occupation by various groups and subgroups of the Hidatsa Indian tribe. An interpretation of the development of Hidatsa culture or other cultures responsible for the presence of these major villages in the KNRI would hinge in part on development of a credible, culture-historic sequence for these and other sites in the region. No acceptable, detailed scheme specifically applicable to the KNRI area existed in 1976. Most previous archeological scholars (e.g., George Will and Thad. C. Hecker, Donald Lehmer, and W. R. Wood) saw the Hidatsas as latecomers to the Missouri River valley, having little significant impact on the mainstream cultural development thought to be attributable to the Mandans. The Mandans were seen as the dominant culture in the region, with the Hidatsas borrowing much from the Mandans, and with the Hidatsa developmental scheme closely paralleling that of the Mandans. Many details of the culture-historic scheme for the Mandans had been worked out for regions downstream from the KNRI (Wood 1967; Lehmer 1971). A directly competing and highly contrastive scheme for the culture-history of the area had also been set forth, however, by Alfred W. Bowers (1948, 1965). The sequence, based on a meld of archeological, historical, and ethnographic data, attributed a lengthy cultural tradition to the Hidatsas, independent and distinguishable from Mandan developments. All schemes in existence in 1976 were based on a limited archeological data base and virtually no independent chronometric data. Resolution of the conflict between the competing interpretations of Hidatsa and Mandan culture-history, based on development of a refined archeological taxonomy for the region, was clearly a paramount requirement for reliable interpretation of the resources within the KNRI.

(4) It was well known that the sites within the KNRI contained long records of occupation by various subgroups of the Hidatsas, with this occupation thought to extend from pre-contact times well into the historic period when both the Mandans and Hidatsas abandoned the region. Historic documentation makes it clear that at least the last 100 years of this period, up until abandonment of the area in AD 1845, was one of the most turbulent times for native village inhabitants. In this century the villagers were racked several times by epidemic disease, were under nearly constant hostile pressure from nearby horse nomads, and were subjected to various economic pressures from the advancing Euroamerican fur trade. Because occupation of the Plains Village sites in the KNRI continued uninterrupted through this turbulent era, the archeological sites contain an unparalleled record of culture change as it occurred in a culture contact situation. Thus, these sites comprise a laboratory, a huge storehouse of data, concerning culture change, potentially unparallelled in detail and in continuity anywhere else in the North American continent. The archeological program in the KNRI should at all times focus on interpretation of such a unique information base.

(5) The impending development of the KNRI for public visitation and interpretation would undoubtedly require detailed, project-specific data on particular archeological resources. Assessment and evaluation of particular archeological sites would have to be made with regard to planning for placement and construction of roadways, interpretive features, foot trails, and visitor and administrative facilities. In some instances where a conflict existed between a chosen construction location and the existence of an archeological site, salvage of artifacts and collection of other data relative to the site would have to be planned and executed. The archeological research program for the KNRI was intended to integrate such cultural resource management activities into other pertinent data and interpretive needs, providing a service to the park managers, and maximizing the usefulness of information gained in such resource management activities.

The third part of the 1978 research plan for the KNRI consists of a detailed research design formulated to provide maximum information concerning the problem areas and areas of data need just outlined (Ahler 1978:40-61). Such a program would lead ultimately to both publicly and scholarly oriented interpretation of the archeological resources within the KNRI and assessment of their significance to development of both Plains Village and Euroamerican culture in the area. This would necessarily be a long-term endeavor, and a three-phase program was proposed. Phase I deals with collection of a wide array of baseline information which will completely fill some of the data needs identified above and which will lay the foundation for more detailed studies relevant to other valid research problems. Phase I archeological programs have been largely completed, and it is the purpose of this report to both summarize the results of those specific programs as well as to interpret as much information gained from Phase I research as is possible at the present time.

Phase II is envisioned as a more intensive examination of selected archeological data sources within the KNRI, with choice of those sources and the methods used to study them based on the results of Phase I investigations. Specifically, this phase of archeological investigation is to include intensive test excavation programs at each of the major villages in the KNRI and parallel investigations at a few other selected sites. Phase II of archeological research in the KNRI has not yet been initiated by the NPS.

Phase III of the KNRI archeological program was projected as consisting of major excavation and interpretive programs centering on particular earthlodges within particular sites. The intent would be to excavate and interpret complete dwelling units from multiple, constrastive village sites in the KNRI, and in addition, to incorporate "living archeology" programs and modern earthlodge constructions into both the research and the public interpretive programs.

A series of specific, Phase I activities is prescribed in the 1978 research plan (Ahler 1978:41-49) including the following: 1) development of detailed maps of the KNRI through photogrammetric coverage and other remote sensing procedures; 2) completion of the Executive Order 11593 inventory of archeological and historical sites within the KNRI; 3) proton magnetometer survey of selected archeological sites within the KNRI; 4) controlled artifact surface collection within selected archeological sites in the KNRI; 5) problem-oriented test excavation in a large number of sites in the KNRI; 6) reconnaissance, testing, evaluation, and planning for salvage excavation (mitigation or "data recovery") in designated development areas; 7) cultural resource survey and reconnaissance in selected areas outside of the KNRI; 8) development of baseline information of the environment and paleoenvironment for the KNRI; 9) development of a detailed chronological study of KNRI archeological sites using chronometric dating methods; 10) analysis of existing artifact collections from sites, including those outside of the KNRI, particularly relevant to interpretation of KNRI archeological resources; and 11) assisting the KNRI management in developing a program for control of destructive rodent populations currently residing in several KNRI archeological sites.

Virtually all of these objectives have been addressed to one degree or another during the years since their identification in 1978, and many tasks have been fully accomplished as they were envisioned some 13 to 15 years ago. Various sections which follow in this report document or otherwise summarize the results of the investigations directed towards these 11 goals since 1976.

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Note: References in which an asterisk precedes the date were supported in whole or part by the Midwest Archeological Center's archeological and ethnohistorical research program for the Knife River Indian Villages National Historic Site.

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CHAPTER 4

THE KNRI ARCHEOLOGICAL INVENTORY SUBPROGRAM

Stanley A. Ahler

INTRODUCTION

A program of cultural resource reconnaissance and inventory was conducted in the Knife River Indian Villages National Historic Site (KNRI) in Mercer County, North Dakota, during the period 1976 through 1980. This program was conducted in accordance with Executive Order 11593 (1971), having the specific goals of determining the location, content, function, age, and significance of cultural resources lying within the KNRI on lands owned and/or managed by the National Park Service (NPS). Data from this program are intended to be useful both to NPS managers and planners who are charged with the responsibility of preservation and development of resources in the KNRI for public interpretation, and to archeologists and historians who are seeking knowledge of the history and prehistory of the explorers, fur traders, Mandans, Hidatsas, and yet more ancient peoples who lived in this area during the past few thousand years.

A comprehensive report by Lovick and Ahler (1982) has been prepared on the Phase I cultural resource reconnaissance and inventory program in the KNRI. That report contains summary data on the environmental setting of the KNRI, a summarization of the culture-historic taxonomy used to classify the KNRI archeological sites, a synopsis of previous archeological investigations in the KNRI area (see also Chapter 2, this volume), discussions of survey methods and results, data summaries on surface artifact collections (see Chapter 6, this volume), a classification of the inventoried resources according to function and taxonomic placement, and brief descriptions of each archeological site in the KNRI. What follows in this chapter is a general summary of most of the topics covered in that report, focusing on the functional and culture-historic classification of various sites in the KNRI. This section is taken largely from the Lovick and Ahler report (1982:1-19), with editing and revision as necessary based on information subsequently published in reports on test excavations at various sites in the KNRI (Ahler, ed. 1984; Ahler and Mehrer 1984; Ahler and Swenson 1985; Ahler et al. 1983; Toom and Ahler 1985).

METHODS AND PROCEDURES

Even though the inventory program was not initiated until the NPS began to purchase land for the KNRI in 1976, the archeological and historical data upon which it is based began to be recorded more than two centuries ago. Of particular significance are a large number of historic accounts and documents generated by early Euroamerican and American explorers, fur traders, adventurers and their descendants who mapped, exploited, and eventually settled the area and, in so doing, recorded a great deal of information on the native cultures which they encountered. Historic documents of significance are reviewed in Wood (1977b) (see also Chapter 11, this volume); some of the most important early documentary records were provided by La Vérendrye, Evans, Mackay, Thompson, Lewis and Clark, Henry, Larocque, Bradbury, Brackenridge, Catlin, Maximilian, and Bodmer.

Archeological investigations began in earnest in the KNRI area early in the twentieth century (see Chapter 2). The early archeological mapping efforts organized by Orin G. Libby of the State Historical Society of North Dakota in 1906-1909 and by George Will and Herbert F. Spinden in 1911 and 1919 produced invaluable data on the location and function of many archeological sites and features which today are nearly obliterated by decades of cultivation and more severe disturbances. These early investigations, like most archeological research that has followed, concentrated on the large earthlodge village sites which in the KNRI include Lower Hidatsa Village, Sakakawea Village, and Big Hidatsa Village. These sites are today the focal point of the KNRI interpretive program, although we now know that they constitute only a small fraction of the full range of resources within the KNRI. Later archeological research of some significance to the present program includes the work of Alfred Bowers for the Logan Museum, primarily in the period from 1929-1933; W. Duncan Strong's testing programs for Columbia University in 1938; additional explorations by the State Historical Society in the years from 1920 to 1942; and a number of significant projects undertaken by Donald J.

Lehmer and W. Raymond Wood from Dana College and the University of Missouri, respectively, in the late 1960s and early 1970s. These studies have been summarized in Chapter 2.

Nearly all previous archeological investigations dealing with data from the upper Knife-Heart region and neighboring areas in the Missouri valley have been intended to contribute to models of the culture-history of the Plains Village groups (Mandans, Hidatsas, and Arikaras) who occupied the Middle Missouri subarea in historic times. Four notable efforts at synthesizing the culture-history of the region have occurred: Will and Hecker (1944); Bowers (1948); Lehmer (1971); and Wood (1986). These studies and their strong points and shortcomings are also reviewed in Chapter 2.

Recent archeological research within the KNRI has convinced us that none of the existing general culture-historic models for the prehistory of the Middle Missouri subarea are fully adequate for classification of the archeological record at the KNRI and in the upper Knife-Heart region. The reasons for this are multiple. Bower's (1948) model probably comes the closest to being directly usable for the KNRI area; in fact, his concepts of the prehistoric development and interaction among the Mandans, Hidatsas, and Arikaras may be generally accurate. Even so, his organization of the archeological data base into foci can today be questioned due to his lack of control on absolute chronology and sampling problems related to mixed components and other factors. Lehmer's model (1971) (and that of Will and Hecker 1944, on which Lehmer's work is based) appears to be even less useful, because it is structured according to overly simplistic ideas about diffusion and ethnic group interaction and migrations. Above all, this model makes little attempt to mesh Mandan and Hidatsa oral traditions with the complexities of archeological data directly from the upper Knife-Heart region. Wood's model (1986), while grounded in data directly from the region, still does not account adequately for certain archeological manifestations known to occur in the KNRI, and it suffers from some of the same theoretical shortcomings of the Lehmer model.

Faced with a series of general culture-historical models for the upper Knife-Heart region which appear to be either outdated or otherwise inadequate, we have chosen to refocus attention on the basic dimensions of form, space, and time and to formulate or reformulate the basic analytical units of component and phase which can form the building blocks leading to broader synthetic statements of culture-history.

Within the KNRI, the attempt to organize components into low-level culture-historical units such as phases has dealt almost entirely with Plains Village period sites which include by far the majority of the cultural resources in the area. For the Plains Village period, six basic culture-historic units are used for the purpose of organizing the inventory of KNRI archeological sites. These units include: the Clark's Creek phase (AD 1000-1200; Wood 1986); the Nailati Phase (AD 1200-1400; Calabrese 1972; Lee 1980); the Heart River phase (AD 1400-1650; Ahler and Weston 1981; Lehmer 1971:203-205); the Scattered Village complex (AD 1400-1650; Lovick and Ahler 1982:73-75); a protohistoric unit provisionally termed the Transitional Phase (AD 1650-1750; Ahler and Weston 1981:60-64); and the Knife River phase (AD 1750-1861; Lehmer 1971:205-206; Lehmer et al. 1978).[1] The newly recognized but poorly understood Scattered Village complex is perhaps the most enigmatic of the culture-historic units presently in use, possibly occurring contemporaneously with the Heart River phase, yet contrasting strongly with the Heart River phase in settlement pattern, ceramic content, and lithic artifact content. It is thought that most of the story of the prehistory of the Mandans and Hidatsas and the record of their interaction in the Missouri River valley (key study goals of the KNRI program) are to be found within archeological data from Heart River phase and Scattered Village complex components.

A large number of data sources were used for the location, assessment, and evaluation of cultural resources in the KNRI. Historic documents (Wood 1977a, 1977b; Wood and Thiessen 1985; Gough 1988) have played an important role in documenting the age and function of several archeological features in the area. Equally important have been data from the 1909 Libby-Stout mapping expedition. Ethnographic information collected by Bowers (1950, 1965) and Gilbert Wilson (1914 and thereafter) in the early part of this century has also proved of value in

[1] The reader should note that the above-named system used for the inventory of cultural resources within the KNRI is somewhat different from the more refined taxonomic system which eventually developed out of the Phase I research studies, as discussed in Chapter 25.

interpretation of site age and function. Other significant documentary sources include several series of vertical and oblique aerial photographs covering the KNRI area, the earliest of which was taken in 1938 (see Chapter 9, this volume). Several U. S. Department of Agriculture air photo series document successive land use changes in the KNRI, and these and the 1977 false-color infrared series produced by the NPS document a large number of archeological features which are no longer visible on the ground. Finally, two excellent series of modern contour maps, one at 0.5 ft interval covering each of the major village sites in the KNRI, and the other at 0.5 m interval for the entire KNRI, provide excellent tools for site description and documentation.

On-the-ground examination, surface artifact collection, and subsequent analysis of surface artifact data have provided the largest block of information central to the goal of locating and assessing KNRI cultural resources. Four distinct procedures have been used for surface inspections in the KNRI. The most precise is the point-quarter survey technique (Ahler et al. 1979; Ahler and Weston 1980) applied in previously cultivated areas where ground surface visibility was relatively good. A second, similar, point-quarter procedure was also adapted for use in uncultivated, pasture areas. Point-quarter survey was applied in approximately 11 percent of the KNRI land surface. The point-quarter technique generates data on both artifact content and surface artifact density measurements, without the necessity of artifact collection, on a grid system covering a large land tract. The resulting surface artifact density data have been plotted spatially using the SYMAP computer graphics package (Dougenik and Sheehan 1975), and such maps are used to empirically determine the locations of site boundaries, usually to a precision of ±10 meters as plotted on the 1:1,000 scale KNRI base maps (see Lovick and Ahler 1982:126-141 for results of the point-quarter survey).

The two other on-the-ground reconnaissance procedures applied within the KNRI include systematic explorations with a power auger and traditional or conventional on-the-ground reconnaissance. The auger survey was confined largely to a floodplain area in the northern part of the KNRI where surface visibility was minimal due to heavy vegetation cover yet where the likelihood of cultural resources was relatively high due to the geological and topographic setting. Approximately 8 percent of the KNRI surface was examined in this manner, and results are considered to be rewarding. Traditional reconnaissance involved walking the ground surface in transects and flagging discovered artifact concentrations, followed by field definition of sites based on artifact distributions and topographic considerations. Traditional survey also included detailed examination of the cutbank and shoreline along the Knife River though the KNRI. Approximately 65 percent of the KNRI surface was covered by traditional survey.

Surface artifact collections have been taken from a large number of KNRI sites, and, in areas of high resource density, the collections have proven essential for determining site boundaries and providing preliminary culture-historic assessment of many resources. More than 117,000 artifacts have been collected from the surface of KNRI sites since the inception of the KNRI program. A large part of that sample (about 91,000 specimens) is from intensive collections within major village sites and is not directly relevant to the general inventory program. Approximately 26,000 artifacts have been recovered in spatially controlled intensive collections in other site areas. Chapter 6 discusses controlled surface collection procedures and results in the KNRI.

Analysis of surface artifacts has focused on two major classes, ceramics and chipped stone remains. Ceramic rim sherds have been analyzed by cross-cutting variables of rim form and decorative technique, and ceramic body sherds have been classified according to surface treatment and decoration. Stone tools are separated from flaking debris, and tools have been quantified by technological class, use-phase class, raw material type, and degree of patination. Flaking debris has been quantified by raw material type and patination; data on these two variables proved most useful in both tools and flaking debris for culture-historic assessment of components in the KNRI (see Lovick and Ahler 1982:161-195 for analysis of surface collection data). Test excavations have been conducted in 14 sites in the KNRI, and data from these sources have also been used in the inventory project (see Chapter 5).

Fifty-five archeological and historic sites were documented as a result of the formal reconnaissance and inventory program in the KNRI (Lovick and Ahler 1982). One additional site has been documented since that time (the Baker Cemetery, 32ME787). The distribution of these sites within the KNRI is shown in Figure 4.1. Only four of these sites were formally recorded prior to initiation

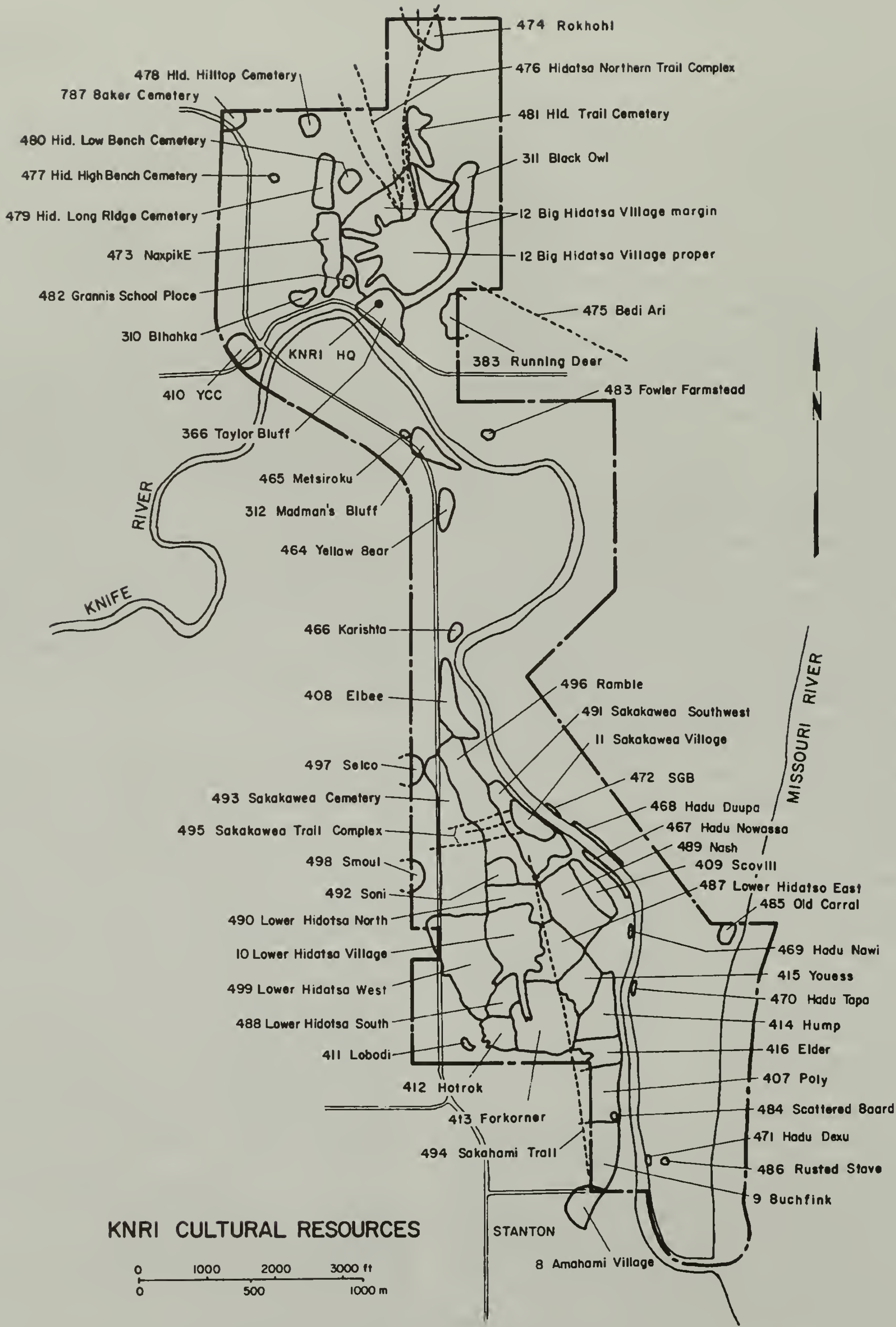

Figure 4.1. Distribution of all known archeological and historic sites in the KNRI.

of the University of North Dakota/NPS reconnaissance program (the three major villages and the Buchfink site), although a number of the sites or individual features had previously been observed and described. Together, these 56 sites cover approximately 25 percent of the total surface area within the KNRI, with the remaining 75 percent designated as various non-site zones. Even the non-site zones, particularly those on higher, geologically older ground surfaces, are not free of evidence of previous human activities; evidence there is sufficiently dispersed or hidden, however, to preclude accurate assessment of site boundaries and interpretation of human activities at those locations without further investigations.

The 56 cultural resource sites within the KNRI have been classified according to two cross-cutting schemes; one is a descriptive/functional classification which deals with the physical appearance and inferred functional content of the sites, and the other is a culture-historic classification which places sites and components in the previously mentioned taxonomic units based largely on stylistic or other variation in artifact content. Any given site may have more than one descriptive/functional classification depending on the variety and range of activities inferred to have occurred there. This happens because many sites are in topographic settings which were useful for various purposes which changed with passage of time and shifts in settlement patterns. Similarly, a large number of the sites contain evidence of multiple components or episodes of occupation and activities which fall into more than one culture-historic unit. This again reflects the continued desirability of certain topographic settings for cultural activities over long periods of time. When functional-descriptive classification and culture-historic classification of the sites are considered together, a diachronic record of changing land use and settlement patterns in the KNRI emerges.

SUMMARY OF CULTURE-HISTORIC AND DESCRIPTIVE/FUNCTIONAL CLASSIFICATIONS

The culture-historic classification of all sites in the KNRI is summarized in Table 4.1, and the descriptive/functional classification is summarized in Table 4.2. The earliest archeological components in the KNRI can generally be classified as belonging to the pre-Plains Village period (pre-AD 1000), meaning that these components belong to unspecified Archaic tradition (6000 BC-AD 1) or Woodland tradition (AD 1-1000) culture-historic units. In nearly all cases, the temporal classification as pre-Plains Village period in age is based on occurrence of moderately to heavily patinated Knife River flint stone tools and flaking debris (cf. VanNest 1985) and/or the occurrence of projectile points which are distinctly non-Plains Village in form. Currently 17 components in the KNRI are assigned to the pre-Plains Village period (Table 4.1; Figure 4.2). All of these components are classified descriptively as artifact debris (primarily lithic) scatters, meaning that they are composed of diffuse scatters of flaking debris, stone tools, fire-cracked rock, and occasionally bone, and that more specific identification of site function is not presently possible (Table 4.2). Only three of these components have been identified in stratified contexts (identified as preceramic in Table 4.1), with the remaining 14 occurring as surface scatters, and in almost all cases as a minor component in a site where a later component occurs in greater prominence or density.

The stratified pre-Plains Village components are clearly the most significant ones in the group of 17, these occurring at the Scovill site, the Elbee site, and the Taylor Bluff site. At Scovill, a diffuse scatter of heavily patinated lithic materials is found stratified below Plains Village materials within the mid-Holocene age Pick City member of the Oahe formation (Clayton et al. 1976). The sample from Scovill is small and diagnostic materials are rare (Ahler and Mehrer 1984:162-191). At the Elbee site, a nonceramic component is sealed in a paleosol about one meter below the present surface of the A Terrace, and C-14 dates from loci stratigraphically below this horizon date this component to younger than 2,970 radiocarbon years BP (Ahler, ed. 1984). This component lacks stylistically diagnostic materials but contains heavily patinated chipped stone artifacts, fire-cracked rock, and a small amount of bone debris. At the Taylor Bluff site, the preceramic component occurs in a paleosol dated by C-14 to 3,430 radiocarbon years BP; this component is known primarily from the cutbank exposure at the site which has yielded fragmented bison bone and charcoal, but no diagnostic lithic remains (cf. Ahler, ed. 1988).

It is difficult to assign a more precise culture-historic classification to any of the pre-Plains Village components. Projectile points, a temporally sensitive artifact type, include a wide diversity of dart and possible arrowpoint forms which might span the Middle and Late Archaic and entire Woodland period (perhaps from 7,000

Table 4.1 Summary of the culture-historic classification of sites recorded in the Knife River Indian Villages National Historic Site.

Site Number (32ME_)	Site Name	Euroamerican Tradition	General Plains Village Tradition	Knife River Phase	Transitional Phase	Heart River Phase	Scattered Village Complex	Nailati Phase	Pre-Village (Woodland or Preceramic)	Pre-Ceramic	Unknown
9	Buchfink	X	-	-	-	-	-	X	X	-	-
10	Lower Hidatsa	-	-	X	X	X	-	-	X	-	-
11	Sakakawea	-	-	X	-	-	-	-	-	-	-
12	Big Hidatsa	X	-	X	X	X	X	-	X	-	-
310	Bihohka	-	X	-	-	-	-	-	X	-	-
311	Black Owl	-	-	-	-	-	X	-	-	-	-
312	Madman's Bluff	X	-	-	-	-	X	-	-	-	-
366	Taylor Bluff	X	X	X	-	-	-	-	-	X	-
383	Running Deer	-	-	X	X	-	X	-	-	-	-
407	Poly	X	-	-	-	-	?	X	X	-	-
408	Elbee	X	X	X	-	-	?	-	-	X	-
409	Scovill	X	X	X	-	-	X	-	-	X	-
410	YCC	-	-	-	-	-	X	-	-	-	-
411	Lobodi	-	X	-	-	-	-	-	-	-	X
412	Hotrok	-	-	-	-	X	X	-	X	-	-
413	Forkorner	-	-	-	-	-	X	-	X	-	-
414	Hump	-	-	-	-	-	X	?	X	-	-
415	Youess	-	-	-	-	-	X	-	X	-	-
416	Elder	-	-	-	-	-	?	-	-	-	-
464	Yellow Bear	X	-	-	-	-	X	-	-	-	-
465	Metsiroku	-	X	-	-	-	-	-	-	-	-
466	Karishta	-	X	-	-	-	-	-	-	-	-
467	Hadu Nowassa	-	X	-	-	-	-	-	-	-	-
468	Hadu Duupa	-	-	-	-	-	-	-	-	-	X
469	Hadu Nawi	-	-	-	-	-	-	-	-	-	X
470	Hadu Topa	-	-	-	-	-	-	-	-	-	X
471	Hadu Kexu	-	-	-	-	-	-	-	-	-	X
472	SGB	-	-	-	-	-	-	-	-	-	X
473	NaxpikE	-	X	-	-	-	-	-	X	-	-
474	Rokhohl	-	-	-	-	-	-	-	X	-	-
475	Bedi Ari	-	X	-	-	-	-	-	-	-	-
476	Hidatsa Northern Trail Complex	-	X	-	-	-	-	-	-	-	-
477	Hidatsa High Bench Cemetery	-	X	-	-	-	-	-	-	-	-
478	Hidatsa Hilltop Cemetery	-	X	-	-	-	-	-	-	-	-
479	Hidatsa Long Ridge Cemetery	-	X	-	-	-	-	-	-	-	-
480	Hidatsa Low Bench Cemetery	-	X	-	-	-	-	-	-	-	-
481	Hidatsa Trail Cemetery	-	X	-	-	-	-	-	-	-	-
482	Grannis School Place	X	-	-	-	-	-	-	-	-	-
483	Fowler Farmstead	X	-	-	-	-	-	-	-	-	-
484	Scattered Board	X	-	-	-	-	-	-	-	-	-
485	Old Corral	X	-	-	-	-	-	-	-	-	-
486	Rusted Stove	X	-	-	-	-	-	-	-	-	-
487	Lower Hidatsa East	-	X	-	-	-	X	-	-	-	-
488	Lower Hidatsa South	-	X	-	-	-	-	-	-	-	-

Table 4. 1. Concluded.

Site Number (32ME_)	Site Name	Euroamerican Tradition	General Plains Village Tradition	Knife River Phase	Transitional Phase	Heart River Phase	Scattered Village Complex	Nailati Phase	Pre-Village (Woodland or Preceramic)	Pre-Ceramic	Un-known
489	Nash	-	X	-	-	-	-	-	-	-	-
490	Lower Hidatsa North	-	X	-	-	-	-	-	-	-	-
491	Sakakawea Southwest	-	-	X	-	-	-	-	-	-	-
492	Soni	-	X	-	-	-	-	-	-	-	-
493	Sakakawea Cemetery	-	X	-	-	-	-	-	X	-	-
494	Sakahami Trail	-	-	X	-	-	-	-	-	-	-
495	Sakakawea Trail Complex	-	-	X	-	-	-	-	-	-	-
496	Ramble	-	X	-	-	-	-	-	-	-	-
497	Selca	-	X	-	-	-	-	-	X	-	-
498	Smaul	-	X	-	-	-	-	-	X	-	-
499	Lower Hidatsa West	X	X	-	-	X	-	-	X	-	-
787	Baker Cemetery	-	X	-	-	-	-	-	-	-	-
Total		14	27	10	3	4	15?	3?	15	3	6

Table 4.2. Summary of the descriptive/functional classification of sites recorded in the Knife River Indian Villages National Historic Site.

Site Number (32ME_)	Site Name	Major Village	Village Periphery Zone	Off-Village Activity Area	Less Prominent Village	Cemetery	Trail	Farmstead or Homestead	Other Historic Sites	Debris Scatter
9	Buchfink	-	-	-	X	-	-	X	?	X
10	Lower Hidatsa	X	-	-	-	-	-	-	-	-
11	Sakakawea	X	-	-	-	-	-	-	-	-
12	Big Hidatsa	X	-	-	X	-	-	X	-	X
310	Bihohka	-	-	-	-	-	-	-	-	X
311	Black Owl	-	-	-	X	-	-	-	-	-
312	Madman's Bluff	-	-	-	X	-	-	X	-	-
366	Taylor Bluff	-	-	X	-	-	-	X	-	X
383	Running Deer	-	-	X	?	-	-	-	-	-
407	Poly	-	-	-	X	-	-	X	-	X
408	Elbee	-	-	-	X	-	X	X	-	X
409	Scovill	-	-	-	X	X	-	X	-	X
410	YCC	-	-	-	X	-	-	-	-	-
411	Lobodi	-	-	X	-	X	-	-	-	-

Table 4.2. Concluded.

Site Number (32ME_)	Site Name	Major Village	Village Periphery Zone	Off-Village Activity Area	Less Prominent Village	Cemetery	Trail	Farmstead or Homestead	Other Historic Sites	Debris Scatter
412	Hotrok	-	-	X	-	-	-	-	-	X
413	Forkorner	-	-	-	X	-	-	-	-	X
414	Hump	-	-	-	X	-	-	-	-	X
415	Youess	-	-	-	X	-	-	-	-	X
416	Elder	-	-	-	X	-	-	-	-	-
464	Yellow Bear	-	-	-	X	-	-	X	-	-
465	Metsiroku	-	-	-	-	-	-	-	-	X
466	Karishta	-	-	-	-	-	-	-	-	X
467	Hadu Nowassa	-	-	X	-	-	-	-	-	-
468	Hadu Duupa	-	-	-	-	-	-	-	-	X
469	Hadu Nawi	-	-	-	-	-	-	-	-	X
470	Hadu Topa	-	-	-	-	-	-	-	-	X
471	Hadu Kexu	-	-	-	-	-	-	-	-	X
472	SGB	-	-	-	-	-	-	-	-	X
473	NaxpikE	-	-	X	-	-	-	-	-	X
474	Rokhohl	-	-	-	-	-	-	-	-	X
475	Bedi Ari	-	-	-	-	-	X	-	-	-
476	Hidatsa Northern Trail Complex	-	-	-	-	-	X	-	-	-
477	Hidatsa High Bench Cemetery	-	-	-	-	X	-	-	-	-
478	Hidatsa Hilltop Cemetery	-	-	-	-	X	-	-	-	-
479	Hidatsa Long Ridge Cemetery	-	-	-	-	X	-	-	-	-
480	Hidatsa Low Bench Cemetery	-	-	-	-	X	-	-	-	-
481	Hidatsa Trail Cemetery	-	-	-	-	X	-	-	-	-
482	Grannis School Place	-	-	-	-	-	-	-	X	-
483	Fowler Farmstead	-	-	-	-	-	-	X	-	-
484	Scattered Board	-	-	-	-	-	-	-	X	-
485	Old Corral	-	-	-	-	-	-	-	X	-
486	Rusted Stove	-	-	-	-	-	-	-	X	-
487	Lower Hidatsa East	-	X	-	X	-	-	-	-	-
488	Lower Hidatsa South	-	X	-	-	-	-	-	-	-
489	Nash	-	-	X	-	-	-	-	-	-
490	Lower Hidatsa North	-	X	-	-	-	-	-	-	-
491	Sakakawea Southwest	-	X	-	-	-	-	-	-	-
492	Soni	-	-	X	-	-	-	-	-	-
493	Sakakawea Cemetery	-	-	X	-	X	-	-	-	X
494	Sakahami Trail	-	-	-	-	-	X	-	-	-
495	Sakakawea Trail Complex	-	-	-	-	-	X	-	-	-
496	Ramble	-	-	X	-	X	-	-	-	X
497	Selca	-	-	X	-	X	-	-	-	X
498	Smaul	-	-	X	-	X	-	-	-	X
499	Lower Hidatsa West	-	X	-	-	X	-	-	-	X
787	Baker Cemetery	-	-	-	-	X	-	-	-	-
Total		3	5	12	15	13	5	9	5	25

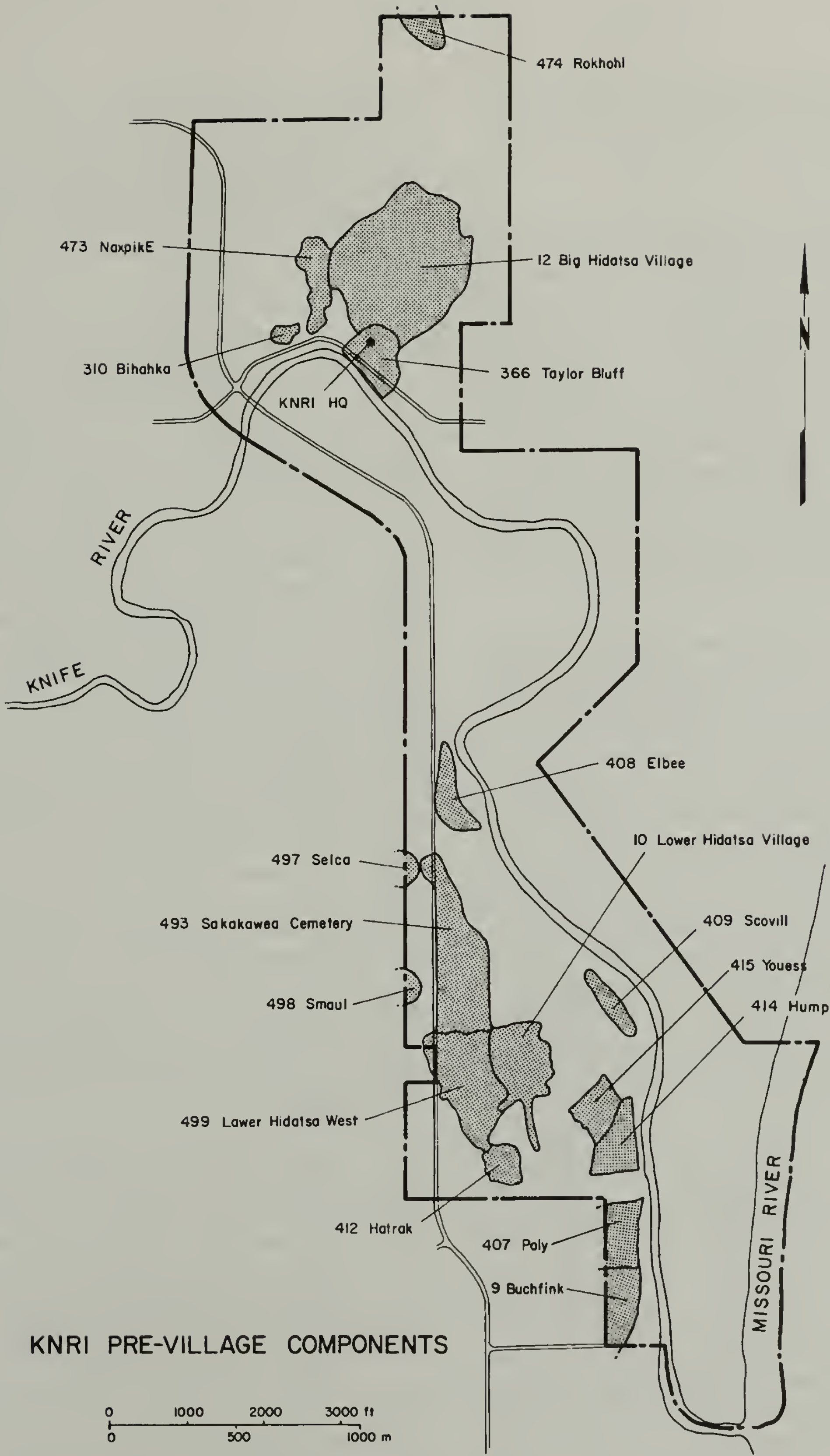

Figure 4.2. Distribution of sites with pre-Plains Village period components in the KNRI.

to 1,000 years BP) (see Chapter 23). No definite Woodland period ceramics have been found at any site within the KNRI, however.

The next major temporal period is the Plains Village period with its associated Plains Village tradition (AD 1000-1861). In keeping with the earlier discussion, this lengthy period is not organized here into other traditions, horizons, or variants, but rather, it is broken into a number of phases or similarly-scaled analytic units to which individual site components are assigned (without consideration here of broader culture-historic schemes and implications). The earliest such phase recognized in the study area is the Clark's Creek phase (AD 1000-1200; Wood 1986); no village components in the KNRI are assigned to the Clark's Creek phase, although a component of this phase exists at the nearby Stiefel site (32ME202) about 3 km upstream on the Knife River.

Chronologically the next unit in the village period is the Nailati phase (AD 1200-1400), originally defined at the Cross Ranch site (32OL14; Calabrese 1972) and dealt with in some detail at the White Buffalo Robe site (Lee 1980) near the KNRI. The main components at the Buchfink site and at the Poly site are tentatively assigned to the Nailati phase and the main component at the Hump site possibly belongs to this unit (rather than to the Scattered Village complex) (Table 4.1). These assignments are based on the occurrence of Fort Yates ware pottery and a high frequency of check-stamped body sherd surface treatment (Ahler and Mehrer 1984:302, 307). All three sites are descriptively/functionally classified as less prominent village sites (Table 4.2), meaning that they are dispersed in plan without surface evidence of architecture or major midden accumulations but with the full functional range of Plains Village artifact types.

Scattered Village complex components (AD 1400-1650) comprise the next major culture-historic unit within the Plains Village period in the KNRI (see Figure 4.3). Scattered Village components are tentatively identified at 15 sites in the KNRI (Table 4.1), with this identification being most firm at seven sites which have been intensively surface collected (Poly, Scovill, Forkorner, Hump, and Youess) and/or test excavated (Running Deer, Poly, Elbee, Scovill, Forkorner, Hump, Youess, Big Hidatsa, and Hotrok). The remaining six components in the Scattered Village complex are so assigned on the basis of general observations on surface ceramics and lithics as well as surface expression and location. Scattered Village complex sites vary in size from about 0.6 to 7.0 hectares (1.25 - 17.5 acres), and all such components are tentatively classified from a descriptive/functional perspective as less prominent villages (Table 4.2). The latter classification is probably most firm for several of the larger sites which have been subjected to controlled surface artifact collection and test excavation and which can be demonstrated to contain the full functional range of village artifacts and dispersed midden deposits (cf. Ahler and Mehrer 1984). Such a classification is largely a guess for several locations where site size is small and/or where functional artifact content is basically unknown due to poor surface visibility or small sample size (such as at Running Deer, Black Owl, Madman's Bluff, YCC, Elder, Yellow Bear, and Lower Hidatsa East).

Within the group identified as Scattered Village complex sites, two distinct variants can be identified on the basis of ceramic and lithic content (Ahler and Mehrer 1984:316). The Youess and Forkorner sites exemplify the dominant variant which is distinguished by a low but consistent frequency of check-stamping in pottery body sherds, approximately equal proportions of unnamed S-rims and straight rim vessels, and a high occurrence of clear/grey chalcedony in the chipped lithic material. The second variant is identified clearly at the Elbee site and possibly at the Scovill site; assemblages there are characterized by near-absence of check-stamping in body sherds, a high frequency of unnamed straight rim vessels decorated most frequently by tool-modifications, and a lithic aggregate reflecting predominant use of Knife River flint. Remnants of a circular house are also found at Elbee. Overall, the Elbee ceramic assemblage is more similar to Extended Coalescent variant assemblages from South Dakota than it is to assemblages from other nearby Scattered Village complex components (Ahler 1984:115-116).

Within the three major villages in the KNRI are found expressions of all three remaining phases identified for the Plains Village period (Table 4.1). The Heart River phase, dated generally at AD 1400-1650, occurs at Lower Hidatsa Village (Ahler and Weston 1981) where it is tentatively dated in a more restricted period from about AD 1450 to 1600. Artifacts assigned to time unit 6 at Big Hidatsa Village (AD 1600-1650) could also possibly be assigned to the Heart River Phase (Ahler and Swenson 1985). The main components at the Hotrok site (Ahler and Mehrer 1984:45-72) and the Lower Hidatsa West site (Toom and Ahler 1985) can also be assigned to the Heart

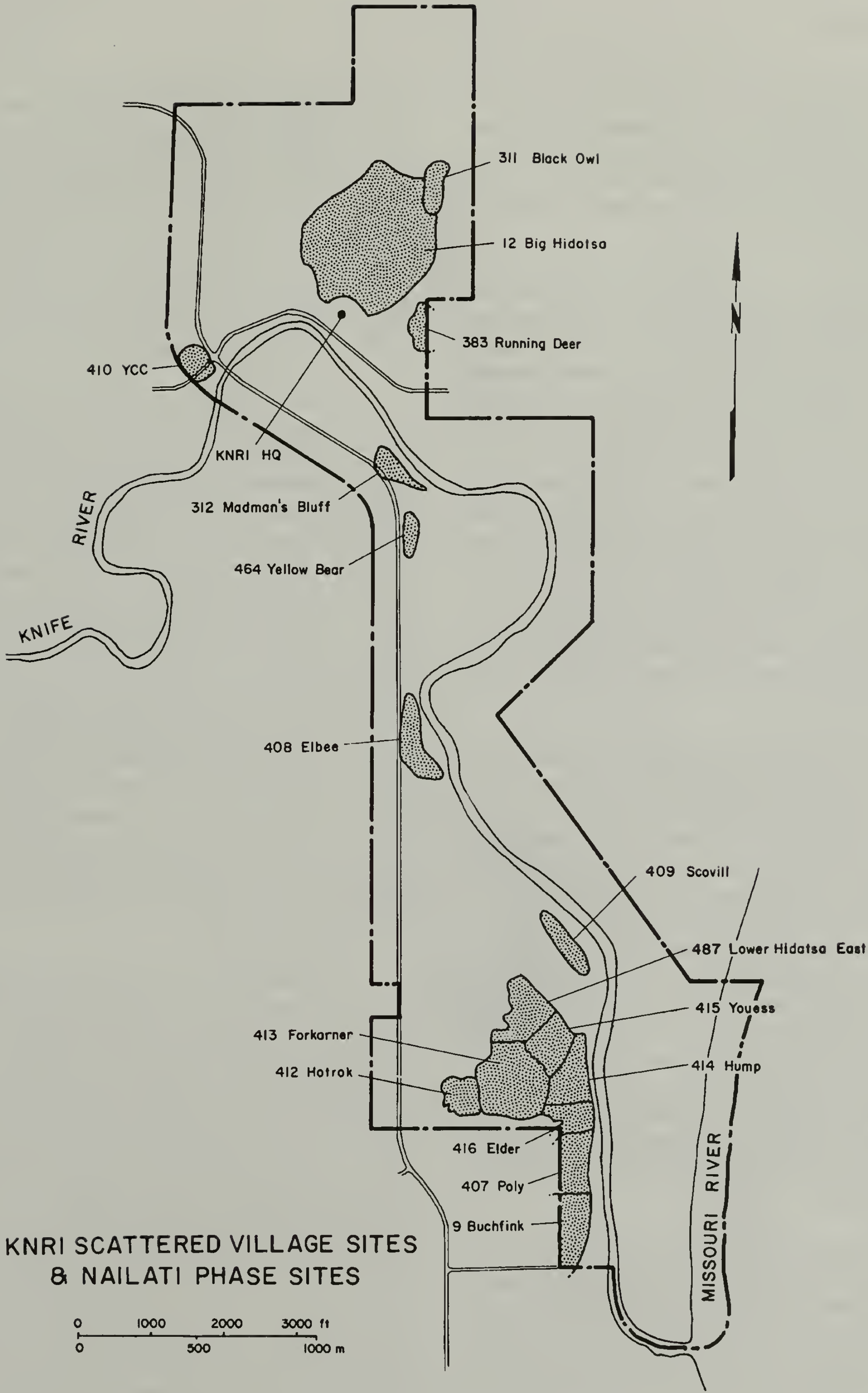

Figure 4.3. Distribution of sites with Scattered Village complex or Nailati phase components in the KNRI.

River phase. The major village expressions of the Heart River phase are represented by apparently circular houses, ceramics dominated by Le Beau S-Rim ware with cord-impressed decoration, predominant use of Knife River flint for stone tools, and deep midden accumulations reflecting long periods of occupation.

The next taxonomic unit recognized in major village sites is provisionally termed the Transitional phase (Table 4.1). This unit is characterized by village occupations with large accumulations of midden, apparently circular houses, ceramics containing both Le Beau S-Rim ware and a braced, cord-decorated, S-rim ware distinct from Le Beau ware, and continued emphasis on use of Knife River flint. Euroamerican trade artifacts occur in very minor quantities in this phase. A Transitional phase component occurs at Lower Hidatsa Village (Ahler and Weston 1981) where it is suggested to date in the range AD 1600-1700, and materials in time periods 4 and 5 at Big Hidatsa Village (AD 1650-1745) can probably also be assigned to this unit (Ahler and Swenson 1985). Such a component also occurs at the Running Deer site (Ahler and Mehrer 1984:73-102).

The Knife River phase is the final Plains Village period culture-historic unit presently recognized in the KNRI, and components assigned to this phase occur in all three major village occupations as well as at several other spatially and functionally related sites (Table 4.1). This is a protohistoric and fully historic period phase (circa AD 1700-1862) characterized by progressively increasing occurrence of Euroamerican trade artifacts, decreasing use of native stone and ceramic technologies, predominantly Knife River ware pottery, and increasing use of diverse local and non-local lithic resources. Knife River phase villages were very compact and were fortified in the fully historic period. The Knife River phase component at Lower Hidatsa Village is now suggested to date in the period circa AD 1700-1780; at Sakakawea Village, in the period circa AD 1795-1834; and at Big Hidatsa Village, in the period circa AD 1745-1845.

A great number of the remaining Plains Village period sites in the KNRI contain one or more components which are functionally and chronologically linked to the occupations of the three major villages during one or more of the Heart River, Transitional, and Knife River phases (Table 4.1; Figure 4.4). For a variety of reasons many of these sites cannot be assigned to a specific one of these phases, and they are simply designated as general Plains Village tradition in association (Table 4.1). It is easiest to consider these components collectively as related to the major village occupations in the KNRI without specifying in most cases precise phase associations during the period AD 1450-1845. These sites are descriptively/functionally broken down into a number of other categories not previously occurring in the Plains Village period, including village periphery zones, off-village activity areas, cemeteries, trails, and debris scatters (Table 4.2).

Village periphery zone sites and components occur around all three major villages (Figure 4.4) and consist of broad, fairly dense artifact scatters, lacking visible accumulation of midden mounds or architectural features, in the areas immediately adjacent to the residential cores of the villages proper. A wide variety of activities is thought to have occurred at these sites, linked primarily to the use of greater space than was available in the village proper. The area immediately surrounding the Lower Hidatsa Village proper is subdivided into four discrete periphery zone sites. A single periphery zone site is defined surrounding the uneroded portion of the Sakakawea Village, and at Big Hidatsa Village, a large periphery zone area is defined for the site without it receiving a separate site number and designation. At Lower Hidatsa Village and Sakakawea Village, extensive surface collections and excavated collections (Toom and Ahler 1985) from the periphery zone sites confirm an artifact content generally similar in function and style to the material culture found within the villages proper.

Off-village activity areas are sites which are farther removed from the major villages than periphery zones, but which are thought to be closely linked to use of the major villages (Table 4.2; Figure 4.4). Evidence of special activities, distinct from routine intra-village activies, occurs in some of these sites. Three off-village activity sites are found in the north end of the KNRI apparently linked to the occupation of Big Hidatsa Village (NaxpikE, Taylor Bluff, Running Deer). Artifact content and location indicate use of these sites for village ceremonial activities, as a possible refuge area for populations seeking protection near Big Hidatsa, and as a possible seasonal horticultural activity center, respectively. In the south end of the KNRI, components at nine sites are identified as reflecting off-village activity locations (Table 4.2; Figure 4.4). A great diversity of activities is reflected there by surface expression and content ranging from concentrations of fire-

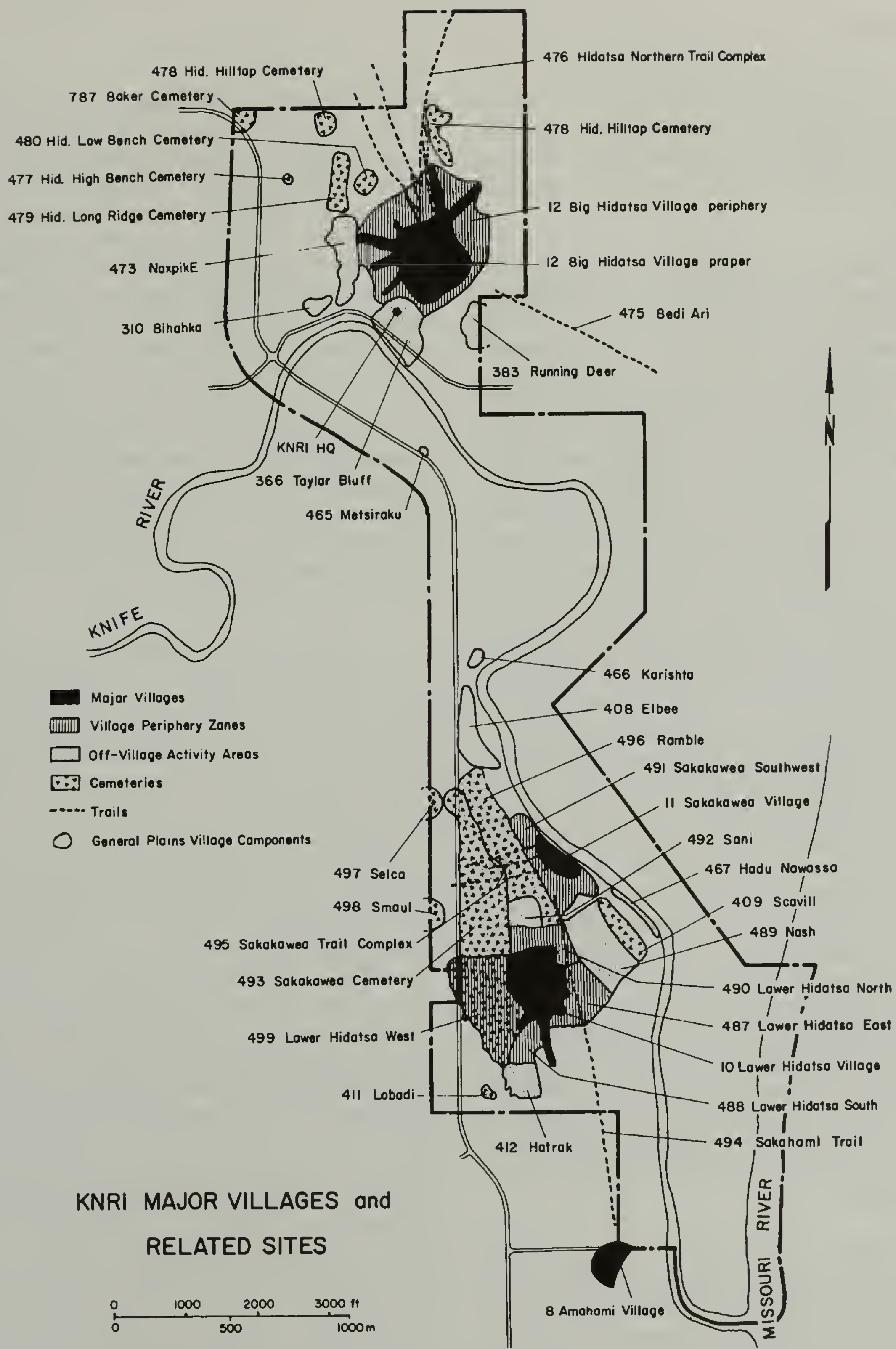

Figure 4.4. Distribution of major villages and chronologically related components at other sites organized by descriptive/functional groupings, KNRI. Taxonomic units include the Heart River phase, Transitional phase, Knife River phase, and general Plains Village tradition.

cracked rock at the Hotrok, Soni, Sakakawea Cemetery, and Ramble sites to bone concentrations at Hadu Nowassa and scatters of atypical artifactual debris perhaps relating to games and trading activities at Lobodi, Ramble, Selca, and Smaul.

Cemetery sites are defined on the basis of either surface expressions of burial pits, historic data on burial pit locations, or observations of human bone on the site surface. Thirteen sites are identified as having cemetery components (Table 4.2; Figure 4.4). Most but not necessarily all of these are probably related to the occupation of the three major villages, simply on the basis of population density in the area at that time as well as first-hand historic accounts of use of some of these general locations for necroceremonial activities. There are six cemetery sites in the vicinity of Big Hidatsa Village, all presumably associated with the occupation of that village. One of these is on the hill slope north of the village and the remaining five are on elevated areas to the northwest of the village; all occur in locations commanding a good view of the village proper. Seven cemetery sites are identified for the southern part of the KNRI, and these are thought to be associated with occupations of both Lower Hidatsa and Sakakawea Villages. A major cemetery area containing two large clusters of burials is identified at the Sakakawea Cemetery site west of Sakakawea Village and northwest of Lower Hidatsa Village. Several human burials are known to have been removed from the Scovill site, and these appear to be late in age and associated with post-contact period occupations in the area (Ahler and Mehrer 1984:162-191). A single infant burial was discovered in testing at the Lower Hidatsa West periphery zone site (Toom and Ahler 1985). Scattered human bone has been observed on the ground surface at the Ramble, Lobodi, Smaul, and Selca sites. The culture-historic identification of the human remains at Smaul and Selca remains open to question because both sites contain pre-Plains Village period components and both sites are found in topographically elevated settings similar to those frequently used for Woodland period burial mounds.

Trail system sites (Table 4.2) are associated with Sakakawea Village and Big Hidatsa Village (Figure 4.4), both of which contain fully historic components during which time the horse was in widespread use. Two trail complexes are defined for Big Hidatsa Village, one leading in several paths out of the village to the north, and the other linking the village to the bank of the Missouri River to the southwest. At Sakakawea, several trails lead from the village to the higher terraces to the west, and a portion of the main trail linking Sakakawea Village with Amahami Village and other settlements downriver has been identified. A possible segment of a trail linking Sakakawea Village and Big Hidatsa Village has been found in excavation at the Elbee site (Ahler 1984b). Early mapping data indicate the existence of several other trails, but many of these are not confirmable today by air-photo or on-the-ground examination, and these are not presently designated as sites.

Four other sites (Bihohka, Elbee, Metsiroku, Karishta) exhibit very diffuse scatters of artifactual debris which for one reason or another can be tentatively linked to the major episodes of occupation at the major villages, but which are too dispersed and ephemeral to allow meaningful descriptive/functional classification other than as debris scatters (Figure 4.4; Table 4.2).

Fourteen sites in the KNRI contain components which have been assigned to the Euroamerican tradition (Table 4.1; Figure 4.5). All of these components with one possible exception are thought to be related to the Euroamerican period (AD 1861 to the present) which follows abandonment of the upper Knife-Heart region by all Native American groups and which is associated with Euroamerican military/civilian occupation. Six archeological sites contain Euroamerican components consisting of recently operated farmsteads with associated residences, outbuildings, and standing structures of various kinds. In all six cases, these components are superimposed over earlier Plains Village period occupations. These include the Nate Olds (Big Hidatsa Village), Byron Grannis (Taylor Bluff), William Russel (Elbee), Maynard Borner (Madman's Bluff), Herbert Oberlander (Scovill), and Roy Schreiber (Buchfink) farmsteads. Three somewhat earlier farmstead or homestead locations lacking standing structures at the time of survey are also designated as Euroamerican tradition components. These include the Fowler Farmstead, the Boerner homestead, and the Walker homestead, with the latter two also overlying earlier Plains Village archeological components (Yellow Bear and Poly, respectively). The remaining Euroamerican components consist primarily of historic debris and artifact scatters having a variety of possible functions. Included here are the Grannis School Place (a former county school house location), the Old Corral site (a livestock management operation), and the Scattered Board, Rusted Stove, and

Lower Hidatsa West sites (debris scatters of uncertain specific origin and function).

No Euroamerican components in the KNRI can be traced to the early part of the Euroamerican tradition, which in this area would be the fur trade period (prior to AD 1861), when the Plains Village tradition was still the dominant cultural force in the vicinity. This is true despite the intensive trading activities carried on at the villages in the first half of the nineteenth century and intensive survey designed to locate such sites (see Chapter 13). One possible exception may exist at the Buchfink site where an earthwork feature mapped in the early part of this century was identified as a "soldier's fortification," implying a possibility that it may represent a palisade surrounding an early trading post (cf. Ahler and Mehrer 1984:103-132). This feature has been all but completely destroyed by gravel mining, apparently eliminating any possibility of investigation.

Five sites consist entirely of components unclassifiable according to culture-historic unit (Table 4.1). These include four bone scatters or bone concentrations and a scatter of lithic debris (Hadu Duupa, Hadu Nawi, Hadu Topa, Hadu Dexu, SGB), all of which are exposed along the banks of the Knife River. Some and perhaps all of these sites are of secondary origin, consisting of bone and debris washed downstream and concentrated in those areas. All are considered to be of little scientific or interpretive significance.

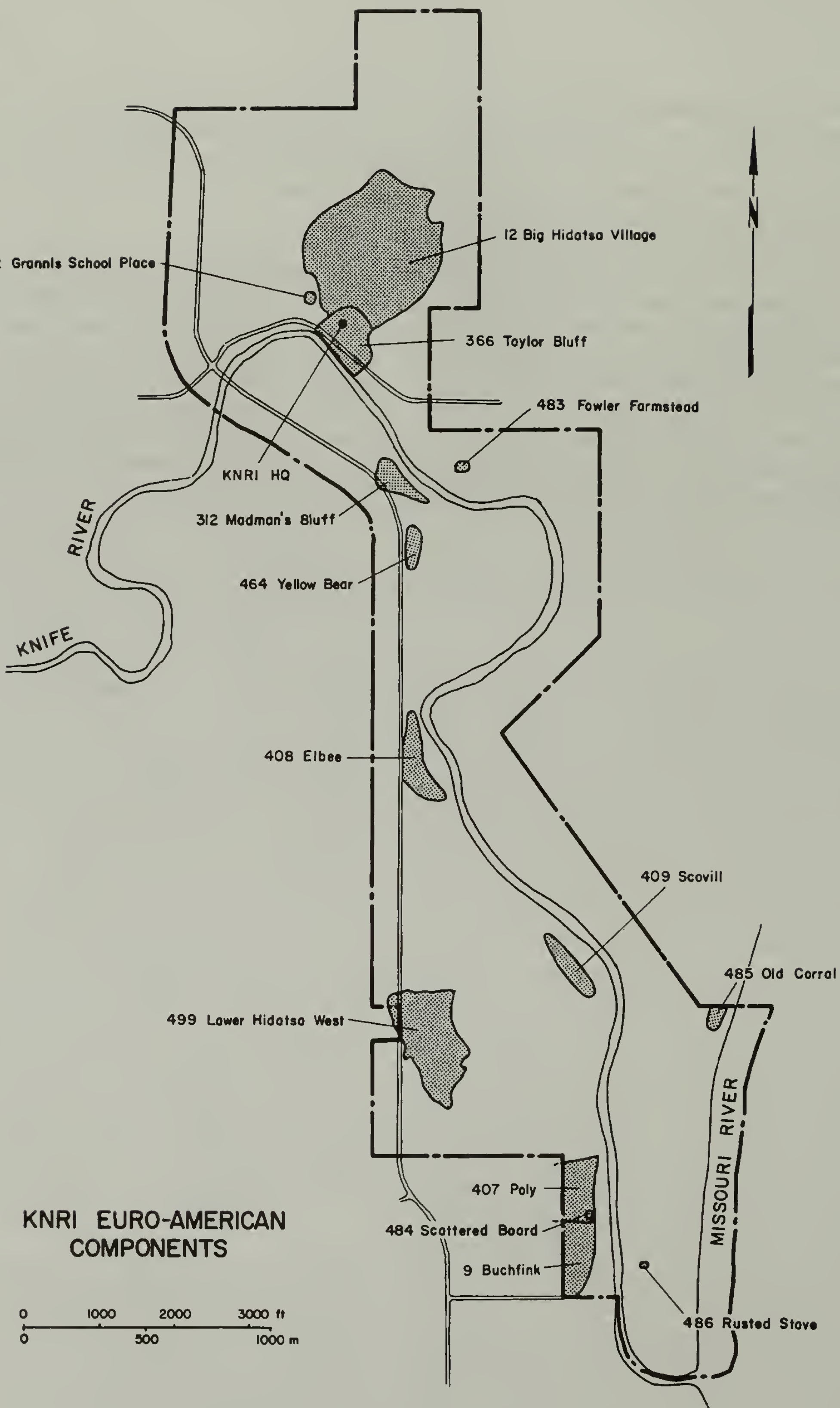

Figure 4.5. Distribution of sites with Euroamerican tradition components in the KNRI.

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CHAPTER 5

THE KNRI PHASE I EXCAVATION SUBPROGRAM

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INTRODUCTION

Excavations of varying scale have been conducted at a total of 14 archeological sites in the KNRI since 1976. These excavations have been conducted for three fairly distinct purposes and, accordingly, they can be classified into three different types: problem oriented testing; excavation for the purpose of site evaluation; and salvage excavation or mitigation. Table 5.1 provides a chronological summary of archeological excavations conducted in the KNRI since 1976, giving the purpose of excavation in each case, a measure of the scale of excavation, and a reference to the major report on that excavation.[1] Note that excavations of more than one type have been conducted in some sites.

PROCEDURES

Throughout the KNRI testing program an explicit attempt was made to maintain consistency in field and laboratory procedures from one site or project to the next, thereby building a data base for the KNRI having maximum intra-site comparability. This is true particularly with regard to artifact recovery procedures. Because it can be demonstrated by experiment that most debris from stone tool pressure flaking, thought to have been a common activity in village sites, will pass through a 4-per-inch mesh hardware cloth, it was deemed necessary to use an even finer mesh screen for artifact recovery. In addition, it was clear that many of the sites to be studied contained very small glass trade beads, a horizon marker for the post-contact period. For these reasons, artifact recovery over 16-per-inch mesh window screen has been the rule for all excavations in the KNRI. Because of the fine mesh of this screen, dry screening was not practical, and waterscreen recovery has been pursued in nearly all instances.

The only deviations from this recovery procedure with respect to problem oriented excavations were in certain cultivated sites studied in 1979 and 1981 (Ahler and Mehrer 1984:10-11). In the Hotrok and Forkorner excavations in 1979, a portion of the disturbed plowzone was removed without screening in order to enhance the discovery of subplowzone features, while a sample of the plowzone from those sites was subjected to fine-mesh waterscreen recovery. At the Hump, Youess, Forkorner, and Buchfink sites in 1981, a portion of the plowzone in the excavated area (usually 75 percent of the excavation area) was removed without screening, while the remaining fraction (usually 25 percent) was subjected to quarter-inch dry screen recovery. This was done to expedite exposure of subplowzone features, the focal point of excavations that year, which were then excavated with fine-mesh waterscreen recovery.

Artifact processing, quantification, and classification procedures have been fairly consistent for all test excavation samples (and for all excavated samples of any kind from the KNRI) throughout the duration of the Phase I program. The most recent discussion of those procedures is found in the the Big Hidatsa excavation report (Ahler and Swenson 1985:69-85 and appendices), and similar discussions are provided in each of the test excavation reports listed in Table 5.1. A discussion of analytical procedures with regard to faunal remains is found in Falk et al. (1991:2-4). Except in a rare instance where a massive amount of fire-cracked rock was present in the Hotrok excavated sample (Ahler and Mehrer 1984:11), no field sorting of any screened site sediments has occurred and virtually all screen-collected debris has been returned to the lab for processing. In general, artifact processing in the lab begins with size-grading of all collected debris, followed by water flotation for the purpose of removing both obstructive organic materials (rootlets, etc.) and analyzable light fraction remains (seeds, charcoal). The heavy frac-

[1] Subsequent to the completion of Phase I field activities in the KNRI, excavation has occurred at a number of other locations within the park, not listed in Table 5.1. These studies are for the most part construction-related testing and salvage excavations, reported by Ahler (ed. 1988), Toom (ed. 1989), and Toom and Ahler (1985). Data from these reports are not included in the present summary nor in any of the analyses which occur in the accompanying chapters of this volume.

Table 5.1. Summary data on Phase I archeological excavations at sites in the KNRI since 1976.

Year Excavated	Site	Type of Excavation	Excavated Area, m^2	Percent of Total Site Area	Report Reference
1976	Sakakawea 32ME11	salvage	9.0	0.041	Ahler et al. 1980
1977	Sakakawea 32ME11	salvage & prob. oriented	8.0	0.036	Ahler et al. 1980
1978	Sakakawea 32ME11	salvage	--	--	Ahler et al. 1980
	Lower Hidatsa 32ME10	prob. oriented	10.0	0.020	Ahler & Weston 1981
	Poly 32ME407	prob. oriented	8.0	0.019	Ahler & Mehrer 1984
	Scovill 32ME409	evaluation	12.0	0.080	Ahler & Mehrer 1984
	Elbee 32ME408	evaluation & salvage	100.0	0.323	Ahler, ed. 1984
	Taylor Bluff 32ME366	salvage	2.0	0.005	Taylor 1978
1979	Hotrok 32ME412	prob. oriented	59.0	0.328	Ahler & Mehrer 1984
	Forkorner 32ME413	prob. oriented	56.0	0.080	Ahler & Mehrer 1984
	Lower Hidatsa West 32ME499	evaluation	1467.0	1.405*	Ahler 1979; Toom et al. 1985
	Taylor Bluff 32ME366	evaluation	2.0	0.005	letter from Ahler to Curran
1979	Buchfink 32ME9	salvage	7.0	0.018	Ahler & Mehrer 1984
1980	Big Hidatsa 32ME12	prob. oriented	46.0	0.019	Ahler & Swenson 1985
	Running Deer 32ME366	prob. oriented	4.0	0.036	Ahler & Mehrer 1984
1981	Buchfink 32ME9	prob. oriented	16.0	0.041	Ahler & Mehrer 1984
	Forkorner 32ME413	prob. oriented	27.0	0.039	Ahler & Mehrer 1984
	Hump 32ME414	prob. oriented	10.0	0.040	Ahler & Mehrer 1984
	Youess 32ME415	prob. oriented	28.0	0.088	Ahler & Mehrer 1984
	Sakakawea 32ME11	prob. oriented	4.0	0.018	
1982	Taylor Bluff 32ME366	salvage	8.39	0.021	Ahler et al. 1983

Note: * Of the total excavated area of 1467 square meters in the vicinity of the Lower Hidatsa West site, ca. 1054 square meters of this falls within the designated site boundary, constituting ca. 1.405% of the estimated total site area of 7.5 hectares.

tion is then sorted into constituent artifact and material classes by size grade. Some artifact classes are then batch-quantified by count and/or weight according to size grade without further analysis (e.g., fire-cracked rock, fired clay, ash, etc.). Other selected artifact classes, thought to contain culture-historically sensitive information or other useful behavioral data, are then individually studied in much greater detail according to various specialized analytical and classificatory schemes. These categories include body sherds and rim sherds, stone tools, flaking debris, historic trade artifacts, modified vertebrate and invertebrate remains, and identifiable unmodified vertebrate remains.

An inventory of all KNRI artifact collections from excavations conducted since 1976 (problem oriented and other) was prepared in a five-card image format. This inventory consists primarily of count and/or weight data for basic artifact and material classes, in some cases organized by size grade as well, for every site catalog number (each distinct excavated provenience) for excavated sites. This inventory was submitted by UND to the NPS in several forms, along with appropriate record format information necessary for its proper utilization (Ahler 1987a). In addition, computerized classification and other analytical data specific to certain more intensively analyzed excavated artifact classes were also submitted in several media to the NPS for their future research use. These inventories include computerized classification/analytical data for individual stone tools, individual pottery vessels, pottery body sherd samples, glass trade bead samples, and individual identifiable vertebrate faunal remains (cf. Ahler 1987a; Falk et al. 1991).

All artifacts and records generated by UND as a result of the Phase I program were organized and packaged for long-term curation (Ahler 1987b) and were subsequently transferred to the park for permanent storage and management.

PROBLEM ORIENTED TESTING

The Phase I problem oriented test excavation program was most clearly spelled out in the 1978 KNRI archeological research plan (Ahler 1978:44). The following goals were identified in 1978: 1) determination of artifact debris density in various archeological sites and assessment of associated laboratory processing costs; 2) optimization of artifact recovery procedures in varied site settings; 3) determination of site subsurface stratigraphy; 4) determination of the presence or absence of cemetery areas in various locations in the KNRI; 5) exploration of anomalies detected in aerial photographic coverage; and 6) delineation of the presence, absence, and composition of buried cultural components.

Two things should be noted: that these goals deal almost exclusively (except for goal 1) with information to be gained from the field, ignoring a host of possible analytical and interpretive goals and expectations; and that these goals are quite modest relative to the information gain which could be expected to derive from a testing program. The intent in 1978 was to leave the more complex field problems and artifact analytical problems for study in the Phase II testing program. Among the goals in the Phase II testing program would be the collection and analysis of chronometrically datable materials, stylistically sensitive artifacts, subsistence remains, and artifact manufacturing debris from varied intra-site contexts in selected sites in the KNRI (Ahler 1978:50).

In retrospect, it is clear that those of us directing the Phase I test excavation program have had a difficult time limiting research activities to the specific goals identified for the Phase I program. For example, to the list above we have explicitly added another goal, (7) the collection of chronometrically datable samples. This was necessary because the Phase I chronometric program in the KNRI, dedicated primarily to exploration of viable chronometric dating procedures for the particular setting, could not proceed without field samples upon which to conduct the pilot dating studies. A more major departure than this, however, has to do with the level of intensity of laboratory analyses conducted with artifacts derived from the Phase I program. In many cases we have intensively studied stone tools, pottery vessels, body sherds, trade artifacts, and vertebrate remains, extracting as much data as possible which appeared relevant to the major research problems identified for the overall KNRI program (see Chapter 3).

There are at least two reasons for this procedure which may be seen as a major departure from the Phase I program. One is that in order to assess the potential of various KNRI excavated samples for use in solving the problems identified in the general research plan, we need to actually attempt to use the existing collections for those purposes. For example, it is difficult to know how much culture-historic information can be extracted from pottery collections without actually attempting such analysis with existing artifacts, and it is difficult to make recommendations concerning future analytical procedures without having conducted trial analyses. A second reason is that the NPS and KNRI park management personnel have been constantly in need of interpretive information concerning the KNRI archeological resources. It is quite understandable that they do not wish to wait until the completion of Phase II and Phase III research to begin to develop interpretive information on the park. In light of this, we have in many cases attempted to directly address the problems identified for Phase II and III research using the existing Phase I test excavation information.

One potentially negative effect of these expansions of the Phase I goals has been to lengthen the time necessary for the analysis and reporting on Phase I excavation programs. On the positive side, a wealth of useful information has been produced as a result of the expanded Phase I analytical program, ranging from fairly well-honed analytical procedures for a wide array of artifact types to preliminary answers to several of the broad research problems set forth for the full KNRI program. Precisely these positive and negative effects were weighed and discussed in the meeting of UND and NPS project personnel in Denver on December 19, 1980, where the fates of the Phase I, Phase II, and Phase III programs were determined (see Chapter 1). It was decided at that meeting, in light of the fact that no plans were underway at that time to actively pursue Phase II program objectives, that the Phase I program would be expanded along the lines stated here. The results of this expanded analytical and interpretive effort, centered primarily on existing excavated Phase I artifact samples from the KNRI and elsewhere, comprise the bulk of the information presented in Chapters 17-21 and 24-25 which address the interpretation of the KNRI and regional archeological record.

Problem oriented test excavation has been conducted at 11 of the 14 sites in the KNRI excavated since 1976 (Table 5.1). The tested sites include each of the three major villages (Sakakawea, Lower Hidatsa, and Big Hidatsa) and eight other smaller or less prominent Plains Village period sites (Poly, Scovill, Hotrok, Forkorner, Running Deer, Buchfink, Hump, and Youess).

Problem oriented test excavations were conducted at the Sakakawea Village (32ME11) in 1977 and in 1981. The 1977 fieldwork at the site was in part a continuation of the salvage excavation which had begun there in 1976 in anticipation of a bank stabilization construction program. In 1976 the salvage excavation was focused primarily on a single house (House 28) eroding from the downstream end of the cutbank exposure through the site. The excavation in 1977 was designed to salvage artifacts from near the eroding bank in the central and upstream portions of the cutbank, as well as to collect information from a house in the interior of the site. To serve the latter problem oriented goal, single 1 x 2 m test units were placed inside and outside of a prominent house depression in the west-central part of the village (House 16). Thus, the excavated sample from Sakakawea Village is highly limited, with only 4 square meters of excavated area reflecting locations away from the cutbank edge, and with the remaining site samples from an excavated area of circa 13 square meters dictated largely by the need to salvage materials from the eroding cutbank edge. Analysis of the 1976 and 1977 Sakakawea Village test excavation data has been reported by Ahler et al. (1980).

The 1981 problem oriented testing at Sakakawea Village consisted of excavation of a 2 x 2 m square to expose the central hearth in House 16, previously tested in the 1977 field program. Two hearths were in fact discovered, and one of them was sampled for archeomagnetic data (see Chapter 8). The 1981 fieldwork has been briefly described by Ahler (1981), but the artifacts recovered in this excavation have not been analyzed or reported.

Problem oriented excavations were conducted at Lower Hidatsa Village (32ME10) in 1978. Five 1 x 2 m test units were excavated, four of these placed in inside- and outside-house settings in close proximity in the northeastern margin of the site, with a final unit placed in the southern part of the site for a contrastive sampling purpose. The intent was to excavate in apparently very deep midden deposits and to sample an area which showed high magnetic anomalies, while also gathering potentially contrastive inside- versus outside-house artifact content data. Midden deposits more than 2.0 m deep were encountered in two of the five excavation units. The spatial coverage at Lower Hidatsa is unquestionably highly selective, and there is little way of knowing if we have actually sampled all of the major occupational components at the village. The Lower Hidatsa Village excavation program has been reported by Ahler and Weston (1981).

Problem oriented testing was conducted at Big Hidatsa Village (32ME12) in 1980. This is unquestionably the most ambitious and most extensive testing program at any of the sites in the KNRI. This is due in part to the extremely large size of the site and the apparent internal complexity of the site evident from surface observations and other topographic data. Thirteen 1 x 2 m test units with complete waterscreen recovery were selectively placed in all of six spatially separate subdivisions of the site. Emphasis was on outside-house contexts where site stratigraphy might be most clear, with only three of these units intentionally placed in inside-house settings. A maximum of 1.8 meters of stratified midden was documented in one of these tests. In addition, two 1 x 10 m long trenches, excavated primarily without screened recovery, and a series of several auger samples were excavated in linear mound features which emanate from the village proper. These less controlled tests were designed to sample artifacts from the ridges or mounds and to examine the internal stratigraphy of one of the mounds. Based on these tests, it was determined that the tested ridges are humanly constructed and relate to an early portion of the occupation period of the village; their specific function remains undetermined. The Big Hidatsa test excavation program is more completely described by Ahler and Swenson (1985).

During the reconnaissance program conducted in 1980 in the KNRI, a buried Plains Village period site

(Running Deer, 32ME383) was discovered in the Missouri River flood plain immediately adjacent to Big Hidatsa Village. Documented archeological sites in the Missouri River flood plain are quite rare anywhere in the Middle Missouri subarea, with historic sources indicating that the Plains Villagers used the flood plain seasonally for farming in warm weather months and for winter habitation during coldest months. Thus we were particularly interested in the content of the Running Deer site. Accordingly, limited testing consisting of two 1 x 2 m units was conducted there late in 1980, at the end of the normal field season at Big Hidatsa Village. We hoped to establish the chronology of the site and its function, as well as to address the possibility that it might have been a winter habitation location. Unfortunately, the excavations were too limited in extent to yield all the information desired. The site appears to have been used somewhat contemporaneously with the full, lengthy period of occupation at nearby Big Hidatsa Village. This fact coupled with the proximity of the two sites suggests that the Running Deer site is not a winter village used by the Big Hidatsa inhabitants because they would have had to move farther away from their summer village than the Running Deer location to obtain adequate winter wood supplies. Excavation at Running Deer is reported in full by Ahler and Mehrer (1984).

Problem oriented testing was conducted at the Poly site (32ME407) in 1978. This is a less prominent village site. The site was selected for testing based in part on controlled surface artifact collection data generated for the location in 1977 (Ahler and Swenson 1980) and based on magnetic survey data from the location in 1977, as well. Several uninterpreted magnetic features were apparent at the site (Weymouth 1978), and surface artifacts indicated that the occupation there predated occupation at the more prominent major villages in the KNRI. Four 1 x 2 m test units were dug there, with placement designated largely by locations of magnetic anomalies or other magnetic patterns. One cultural feature was found which accounted for one specific magnetic anomaly. A cultural deposit highly disturbed by rodent activity was found in each of the tests. Testing at the Poly site is reported by Ahler and Mehrer (1984).

Problem oriented testing was conducted at the Hotrok site (32ME412) in 1979. This site is represented on the surface by several highly dense concentrations of fire-cracked rock superimposed on a much more dispersed scatter of a wider range of artifact types (Ahler et al. 1979:46-47). Excavation was conducted here to determine the source of the fire-cracked rock, to attempt to establish the function of the site, and to assess the relationship between the use of this site and occupation at nearby Lower Hidatsa Village. This work required a program in which portions of the excavated plowzone were sampled for artifacts by waterscreen recovery, while larger areas of plowzone were removed without screening to expose possible remnants of subplowzone features. The Hotrok site is interpreted as a probable sweatlodge refuse dump area superimposed on an earlier scattered occupation. The sweatlodge refuse there was likely deposited by the occupants of Lower Hidatsa Village. The excavations are reported in full by Ahler and Mehrer (1984).

In 1979 problem oriented tests were also placed in the western portion of the Forkorner site (32ME413), a large, less prominent village site which had recently been documented in a surface reconnaissance program (Ahler et al. 1979:47-49). Like the Poly site tested the year before, the Forkorner site was estimated to be prehistoric in age and to predate the main period of occupation represented in all the major villages in the KNRI. Thus, testing was designed to assess the research potential of shallow cultivated sites such as this one, and at the same time, to collect culture-historically useful samples of artifacts and datable remains if such existed. With these goals in mind, the excavation systematically sampled portions of the plowzone with waterscreen recovery, and, as at Hotrok, it also was designed to remove without artifact recovery portions of the plowzone for purposes of exposure of subplowzone feature remnants. Several features were found in this manner, and these were excavated with full artifact recovery. Charcoal samples were collected and dated, as were pottery samples dated by the thermoluminescence technique. This excavation is reported by Ahler and Mehrer (1984).

The 1979 tests at Forkorner demonstrated the information potential within such shallow cultivated villages. Ongoing studies indicated also that such early village sites are probably highly significant to the interpretation of early, prehistoric Hidatsa habitation and cultural development in the KNRI. Based on these premises, additional problem oriented testing was conducted at the Buchfink (32ME9), Youess (32ME415), and Hump (32ME414) sites and in the eastern part of the Forkorner site (32ME413) in 1981. These sites all share with Forkorner a shallow, plow-disturbed occupational horizon and possible culture-historic classification as part of the newly defined Scattered Village complex. The 1981 excavation program was very narrow and specific in scope, designed particularly to locate as rapidly as possible artifact-bearing remnants of subplowzone features and to sample those features for artifact content and datable remains. A combined program of magnetic survey, systematic small diameter coring, rapid removal of plowzone sediments, and controlled feature excavation with full artifact recovery was implemented. The program was successful in obtaining interpretable artifact samples from all four sites and in deriving C-14 samples from all sites except Buchfink. The 1981 excavation program at all four sites is reported by Ahler and Mehrer (1984).

TESTING FOR EVALUATION

This type of test excavation is directed toward the collection of information on a site's artifact content and its significance relevant to defined KNRI research problems, and conducted within the context of a possible impact on the site due to some planned park development or construction program. In essence, this work generally has consisted of evaluating the significance of a site, and if necessary, conducting work sufficient to develop a viable plan for salvage excavation or mitigation should such become necessary. This type of test excavation program was identified as an important component of the KNRI archeological program in the 1978 research plan (Ahler 1978:45), specifically with regard to choosing a site for a planned KNRI visitor/administrative center.

Evaluative test excavation has generally been conducted using field procedures and artifact analysis procedures maximally compatible with procedures used in other forms of excavation (see discussion in the introductory section for specifics and citations). The intent has been to generate a data base, where possible, which is maximally useful for achieving other Phase I goals specifically relevant to overall KNRI research aims, in addition to providing input for cultural resource management decisions relative to planned park developments.

In 1978 a small-scale evaluative test excavation of the Scovill site (32ME409) was conducted because the site was being considered at that time as a prime location for construction of the planned visitor/administrative center. Testing was conducted to confirm the existence of significant subsurface archeological deposits and to further assess the content of the site. Excavation in a small area in the central part of the site revealed a major prehistoric Plains Village period component with associated subsurface features, a minor pre-village period component(s), and the presence of several human burials thought to be post-contact in age and to relate to occupation of nearby Sakakawea Village. The excavation of one human burial eroding from a cutbank proved to be a very sensitive issue with the Three Affiliated Tribes, and the skeletal remains were returned to the NPS for reburial at the site in the fall of 1979. Based on the excavation results, the Scovill site area was removed from consideration as a possible location for construction of the park visitor facility. This excavation is reported by Ahler and Mehrer (1984).

Also in 1978, an evaluative test excavation program was initiated early in the summer at the Elbee site (32ME408), a newly discovered but poorly understood site on the A Terrace surface a short distance up the Knife River from Sakakawea Village. The excavation was necessary because a haul road providing access for construction vehicles to the stabilization construction along the cutbank at the Sakakawea Village was scheduled for construction across the center of the site, and surface artifacts suggested that the site might be of some significance. Evaluation was conducted by excavating a series of eight 2 x 2 m squares along the proposed road axis and a 2 x 4 m unit in a nearby area with a high surface artifact concentration. This excavation revealed several features, including a circular house structure, directly in the proposed road path. Because no provisions or funding arrangements had actually been made to conduct salvage excavations at the site, the evaluative testing program was continued for as long as the 1978 summer schedule and budget would allow, thereby constituting de facto mitigation of the impact of road construction without going through a proper planning or separate funding process. Excavation was eventually expanded to cover an area of 100 square meters, about 30 percent of the site area directly impacted by road construction. A pre-village period component was discovered but was not thoroughly investigated. A portion of the house feature and other features and plowzone artifacts were salvaged in a block excavation which was largely confined to the plowzone.

Because a mitigation plan was never developed for the excavation program at the Elbee site, additional funding over and above that already programmed for other aspects of the Phase I KNRI archeological program was never specifically provided for artifact analysis and reporting. A report on the Elbee site excavation was eventually produced (Ahler, ed. 1984), due in large part to volunteer efforts from UND students and staff. The artifact collection has proven to be one of the most interesting and enigmatic from any site in the park, indicating strong connections of yet unexplained nature between occupants of the Elbee site and peoples normally classified by archeologists as part of the Extended variant of the Coalescent tradition in sites in northern South Dakota.

A very small-scale evaluation program was conducted at the Taylor Bluff site (32ME366) in 1979 in conjunction with planned construction of a new sewer drain field for the former Grannis farm house which was at the time being turned into the interim visitor/administrative center for the park. Single 1 x 1 m test units were excavated along each leg of the planned sewer pipe. Very few artifacts were found, and historically disturbed deposits existed through the full depth of excavation. Clearance for the construction project without further archeological work was recommended (letter report from S. Ahler to Earle Curran, 1979). Additional evaluative excavations consisting of two 1 x 1 m squares were conducted within an area proposed for construction of a fire cache storage and maintenance building within the Taylor Bluff site. A finding of no significant effect resulted from these studies (Toom and Ahler 1985).

The most comprehensive evaluative test excavation program to date in the KNRI was conducted in 1979 in and near the Lower Hidatsa West site (32ME499; Toom et al. 1985). Three of four alternate locations for construction of the proposed KNRI visitor/administrative facility (Areas A, B, and C) fell within or near the site. A detailed surface reconnaissance program in the same area had already provided an information base sufficient to recommend that, from an archeological perspective, Area C was the least desirable of the three alternatives based on a relatively high density of surface artifacts and spatially structured artifact patterning in that area. Area A contained virtually no surface-visible archeology, and very few surface remains were evident in Area B. Regardless of the archeologists' recommendations based on surface artifact data, Area C remained the NPS planners' first choice for visitor center location, due largely to its proximity to various major villages.

Immediately prior to initiation of the 1979 field program, NPS planners called for an intensive test excavation program in Areas A, B, and C to provide additional data for further evaluation of the construction site alternatives. This excavation program was focused on Areas B and C, with less attention paid to Area A which was practically archeologically sterile. The testing program used a three-pronged approach combining magnetic survey aimed at discovery of subsurface cultural anomalies, excavation of a total of 205 systematically placed 1 x 1 m test units with waterscreened recovery, and hand removal without screened recovery of an additional 1,271 square meters of plowzone deposit for exposure of subplowzone features. Virtually no artifacts were found in Area A, and few artifacts and few features were found in Area B. A moderately dense artifact scatter with localized variations in density and content suggestive of interpretable activity areas was found in Area C. A number of subplowzone features, including a single human burial, were found in Area C. These data essentially confirmed, at great effort and expense, what was already known about all areas based on surface data. Alternate mitigation plans were developed for Areas B and C, and it was again recommended that construction of the visitor center in Area B or A would minimize the impact on significant KNRI cultural resources. These excavations are reported by Ahler (1979) and Toom and Ahler (1985).

The discovery of a human burial in Area C elicited considerable reaction from the Three Affiliated Tribes against the possibility of visitor center construction in that area. Weighing both the design considerations as well as cultural resource and public relation concerns, NPS management made the decision to select Area B as the proposed visitor/administrative facility construction location (Mintzmyer 1984).

SALVAGE EXCAVATIONS

Salvage excavation or excavation for the purpose of mitigation consists of excavation designed to maximize recovery of artifacts and recording of interpretable information from a site or portion of a site prior to its disturbance, destruction, or concealment due to a construction program or some natural process (e.g., cutbank erosion along the Knife River). The purpose of mitigation or salvage excavation is to maximize the information gain from the target cultural resource with a minimum input of labor and other costs. The mere collection of artifacts does not constitute an adequate mitigation program; along with this goes an obligation to fully analyze, document (report), and interpret the recovered artifacts and recorded data to the fullest extent possible.

Salvage excavation, beyond the ongoing work that was in progress at the Sakakawea Village cutbank, was not specifically incorporated into Phase I activities in the 1978 KNRI research plan (Ahler 1978). The thinking at that time was that salvage excavations and mitigation programs were usually linked to a specific construction project or development program. Federal law allows a portion of each construction program budget to be earmarked specifically for conducting archeological mitigation activities, and a host of interlocking regulations spell out how such mitigation programs are to be planned and implemented (the "Section 106 process"). In 1978 when the KNRI research plan was being finalized, it was assumed that this process would be in effect in the KNRI, and that specific mitigation projects would neither have to be accounted for nor budgeted for as part of the Phase I archeological research program.

Such proved not to be the case, at least in some instances, as is documented in the discussion of the Elbee site evaluation-turned-mitigation program in the preceding section. In that instance, evaluation demonstrated the need for a mitigation plan, but such a plan was never formally developed, subjected to review, or separately funded. The reader is referred to the discussion in the previous section and to the Elbee excavation report (Ahler, ed. 1984) for additional details on the Elbee site mitigation program.

Salvage activities were conducted at three other KNRI sites during the course of Phase I investigations. The most ambitious of these programs was the salvage excavation and cutbank profile documentation conducted along the eroding bank of the Knife River through the Sakakawea Village (32ME11). The work began in 1976 with the efforts of an MWAC archeological crew under the direction of Robert K. Nickel. Excavations with full fine-mesh waterscreen recovery were conducted along a 31 m segment of the cutbank in the southeastern end of the site. Village midden deposits up to a meter in depth and a meter in width back from the bank edge, on either side of and within House 28, were excavated and processed before they slumped into the Knife River. The excavation occurred in discontinuous segments, conforming in part to slump blocks along the bank edge. The full extent of the cutbank profile through House 28 was then documented with scale drawings and photographs.

It was readily apparent that actual excavation of a significant percentage of the cutbank area which would be lost to slumping (a loss which would continue even after construction of a stabilization berm along the lower portion of the bank) could not occur due to funding limitations. Thus, in 1977, the salvage plan at Sakakawea was altered to obtain at least a small amount of information from the full extent of the cutbank. Two 1 x 2 m excavation units were dug in 1977 near the cutbank edge, one in the central part of the site and the other near the upstream end of the village. In addition, the process of cleaning, profiling, and documenting the exposed cutbank cross-section through the village midden was extended upstream from House 28 along the bank. In 1978 no further excavation occurred along the bank, but cutbank profile documentation was continued and completed, with short interruptions, along the full extent of the cutbank exposure. Both the salvage excavation and the bank profiling are reported by Ahler et al. (1980). In 1979 a stabilization berm was constructed along the Sakakawea cutbank. While this berm will eventually eliminate massive slumping, the upper 3-4 m of the bank face remain unprotected and the village midden deposits have continued to erode in large slump blocks to the present time. This process will continue until a stable angle of repose is achieved and the bank face becomes covered with vegetation.

A very minor salvage excavation occurred in 1979 at the Buchfink site (32ME9). A gravel mine was developed sometime after the 1930s in the northeastern part of the site. Remnants of several Plains Village features and a midden concentration were visible on the present ground surface, in an entry ramp cut into the north side of the gravel pit. A brief excavation was conducted in 1979 to remove the contents of these visible features and sample a part of the exposed midden. These excavations, which produced little artifact content and no chronometrically datable samples, are described by Ahler and Mehrer (1984).

The final salvage excavation occurring under the Phase I program was conducted in 1982 at the Taylor Bluff site (32ME366) in conjunction with several small-scale construction projects being conducted in relation to development of the interim visitor center at the former Byron Grannis farm house which lies within the bounds of the archeological site.[2] Complete excavation with waterscreen recovery was conducted in an area to be disturbed by a new well drilling operation and by installation of a signpost in the fortified part of the site. Complete excavation with artifact recovery from cultural horizons only was conducted in a nearby area where a coal chute was to be constructed. The presence of a post-contact period occupation was documented, as were apparently multiple, earlier Plains Village occupations buried much deeper in the site. The results of this work are reported by Ahler et al. (1983).

ASSESSMENT OF PROBLEM ORIENTED OBJECTIVES

Excavation for the purpose of site evaluation and for mitigation can be assumed to have generally met those primary purposes, within the site-specific limitations and shortages of funding mentioned in a previous section concerning certain site mitigation projects. Several more specific objectives have been outlined in the first section of this chapter concerning problem oriented test excavations to be conducted in the Phase I program. It is useful at this time to assess those objectives and data and activities conducted within the framework of the Phase I program which can be brought to bear on those problems. In this assessment, data will be presented which derive from evaluative and salvage excavations, as well as from the purely problem oriented studies, in order to present as much useful information within a single descriptive framework as possible.

Table 5.2 provides a general summary of the amounts and kinds of artifacts which have been collected in all Phase I excavation programs in the KNRI, as reported in references cited in Table 5.1. This provides a general measure of the magnitude of the artifact collections from various sites and gives a general idea of the data base from which to assess the accomplishment of various Phase I objectives. These data are not ideal for quantititive evaluations, however, because they derive in several cases from mixed recovery procedures, including fine-mesh waterscreen samples, quarter-inch dry screened samples, and unscreened samples in some cases. To provide a more uniform basis for comparison of site collections relevant to particular Phase I problems, artifact quantification derived from fine-mesh waterscreen samples only is used, as presented in Table 5.3. Included in that table is also information on total excavated volume at each site, and the volume of site matrix processed by fine-mesh recovery, or the recovery procedure yielding the tabulated artifact counts and weights in the same table. The data for the Taylor Bluff site, occurring in Tables 5.2 and 5.3 and elsewhere later in this chapter, derive from the 1982 salvage excavation only.

One of the particular problems to be studied in the Phase I testing program was the determination of artifact debris densities in various archeological sites, thereby providing some measure of what can be expected from future excavations in the same sites in later phases of the KNRI research program. Table 5.4 provides computations of densities of various artifact classes for each tested site. The data are presented as either counts (n) per cubic meter of waterscreened excavated sediment or as weight (kg) per cubic meter of similarly excavated and processed sediment. Several additional artifact classes such as fired clay, ash, burned earth, etc., are excluded from the tabulations; data on fire-cracked rock are included to provide some measure of the frequency of such "batch" debris classes which are usually given secondary analytical attention. Volumes of excavated waterscreened matrix used for computation were in a few cases restricted to the volume of matrix in Plains Village artifact-bearing deposits (see notations in Table 5.3). This was done to exclude large volumes of waterscreened matrix removed from essentially sterile deposits while searching for deeply buried pre-village age horizons. Such deposits would probably not be excavated in future problem oriented studies, and using these volumes in the computations would tend to deflate actual artifact densities in the Plains Village deposits.

A summary measure of artifact density is provided by adding the total counts of sherds, stone tools, flaking debris, and fire-cracked rock, then dividing by 1,000, and then adding this figure to the number of kilograms of recovered bone from the same sample. While the units of measure are not internally consistent (counts in thousands added to weight in thousands of grams), a

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[2] Subsequent to the completion of Phase I field activities, a major salvage excavation occurred in 1983 at the Taylor Bluff Village. These investigations, not treated in this volume, are reported in detail elsewhere (Ahler 1988).

Table 5.2. General summary of artifacts recovered in NPS-sponsored excavation programs at archeological sites in the KNRI.

Site	Pottery Vessels n	Total Sherds n	Stone Tools n	Flaking Debris n	FCR n	Ident. Bone n	Vert. Fauna kg	Trade Art. n	Misc. Hist. n
Buchfink	67	1642	120	2299	563	43	2.80	1	0
Lower Hidatsa	925	46981	2828	157293	20357	DNA	321.72	92	2
Sakakawea	359	22570	501	9409	19104	DNA	186.07	3567	0
Big Hidatsa	1127	56320	2965	95953	36269	DNA	305.43	3611	1
Taylor Bluff	5	175	16	540	40	18	0.64	69	4308
Running Deer	16	354	20	1485	137	20	2.10	8	0
Poly	153	3701	189	8368	540	34	1.99	0	12
Elbee	102	3967	328	7504	1432	78	5.47	42	1059
Scovill	85	2143	113	5662	370	35	1.49	9	945
Hotrok	8	336	43	1706	9493	1	0.17	0	56
Forkorner	304	7106	555	12609	1796	159	6.35	25	2
Hump	32	684	55	689	199	45	3.35	0	0
Youess	231	5923	589	9167	2487	273	14.42	1	1
Lower Hidatsa West	67	1106	153	3663	1731	33	2.18	10	1729
Total	3481	153008	8475	316347	94518	739+	854.18	7435	8115

Notes: Data in this table are from reports cited in Table 1, this section.
DNA = data not available
FCR = fire-cracked rock
Ident. Bone = identifiable vertebrate fauna of size grade 3 or larger
Vert. Fauna = vertebrate fauna of size grade 3 or larger
Trade Art. = trade beads, metal, glass and pottery of size grade 5 or larger
Misc. Hist. = miscellaneous artifacts of recent historic origin

useful composite measure is derived nonetheless which provides a means for comparison of overall artifact return among sites. The data in Table 5.4 indicate tremendous variation in the density of artifacts in tested sites in the KNRI. Lower Hidatsa Village has the highest 1,000 item composite density, at 33.60 per cubic meter of water-screened sediment. This is more than 250 times as great as the documented artifact density in the excavated part of the Taylor Bluff site. We can note that the highest densities are present in the major villages, Lower Hidatsa, Big Hidatsa, and Sakakawea, while lower densities occur in each of the less prominent village sites.

It is useful to note that the two lowest density measures from Taylor Bluff and Lower Hidatsa West are associated with excavations which were intentionally not placed in parts of the sites most productive of artifacts. In each case, excavation location was determined by KNRI management concerns and development plans. At Taylor Bluff, deposits with much higher artifact density than

Table 5.3. Quantification of selected artifact classes recovered by waterscreened, fine-mesh recovery for sites excavated in the Phase I KNRI archeological program.

Site	Total Excavated Volume cubic m	Total Volume Water-screened	Total Sherds n	Stone Tools n	Flaking Debris n	FCR n	Ident. Bone n	Vert. Fauna kg	Trade Art. n
Buchfink	7.902	1.244	879	57	2043	356	26	2.15	1
Lower Hidatsa	16.343	16.343	46981	2828	157293	20357	DNA	321.72	92
Sakakawea	20.642	20.642	22570	422	9409	19104	DNA	186.07	3558
Big Hidatsa	48.736	37.336 (30.198)*	55272	2835	90539	35586	DNA	296.31	3598
Taylor Bluff	11.330	8.900	179	16	539	40	14	0.35	69
Running Deer	4.800	4.200	354	20	1485	137	20	2.1	8
Poly	5.107	5.107 (4.322)*	3701	189	8368	540	34	1.99	0
Elbee	28.493	20.323	3862	266	7382	1363	71	5.39	41
Scovill	5.609	5.609	2134	103	5662	370	35	1.49	9
Hotrok	12.530	6.150	326	37	1698	7614	1	0.02	0
Forkorner	21.221	9.282	6377	482	12217	1510	165	6.23	25
Hump	3.825	1.905 (0.743)*	426	34	619	102	45	3.33	0
Youess	9.269	2.742	4063	489	8628	1787	261	13.35	1
Lower Hidatsa West	320.335	56.708 (42.683)*	370	116	3670	1610	30	1.91	9
Total	516.142	196.491 (173.381)*	147494	7894	309552	90476	702+	842.41	7411

Notes: * indicates waterscreened volume of Plains Village period sediments, excluding waterscreened volume in culturally unproductive deep tests, used for computing data in Table 5.4. See Table 5.2 for other notes.

those reported here have been confirmed in the fortified part of the site (based on recent salvage excavation along the cutbank; cf. Ahler 1988) (see footnotes 1 and 2). Much of the excavation at Lower Hidatsa West was in fact located outside the site limit based on surface data, and these nonproductive excavations are included in the data set for that site. If the Taylor Bluff and Lower Hidatsa West density data are excluded from the comparisons among sites, we see roughly a 40-fold variation in artifact return among sites.

A second aspect of the problem of assessing subsurface artifact density in KNRI sites is to provide some means of relating such density information to artifact processing and reporting costs, thereby providing not only a means for predicting what can be expected to occur in future excavations, but approximately what such excavations and related reporting can be expected to cost. The best available predictive measure for future excavation costs is the actual cost incurred in the Phase I program for excavating, analyzing, and reporting on the present artifact samples. Such cost data are presented in Table 5.5, broken down by field cost versus lab and reporting costs for each site. Unit costs are presented in several terms in that table, in dollars per square meter of excavated area, dollars per cubic meter of excavated site volume, dollars of field cost only per cubic meter of excavated site volume, dollars per cubic meter of excavated and waterscreened site volume (often only a fraction of the total excavated volume), and as dollars per 1,000 item composite recovered in waterscreened processing.

The presented total costs and unit costs derived from them are in fact only estimates which are subject to some degree of error. If error occurs, it does not lie so much in the grand total for the excavation program as it does in the breakdown according to site. This is the case because only in rare cases do project budgets or records break down costs precisely according to specific site. Throughout much of the Phase I program, several sites were being studied simultaneously, and the estimated costs are derived from other records which provide estimated breakdowns of effort expenditures directed towards particular project tasks. Field costs are probably the most accurate because detailed budgets were made up for each field season which were generally adhered to fairly closely; in addition, various field progress reports give detailed breakdowns of effort in person-days by excavated site. Laboratory costs are much more difficult to break down precisely

Table 5.4. Density in counts (n) or weight (kg) per cubic meter for selected general artifact classes recovered by waterscreen, fine-mesh procedures in KNRI excavated sites.

Site	Total Sherds n	Stone Tools n	Flaking Debris n	FCR n	Ident. Bone n	Vert. Fauna kg	Trade Art. n	1000 Item Composite*
Buchfink	707	46	1642	286	21	1.73	1	4.43
Lower Hidatsa	2875	173	9624	1246	DNA	19.69	6	33.60
Sakakawea	1093	20	456	925	DNA	9.01	172	11.51
Big Hidatsa	1830	94	2998	1178	DNA	9.81	119	15.91
Taylor Bluff	20	2	61	4	2	0.04	8	0.13
Running Deer	84	5	354	33	5	0.50	2	0.98
Poly	856	44	1936	125	8	0.46	0	3.42
Elbee	190	13	363	67	3	0.27	2	0.90
Scovill	380	18	1009	66	6	0.27	2	1.74
Hotrok	53	6	276	1238	<1	<0.01	0	1.58
Forkorner	687	52	1316	163	18	0.67	3	2.89
Hump	573	46	933	137	61	4.48	0	5.99
Youess	1482	178	3146	652	95	4.87	<1	10.33
Lower Hidatsa West	9	3	86	38	1	0.04	<1	0.18
Overall	845	45	1773	518	DNA	4.83	42	

Note: * The 1000 item composite figure is derived from addition of total count of sherds, stone tools, flaking debris, and fire-cracked rock, divided by 1000, with this figure then added to the number of kg of vertebrate fauna, then divided by the number of cubic meters waterscreened volume. The raw data derive from Table 5.3.

Table 5.5. Cost analysis for Phase I excavation, analysis, and reporting for sites in the KNRI.

Site	Total Field Cost	Total Lab & Report Cost	Total Cost	Cost per Area sq m	Cost per Volume cu m	Field Cost per Volume cu m	Cost per Waterscr. cu m	Cost per 1000 Items*
Buchfink	$ 3741	$ 2708	$ 6449	$ 280	$ 816	$ 473	$ 5184	$ 1170
Hidatsa	10677	89958	100635	1064	6158	653	6158	183
Sakakawea	26828	59035	85863	5051	4160	1300	4160	361
Big Hidatsa	23990	162518	186508	4055	3827	492	6176	388
Taylor Bluff	5750	10981	16731	1994	1477	508	1880	14938
Running Deer	1714	1169	2883	721	601	295	686	703
Poly	5620	7496	13116	1640	2568	1100	3035	887
Elbee	10115	23196	33311	333	1169	355	1639	1824
Scovill	7867	4854	12721	1060	2268	1402	2268	1303
Hotrok	3340	6781	10121	172	808	266	1646	1043
Forkorner	7682	12924	20606	248	971	362	2220	768
Hump	3607	953	4560	456	1192	943	6137	1011
Youess	6012	10640	16652	595	1797	649	6073	588
Lower Hid. West	27056	22677	49733	34	155	84	1165	6476
Overall	143999	415890	559889	298	1091	281	3208	401

Note: * The 1000 item composite figure is derived from addition of total count of sherds, stone tools, flaking debris, and fire-cracked rock, divided by 1000, with this figure then added to the number of kg of vertebrate fauna. These data derive from Table 5.3, for waterscreened samples only.

by site. The breakdown was based on combined person-months of effort estimated to have been directed toward various site samples as documented in the numerous progress reports submitted by UND to the NPS throughout the Phase I period. Total laboratory/reporting effort in person-months was compiled by site sample for each project effort or contract period, and the budgeted laboratory expenditures for that period were proportioned by site accordingly. Input from Ahler for directing and writing tasks was estimated separately from other effort estimates because a fairly accurate, separate accounting of the salary cost for his position has been maintained throughout the project.

While field costs for each site, including the less prominent sites (small sites), were fairly accurately determined, laboratory costs for individual small sites were difficult to compile directly (specifically, Buchfink, Running Deer, Poly, Scovill, Hotrok, Forkorner, Hump, and Youess). In most cases project records and progress reports state that lab effort was directed collectively toward the "small site" samples, without breakdown by site. In this instance, the total cost for analysis and reporting on all small sites (cf. Ahler and Mehrer 1984) was compiled, and it was proportioned among sites according to their relative total artifact content as documented in Table 5.2. This provides an element of circularity in reasoning which affects the relationship between artifact density and total archeological costs, offset to some degree by the fact that field costs were computed independently for each of these sites. Costs for the Elbee, Taylor Bluff, and Lower Hidatsa West excavations were not included in this procedure but were computed completely independently.

It can also be noted that the costs for work at Sakakawea Village include not only the excavation conducted in 1976 and 1977 and subsequent artifact analysis but also the highly interrelated profile documentation which occurred in 1976 through 1978 and which was also incorporated in the reporting effort. This tends to make the unit costs for excavation at the site somewhat higher than they might be in a future project which did not involve a similar amount of non-excavation effort.

The archeological excavation costs were incurred primarily in the period 1978 through 1984. No attempt has been made to adjust for inflation during this period, because in many cases work on a particular site sample continued for as much as four years or more. Because of this, most of the unit costs presented here should be considered as somewhat of an underestimate of what similar work would cost in today's dollars.

In computing the total costs, several cost elements in addition to the primary input from the NPS through its various Phase I contracts and purchase orders with UND were taken into account. Additional costs included in the total which are relevant to the excavation program include 1) a purchase order between the NPS and the University of Nebraska to study and report on fauna from the Sakakawea excavation, 2) donated labor from UND field school students who were involved in all of the field programs from 1977 through 1981, 3) direct salary support provided by UND for lab work, 4) labor costs for UND student lab workers paid by the CETA and College Work-Study programs, 5) volunteer efforts from students and others involved in analysis and reporting, 6) estimated costs for fieldwork in 1976, 1977, and 1979 paid directly by MWAC for staff and crew at the Sakakawea and Lower Hidatsa West sites, 7) UND's contribution to salary support for Ahler's position on the project, and 8) support for chronometric dating programs provided both by NPS and also by other sources independent of the Phase I UND contracts.

Unit costs are perhaps of considerable interest, providing a basis for predicting costs of future excavation in the KNRI archeological sites. Certain unit cost measures are possibly more useful than others. Costs per square meter of excavated area (Table 5.5) vary widely from one site to another. While giving some measure of what actual costs might be for a given site, the wide variation across sites is a reflection of the combined effects of variation in depth of cultural deposits in a given site and artifact density in those deposits. Thus, costs per unit area are perhaps least useful for projection beyond the particular sites in question. Costs per cubic meter of excavated volume vary less drastically among sites (Table 5.5), but the wide variation evident is in part due again to varying site artifact density among sites. Cost per 1,000 item artifact composite also varies, and examination of artifact density data (Table 5.4) indicates that unit costs per artifact are greatest in sites with lowest artifact density and lowest in sites with highest artifact density. This illustrates efficiency in scale, with artifacts being retrieved, analyzed, and interpreted most efficiently in situations where they are most densely concentrated in a given unit of excavated site volume.

The relationship between general artifact density and overall unit costs for excavation and reporting is of particular interest, not only to KNRI planners, managers, and future archeologists, but also to cultural resource managers dealing with properties outside the KNRI. Such data are summarized in Table 5.6. To better illustrate the relationship between artifact density and unit costs, sites are ranked in descending order according to artifact density measured in 1,000 item composite per cubic meter of excavated, waterscreened volume. Waterscreen-ing provides the key to consistency in recovery and comparability of density measures across sites. Three measures of unit costs are provided, including laboratory costs only per volume of waterscreened excavation, total field and lab costs per volume of waterscreened excavation, and total field and lab costs per volume of all excavation by all recovery procedures. Caution should be taken in using some of the figures. In several instances, waterscreen recovery was applied to less than half of the total excavated site sediment, and in such cases (indicated by *, Table 5.6), costs per unit of waterscreened excavated volume may be misleading because they also include costs for excavation, recovery, analysis, and reporting on significant parts of the site not subjected to the waterscreen recovery procedure. This is true because costs for recovery, analysis, and reporting at a site cannot be broken out separately by recovery procedure. Similarly, for those same site samples, costs per unit of total excavated site volume (indicated by **, Table 5.6) provide somewhat of an underestimate of what excavation with full recovery might cost in that particular site or a similar site. If excavations were to occur in which fine- mesh waterscreen recovery or similar consistent recovery were to be applied to the majority of excavated sediments, the actual costs would probably lie somewhere between the two extremes given in the third and fourth data columns in Table 5.6. To estimate what that cost might be, a figure representing the mean of the two extremes in those two columns in given in the final right-hand column in Table 5.6.

Note that there is a fairly clear relationship between increasing artifact density and increasing archeological costs per cubic meter of excavation as documented by the left-hand and right-hand data columns in Table 5.6. The relationship is not precisely correlated, with the density values exhibiting a 250-fold variation between the extremes while costs vary only about fourfold between the same extremes. Again, the economy of scale is evident in the data. These figures indicate that in high artifact density sites, those with a 1,000 item composite

Table 5.6. Comparison of recovered artifact density in waterscreened excavation samples with laboratory costs and total costs on a cubic meter basis for KNRI excavated sites.

Site	Artifact Density in 1000 Items per cu m	Laboratory Costs per Waterscreened Cubic Meter	Total Costs per Waterscreened Cubic Meter	Total Costs per Cubic Meter All Excv.	Mean of Two Previous Columns
Lower Hidatsa	33.60	$ 5504	$ 6158	$ 6158	$ 6158
Big Hidatsa	15.91	5382	6176	3827	5002
Sakakawea	11.51	2860	4160	4160	4160
Youess	10.33	3880*	6073*	1797**	3935
Hump	5.99	1283*	6137*	1192**	3665
Buchfink	4.43	2177*	5184*	816**	3000
Poly	3.42	1734	3035	2568	2802
Forkorner	2.89	1392*	2220*	971**	1596
Scovill	1.74	865	2268	2268	2268
Hotrok	1.58	1103*	1646*	808**	1227
Running Deer	0.98	278	686	601	644
Elbee	0.90	1141	1639	1169	1404
Lower Hid. West	0.18	531*	1165*	155**	660
Taylor Bluff	0.13	1234	1880	1477	1678

Notes: * Designates a situation where less than half of the excavated volume was waterscreened, in which case the costs per cubic meter of excavated waterscreened volume are probably inflated because they include the costs of all excavation.

** Designates a situation where less than half of the excavated volume was waterscreened, in which case the costs per cubic meter of all excavated volume are probably underestimated, including significant volumes of sediments not processed for artifacts.

figure of 10.0 or greater per cubic meter, costs can be expected to be on the order of from $4,000 to more than $6,000 per cubic meter of excavated, fully processed site volume. In most cases, excavation and reporting costs cannot be expected to fall below circa $1,500 per cubic meter, regardless of how low the artifact density is. Exceptions to this in the present data set include the work at the Running Deer site and at the Lower Hidatsa West site, where estimates even for waterscreened unit volume fall below $1,500 per cubic meter. Running Deer was particularly cost-efficient perhaps due to the fact that fieldwork there was nested within the ongoing, larger-scale excavation program at the nearby Big Hidatsa Village, with setup and breakdown costs in the field program perhaps being absorbed by the larger project. Lower Hidatsa West work was particularly efficient because virtually all of the excavation was confined to the plowzone which, after practice, was excavated in a highly repetitive machine-like fashion by the crew members. In addition, it was a protracted, large-scale program lasting several weeks.

A second problem to be addressed in the KNRI test excavation program was the optimization of artifact recovery procedures. This is in part a logistical problem, addressing the question of whether fine-mesh waterscreen recovery should be applied to nearly all excavated samples, and if so, how it can be accomplished at all sites in the KNRI. We can say first that fine-mesh waterscreen recovery has been and should continue to be the rule in KNRI excavations. We will discuss this more in a moment. Concerning the question of how to accomplish waterscreening in various settings, this is really not a problem in the KNRI. Initially it was thought that access to water might be a problem, but such proved not to be the case. For sites so far from the Knife River as to make wheelbarrowing the excavated dirt to the river impractical, transport in a truck was found to be efficient and practical. A little experimentation quickly showed us that either five or six wheelbarrows full of excavated sediment could easily be loaded by ramp into the bed of a normal-size pickup truck, and once secured by chain binder, could be transported to any convenient river location for off-loading and waterscreen processing. This system worked quite efficiently at virtually all sites not directly on the Knife River.

In terms of labor efficiency, this type of waterscreen operation remains more efficient than on-site dry screen recovery using shaker screens. In the shaker screen operation, one screener is required for each excavator. In the waterscreen operation, a team consisting of one wheelbarrow loader/truck driver and one waterscreen operator can support up to four excavators, while an added person at the waterscreen apparatus can expand the support to six to eight excavators.

There is no question that fine-mesh artifact recovery (over 16-per-inch mesh window screen) should be the rule in future excavation at the KNRI. Such recovery is necessary to consistently collect small glass trade beads which occur in many of the sites, as well as micro-vertebrate remains which occur in sixteenth inch (size grade 5) and eighth inch (size grade 4) fractions. In addition, size grade 4 (eighth inch fraction) flaking debris which is directly indicative of most tool modification and maintenance operations occurring on-site (in particular, pressure flaking) is important to site interpretation and must be collected with smaller than quarter-inch screen. There are some instances in which all excavated site sediment need not be processed with fine-mesh recovery, as illustrated in the Phase I testing program. In particular, those were situations where disturbed plowzone deposits were being removed for exposure of features and where deep site sediments were being excavated for purposes of access to particular, buried, previously known cultural horizons. In the case of plowzone sediments, a fine-mesh recovery procedure should probably be applied to a sample of all excavated deposits. Unscreened plowzone sediments should be returned directly to the locus of excavation by backfilling after the subplowzone deposits have been exposed and examined for features. As a rule, any uncultivated deposit known to contain Plains Village period artifacts or having unknown cultural content should be subjected to 100 percent fine-mesh artifact recovery during excavation.

This is not to imply that sampling cannot be efficiently used in future excavation programs in the KNRI. Sampling according to which areas are to be excavated can certainly be used in the field. The recommendation is that sampling according to which kinds of artifacts are to be studied be applied in the lab rather than in the field. Because virtually all site sediments in the KNRI are likely to contain artifacts smaller than 4-per-inch mesh which may be of particular interest to certain research problems, the practice should be to consistently collect such small-scale remains as a matter of course in all KNRI excavations. Whether such artifacts are sorted out and analyzed is another matter, dependent upon the particular research questions being studied.

A small amount of reflection leads to the conclusion that, without some form of sampling, few complete house features will ever be excavated at any of the major village sites in the KNRI if the excavation and reporting costs remain in the range of $4,000 to $6,000 per cubic meter. (At this rate, it might cost more than one million dollars to completely excavate and report on one house feature at Lower Hidatsa Village.) The key to cutting these costs is excavation unit placement sampling (rather than recovery sampling), which would take place in the field, in combination with artifact sampling which would take place in the laboratory. Artifact sampling will be easily effected in the laboratory by simply size-grading the excavated and recovered debris and by selectively sorting only the artifact classes of particular interest from the pertinent size grades. In the small-scale exploratory programs which have characterized the Phase I excavation program, we have felt it necessary to fully recover, sort, and quantify nearly all potentially pertinent artifact classes for purposes of documenting the information base available in each site. This should remain the rule in virtually all evaluative test excavation programs, in the KNRI and elsewhere, where so many unknowns exist about site content and research potential. In future Phase II and Phase III excavation programs (and at well-planned "mitigation" programs in the KNRI and elsewhere), the laboratory sorting and artifact analysis can be much more selective and therefore more cost-efficient based on the particular research problems being studied.

A third problem identified for the Phase I problem oriented testing program has been the need to document subsurface site stratigraphy, particularly within the major villages and less prominent villages in the KNRI. Such information is of value for planning future excavation programs linked to culture-historic interpretations and detailed chronometric dating. This goal has been achieved to some degree for all of the major sites and several minor sites in the KNRI. All major villages have been shown to have interpretable internal stratigraphy, best documented in horizontally layered outside-house midden deposits. At Sakakawea Village these deposits reach more than a meter in depth, at Big Hidatsa they range up to at least 1.8 m in depth, and at Lower Hidatsa localized deposits more than 2.5 m in depth are well stratified. In each case, these stratified deposits demonstrate potential for studying chronological change in artifact content and for providing data for culture-historic reconstruction. Exploratory studies have also demonstrated that particular parts of the major villages are not amenable to stratigraphic studies. This is particularly true in site matrix which has accumulated near the periphery of earthlodge floors. Based on data from both Sakakawea and Big Hidatsa, this appears to have been a favorite area for digging and redigging of storage pits, an activity which tends to result in extremely confused stratigraphic data. In addition, this house area is subject to accumulation of overturned roof and wall cover sediments (overlying the *atuti* area) as the earthlodge superstructure collapsed. Thus these house margin areas are to be avoided in excavation where vertically controlled stratigraphic information is required. The interior parts of house floors, near the hearth, seem in many cases to be well-stratified, documenting superimposed floors, in some cases separated by apparent episodes of house burning and roof collapse. These details are documented in each of the major village site reports (Ahler et al. 1980; Ahler and Weston 1981; Ahler and Swenson 1985).

Stratigraphic data were also collected from several of the less prominent villages (cf. Ahler and Mehrer 1984; Ahler, ed. 1984). At Buchfink and particularly at the nearby Poly site an amorphous zone of village midden was documented some 20-40 cm below surface, with no apparent internal stratigraphy. In each case, rodent disturbance had greatly affected the integrity of many cultural features and other stratigraphic details. Tests in cultivated sites (Youess, Buchfink, Forkorner, Hump, Hotrok, Elbee, and others) indicate that substantial remnants of many cultural features still exist beneath the plowzone, relatively undisturbed by the cultivation process. While midden deposits in such sites are now largely mixed within the plowzone, these sites still contain a great deal of interpretable information on community patterning which could be incorporated into the KNRI interpretative program following proper excavation and analysis.

A fourth stated goal for the problem oriented testing program was exploration for human burials and identification of cemetery areas within the KNRI. Several such possible areas had been previously identified in historic records. Because the disturbance or investigation of human burials proved to be such a sensitive issue with the Three Affiliated Tribes, this component of the testing program was never conducted, and cemetery areas were documented as well as possible from historic evidence and from surface observations (see the discussion of cemeteries in Lovick and Ahler 1982). Only two human burials were actually encountered in excavation in the Phase I excavation program. One was at the Scovill site; this burial was found eroding from a pit exposed in a cutbank at the site, and it was excavated in a salvage effort to maintain the association among the bones which were present (Ahler and Mehrer 1984:173, 176). The second was an infant burial encountered in 1979 in the testing in Area C in the visitor center evaluation program (Toom and Ahler 1985). The skeletal remains of both individuals were returned to the KNRI in the fall of 1979 for the purpose of reburial by the Three Affiliated Tribes in locations closely proximate to the original burial locations.

A fifth component of the problem oriented testing program was investigation of anomalies detected in aerial photographic coverage of the KNRI. We have broadened this goal to include study of anamolies detected in other remote sensing coverage as well, including the extensive magnetic survey of sites in the KNRI. One particular excavation, at the Big Hidatsa Village, was designed to specifically investigate features which were originally detected in aerial photographs. The features are the series of possibly six raised ridges which extend outward in various directions from the central part of the village. All these ridges were originally detected on air photos, with most subsequently found to be visible on the ground as well. The testing program at Big Hidatsa included digging two 10 m trenches through one ridge, auger sampling the same ridge, and auger sampling two other ridge features. From this we conclude that the tested features are all humanly constructed, comprised, at least in part, from earth and debris carried from the central part of the village. The specific function of these features remains unknown (cf. Ahler and Swenson 1985:32-41). Two similar ridges are evident in uncultivated areas on the south side of Lower Hidatsa Village, and aerial photographs of the area indicate that other such ridges may have once existed in now cultivated areas on other sides of Lower Hidatsa Village (cf. Lovick and Ahler 1982:226).

Test excavation has been used on numerous occasions to investigate specific anomalies and broader patterns detected in the proton magnetometer survey of selected sites in the KNRI. Most of the excavation unit locations at Lower Hidatsa Village were determined by magnetic survey data, with units placed to penetrate large magnetic highs as well as lows (Ahler and Weston 1981:26-27). One excavation unit at Big Hidatsa Village was specifically placed to transect and investigate a large linear magnetic anomaly through the north-central part of the site (Ahler and Swenson 1985:45). All four test units at Poly site were placed with reference to either magnetic highs or broad magnetic lows, for the purpose of contrast assessment (Ahler and Mehrer 1984:135-137). The 1981 excavation of a hearth in House 16 at Sakakawea village was guided by magnetic survey data. An attempt was made to use magnetic data to locate significant features at the Elbee site, prior to excavation there, but the presence of a large amount of historic metal in the plowzone at the site thwarted this effort (Ahler 1984a:11). Magnetic survey preceded excavations at the Hotrok site, and specific testing of a magnetic anomaly there showed no interpretable cultural origin for the magnetic patterns (Ahler and Mehrer 1984:48, 50). Magnetic survey was used extensively in advance of and in conjunction with testing in visitor center locations in the Lower Hidatsa West site in 1979. Coring revealed no detectable cultural features associated with most magnetic anomalies, while one large pit detected as a magnetic anomaly was excavated (Toom and Ahler 1985). Magnetic survey preceded the work at the Running Deer site in 1980, and magnetic survey was conducted for small block areas within the Hump site and eastern part of the Forkorner site in the 1981 testing program. Nearly all magnetic anomalies detected in those survey blocks were also investigated by hand coring, with most magnetic patterns seeming to be features of geological origin rather than cultural origin (Ahler and Mehrer 1984:197-200, 252). The magnetic survey program at KNRI is reviewed in Chapter 10.

A final goal of the Phase I problem oriented program has been the delineation of presence, absence, and composition of buried, pre-village period cultural components in the KNRI. This work has been conducted in all cases in conjunction with other testing programs for various purposes focused primarily on the Plains Village components at various sites. A detailed inspection of the entire cutbank at Sakakawea Village was conducted to determine if earlier components existed there stratified beneath major village deposits. Nothing of note was detected, despite the presence of significant numbers of pre- village age artifacts in the village middens. These are now attributed largely to recycling by the villagers of early surface artifacts, rather than to disturbance of buried pre-village cultural horizons at the site (Ahler et al. 1980:197). Several test units at Big Hidatsa Village were specifically extended into deep A Terrace alluvial deposits in search of buried components; only one test unit produced a clearly isolable cultural horizon (Ahler and Swenson 1985:264). The 1982 mitigation program at the nearby Taylor Bluff site was specifically designed to explore for deeply buried deposits which had earlier been detected in Taylor's mitigative excavation (1978) and in examination of the Knife River cutbank through the site. Only sparse pre-village period cultural remains were found (Ahler et al. 1983:75).

The evaluation and mitigation work at Elbee established the presence of a buried, pre-village age cultural zone in the upper part of the A Terrace deposits at that site (Ahler 1984b:148-149). Buried, apparently pre-village age components have been confirmed in excavation data and in cutbank profiling at the Scovill site (Ahler and Mehrer 1984:172). At the Hump and Poly sites, excavations in single units were continued until Pleistocene age gravels were encountered. No distinctive pre-village component could be isolated there, despite the presence of apparently early artifacts on the surface at each site (Ahler and Mehrer 1984:141-145,254). A similar situation prevails at the Lower Hidatsa West site. A small number of pre-village age artifacts have been found there at or near the surface; several tests reaching Pleistocene age sediments failed to reveal interpretable pre-village period cultural components (Toom and Ahler 1985).

A few other sites also contain evidence of pre-village components, documented in surface collections (Lovick and Ahler 1982). In general, all available evidence indicates that pre-village period occupation of the land within the KNRI was sporadic and not intensive. While artifacts equatable in age with earliest human habitation of the region can be expected to be found in the KNRI based on geologic data (up to 11,000 years in age), few finds of great antiquity and or particular significance have been made directly within the KNRI. Data on the content of pre-village period components in the KNRI and the immediately surrounding area are summarized in another section of this report (see Chapter 23).

SUMMARY OF EXCAVATED COMPONENTS AT EXCAVATED SITES

Table 5.7 provides a summary of major cultural components recognized at excavated archeological sites in the KNRI. General taxonomic unit classifications are given for each component, based on data which have been presented in the primary excavation reports listed for each site in Table 5.1. These taxonomic unit identifications are based on the system currently in use for the KNRI sites and the upper Knife-Heart region (cf. Lovick and Ahler 1982:47-48) rather than on the refined assessment of this topic presented in Chapter 25. General dates for site occupancy are provided for each component or occupational episode based on chronometric data for each site (see Chapter 8) and historic documentation for date of abandonment of certain sites. In most cases, the pre-village component identifications are based on surface collected artifacts rather than recognition of distinct pre-village period cultural horizons in excavation.

Lower Hidatsa Village and Big Hidatsa Village contain the most lengthy episodes of continuous occupancy, in each case thought to span a period of more than two centuries. There is considerable overlap in the period of occupation of these two sites, enhancing the potential for detailed cross-site comparisons in stylistic variation and culture change. Sakakawea Village reflects an occupation period lasting several decades which overlaps with the period of occupation at Big Hidatsa Village. Judging by the shallowness of midden deposits and lower artifact densities (see Table 5.6) virtually all other excavated Plains Village sites were occupied for considerably shorter periods of time than was Sakakawea Village, perhaps for a decade or less. Alternatively, some of these sites may have been occupied on an intermittent basis for a somewhat longer period than this, with the shallow middens reflecting a settlement strategy different from that documented in the historic period where occupancy was relatively continuous throughout the non-winter months of each year.

Table 5.7. Summary of cultural components and periods of occupation recognized at excavated sites in the KNRI.

Site	Recognized General Culture-Historic Units	Approx. Period of Occupation
Buchfink 32ME9	Nailati Phase	AD 1250-1400*
	preceramic	?
Lower Hidatsa 32ME10	Heart River Phase thru Knife River Phase	AD 1450-1780
	preceramic	?
Sakakawea 32ME11	Knife River Phase	AD 1795-1834/37
Big Hidatsa 32ME12	Heart River Phase ? thru Knife River Phase	AD 1600-1845
	Scattered Village Complex	AD 1400-1500*
	pre-village	?
Taylor Bluff 32ME366	Knife River Phase	AD 1750-1862*
	prehistoric Plains Village	AD 1400-1700*
	preceramic	2000-1000 BC*
Running Deer 32ME383	Transitional Phase thru Knife River Phase	AD 1700-1845*
	Scattered Village Complex	AD 1400-1500*
Poly 32ME407	Nailati Phase or Scattered Village Complex	AD 1400-1500*
	preceramic	?
Elbee 32ME408	Knife River Phase	AD 1795-1862*
	unidentified prehistoric Plains Village (Extended Coalescent-like)	AD 1520-1630*
	other prehistoric Village components	AD 1300-1600*
	preceramic	1000-1 BC*
Scovill 32ME409	Knife River Phase	AD 1795-1837*
	prehistoric Plains Village	AD 1520-1630*
	Scattered Village Complex	AD 1400-1600*
	preceramic	?
Hotrok 32ME412	Heart River Phase	AD 1450-1700*
	Scattered Village Complex	AD 1400-1600*
	preceramic	?
Forkorner 32ME413	Scattered Village Complex	AD 1400-1450*
	preceramic	?
Hump 32ME414	Scattered Village Complex	AD 1395-1450*
	preceramic	?
Youess 32ME415	Scattered Village Complex	AD 1350-1420*
	preceramic	?
Lower Hidatsa West 32ME499	postcontact Plains Village	AD 1700-1862*
	Heart River Phase	AD 1450-1700*
	preceramic	?

Note: * Indicates estimated bracketing dates for the occupation, with the actual occupation probably being much shorter than this.

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Note: References in which an asterisk precedes the date were supported in whole or part by the Midwest Archeological Center's archeological and ethnohistorical research program for the Knife River Indian Villages National Historic Site.

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CHAPTER 6

THE KNRI CONTROLLED SURFACE COLLECTION SUBPROGRAM

Stanley A. Ahler

The controlled surface collection program is one of the components of the overall Phase I research program outlined in the 1978 research plan (Ahler 1978:43). As originally formulated, the program was to focus specifically on detailed intrasite collections from each of the major villages, Sakakawea, Lower Hidatsa, and Big Hidatsa. Two primary objectives for the program were envisioned, with a third, secondary objective as well. The foremost objective was to document the spatial distribution of various classes of artifacts within each of the major village sites. The sites are known to be quite complex and in the case of Lower Hidatsa and Big Hidatsa to have been occupied for a quite lengthy period of time. The surface artifact data were expected to vary in content, age, and density from one part of the site to another. On the assumption that the surface patterns provide a reasonable model of subsurface content and spatial variation in artifact content, demonstrated to be true in other studies (Redman and Watson 1970), the controlled surface data could then be used to develop sampling strategies and to plan the locations of excavation units within each major village in the Phase II and Phase III excavation programs (Ahler 1978:43).

A second objective of the controlled surface collection program in each major village was to collect data on the severity and extent of rodent disturbance in each village site by documenting the area and distribution of rodent backdirt piles on the site surfaces. This information would be used to assess the overall impact of rodent activity on each site and if necessary, to assist the park management in developing a rodent control or extermination program at appropriate sites.

A third objective of the controlled surface artifact collection program as envisioned in 1978 was to recover artifacts useful for interpretation of individual sites, especially exhibit quality artifacts which might inadvertently be picked up by visitors if left on the ground surface for an extended period of time (Ahler 1978:43).

As it turned out, the controlled surface collection program described in the 1978 research plan was never completed in the major village sites. The program was actually begun during the 1977 field season, as described below, but by the 1978 field season weed and vegetation cover at each of the major villages was so dense that not enough ground surface was visible to continue the program. A program of systematic defoliation for the purpose of increasing surface visibility was suggested as a possibility in the research plan (Ahler 1978:44), but this idea was not implemented after consideration of the harmful secondary effects such defoliation might have on the site deposits.

As Phase I work in the KNRI continued, however, the need was seen to continue the controlled surface collection program in additional sites other than the three major villages. This was particularly true in the case of the extensive scatter of archeological materials evident on the ground surface of the Stanton Terrace extending all the way from near Sakakawea Village to the town of Stanton to the south. The surface reconnaissance program conducted in this area in 1978 and 1979 made it clear that many potentially overlapping and nearly continuous sites existed throughout this area, and a program of spatially controlled artifact collection was implemented to be used in conjunction with surface artifact density data from the point-quarter survey in the same area to help define site boundaries and determine the culture-historic placement of several of the less prominent villages. This controlled surface artifact collection was made before test excavations were conducted in many of the same sites, and the artifact data from these collections allowed a culture-historic classification of many of these sites and assisted in the design of the problem oriented testing program conducted in some of these sites in 1981.

Thus, spatially controlled surface collection with several different aims was conducted in several sites in the KNRI during Phase I research, with several different aims involved. In general, these activities can be organized into two general types according to the kinds of artifacts collected and the procedures involved. One is what is called total controlled surface collection in which all visible artifacts were collected from the ground surface within a specified sample plot or quadrat, or portion thereof. The second can be called a selective controlled surface collection in which only selected artifact classes of use for studying particular problems were collected. The first procedure is designed to allow accurate computations of surface artifact density variation as well as to recover artifact samples useful for site interpretation. Total controlled collection was applied in the major villages and at a few other sites in 1977 and 1978. The collections produced from this procedure are extremely large and border on being unmanageable in size. This fact contributed a great deal to the adaptation of the point- quarter surface survey method for measuring spatial variation in surface artifact density (Ahler et al. 1979; Ahler and Weston 1980), a far more efficient procedure for reaching the same end. Following implementation of the point-quarter survey program in 1978, virtually all controlled surface collection from that time forward was selective in nature, focusing only on artifacts thought to be useful in culture-historic interpretation of sites and site subareas.

Total controlled surface artifact collection was conducted at six archeological sites in the KNRI in 1977 and 1978. Data on the artifact content in those collections and the collected areas are presented in Table 6.1.

The controlled collection program in the Sakakawea and Lower Hidatsa Villages was conducted in the 1977 season under a single common field procedure. This program and its results have been reported in detail by Ahler and Benz (1980). The sites were first gridded in 20 x 20 m blocks (the same as used for proton magnetometer survey), and each block was then subdivided into 16, 5 x 5 m squares for greater ease and precision in recording spatial locations of collected artifacts. The ground surface cover in each 5 x 5 m collection square was then accurately mapped to scale, and all visible surface artifacts were collected separately from each type of surface cover area (rodent burrow backdirt piles, grass covered areas, paths or trails, etc.). A 4,000 square meter area in the Sakakawea Village and a 1,600 square meter area in Lower Hidatsa Village were surface collected in this fashion, yielding a total collection of more than 91,000 individual artifacts (Table 6.1). These artifacts were sorted and counted by

Table 6.1. Artifact inventory for total controlled surface collections at sites within the KNRI.

Site & Area	Rim Sherds	Body Sherds	Stone Tools	Flaking Debris	Unmodif. Bone	Modif. Bone	FCR	Hist-oric	Other	Total
Lower Hidatsa 32ME10 1600 sq m	166	6342	583	4127	25593	17	2746	17	692	40283
Sakakawea 32ME11 4000 sq m	74	3316	40	376	44166	24	2104	379	893	51372
Poly 32ME407 5200 sq m	101	1000	24	563	1653	9	200	0	76	3626
Hump 32ME414 12600 sq m	78	814	179	703	1175	0	1017	0	176	4142
Youess 32ME415 7100 sq m	69	719	162	697	1132	0	542	0	166	3487
Lower Hidatsa West 32ME499 3200 sq m		artifacts have not been quantified by type								1009
Total	488+	12191+	988+	6466+	73719+	50	6609+	396	2003+	103919

basic material or artifact types, collection areas were computed for each ground cover type according to the collection plan maps, and these data were used to compute densities of artifacts per unit surface area according to various ground covers. Not surprisingly, artifacts were found to be some 26 times more dense in rodent burrow areas than in vegetated areas (Ahler and Benz 1980).

At Sakakawea Village spatial variations in surface artifact density values for rodent burrow surfaces were displayed across the collected part of the site by use of isoline or contour maps produced in the SYMAP computer graphics package (Dougenik and Sheehan 1975). These mapped displays of artifact density across the site revealed a heavy concentration of most artifact types in outside house areas; trade artifacts in some cases showed a contrastive pattern, being heavily concentrated inside certain of the house depressions (Ahler and Benz 1980:46-47). A similar mapping program was not conducted at Lower Hidatsa Village because of the more limited spatial extent of the controlled surface collection.

Rodent backdirt piles were found to cover approximately 16 percent of the surveyed surface area at Sakakawea in 1977, and about 11 percent of the survey area at Lower Hidatsa Village (Ahler and Benz 1980:26, 37). Several rodent burrow backdirt piles at each of the two villages were excavated; based on the computed volumes of the excavated rodent spoil piles, it was estimated that the backdirt piles visible on the surface at Sakakawea Village in 1977 constituted about 0.84 percent of the total volume of site midden. Similar computations led to the estimate that rodent burrow backdirt piles at Lower Hidatsa constituted an estimated 0.31 percent of the total site midden volume. If we assume that the backdirt piles visible at any one time, as in 1977, would become completely revegetated in three years, and that every three years a similar volume of material would be generated by rodent activity, it can be estimated that the entire archeological midden deposit in the Sakakawea Village could be completely disturbed by rodent activity in a period of about 350 years. A considerably lesser amount of time would be sufficient to render the site deposits unuseful for scientific investigations due to the severity of rodent disturbance. If we consider that the site has already been abandoned for about 150 years, these computations suggest that up to 40 percent of the original site deposits could already be disturbed by rodent activity. Excavations indicate that the degree of disturbance is probably not quite that extensive, but that rodent disturbance is severe and ongoing, nonetheless.

A less ambitious total surface collection program was also conducted at the Poly site in the southern part of the KNRI in 1977. This site, recently discovered by park personnel and partially mapped by proton magnetometer, was collected in a series of 13, 20 x 20 m quadrats covering a total area of 5,200 square meters. This site was also highly disturbed at the time by a very active ground squirrel colony, and detailed maps of rodent burrow backdirt piles were made. Comparison of rodent burrow backdirt pile density variation and surface artifact density variations across the 13 collection blocks indicated little apparent correlation between rodent activity and the cultural content of the site. We were interested in knowing if the mere presence of rodent burrows, visible on low-altitude aerial photographs of the KNRI, could be used to predict the presence of subsurface archeological deposits. Such appeared not to be the case within the Poly site. The total surface collection from the Poly site was used to provide a tentative culture-historic assessment of the site as prehistoric in age and potentially related to the Nailati phase in the region. A detailed report on the surface artifact collection, along with data on intensive surface collections from the Stanton Ferry site (32ML6) and Stiefel site (32ME202), outside the KNRI, can be found in the report by Ahler and Swenson (1980). The surface collections from these three sites provided a valuable first assessment of the material culture for prehistoric village complexes in the region, and provided an artifact base upon which to develop and test the ceramic coding system applied to pottery collections from the region (Swenson and Ahler 1978; Ahler and Swenson 1985).

Additional total controlled surface collections were made in 1978 in a block area of about 19,700 square meters which overlapped the juncture of the Hump site (32ME414) and the Youess site (32ME415) in a cultivated area in the southern part of the KNRI. This collection was taken in 10 m square collection quadrats. The primary purpose was to provide hard data on actual surface artifact density variations which could be used to assess the reliability of the point-quarter surface survey procedure for documenting patterned variation in surface artifact occurrence. This collection of about 7,500 artifacts was used secondarily for culture-historic assessment of the two sites. The comparison between collected artifact densities and densities computed without collection from point-quarter measurements proved quite satisfactory, with each procedure allowing an accurate demarcation of the juncture between the two sites based on a low density trough. This study was reported by Griffin and Carlson (1978), and the surface collections were subsequently used in the reconnaissance program for culture-historic assessment of each site (Lovick and Ahler 1982).

One additional total controlled collection was made in 1978 in two small "recheck areas" in the Buchfink Cultivated Tract in the southwestern corner of the KNRI. This work was done in conjunction with the original pilot study of the point-quarter survey method (Ahler et al. 1979). Approximately 1,009 artifacts were collected from a total of 32, 10 x 10 m quadrats. The same areas were surveyed on 10 m intervals by the point-quarter method, and maps of patterns in surface artifact density variation were prepared and compared using the two collection and non-collection data sets. The results proved to be comparable, leading to the expanded application of the collectionless point-quarter survey in large areas of the KNRI. The artifacts collected in this project were not analyzed beyond simple quantification by count.

Selective controlled surface artifact collections were made at nine of the additional sites in the KNRI in 1979 and 1980. The content of these collections and data on collection area are summarized by site in Table 6.2. As noted previously, the purpose in making these collections was primarily to recover artifacts which would be useful, in the absence of excavated samples, for preliminary culture-historic classification of KNRI archeological sites. These collections were specifically limited to chipped stone materials (tools and flaking debris), other stone tools of any kind (ground stone), and all pottery. If modified bone or trade artifacts were observed, they were also collected, but other materials were not routinely collected. The raw material composition of chipped stone tools and flaking debris in these collections has been shown to vary in correlation with pottery composition, and these collections have been analyzed in a preliminary fashion and reported by Lovick and Ahler (1982:161-220). Stone artifacts in the collections have not been further studied in great detail during subsequent aspects of the Phase I analytical program, in deference to better controlled excavated samples from most of these sites. Pottery rim sherds in the collections, in contrast, have been coded in detail and merged where possible with excavated samples from the same sites in order to expand the ceramic data base for all KNRI sites.

In addition to the various kinds of controlled surface artifact collections discussed above, relatively small uncontrolled surface collections have been made at a total of at least 25 other archeological sites in the KNRI. In most cases, these collections consist of individual artifacts which are opportunistically recovered from the site surface. Some of these collections were made by park visitors, some by park staff, and others by UND archeological crew members in the course of various work in the park. In several instances collection focused on unusual single artifacts which were collected to keep them from being carried off by curious visitors. Some of these items are culturally diagnostic artifacts, such as projectile points, observed during the point-quarter reconnaissance program. It is through this type of collection that several of the preceramic components were first documented at several KNRI sites. While these artifacts have not been analyzed in great detail, they have been inventoried and documented in Lovick and Ahler (1982:Table 9, pp. 162-165).

The locations of all plotted individual surface collected artifacts as well as the locations of all controlled surface collection quadrats, exclusive of collection areas within Lower Hidatsa and Sakakawea villages, have been plotted accurately on the 1:1,000 scale archeological basemaps of the KNRI. Copies of these maps were generated and submitted to the NPS as an appendix to the KNRI surface reconnaissance report (Lovick and Ahler 1982:Appendix B). Detailed scale maps of the total collection areas within the two major villages are found in the report by Ahler and Benz (1980).

Table 6.2. Artifact inventory for selective controlled surface collections at sites within the KNRI.

Site	Collection Area, sq m	Rim Sherds	Body Sherds	Stone Tools	Flaking Debris	Other	Total
Lower Hidatsa 32ME10	7000	274	1603	537	1811	104	4329
Lower Hidatsa East 32ME487	2800	9	28	59	143	5	244
Lower Hidatsa North 32ME490	2600	16	81	68	94	5	264
NaxpikE 32ME473	6000	3	14	7	25	3	52
Soni 32ME492	2400	8	64	41	154	24	291
Buchfink 32ME9	26100	61	252	124	287	6	730
Forkorner 32ME413	12400	89	550	411	1139	31	2220
Youess 32ME415	11600	144	797	385	1064	101	2491
Bihohka 32ME310	4400	0	9	13	84	0	106
Total	75300	604	3398	1645	4801	279	10727

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Note: References in which an asterisk precedes the date were supported in whole or part by the Midwest Archeological Center's archeological and ethnohistorical research program for the Knife River Indian Villages National Historic Site.

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CHAPTER 7

ANALYSIS OF EXISTING COLLECTIONS

Stanley A. Ahler

INTRODUCTION

The archeological record contained in Plains Village sites within the KNRI pertains almost entirely to the Hidatsas, and in particular, to two of the three recognized subgroups of the Hidatsas, the Awatixas and the Hidatsas-proper. Big Hidatsa Village contains nearly a two and one-half century-long record of Hidatsa-proper cultural development, while Lower Hidatsa Village and Sakakawea Village together contain an even longer record of occupation thought to be attributable to the Awatixas. Earlier Plains Village sites in the KNRI, while quite numerous, each appear to contain evidence of relatively brief occupations by only certain segments of the prehistoric village populations in the region, with major gaps existing in the full period of prehistoric village development in the region as reflected in KNRI sites.

It has been recognized for some time that an understanding of the prehistoric and historic cultural development of the Hidatsas must take into account the existence of the three recognizable subgroups of the Hidatsas who each have unique origin traditions and potentially distinct culture histories (cf. Wood's analysis of Hidatsa origin traditions in Chapter 12). In addition, the cultural development of the Hidatsas or Hidatsa subgroups is highly intertwined with that of the Mandans who were for some centuries in the prehistoric and early historic periods close neighbors to the Hidatsas, living generally downstream from the Hidatsas on the Missouri River. The interrelations and cultural exchange between the two tribes became more intensified in the century immediately preceding the joining of remnants of both groups at Like-a-Fishhook Village in 1845, during which time the Mandans settled in close proximity to the Hidatsas at Knife River largely for purposes of protection against the marauding nomadic Dakotas (cf. Chomko 1986; Stewart 1974).

For the reasons cited above it is apparent that an accurate interpretation of Hidatsa archeology and history as represented in the KNRI must be based on a much larger information base extending well outside the boundaries of the KNRI. Specifically, an attempt should be made to incorporate comparative archeological information on all three subgroups of the Hidatsas, rather than just the two subgroups most clearly represented in KNRI sites. The need for comparative archeological data extends as well into the fully prehistoric era where the archeological record within the KNRI is more incomplete or discontinuous. In addition, the proper interpretation of Hidatsa archeology must incorporate some degree of comparative study of documented Mandan archeological remains, preferably from a series of sites containing some time depth and demonstrably contemporaneous with the Hidatsa villages in the KNRI.

The need for study of archeological data from sites outside the KNRI, as identified above, was recognized at the outset of the Phase I program (Ahler 1978:48). This need was seen as particularly relevant to the identified research problems concerning development of a detailed cultural chronology for the KNRI and concerning the distinction between Mandan and Hidatsa archeological records. Recognizing that the NPS archeological program, particularly in Phase I, could not be expected to fund substantial new data collection programs at key comparative sites outside the KNRI, the partial solution was to focus on analysis of existing artifact collections from sites of particular and critical importance. Limitations inherent in this approach are that comparison is possible only for sites which happen to have been subjected to previous excavation or artifact collection, and that artifact recovery procedures at many such sites often were not thorough enough to allow study of more than a small part of the potentially available material culture. These limitations were recognized in 1977, and the decision was made at that time to focus on examination of pottery rim sherds, a particular artifact class likely to occur in almost all available samples and a class potentially most sensitive to stylistic variation reflective of minor chronological differences and ethnic subgroup differences in the archeological record. Work was initiated in 1977 on development of a detailed attribute analysis coding system for application to a broad array of regional comparative ceramic collections

(Ahler 1978:48), and this coding system had been tested with several site samples by 1978 (Swenson and Ahler 1978:70; later revised, Ahler and Swenson 1985).

As the test excavation and artifact analysis program progressed in the KNRI and as the surface reconnaissance program began to demonstrate the existence of many prehistoric age village components in the KNRI, the emphasis for study in the comparative collection analysis program gradually was broadened. This broadening of scope was also in part a result of expansion of the Phase I program goals to include as much data interpretation as possible, rather than restricting studies to description and development of baseline data alone. This broadening of scope in the comparative program resulted in the decision to incorporate as much data as possible from artifact collections derived from the 1968 Wood/Lehmer testing program in the upper Knife-Heart region (Wood 1986), most of which had been only partially analyzed. Data on lithic and faunal artifacts and remains from the Wood/Lehmer testing program have been used to the extent practicable in the comparative study, and the chronometric program has focused in large part on samples available from this comprehensive testing program.

THE COMPARATIVE COLLECTIONS

Table 7.1 provides a list of all sites outside of the KNRI from which comparative collections were studied as part of the Phase I archeological program. The locations of these sites within the upper Knife-Heart region and in the adjacent Garrison region are illustrated in Figure 7.1. Included in Table 7.1 are batch identifications, an indication of which artifact or material classes were used in comparative studies, the original source for the collection, and references, if previous archeological work at a site has been reported. Batch numbers are a means for tagging separate analytic units for purposes of intra- and intersite analyses, and batch derivations are described more fully in Chapter 17 on pottery analysis. A much more detailed explanation of reasons for inclusion or exclusion of particular data sets from particular sites, along with discussions of analytical procedures, can be found in sections of this report dealing with ceramic analysis (Chapter 17), lithic analysis (Chapter 18), and vertebrate remains (Chapters 19 and 20). Some explanation can be provided here concerning the basis for including certain site samples in the comparative study.

Table 7.1. Inventory of existing artifact collections from sites outside the KNRI which have been included in the KNRI Phase I analysis program.

Batch and Site	Collection Source*	Stone Tools	Flaking Debris ≥ G3	Pottery Vessels	Body* Sherds Surf.Tr.	Body* Sherds Thick.	Vertebrate Remains	Trade Artifacts	Chronometric Samples	Reference
0-3 On-A-Slant (32MO26)	UND 1980	-	3870	155	1765	775	-	X	-	Breakey & Ahler 1985 Richert 1984
4 Molander (32OL7)	W/L 1968	38	29	75	462	98	X	-	-	Wood 1986
	SHS 1966	3	-	31	215	84	-	-	-	Unreported
5 Pretty Point (32OL8)	W/L 1968	415	2489	108	378	336	X	-	X	Wood 1986
6 Smith Farm (32OL9)	W/L 1968	48	172	19	60	42	X	-	-	Wood 1986
7 Lower Sanger (32OL11)	W/L 1968	221	374	84	313	244	X	-	X	Wood 1986
8-12 Upper Sanger (32OL12)	W/L 1968	616	1711	258	923	409	X	-	X	Wood 1986
13 Mile Post 28 (32OL13)	W/L 1968	93	328	66	283	105	X	-	-	Wood 1986
	UMo 1969	-	-	34	-	-	-	-	-	Calabrese 1972

Table 7.1. Continued.

Batch and Site	Collection Source*	Stone Tools	Flaking Debris ≥ G3	Pottery Vessels	Body* Sherds Surf.Tr.	Body* Sherds Thick.	Verte-brate Remains	Trade Arti-facts	Chrono-metric Samples	Reference
14-17 Cross Ranch (32OL14)	W/L 1968	90	575	58	189	102	X	-	-	Wood 1986
	UMo 1969	-	-	363	-	-	X	-	X	Calabrese 1972
18 Bagnell (32OL16)	W/L 1968	176	1089	-	-	-	X	-	-	Wood 1986
	Leh 1970-73	-	-	-	-	-	-	-	X	Lehmer et al. 1973
19 Greenshield (32OL17)	W/L 1968	48	313	52	715	365	X	X	-	Wood 1986
	Leh 1973	13	-	50	224	80	-	-	-	Nicholas & Johnson 1986
20-22 Hensler (32OL18)	W/L 1968	373	3068	157	851	301	X	-	X	Wood 1986
	Bow 1963	-	-	22	14	13	-	-	-	
23-27 Mandan Lake (32OL21)	W/L 1968	1075	9536	351	1695	889	X	-	X	Wood 1986
28 Shoreline (32OL103)	W/L 1968	-	-	56	248	135	X	-	-	Wood 1986
29-33 Mahhaha (32OL22)	W/L 1968	361	1382	450	2575	898	X	X	X	Wood 1986
34 Clark's Creek (32ME1)	W/L 1968	83	175	84	752	101	X	-	X	Wood 1986 Calabrese 1972
35 Fort Clark (32ME2)	W/L 1968	9	17	27	120	107	X	X	-	Wood 1986
36 Lyman Aldren (32ME3)	W/L 1968	192	164	102	165	78	-	-	-	Wood 1986
37 Alderin Creek (32ME4)	W/L 1968	-	-	11	28	22	-	-	-	Wood 1986
	SHS 1968	-	-	114	602	146	-	-	X	unreported
38 Deapolis (32ME5)	Tho 1958-60	-	-	299	44	30	-	-	-	Thompson 1961
	W/L 1968	-	-	10	18	18	-	-	-	Wood 1986
39-40 White Buffalo Robe (32ME7)	UND 1978	775	3922	108	1773	401	X	X	X	Lee 1986
41-42 Amahami (32ME8)	SHS 1970-71	-	-	329	814	465	X	-	-	Lehmer et al. 1978
	DAN 1972									Dill 1975, 1977
72 Stanton Ferry (32ML6)	UND/NPS 1977	130	354	55	311	303	-	-	-	Ahler & Swenson 1980
81 Stiefel (32ME202)	UND/NPS 1977	261	421	53	207	209	-	-	-	Ahler & Swenson 1980

Table 7.1. Concluded.

Batch and Site	Collection Source*	Stone Tools	Flaking Debris ≥ G3	Pottery Vessels	Body* Sherds Surf.Tr.	Body* Sherds Thick.	Verte-brate Remains	Trade Arti-facts	Chrono-metric Samples	Reference
82 Rock (32ME15)	RBS 1947-51	-	-	61	150	127	-	-	-	Lehmer et al. 1978 Hartle 1960
83 Star (32ME16)	RBS 1951	-	-	10	29	29	-	-	-	Metcalf 1963
84 Grandmother's Lodge (32ME59)	SHS 1953-54	76	-	5	2	2	-	-	-	Woolworth 1956
85 Like-A-Fishhook (32ML2)	SHS 1950-54	90	-	25	154	105	-	-	-	Smith 1972
86 Nightwalker's Butte (32ML39)	RBS 1952	-	-	91	1227	599	-	-	-	Lehmer et al. 1978
87 Mondrian Tree (32MZ58)	UND 1980	863	3580	25	154	105	X	X	X	Toom & Gregg 1983
88 Hagen (24DW1)	MSU 1938	-	-	299	117	118	-	-	X	Mulloy 1942
89-90 Hintz (32SN3)	RBS 1952-54	-	-	182	274	291	-	-	-	Wheeler 1963
91 Arzberger (32HU6)	COL 1939	-	-	196	473	327	-	-	X	Spaulding 1956
92 Flaming Arrow (32ML4)	UND 1983	-	-	9	99	96	-	-	X	Toom & Root 1983
93 Sharbono (32BE419)	UND 1976	-	-	17	33	32	-	-	-	Schneider 1983
96 Angus (32OL144)	UND 1982	198	1082	-	96	-	-	-	X	Unreported
97 PG (32OL148)	UND 1982	73	265	-	20	-	-	-	X	Unreported
99 Cross Ranch, Late Woodland Sites	UND 1980, 1981	305	1791	-	152	-	-	-	-	Ahler, Lee & Folk 1981 Ahler, Folk & Picha 1982
100 Sagehorn (32ME101)	W/L 1968	-	-	9	80	42	-	-	-	Wood 1986
Total		6371	36707	4503	18908	8609				

Note * Surf. Tr. = body sherds examined for surface treatment; Thick. = G2 body sherds measured for maximum thickness. Collection Source codes: UND = University of North Dakota; NPS = National Park Service; W/L = Wood and Lehmer program (1968); UMo = Univ. of Missouri-Columbia; Leh = Donald Lehmer independent testing program; Bow = Alfred W. Bowers surface collection; SHS = State Historical Society of ND; Tho = Ralph Thompson collection; DAN = Dana College; RBS = River Basin Surveys; COL = Columbia University.

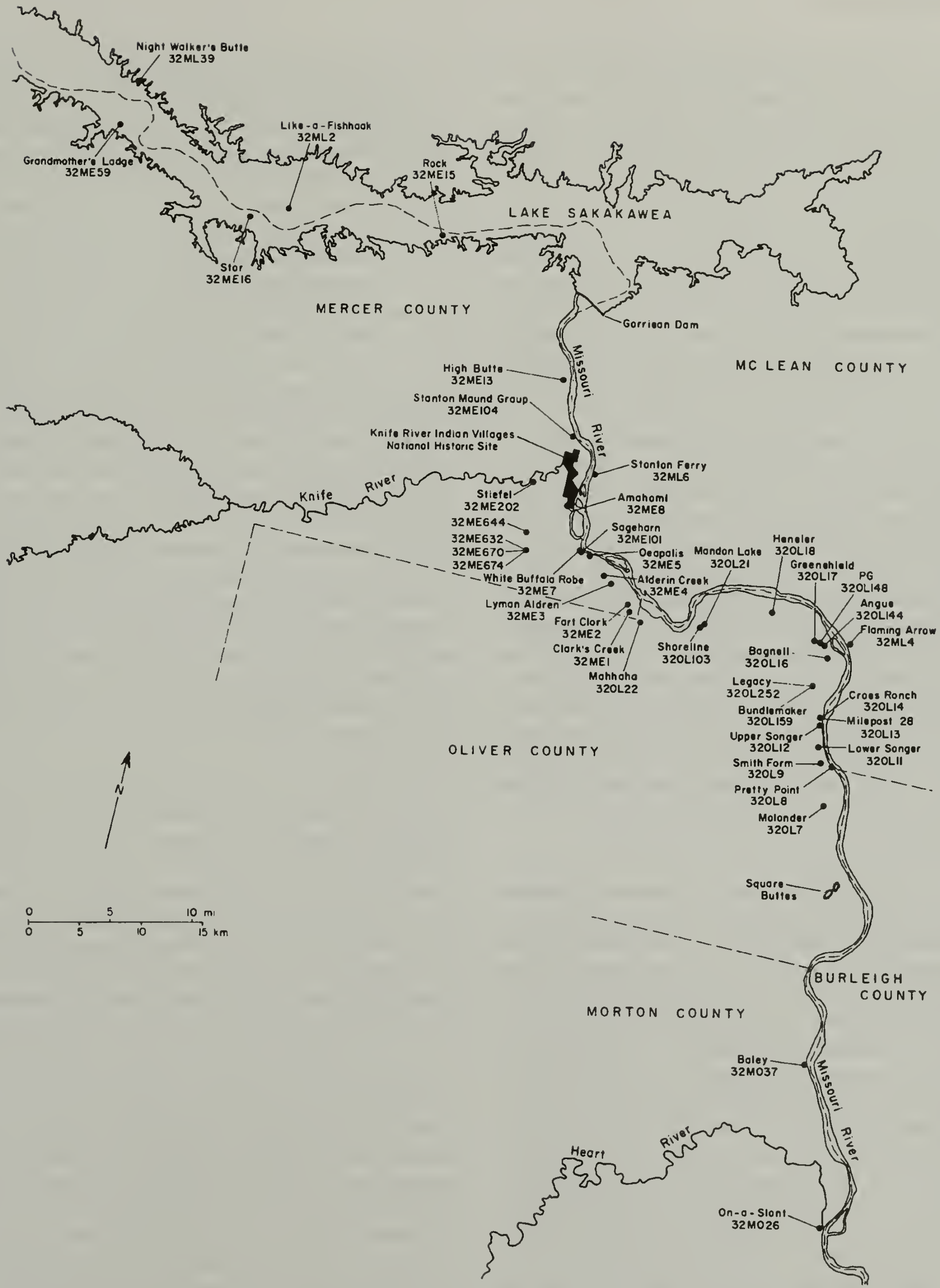

Figure 7.1. Plains Village and other sites in the upper Knife-Heart region and the Garrison region which are discussed in the KNRI comparative analysis program.

Of prime importance is the inclusion of all sites which can be documented historically or through oral traditions as being an integral part of Hidatsa occupation and cultural development in the region. Wood, in Chapter 12 of this volume, provides an analysis of oral traditions of all three subgroups of the Hidatsas and a list of all known archeological sites which can be linked to those traditions. This list also includes all sites containing historically documented occupations by any Hidatsa subgroup in the region. Virtually all sites in this list for which sizeable artifact collections are available have been included in the KNRI comparative analysis program. This includes Molander (32OL7; Wood 1986), Mahhaha (32OL22; Wood 1986), Deapolis (32ME5; Thompson 1961 and Wood 1986), Amahami (32ME8; Lehmer et al. 1978; Dill 1975, 1977), Rock (32ME15; Lehmer et al. 1978 and Hartle 1960), Like-a-Fishhook (32ML2; Smith 1972), Nightwalker's Butte (32ML39; Lehmer et al. 1978), and Flaming Arrow (32ML4; Toom and Root 1983 and Toom 1988). Sites in Wood's list which are outside the KNRI but which were not used in the comparative study include the two Crow Flies High sites (32WI18 and 32MZ1), which are too late to be of detailed analytical interest, and several others for which well-provenienced or large collections do not exist (Jacobsen — 32DU1; Beulah — 32OL23; Black Cat — 32ML5; Scattered — 32MO31). A small, post-contact period artifact sample now exists from Midipadi Butte (32DU2; Kuehn et al. 1984), but it was not available at the time that the comparative analysis was going on at UND.

The need to include historically and traditionally documented Mandan sites in the comparative analysis has not been fully met, due primarily to the lack of controlled collections from many of the key sites. Materials from Deapolis Village (32ME5; Thompson 1961) and from Fort Clark (32ME2; Wood 1986) have been included, but neither of these samples is ideal. The Deapolis sample reflects an agglomeration of artifacts collected in the wake of gravel mining of this highly significant historic site (interestingly, it was once owned by the State of North Dakota), and as such it may represent as much as 50 years of occupation by Mandan groups in the first half of the nineteenth century. The Fort Clark sample almost certainly represents a composite of Mandan artifacts from the period prior to AD 1837 and Arikara artifacts from the period 1838-1860. Black Cat's Village (32ML5), occupied by one subgroup of Mandans around AD 1800-1805, has never been located and may have been washed away by the Missouri River.

Mandan villages which date in the AD 1700s and earlier lie closer to the mouth of the Heart River, in the traditional homeland of the Mandans, and these sites are particularly poorly represented in the comparative study. This reflects both a lack of time by UND staff to include many such sites in the study and an almost complete lack of controlled artifact collections available from such sites. Most of the traditional Mandan villages in that area probably represent several hundred years of time depth, and composite, uncontrolled collections from those sites, such as those available at the State Historical Society of North Dakota, are not particularly useful for the present study. A small sample of artifacts from recent excavations at On-a-Slant Village (32MO26; Ahler, Schneider, and Lee 1981; Breakey and Ahler 1985; Richert 1984) was included in the analysis. Donald Lehmer excavated a house at the Boley site (32MO37) in 1969, but that collection was under study at the time of this analysis by a graduate student at the University of Missouri-Columbia. There is an extremely urgent need to conduct controlled excavations in all of the major villages in the Heart River area which are not in public ownership, before all of these sites go the way of Scattered (32MO31), Boley (32M037), and Larson (32BL9) villages and are completely destroyed by uninformed pothunters and land developers in the Bismarck/Mandan urban area.

The need to study comparative data from prehistoric period sites in the traditional Hidatsa homeland is met by the availability of a large number of surface and excavated collections from numerous sites in the upper Knife-Heart region. The majority of these collections derive from sites not previously mentioned but also tested in the 1968 Wood/Lehmer testing program (collections from Pretty Point, Smith Farm, Lower Sanger, Upper Sanger, Mile Post 28, Cross Ranch, Bagnell, Greenshield, Hensler, Mandan Lake, Shoreline, Mahhaha, Clark's Creek, and Lyman Aldren; Wood 1986; see also Table 7.1) or from spin-offs from that program (Cross Ranch — Calabrese 1972; Greenshield — Nicholas and Johnson 1986). Certain other large collections available from spinoffs from the Wood/Lehmer program are not included; among these are samples from the 1970-1973 excavations at Bagnell (Lehmer et al. 1973) and the 1969 work at Upper Sanger (Stoutamire 1973) which are too large and complex to be organized for study within the time frame for the KNRI program. Other independently excavated prehistoric period regional samples are also included in the present study. These include the substantial collections from the 1978 UND excavations at White Buffalo Robe

(32ME7) (Lee 1980) and selected materials from the unreported 1968 excavations by the State Historical Society of North Dakota at the Alderin Creek site (32ME4). Also useful were controlled surface collections taken as part of the KNRI program from the Stanton Ferry (32ML6) and Stiefel (32ME202) sites in the immediate vicinity of the KNRI (Ahler and Swenson 1980). Finally, we can note the inclusion of a small sample of data from the Grandmother's Lodge site (32ME59), a prehistoric period, Extended Middle Missouri component found a short distance upriver from the KNRI on the Missouri (Woolworth 1956).

Collections from a small number of sites, farther removed from the KNRI than most of those previously discussed, are included for very specific reasons. Among these are artifacts from Star Village (32ME16), a documented Arikara site occupied circa AD 1861 (Metcalf 1963). While this study does not focus on inclusion of Arikara tradition archeological samples, the Star Village sample is included for comparative purposes relative to other late historic Arikara artifacts potentially included in the Greenshield (32OL17) and Fort Clark (32ME2) samples. Also included are data from the Mondrian Tree site (32MZ58), a temporary campsite on the Missouri River just below the mouth of the Yellowstone which contains Plains Village components which reportedly have affinities to the Heart River phase or the Scattered Village complex as presently recognized in the upper Knife-Heart region (Toom and Gregg 1983). Ranging farther to the west, we have also included study of artifacts from the Hagen site (24DW1) (Mulloy 1942) on the Yellowstone River in eastern Montana. This site is included because of its hypothesized identification as a settlement established by some subgroup of the Crows shortly after their separation from the Hidatsas in the upper Knife-Heart region (Mulloy 1942:101; Wood and Downer 1977:85-89; Johnson 1979).

Origin traditions for the Awaxawis and Hidatsas-proper point to the area around Devils Lake and other areas in eastern North Dakota as places to look for early Hidatsa settlements predating the migration of certain subgroups into the Missouri Valley (cf. Bowers 1965; Wood, Chapter 12 of this volume). For that reason we have included artifact samples from the Hintz site (32SN3) on the James River in Stutsman County, a site most representative of the Stutsman focus and hypothesized to be identifiable as Hidatsa and closely related to Bowers' (1948) Painted Woods focus in the upper Knife-Heart region (Wheeler 1963:172). For similar reasons we have included data on parts of a surface collection from the Sharbono site (32BE419) on Graham's Island at Devils Lake (Schneider 1983).

To include comparative information from late Woodland period contexts or extremely early village contexts, we have incorporated limited data from UND excavations conducted during 1980-1982 at the Angus (32OL144), PG (32OL148), and various other late Woodland sites on the Cross Ranch in Oliver County (cf. Ahler, Lee, and Falk 1981; Ahler et al. 1982).

Finally, we have included data from part of the excavated collection from the Arzberger site (39HU6) in South Dakota (Spaulding 1956). Despite Lehmer's classification of the site as belonging to the Initial variant of the Coalescent tradition, which presumably has little to do with Hidatsa cultural developments in North Dakota, certain similarities are apparent in the ceramic samples from Arzberger and some of the Scattered Village complex and Nailati phase samples from the KNRI area. Most notable are the presence of check-stamped vessel body treatment and the occurrence of horizontally trailed, noded, S-rim vessels in each area. Formal comparative analysis of Arzberger and various upper Knife-Heart region ceramic samples is seen as a worthwhile endeavor.

A number of individuals and institutions have cooperated with the UND staff in making the far-flung artifact collections noted above available for study. Collections from Rock Village, Star Village, Nightwalker's Butte, and the Hintz site, originally collected during River Basin Surveys excavations, were studied in the spring of 1983 by Anthony A. Swenson at the United States National Museum, Smithsonian Institution. The analysis of these materials was coordinated and made possible by Dr. Douglas Ubelaker, Chairman of the Department of Anthropology at the Smithsonian Institution, and Mr. George Phebus of the same institution. The Hagen site collection was made available on loan from the University of Montana during 1983 and 1984 for study at UND. We are grateful to Dr. Carling Malouf at the University of Montana for providing this loan and to Mr. Jeffrey Kinney, a graduate student at the University of Montana who at the same time was studying the Hagen collection as part of a Master's thesis project, for facilitating the organization and transfer of the collections to and from UND. The Arzberger

site collections were obtained on loan from the South Dakota Archeological Research Center for study at UND during 1983 and 1984. The UND staff is grateful to the late Dr. Robert Alex, State Archeologist of South Dakota, for arranging the loan.

A large variety of materials was made available on loan from the State Historical Society for study at UND as part of the KNRI comparative analysis program. This includes materials from the 1968 SHSND excavations at the Alderin Creek site, the 1968 and 1969 Wood/Lehmer and University of Missouri collections from Cross Ranch Village, the Ralph Thompson and other collections from Deapolis Village, and SHSND excavated and other collections from Fort Clark, Amahami, Grandmother's Lodge, and Like-a-Fishhook. The UND staff is grateful to Ms. Signe Snortland for facilitating the loan of these materials.

Dr. W. Raymond Wood at the University of Missouri-Columbia graciously made available to UND both copies of the records and notes for the 1968 Wood/Lehmer testing program as well as all previously unpublished artifact collections from that program and from other investigations by himself and Donald Lehmer in the region. The artifacts include materials from the following sites, some of which are not included in the KNRI comparative analysis program (see Table 7.1): Molander, Pretty Point, Smith Farm, Lower Sanger, Upper Sanger (1968 tests only), Greenshield (both 1968 and 1973 excavation samples), Washburn Ferry (32OL102), Hensler (including Bowers' 1963 surface collection and the 1968 sample), Mandan Lake, Shoreline, Mahhaha, Clark's Creek, Fork Clark, Lyman Alderin, Alderin Creek, Deapolis, Boller (32ME6 — 1968 surface collections), Sagehorn (32ME101), White Buffalo Robe (1965, 1967, and 1970 surface collections), Sakakawea, Lower Hidatsa, Big Hidatsa (surface collections from the latter three), Stiefel, and High Butte (32ME13 — 1969 excavated materials). These materials were transferred from the University of Missouri-Columbia to UND in 1983 for study and eventual permanent storage at the State Historical Society of North Dakota.

Finally, we can note the loan made to UND in 1977-1978 by the Illinois State Museum of artifactual materials from approximately two dozen sites studied by Alfred Bowers in his doctoral research (1948). Most notable among these are collections from the Sperry site (32BL4) and the Van Oosting (Hensler) site (32OL18) which, while not used in the final KNRI comparative analysis, were very useful for developing the initial version of the ceramic attribute coding system used with regional samples (Swenson and Ahler 1978). The UND staff is grateful to Dr. Walter Klippel and Dr. Bonnie Whatley Styles for their assistance in arranging the loan of those collections.

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CHAPTER 8

THE KNRI PHASE I CHRONOMETRIC SUBPROGRAM

Stanley A. Ahler and Herbert Haas

INTRODUCTION

Early in the development of the research design for Phase I archeological activities within the KNRI, it was recognized that the study of village site chronologies through chronometric dating procedures would be a high priority endeavor (Ahler 1978:35-36, 47-48). Accurate absolute dating of village components within the KNRI was a necessity for addressing many of the long-range research problems for the KNRI. Such problems included the study of culture change in the post-contact period and assessment of parallels and distinctions between Mandan and Hidatsa culture histories within the region. In this sense, there was little difference between the need for absolute chronological data and the need in many other regional research programs where chronological data are considered to be baseline information essential to the interpretation of many other data sets. As explained in Chapter 3, the Phase I chronometric program initially was conceived as a program for assessing the feasibility of using a diverse array of dating techniques. Eventually, as the focus of Phase I activities shifted toward including interpretation of KNRI resources, the goal of the chronometric program evolved into one of providing as much data as possible on the absolute chronology for all village components within the KNRI.

At the inception of the KNRI archeological program in 1976, very few data on the absolute chronology of KNRI village sites were available. Historic documentation provided relatively precise dates for time of abandonment of both Sakakawea Village (32ME11) and Big Hidatsa Village (32ME12), but no chronometric dates existed for any of the village sites within the KNRI. Additionally, only three Plains Village tradition components in the entire upper Knife-Heart region had been dated by chronometric means (Calabrese 1972; Lehmer et al. 1973; Thiessen 1977:65, 72, 75-76). In 1976, it was known that post-contact period components existed at all three of the major villages within the KNRI. It was felt that the majority of occupations at each of these sites occurred within the eighteenth and nineteenth centuries. From this perspective, it was thought that radiocarbon analysis would be of relatively minor value for developing the chronologies of these major sites due to their apparently recent ages. It was recommended that chronometric studies in the KNRI focus on the feasibility of alternatives to radiocarbon dating, such as studies of thermoluminescence, archeomagnetism, obsidian hydration, hydration of Knife River flint, and dendrochronology (Ahler 1978:47-48).

However, several things happened which changed this emphasis. Excavations were conducted in each of the major villages, demonstrating that substantial stratified deposits lacking trade artifacts occurred at both Lower Hidatsa Village and Big Hidatsa Village; a radiocarbon date for a single sample from deep within Lower Hidatsa Village was considerably older than expected (Ahler 1980:7); and the surface reconnaissance program conducted in 1978 and 1979 indicated that many relatively early pre-contact period Plains Village tradition sites existed within the KNRI. Together, these discoveries led to a reemphasis in the dating program on radiocarbon dating, with samples from many components within the KNRI dated by C-14 analysis. These discoveries also led to the reaffirmation that the resources within the KNRI could not be interpreted without detailed consideration of village components outside the KNRI. This in turn resulted in the expansion of the radiocarbon dating program to include many previously tested sites within the upper Knife-Heart region.

Chronological needs are rather stringent in a situation such as the KNRI, where multiple sites with lengthy periods of at least partially contemporaneous occupation are being studied simultaneously. We need to be able to subdivide the archeological record within each major village into chronologically controlled analytic units which ideally cover as little as 50 years of occupation within what may be a several hundred year sequence. We also need to be able to identify, with some certainty, contemporaneous units within 50-year increments wherever they might occur among sites. Such are the goals of the dating program at Knife River. These goals have been only partially met in the results generated so far. For the major villages, this type of chronology has been generated in large part from historic documentation, stratigraphic information, ceramic seriation, and trade artifact seriation taken in conjunction with available chronometric data. A detailed 50-75 year incremental chronology has been developed for each of the major villages, but this chronology should be considered highly tentative and in need of reassessment should additional archeological work be pursued in the KNRI.

The purpose of this section is primarily to present a summary and evaluation of substantive results in the KNRI chronometric program. The goal here is not to provide an overall interpretation of the cultural chronology and cultural taxonomy for the KNRI sites or for the region. The latter requires integration of data from chronometric, ceramic, lithic, stratigraphic, historic, and ethnographic data sets. Such a data integration will be addressed in Chapter 25. The following subsections provide substantive results of chronometric dating using radiocarbon analysis, thermoluminescence analysis, and obsidian hydration dating. The final subsection provides a comparative summary of results produced by various techniques, providing some direction for future dating studies in the KNRI and the region. This section also provides a tentative ordering of archeological components in the region based on all presently available chronological information.

Dr. Herbert Haas, Director of the Radiocarbon Laboratory at the Center for the Study of Earth and Man, Southern Methodist University (SMU), is a co-author of this chapter because of his contribution to the radiocarbon dating program for the KNRI and for the region. At the time of submittal to the National Park Service, the text of this chapter was written entirely by Ahler, not having had the benefit of review or revision by Haas. Dr. Haas' considerable contribution comes in the form of his careful and consistent processing of radiocarbon samples submitted to the SMU lab for analysis and his presentation of the dating results by way of correspondence and letter reports to S. Ahler. Haas reviewed and reassessed all cases of erratic or inconsistent results identified by Ahler. He then reanalyzed and recounted many of the samples with unusual or questionable results. Many of the SMU dates were counted two or three times, and these are identifiable by sigmas on the order of 30 to 40 years. The nature of Haas' contribution to the KNRI dating program is attested to by the fact that the SMU lab produced 77 of 120 radiocarbon dates (64 percent) available for the upper Knife-Heart region and 62 of 69 radiocarbon dates (90 percent) which are considered here as useful for study of Plains Village period chronology in the region.

Throughout the following sections, chronometric data for archeological samples will be presented with reference to both site number and a "batch" number. Batches are discrete analytic units worthy of separate analysis relative to similarly defined units from the same site or from different sites. For example, a batch may include all analytic data from deposits assigned to a single time period from a stratified site with a long period of occupation (for example, as at Big Hidatsa Village), or the batches may designate data sets from spatially separate proveniences within a single site (as in the data from House 3, House 7, and from test units at the Cross Ranch Village), or a batch may be defined to encompass all samples available from a given site. Batches have been identified with reference to the comparative analysis of ceramic collections from the upper Knife-Heart region and elsewhere (see discussion in Chapter 17). It should be noted that the batch definitions used for ceramics are exploratory in nature, subject to collapse into larger samples for any given site if analysis of various aspects of material culture provides no reason for maintaining separate analytic attention according to original batch designations.

Financial support for the chronometric program in the KNRI and the upper Knife-Heart region has come from a variety of sources. The majority of support has come from the National Park Service through its direct funding of KNRI Phase I investigations. Additional dating has been provided by other agencies who have funded several other research and contract studies in the region, as can be gleaned from the references cited in Tables 8.1, 8.2, and 8.5. Additional support, not as readily apparent in the references cited, has been provided by several UND Faculty Research Grants provided to members of the Department of Anthropology at UND, by the department itself, and by the North Dakota Geological Survey.

RADIOCARBON DATING

A small component of the chronometric program within the KNRI has involved the radiocarbon dating of samples of charcoal, wood, or soil from geologic contexts rather than archeologic contexts within the upper Knife-Heart region. Most of this dating was done in conjunction with Reiten's (1983) study of Quaternary geology in the KNRI area. Because most of the geologic dates are not associated directly with archeological components, and because for most of the geologic dates we are less concerned about small-scale corrections according to dendrochronological correction curves, we will present and discuss the geologic and archeological radiocarbon date sequences separately.

Geologic Radiocarbon Dates

Fourteen radiocarbon dates exist for geologic contexts in the upper Knife-Heart region. A list of these dates and associated provenience information is provided in Table 8.1. The first twelve dates in that table are from loci within the KNRI. These dates were generated in conjunction with Jon Reiten's study (1983) of Holocene terrace chronology and Quaternary geology within the KNRI and in the area near the confluence of the Knife and Missouri Rivers. The two remaining dates are on soluble humates contained within soil samples taken from an exposure of the Leonard Paleosol (the Aggie Brown Member of the Oahe Formation; Clayton et al. 1976; Clayton and Moran 1979) in a railroad cut at the Flaming Arrow site (32ML4) on the east side of the Missouri River near Washburn (cf. Toom and Root 1983; Toom 1988).

The KNRI geologic dates were run on charcoal and wood samples opportunistically exposed in cutbanks along the Knife River within the KNRI. The charcoal was, in most cases, highly dispersed along a lengthy horizontal exposure, indicating a possible origin from forest fires. The wood appears to be driftwood buried in overbank alluvium (Reiten 1983:95). The A Terrace samples from the Taylor Bluff locus derive from a paleosol which also produced scattered, fragmented bison bone exposed in the cutbank. This unit represents an early, pre-village age archeological component at the Taylor Bluff archeological site (32ME366) (Ahler et al. 1983:51; Ahler 1988). The remaining samples from within the KNRI all are from exposures which have Plains Village age archeological components in overlying sediments. Note that all of the KNRI samples are provenienced according to the A, B1, B2, or general B Terrace. These are each Holocene age terraces which have been identified by Reiten along the lower reaches of the Knife River.

Two series of six dates each from contexts within the KNRI were run independently by the Southern Methodist University lab and the University of Georgia lab (UGA), respectively. Three instances of either split samples or pairs of samples from the same context which were run by each lab give indications that the dating results are not comparable between the two labs. Such pairs of dates include SMU-710/UGA-3075, SMU-709/UGA-3070, and SMU-791/UGA-3073. In each instance the UGA dates are younger or more recent, by amounts ranging from 315 to 500 radiocarbon years. While this situation alone is not sufficient for judging the reliability of either set of dates, further indirect evidence suggests that the UGA date series is the less reliable of the two. For example, three of the UGA dates from deeply buried contexts ranging from 2.6 to 4.2 m below present surface yield modern to near-modern dates, a possibility thought to be unlikely given the contexts of the samples. More significant, perhaps, is the fact that a large series of 15 C-14 dates by the UGA lab from the White Buffalo Robe site (32ME7), run at about the same time as the geologic dates from the KNRI, contains results which are inconsistent internally, inconsistent with knowledge of associated archeological materials, and inconsistent with C-14 assays by the SMU lab for samples from the same contexts (Lee and Ahler 1980:141-144). Together, these factors suggest that the UGA lab results for geologic dates are less accurate than the SMU dates. In Reiten's words (1983:95), the UGA dates should be considered to show only order of magnitude ages and general chronological trends.

With these considerations in mind, Reiten used the series of twelve dates to develop a Holocene terrace chronology for the area within and around the KNRI. He judged the lower part of the A Terrace to have formed between circa 8,500 and 4,500 BP, with the alluvium in the upper part of this terrace accumulating in the period 4,500 to 2,500 BP. The bulk of the B1 Terrace is considered to have formed in the period 2,500 to 500 radiocarbon years BP, while the B2 Terrace, the modern floodplain along the Knife River, formed after circa 500 radiocarbon years BP (Reiten 1983:110-119).

The two dates from the Flaming Arrow site are on the soluble humate fraction within a split soil sample taken from the central part of the Leonard Paleosol, assumed to be synonymous with the Aggie Brown Member of the Oahe Formation. This sample was collected during archeological and geological investigations conducted there in the summer of 1983 (Toom and Root 1983; Toom 1988). While this work has not been fully reported, these dates are

Table 8.1. Summary information on radiocarbon dates from geologic contexts in the upper Knife-Heart region of the Missouri River valley.

Site or Location	Lab Number	Material Dated	Within-Site Provenience	Radiocarbon Years BP t 1/2=5568	Reference
Elbee Bluff (32ME408)	SMU-708	charcoal	A terrace, 2.6 m surface depth (sd)	2970 ± 70	Reiten 1983:93
Elbee Bluff (32ME408)	SMU-786	charcoal	A terrace, 3.3 m sd (same as SMU-787)	3940 ± 300	Reiten 1983:93
Elbee Bluff (32ME408)	SMU-787	charcoal	A terrace, 3.3 m sd (same as SMU-786)	3870 ± 160	Reiten 1983:93
Elbee Bluff (32ME408)	UGA-3071	charcoal	B1 terrace, 2.6 m surface depth	35 ± 320	Reiten 1983:93
Taylor Bluff (32ME366)	SMU-710	charcoal	A terrace, 1.8 m sd (same as UGA-3075)	3430 ± 70	Reiten 1983:93
Taylor Bluff (32ME366)	UGA-3075	charcoal	A terrace, 1.8 m sd (same as SMU-710)	2965 ± 75	Reiten 1983:93
Taylor Bluff (32ME366)	UGA-3076	wood	B terrace, 4.5 m surface depth	555 ± 60	Reiten 1983:94
Madman Bluff (32ME312)	SMU-709	charcoal	B1 terrace, 2.2 m sd (same as UGA-3072)	1130 ± 90	Reiten 1983:94
Madman Bluff (32ME312)	UGA-3072	charcoal	B1 terrace, 2.2 m sd (same as SMU-709)	630 ± 75	Reiten 1983:94
Madman Bluff (32ME312)	SMU-791	wood	B2 terrace, 4.2 m sd (split sample with UGA-3074)	330 ± 50	Reiten 1983:94
Madman Bluff (32ME312)	UGA-3074	wood	B2 terrace, 4.2 m sd (split sample with SMU-791)	45 ± 60	Reiten 1983:94
Madman Bluff (32ME312)	UGA-3073	wood	B2 terrace, 4.0 m surface depth	modern	Reiten 1983:94
Flaming Arrow (32ML4)	SMU-1294	soluble soil humates	3.84 m sd, Leonard paleosol, Oahe Formation	9860 ± 100*	Kay and VanNest 1984:70; Toom 1988
Flaming Arrow (32ML4)	SMU-1311	soluble soil humates	3.84 m sd, Leonard paleosol, Oahe Formation	10000 ± 90*	Kay and VanNest 1984:70; Toom 1988

Note: * indicates preliminary date, subject to slight calibration.

not thought to be associated with a definable cultural component at the site, although small pieces of animal bone and a flint flake appear to occur in the same natural horizon. These dates provide some of the first chronometric evidence for the age of the Leonard Paleosol. Together with other dates recently run on the same paleosol from archeological sites in Dunn County (Kay and VanNest 1984:70; Root and Ahler 1984), these dates provide a confirmation of the expected terminal Pleistocene/early Holocene age which was posited for that unit by Clayton et al. (1976:11, 12). These dates provide a "mean residence time" (cf. Campbell et al. 1967) for the ancient ground surface and highly humic horizon designated the Leonard Paleosol, and as such, are only an approximation of the age of that natural geologic unit. The Flaming Arrow site dates for the Leonard Paleosol are perhaps somewhat more accurate than the slightly more recent dates from Dunn County sites, given the more deeply buried context of the Flaming Arrow site samples and the lesser likelihood of contamination by root penetration from more recent ground surfaces.

Archeological Radiocarbon Dates

The availability of radiocarbon dates for archeological components in the upper Knife-Heart region has increased dramatically with the implementation of the KNRI Phase I program and other recent archeological projects in the area. A total of 106 radiocarbon dates associated with archeological materials from 28 sites is presently available for the region. Table 8.2 contains a list of these dates, giving pertinent information on archeological site name (and number), lab number for each date, the type of material dated, the within-site provenience of the dated material, the age of the sample expressed in radiocarbon years BP (uncorrected, before AD 1950) computed according to the 5,568 year half-life, and citation of a reference where the date was first reported or discussed (often in the context of a report on the archeology of the site). Table 8.2 also lists seven additional radiocarbon dates at the end which are associated with archeological sites outside of the upper Knife-Heart region, but which may be of interest in the KNRI Phase I study due to the inclusion of ceramic data from those sites in the comparative ceramic analysis (see Chapter 17). These include two dates each from the Mondrian Tree site (32MZ58) and the Arzberger site (39HU6) and three dates from the Hagen site (24DW1). Thirty-two of the dates listed in Table 8.2 are from sites within the KNRI, while the remaining 74 dates for the region are from sites outside the KNRI.

Table 8.2. Summary of radiocarbon dates from archeological components in the upper Knife-Heart region and from other sites used in this study, arranged from south to north along the Missouri River.

Site or Location	Lab Number	Material Dated	Within-Site Provenience**	Radiocarbon Years BP t 1/2=5568	Reference
Pretty Point (32OL8)	SMU-1253	charcoal	T.1, L.10	460 ± 40	unpublished
Pretty Point (32OL8)	SMU-1283	charcoal	T.1, L.9	515 ± 50	unpublished
Lower Sanger (32OL11)	SMU-1276	charcoal	T.1, L.2	390 ± 40	unpublished
Lower Sanger (32OL11)	SMU-1281	charcoal	T.1, L.3	350 ± 30	unpublished
Lower Sanger (32OL11)	SMU-1255	charcoal	T.1, F.1, L.4	330 ± 50	unpublished
Upper Sanger (32OL12)	SMU-1254	charcoal	T.2, F.2	620 ± 50	unpublished
Upper Sanger (32OL12)	SMU-1277	charcoal	T.2, F.1	650 ± 50	unpublished
Cross Ranch (32OL14)	M-2368	charcoal	H.3, F.105	420 ± 100	Calabrese 1972:13
Cross Ranch (32OL14)	M-2369	wood	H.3, F.158/159	590 ± 100	Calabrese 1972:13

Table 8.2. Continued.

Site or Location	Lab Number	Material Dated	Within-Site Provenience**	Radiocarbon Years BP t 1/2=5568	Reference
Cross Ranch (32OL14)	SMU-1059	charcoal	H.7, F.53, L.2	650 ± 40	unpublished
Cross Ranch (32OL14)	SMU-1202	charcoal	H.7, F.63	530 ± 50	unpublished
Bundlemaker (32OL159)	TX-4242	charcoal	U.3/4, L.2 12-22 cm sd	X 300 ± 60	Ahler et al. 1981:52
Bundlemaker (32OL159)	TX-4243	charcoal	U.3/4, L.18&19 152-172 cm sd	X 2310 ± 80	Ahler et al. 1981:52
Bundlemaker (32OL159)	TX-4244	charcoal	U.3/4, L. 22 202-212 cm sd	X 2160 ± 60	Ahler et al. 1981:52
Bundlemaker (32OL159)	TX-4245	charcoal	U.5, L.2 215 cm sd	X 640 ± 60	Ahler et al. 1981:52
Legacy (32OL252)	TX-4246	charcoal	U.7, L.3 20-30 cm sd	X 1230 ± 570	Ahler et al. 1981:94
Bagnell (32OL16)	WIS-540	charcoal	House 3	380 ± 55	Lehmer et al. 1973:163
Bagnell (32OL16)	WIS-541	charcoal	House 3	375 ± 50	Lehmer et al. 1973:163
Bagnell (32OL16)	WIS-542	charcoal	House 3	260 ± 60	Lehmer et al. 1973:163
Flaming Arrow (32ML4)	SMU-1273	wood	H.1, F.15	830 ± 70	Toom 1988
Flaming Arrow (32ML4)	SMU-1258	soluble humates	H.1, F.15	X 820 ± 60 *	unpublished
Flaming Arrow (32ML4)	SMU-1270	wood	H.1, F.113	1000 ± 50	Toom 1988
Flaming Arrow (32ML4)	SMU-1297	wood	H.1, F.110	900 ± 80	Toom 1988
Angus (32OL144)	SMU-1210	charcoal	U.25, F.8	620 ± 40	unpublished
Angus (32OL144)	SMU-1211	charcoal	U.27, F.10	610 ± 50	unpublished
PG (32OL148)	SMU-1203	charcoal	F.1, north part	700 ± 50	unpublished
PG (32OL148)	SMU-1204	charcoal	F.1, south part	720 ± 50	unpublished
Hensler (32OL18)	SMU-1278	charcoal	T.1, F.1	440 ± 50	unpublished

Table 8.2. Continued.

Site or Location	Lab Number	Material Dated	Within-Site Provenience**	Radiocarbon Years BP t 1/2=5568	Reference
Hensler (32OL18)	SMU-1259	charcoal	T.2, L.2	380 ± 50	unpublished
Mandan Lake (32OL21)	SMU-1274	charcoal	T.1, L.4	330 ± 50	unpublished
Mandan Lake (32OL21)	SMU-1268	charcoal	T.4, L.3	400 ± 50	unpublished
Mandan Lake (32OL21)	SMU-1275	charcoal	T.5, L.4	490 ± 50	unpublished
Mandan Lake (32OL21)	SMU-1257	charcoal	T.5, L.6	340 ± 50	unpublished
Mahhaha (32OL22)	SMU-1337	charcoal	T.2, L.3	X 165 ± 30 * 165 ± 30 *#	unpublished
Mahhaha (32OL22)	SMU-1342	charcoal	T.2, L.3	X 175 ± 30 * 170 ± 30 *#	unpublished
Mahhaha (32OL22)	SMU-1284	charcoal	T.3, L.5	X 530 ± 50	unpublished
Mahhaha (32OL22)	SMU-1292	charcoal	T.3, L.6	355 ± 50	unpublished
Mahhaha (32OL22)	SMU-1262	charcoal	T.3, L.7	460 ± 50	unpublished
Clark's Creek (32ME1)	M-2366	charcoal	T.1, F.1	670 ± 100	Calabrese 1972:34,35
Clark's Creek (32ME1)	M-2367	charcoal	T.1, F.1	770 ± 110	Calabrese 1972:34
Clark's Creek (32ME1)	SMU-1286	charcoal	T.1, F.1	750 ± 50	unpublished
Alderin Creek (32ME4)	SMU-1263	charcoal	X104, F.137	300 ± 50	unpublished
Alderin Creek (32ME4)	SMU-1266	charcoal	X104, F.137	310 ± 50	unpublished
Alderin Creek (32ME4)	SMU-1267	charcoal	X104, F.132	310 ± 50	unpublished
White Buffalo Robe (32ME7)	SMU-725	charcoal	Area 01, F.242	X 380 ± 40	Lee and Ahler 1980:140
White Buffalo Robe (32ME7)	SMU-730	charcoal	Area 04, F.161	X 420 ± 50	Lee and Ahler 1980:140

Table 8.2. Continued.

Site or Location	Lab Number	Material Dated	Within-Site Provenience**	Radiocarbon Years BP t 1/2=5568	Reference
White Buffalo Robe (32ME7)	SMU-731	charcoal	Area 11, Midden	410 ± 50	Lee and Ahler 1980:140
White Buffalo Robe (32ME7)	SMU-793	charcoal	Area 01, F.4	240 ± 50	Lee and Ahler 1980:140
White Buffalo Robe (32ME7)	SMU-795	charcoal	Area 11, F.236	370 ± 50	Lee and Ahler 1980:140
White Buffalo Robe (32ME7)	SMU-724	charcoal	H.1, F.118	700 ± 50	Lee and Ahler 1980:140
White Buffalo Robe (32ME7)	SMU-729	charcoal	H.6, F.38	630 ± 40	Lee and Ahler 1980:140
White Buffalo Robe (32ME7)	SMU-732	charcoal	H.8, F.240	730 ± 50	Lee and Ahler 1980:140
White Buffalo Robe (32ME7)	SMU-794	charcoal	H.1, F.121	740 ± 50	Lee and Ahler 1980:140
White Buffalo Robe (32ME7)	SMU-796	charcoal	H.1, F.144	580 ± 40	Lee and Ahler 1980:140
White Buffalo Robe (32ME7)	UGA-2993	charcoal	H.1, F.121	X 500 ± 55	Lee and Ahler 1980:142
White Buffalo Robe (32ME7)	UGA-2994	charcoal	Area 02, F.38	X 215 ± 55	Lee and Ahler 1980:142
White Buffalo Robe (32ME7)	UGA-2995	charcoal	Area 01, F.242 same as SMU-725	X 10 ± 70	Lee and Ahler 1980:142
White Buffalo Robe (32ME7)	UGA-2996	charcoal	Area 05, F.176	X 365 ± 65	Lee and Ahler 1980:142
White Buffalo Robe (32ME7)	UGA-2997	charcoal	Area 04, F.90	X 805 ± 65	Lee and Ahler 1980:142
White Buffalo Robe (32ME7)	UGA-2998	charcoal	Area 04, F.195	X 70 ± 75	Lee and Ahler 1980:142
White Buffalo Robe (32ME7)	UGA-2999	charcoal	Area 04, F.226	X 275 ± 50	Lee and Ahler 1980:142
White Buffalo Robe (32ME7)	UGA-3000	charcoal	Area 03, F.61	X 1025 ± 60	Lee and Ahler 1980:142
White Buffalo Robe (32ME7)	UGA-3001	charcoal	Area 01, F.11	X 910 ± 60	Lee and Ahler 1980:142
White Buffalo Robe (32ME7)	UGA-3002	charcoal	Area 01, F.210	X modern	Lee and Ahler 1980:142

Table 8.2. Continued.

Site or Location	Lab Number	Material Dated	Within-Site Provenience**	Radiocarbon Years BP t 1/2=5568	Reference
White Buffalo Robe (32ME7)	UGA-3003	charcoal	Area 01, F.255	X 755 ± 90	Lee and Ahler 1980:142
White Buffalo Robe (32ME7)	UGA-3004	charcoal	Area 06, F.140	X 925 ± 65	Lee and Ahler 1980:142
White Buffalo Robe (32ME7)	UGA-3005	charcoal	Area 02, F.232	X 590 ± 70	Lee and Ahler 1980:142
White Buffalo Robe (32ME7)	UGA-3006	charcoal	Area 07, F.132	X 420 ± 70	Lee and Ahler 1980:142
White Buffalo Robe (32ME7)	UGA-3007	charcoal	Area 11, Midden same as SMU-731	X 675 ± 85	Lee and Ahler 1980:142
32ME632	BETA-8308	charcoal	T.1, 515 cm sd	X 160 ± 90	Greiser and Greiser 1984
32ME644	BETA-8310	wood	T.7, F.1	X 140 ± 80	Greiser and Greiser 1984
32ME670	BETA-8311	bone	T.4, 37 cm sd	X 1950 ± 90	Greiser and Greiser 1984
32ME674	BETA-8380	bone	Trench 1, 0-25 cm sd	X 1750 ± 60	Greiser and Greiser 1984
Lower Hidatsa (32ME10)	SMU-798	charcoal	U.3, L.16 250-265 cm sd	310 ± 60	Ahler and Weston 1981:51
Lower Hidatsa (32ME10)	SMU-1011	charcoal	U.4, L.7, 90-105 cm sd	310 ± 40	unpublished
Lower Hidatsa (32ME10)	SMU-1345	charcoal	U.4, L.11 120-135 cm sd	X 370 ± 60 * 390 ± 60 *#	unpublished
Lower Hidatsa (32ME10)	SMU-1336	charcoal	U.4, F.8 146-163 cm sd	X 340 ± 30 * 350 ± 30 *#	unpublished
Lower Hidatsa (32ME10)	SMU-1012	charcoal	U.4, L.20 180-195 cm sd	480 ± 50	unpublished
Lower Hidatsa (32ME10)	BETA-1495	charcoal	U.4, L.4 45-60 cm sd	X 400 ± 60	Ahler and Weston 1981:51
Lower Hidatsa (32ME10)	BETA-1496	charcoal	U.4, L.7 90-105 cm sd	X 930 ± 110	Ahler and Weston 1981:51
Lower Hidatsa (32ME10)	BETA-1497	charcoal	U.4, L.11 120-135 cm sd	X 725 ± 70	Ahler and Weston 1981:51
Lower Hidatsa (32ME10)	BETA-1498	charcoal	U.4, L.14 146-163 cm sd	X 520 ± 70	Ahler and Weston 1981:51

Table 8.2. Continued.

Site or Location	Lab Number	Material Dated	Within-Site Provenience**	Radiocarbon Years BP t 1/2=5568	Reference
Lower Hidatsa (32ME10)	BETA-1499	charcoal	U.4, L.20 180-195 cm sd	X 730 ± 50	Ahler and Weston 1981:51
Poly (32ME407)	SMU-800	charcoal	U.2, F.3	440 ± 50	Ahler and Mehrer 1984:147
Forkorner (32ME413)	SMU-1085	charcoal	F.17, L.1&2	450 ± 30	Ahler and Mehrer 1984:210
Forkorner (32ME413)	SMU-1086	charcoal	F.15, L.3	570 ± 60	Ahler and Mehrer 1984:210
Forkorner (32ME413)	SMU-1100	charcoal	F.18, L.1	450 ± 40	Ahler and Mehrer 1984:210
Forkorner (32ME413)	SMU-1102	soluble humates	F.18, L.1	X 630 ± 200 X 630 ± 200 #	Ahler and Mehrer 1984:210
Forkorner (32ME413)	SMU-801	charcoal	180NE422, F.9	520 ± 50	Ahler and Mehrer 1984:210
Hump (32ME414)	SMU-1088	charcoal	F.1, L.2	X 525 ± 120 525 ± 120 #	Ahler and Mehrer 1984:258
Hump (32ME414)	SMU-1087	soluble humates	F.1, L.2	X 410 ± 70 X 430 ± 70 #	Ahler and Mehrer 1984:258
Youess (32ME415)	SMU-1064	charcoal	F.7, L.2	470 ± 40	Ahler and Mehrer 1984:279
Youess (32ME415)	SMU-1083	soluble humates	F.7, L.2	X 390 ± 40 X 380 ± 40 #	Ahler and Mehrer 1984:279
Youess (32ME415)	SMU-1062	charcoal	F.7, L.2	510 ± 30	Ahler and Mehrer 1984:279
Youess (32ME415)	SMU-1075	charcoal	F.1, L.2&3	560 ± 50	Ahler and Mehrer 1984:279
Youess (32ME415)	SMU-1077	charcoal	F.3, L.1	470 ± 40	Ahler and Mehrer 1984:279
Elbee (32ME408)	SMU-797	charcoal	F.4, L.2	440 ± 40	Ahler 1984:34
Elbee (32ME408)	SMU-1101	charcoal	F.4, L.2	X 280 ± 40 270 ± 40 #	Ahler 1984:34
Elbee (32ME408)	SMU-1103	charcoal	F.4, L.4	X 340 ± 30 330 ± 30 #	Ahler 1984:34

Table 8.2. Concluded.

Site or Location	Lab Number	Material Dated	Within-Site Provenience**	Radiocarbon Years BP t 1/2=5568	Reference
Big Hidatsa (32ME12)	SMU-971	charcoal	U.1, F.97 175-239 cm sd	240 ± 30	Ahler and Swenson 1985:104
Big Hidatsa (32ME12)	SMU-974	charcoal	U.1, F.97 239-264 cm sd	X 170 ± 50 160 ± 50 #	Ahler and Swenson 1985:104
Big Hidatsa (32ME12)	SMU-1168	charcoal	U.6, L.10 70-77 cm sd	350 ± 40	Ahler and Swenson 1985:104
Big Hidatsa (32ME12)	SMU-1169	charcoal	U.6, L.11 77-92 cm sd	180 ± 50	Ahler and Swenson 1985:104
Big Hidatsa (32ME12)	SMU-1197	charcoal	U.6, L.12 92-110 cm sd	440 ± 50	Ahler and Swenson 1985:104
Big Hidatsa (32ME12)	SMU-1198	charcoal	U.6, L.13 110-125 cm sd	470 ± 50	Ahler and Swenson 1985:104
High Butte (32ME13)	N-1428	charcoal	Feature 2	X 1600 ± 145	Wood and Johnson 1973:71
<u>Sites Outside the Upper Knife-Heart Region</u>					
Mondrian Tree (32MZ58)	UCR-1333	charcoal	BU-15, F.220 20 cm sd	320 ± 70	Toom 1983:8.34
Mondrian Tree (32MZ58)	UCR-1335	charcoal	BU-15, F.205 20 cm sd	350 ± 60	Toom 1983:8.34
Hagen (24DW1)	WIS-863	charcoal		490 ± 55	Wood and Downer 1977:87
Hagen (24DW1)	WIS-864	charcoal		X 780 ± 55	Wood and Downer 1977:87
Hagen (24DW1)	WIS-865	charcoal		X 775 ± 55	Wood and Downer 1977:87
Arzberger (39HU6)	M-1126			500 ± 150	Lehmer 1971:114
Arzberber (39HU6)	M-1126a			430 ± 200	Lehmer 1971:114

Notes: * = denotes preliminary dates, subject to slight change upon final lab calibration.

X = in the "Radiocarbon Years BP" column, denotes dates excluded for various reasons from further assessments of regional Plains Village period chronology. In the "Within-Site Provenience" column, denotes excavation unit.

= denotes dates corrected for C13/12 fractionation; other SMU- dates not so designated are not corrected for C13/12 fractionation. Information is generally lacking concerning C13/12 fractionation for dates other than those from the SMU-lab, and those dates are reproduced here as reported.

** = provenience abbreviations: T. = Test Unit; L. = Level; H. = House; F. = Feature; U. = Unit or Excavation Unit; X = Excavation Unit; sd = surface depth (depth below surface).

Twenty-nine of the dates from the upper Knife-Heart region in Table 8.2 are reported here for the first time. These dated samples come primarily from sites excavated in the 1968 Wood/Lehmer testing program (discussed in Wood 1986 and in Chapter 2), including the dates from the Pretty Point, Lower Sanger, Upper Sanger, Hensler, Mandan Lake, Mahhaha, and Clark's Creek villages. Additional dates were run on samples collected in the 1969 excavations at the Cross Ranch Village (Calabrese 1972) and on samples associated with a circular earthlodge excavated by the State Historical Society of North Dakota in 1968 at the Alderin Creek Village (excavations unreported). Four previously unreported dates derive from the 1978 test excavation materials at Lower Hidatsa village within the KNRI. These samples were run after the excavation report was written (Ahler and Weston 1981), when it became clear that substantial pre-contact period deposits existed at the site and that several of the available C-14 dates for those deposits were unreliable.

The rationale for sample selection within the context of the KNRI Phase I program has been relatively straightforward. First, we have in general avoided using radiocarbon procedures to date deposits which contain substantial amounts of trade artifacts. The submitted samples derive almost exclusively from contexts either lacking trade artifacts or having such materials in extremely low density. Thus, C-14 analysis has not been used to date the upper half of the midden deposit at Lower Hidatsa Village, the later two-thirds of the midden deposit at Big Hidatsa Village, nor any of the deposits at Sakakawea Village. The assumption is that these archeological contexts are too recent to be dated accurately with C-14 analysis. Second, where stratified pre-contact age cultural horizons exist, we have attempted to date several samples representing the full potential age range of such stratified sequences. This is exemplified by the sample series from excavation unit 6 at Big Hidatsa Village, the sample series from AC units 3 and 4 at Lower Hidatsa Village, and in the sample series from excavation units 2 and 3 at Mahhaha Village. In some other deeply stratified sites, sufficient charcoal was not available to date such a stratified sample series (e.g., at Upper Sanger Village). Third, we have attempted to date at least two samples from each excavated site within the region which has also produced a pottery or stone tool sample sufficient for culture-historic interpretation. We have avoided dating single samples from any site, feeling that two or three samples from a given site context provides a better basis for judging the accuracy and reliability of the dating results. In sites such as Mandan Lake which produced relatively large excavated collections from multiple excavation units, a larger series of samples was dated, with sample selection guided in part by a preliminary assessment of the pottery typology from various intrasite contexts.

As noted previously, the majority of the dates from the upper Knife-Heart region have been produced as the result of a sustained radiocarbon dating program conducted by Herbert Haas at the SMU Radiocarbon Laboratory working in cooperation and coordination with Stanley Ahler at UND. In addition to the goal of providing reliable and accurate dates for archeological materials found in numerous contexts in the region, the SMU/UND/NPS dating program has also addressed, in a limited fashion, several more specific problems pertinent to establishing confidence in the dating results and in their interpretaion. In the remainder of this subsection, we will briefly discuss the specific problems addressed in the dating program before turning to an evaluation and interpretation of all C-14 dates available for the region.

Specific Problems

One topic addressed in the C-14 dating program has been a preliminary assessment of the possible effects of soluble humate contamination in charcoal samples. This study was prompted by the observation that C-14 dates from the SMU laboratory often differed considerably from dates produced in other laboratories on samples from the same sites, from the same contexts, and in some cases from the same dated material (see the discussion of geologic dates, in a preceding section, and compare SMU and UGA dates from White Buffalo Robe and SMU and BETA dates from Lower Hidatsa, in Table 8.2). It was posited that some of these differences might derive from incomplete removal of soluble humates from some charcoal samples, this itself being perhaps a result of rapid pretreatment procedures used in labs offering short turn-around times.

To assess this idea, both the soluble humate (humic acid) and the insoluble (solid carbon) fractions of three charcoal samples from the KNRI were intentionally dated, and the results compared. The sample pairs are SMU-1100/SMU-1102 from the Forkorner site, SMU-1088/SMU-1087 from the Hump site, and SMU- 1064/SMU-1083 from the Youess site (Table 8.2). In the first pair the central tendency of the soluble humate fraction date is 180 radiocarbon years older, in the second it is 95 radiocarbon years younger, and in the third it is 90 radiocarbon years younger. With reference to the dates on insoluble carbon, the first humate date is 40 percent older, the second is 18 percent younger, and the third is 19 percent younger. In the first two pairs, the central tendencies overlap at one standard deviation, while in the third pair they do not. Due to the relatively large standard deviations associated with some of the determinations, the results are best judged as inconclusive. The results suggest that incomplete sample pretreatment could produce a date that is either too old or one that is too young. It is also clear that errors on the order of 90 to 180 years, seemingly possible from incomplete pretreatment and incomplete removal of soluble humates, could substantially alter the interpretation of C-14 dates from Plains Village sites in the region where the goal is regional chronology expressed in 50-100 year time increments.

Pertinent to this problem is Haas' observation that quite lengthy pretreatment times were often necessary for many of the upper Knife-Heart region samples. He notes that the complete removal of soluble humates, one step in pretreatment, often takes about one week for completion. In several samples very dense charcoal pieces are penetrated by secondary carbonate. Removal of secondary carbonates in an acid solution, a separate step in pretreatment, often takes up to ten days for completion. These observations, taken in conjunction with observed differences between radiocarbon ages for soluble and insoluble humic fractions and the stringent dating requirements necessary for interpretation of the Plains Village period sites, combine to suggest that radiocarbon dates produced in rapid-delivery laboratories can be expected to occasionally or frequently produce less than optimal results for samples within the age range and geographic area of interest.

A second problem investigated in a very preliminary fashion is the possible effect of waterscreen recovery on charcoal used for radiocarbon dating. Much of the charcoal available from excavated Plains Village sites in the KNRI was collected during the course of washing excavated sediment over fine-mesh screen using water pumped directly from the Knife River. Because the Knife River contains the effluent and waste products from many communities, small industries, and residences located upstream, it was unclear if washing archeological charcoal samples with many tens or hundreds of gallons of such water might not contaminate the samples for purposes of C-14 analysis. Many C-14 dates previously run for the Middle Missouri subarea were collected in such waterscreening recovery apparatus, but until about midway in the Phase I dating program we had not directly assessed the effects of waterscreening on the dating results.

To partially test the possible effects of waterscreen recovery processing on C-14 dating, two pairs of samples from the same excavation context but recovered by hand-picking of the charcoal with the use of metal collection tools on the one hand, and waterscreened recovery on the other, were selected for dating. The hand-picked samples are SMU-1064 from the Youess site and SMU-1101 from the Elbee site, matched with waterscreened samples SMU-1062 and SMU-797, respectively. The SMU-1064/SMU-1062 pair yields dates which differ by only 40 radiocarbon years, with considerable overlap at one standard deviation, while the SMU-1101/SMU-797 pair yields dates which differ by 170 radiocarbon years and which do not overlap at two standard deviations. Computation of the T test statistic according to procedures in Ward and Wilson (1978:23) shows neither of the pairs to be significantly different (at $p=0.05$). Thus the results, while highly limited in scope, seem to indicate no significant effect is derived from collection of charcoal in waterscreen recovery using water pumped from the Knife River. Regardless, it is Haas' opinion that hand-picking collection methods probably introduce fewer sources of possible contamination and error, and that hand-picking is the preferred technique for field collection of charcoal samples.

Eleven of the dates run in the SMU lab were corrected for C-13/12 fractionation (Table 8.2). These corrections were conducted intermittently throughout the dating program, primarily to assess Haas' opinion, based on past experience with dating charred wood samples, that C-13/12 fractionation correction would have little significant effect on the dating results. None of the dates so corrected differ from the uncorrected dates by more than 20 years (rounded), supporting the concept that such correction will have little substantive effect on the dating results. In light of this, fractionation correction was not conducted for the majority of the SMU samples. With reference to this potential source of error, we can note that care was taken to exclude charred grasses and corn from all materials submitted to Haas for dating.

Two other problems addressed in the SMU dating program are purely archeological in nature, rather than having to do with evaluation of the radiocarbon dating process itself. One such goal was to provide additional dates for previously dated sites critical to the study of the cultural taxonomy in the region. One of these sites was the Cross Ranch Village (Calabrese 1972), the type site for the Nailati phase, for which two dates separated by 170 radiocarbon years and having 100 year sigmas were previously available (M-2368 and M-2369). Two additional dates were derived from charcoal from a second house at the site, yielding a larger group of dates which are internally consistent and which can be averaged to provide a more precise age estimate for the village. A second similar endeavor was conducted for Clark's Creek Village (Calabrese 1972), the type site for the Clark's Creek phase. The two existing dates for the site with 100 year sigmas (M-2366 and M-2367) were supplemented with an additional date run at the SMU lab (SMU-1286), considerably improving understanding of the chronological placement of the site.

One other specific application of radiocarbon dating to a particular archeological problem occurred with samples from Mahhaha Village (32OL22). The 1968 tests at the site revealed the midden there to be relatively deep and well-stratified. The upper excavation levels in tests 2 and 3 are dominated by Knife River ware while the lowermost levels in the same units are dominated by S-rim pottery forms. Intermediate levels contain a wide variety of pottery types. The problem to be addressed is whether the sequence at Mahhaha Village represents a continuous long-term occupation, or if it represents two shorter-term occupations separated by a lengthy occupational hiatus, with mixing of the artifacts occurring between the two components in the stratified test units. To assess these possibilities, two radiocarbon dates were run on charcoal fragments of different sizes from intermediate level 3 in test unit 2. The reasoning is that if level 3 contains a mixture of charcoal from two components of quite different age, then the later, more recent charcoal will tend to be concentrated in larger-size pieces, while charcoal from the earlier component will have been subjected to greater disturbance and it will tend to occur in smaller-sized pieces. One dated sample from level 3 (SMU-1337) contained only size grade 4 charcoal (1/8-1/4 inch diameter), while the other sample from that same context (SMU-1342) contained only size grade 2 and 3 fragments (1/4-1 inch diameter). If the dated deposits are a highly mixed composite from two components, we expect the small-sized charcoal to date considerably earlier than the large-sized charcoal. If they are an unmixed, single component deposit we expect the two samples to date approximately the same.

The results (Table 8.2) indicate that the two samples (SMU-1337 and SMU-1342) have almost identical radiocarbon ages, differing by only five years. This strongly supports the idea that the charcoal dated from level 3 of test unit 2 derives from a single episode of site occupation. This in turn suggests that the occupation at Mahhaha Village was relatively continuous, rather than occurring in discrete episodes separated by a lengthy period of site abandonment.

Sample Evaluation

The first step in the interpretation of the radiocarbon dates from archeological sites in the region and elsewhere is an evaluation of their accuracy, reliability, and potential usefulness for interpreting the archeological resources under study. For various reasons, not all of the dates in Table 8.2 are equally useful within the context of the Phase I KNRI interpretive program. Several dates have been excluded from further consideration, and all such excluded dates are designated with an "X" in Table 8.2. It is well recognized that not every C-14 date will be accurate and interpretable, due to many factors such as contamination, laboratory errors, errors from unknown sources, and inconclusive or inappropriate associations with other cultural materials. Several criteria for evaluation, identification and exclusion of unuseful dates were applied to the data listed in Table 8.2.

Uncertain or Inappropriate Cultural Associations

Involved here are twelve dates which are excluded because they are associated with cultural materials of little relevance to the focus of the KNRI program or because they have uncertain cultural associations. This includes a total of four dates on Woodland period deposits at the High Butte site (N-1428) and from the Bundlemaker site (TX-4243 and TX-4244) and the Legacy site (TX-4246) on the Cross Ranch. Also excluded are two other dates from the Bundlemaker site (TX-4245 and TX-4242) on the Cross Ranch which are associated, respectively, with a very small sample of Plains Village artifacts not useful in this study and with a natural stratigraphic horizon overlying Plains Woodland artifacts. Also excluded are four dates from an equal number of sites in the breaks zone in the Glenharold Mine area south of Stanton which have uncertain cultural content or insufficient associated artifacts for meaningful interpretation (BETA-8308, BETA-8310, BETA-8311, and BETA-8380; Greiser and Greiser 1984). Also excluded are two dates from the White Buffalo Robe site (SMU-725 and SMU-730). These samples were originally identified as being associated with a Knife River phase component at the site (Lee and Ahler 1980:146). Subsequent analysis of several other collections from the region has led Ahler to suspect that the pottery in the two dated contexts is probably primarily Heart River phase in origin rather than Knife River phase in origin. While trade artifacts occur at White Buffalo Robe Village, their presence in several features there may be more a matter of intrusion into Heart River phase contexts rather than an indication of a distinct Knife River phase occupation. The precise cultural taxonomic unit associated with the two dates referenced above remains unclear, and for that reason, they are excluded from further analysis.

General Unreliability Based on Archeological Data

Two large series of dates, each from single sites, were excluded from further consideration because of discrepancies between the dating results and associated archeological information. A single date from another stratified site was also excluded on this basis. One of these series consists of 15 dates run by the University of Georgia lab from the White Buffalo Robe Village (UGA-2993 through UGA-3007). The reasons for considering the dates as unreliable are discussed in detail by Lee and Ahler (1980:141-144). Briefly, most of the White Buffalo Robe samples are associated with one of two major components at the site which are clearly distinguishable based on associated pottery: Nailati phase, the earlier, and Heart River phase, the later. Data from elsewhere indicate also that these two phases do not overlap in time and should separate well through chronometric analysis. The central tendencies for seven UGA Nailati phase dates range from 215 to 1,025 radiocarbon years BP, while five UGA Heart River phase dates range from modern to 910 radiocarbon years BP. Further, four samples were dated by UGA which are either split samples or samples from the same contexts as four samples dated by SMU. The two series of four from two labs differ by an average of 318 radiocarbon years in both positive and negative directions. Because the SMU results for eight samples from White Buffalo are internally consistent with ceramic data and taxonomic placement, the SMU series is considered to be the more reliable of the two and all UGA dates from the White Buffalo Robe site are exluded as being unreliable.

The second large series in this exclusion category consists of five dates produced by Beta Analytic, Inc., on charcoal from the Lower Hidatsa Village (BETA-1495 through BETA-1499; see discussion in Ahler and Weston 1981:52-53). The five dated samples are from deep, well stratified deposits within a single excavation unit which penetrated a layered, outside-house midden. The stratigraphically highest date is associated with trade artifacts, while the lower four are clearly associated with precontact age Heart River phase artifacts which, based on other evidence, accumulated over a 100-150 year period, at most. The dates produced show no pattern consistent with vertical stratigraphy, and they exhibit a range from 400 to 930 radiocarbon years BP. Three split sample dates were eventually run at the SMU lab, with results as follow: for the SMU-1011/BETA-1496 pair, the BETA date is 620 years older; for the SMU-1345/BETA-1497 pair, the BETA date is 335 years older; and for the SMU-1012/BETA-1499 pair, the BETA date is 250 radiocarbon years older. The five BETA dates from this excavation unit have an unweighted average of 661 years, while the four SMU dates from the same unit have a weighted average of 375 radiocarbon years BP. In addition, the SMU dates are generally consistent with the stratigraphy. At three other sites in the region having clearly defined Heart River phase components (Lower Sanger, Alderin Creek, White Buffalo Robe), pooled mean dates range from 307 to 358 radiocarbon years BP, in strong disagreement with the mean of the BETA dates from Lower Hidatsa. Considering all these facts, all five BETA dates from Lower Hidatsa Village have been excluded from consideration as being unreliable and inaccurate.

The lower three dates from stratified deposits in test unit 3 at the Mahhaha Village are inconsistent with the stratigraphy in that excavation unit (SMU-1284, SMU-1292, SMU-1262). The lower two dated samples derive from levels assigned to a common analytical unit, and they are not internally inconsistent with each other, the site stratigraphy, or the general artifact content. The upper date, from level 5 (SMU-1284), is judged to be least consistent with associated ceramic information, and it is excluded from further analysis. Its exclusion eliminates the problem of stratigraphic inconsistency apparent in the excavation unit 2/3 series, and the remaining four dates from these units are compatible with observed stratigraphy.

Exclusion of Soluble Humate Dates

In four instances the SMU lab produced dates on both the soluble humate fraction and the insoluble carbon fraction of wood charcoal samples. In three samples, this was done in order to assess the order of contamination potentially available from soluble humate materials in charcoal samples. Because the soluble humate fraction is considered to be the less desirable material for dating because of uncertainty of its origin and association with archeological materials, three soluble humate dates are excluded from further consideration. These include SMU-1102 from the Forkorner site, SMU-1087 from the Hump site, and SMU-1083 from the Youess site. Also excluded from consideration is a soluble humate date on a wood post from the Flaming Arrow site, SMU-1258. The wood in this post was highly decomposed, and the date on the undigested wood in the same post (SMU-1273), the preferred date, differs by only 10 years, indicating that essentially the same material was dated in each fraction.

Exclusion Based on Statistical Tests

After all of the above exclusions were effected, certain tests were applied to the remaining dates to determine if any of the series of multiple dates thought to be from single archeological contexts in fact differ significantly from each other in a statistical sense. The goal is to test the hypothesis that samples from the same archeological context are in fact representative of a single chronological event. Procedures outlined in Ward and Wilson (1978) are used to test this hypothesis. Testing this hypothesis is necessary prior to combining a series of dates from a given context or from more than one context into a pooled mean for purposes of comparison with dates from other contexts. In all instances, we follow procedures presented by Ward and Wilson for "Case II" situations, in which two or more samples under consideration are not known to be and cannot be assumed to be derived from the same object or piece of dated material. In this case, the error factor for each date used in the computations is composed of both the counting error (the reported sigma, squared) plus an unknown but estimated error factor in the dendrochronological calibration curve (estimated at 50 squared, as given by Clark 1975:256 for dates less than 2,700 years in age). Using formula (7) presented in Ward and Wilson (1978:23) a test statistic T' can be computed which has a chi-square distribution under the null hypothesis that all dates are dating the same event. Chi-square distribution tables and $p=0.05$ are then used to test the null hypothesis for each group of dates from individual contexts in Table 8.2.

The above test for consistency has been applied to all groups of two or more radiocarbon dates from each of the sites listed in Table 8.2, or to all dates from individual "batches" within sites, in cases of sites with multiple components or multiple potential components established on the basis of pottery or spatial subdivisions within the site (see the discussion of batches in Chapter 17). In only one instance was the null hypothesis rejected, this being for the three samples from the Hagen site ($T'=9.975$, $df=2$, $p=<0.01$). This test gives no indication of which sample(s) should be considered as erratic or "outliers" to be excluded from combination with the remainder of the group. Inspection of the three dates from the Hagen site and general knowledge of the pottery collection from the site led to the decision to consider the most recent date (WIS-863) as the one most likely to be associated with the ceramic sample, thereby excluding the two older dates from further consideration. The statistical test results indicate that all other groups of multiple dates from a single batch within an individual site can be combined across each batch; dates can also be combined across batches within sites in cases where additional ceramic analysis indicates that the latter step is justifiable.

Dates Uncorrected for C-13/12 Fractionation

Several of the SMU dates have been corrected for C-13/12 fractionation. In such cases both the corrected and uncorrected dates are given in Table 8.2. Where such correction has been applied, the uncorrected date is excluded from further consideration. Many of the SMU dates were not corrected for C-13/12 fractionation, and those dates were used in uncorrected form in further analyses. In most cases, information is not readily available concerning the use or lack of use of fractionation correction in dates produced by labs other than SMU. In those cases, the dates were used as reported in the subsequent analyses.

Following completion of all of the exclusion processes discussed above, the usable sample of radiocarbon dates available for the KNRI Phase I study of Plains

Village chronology consists of a total of 74 dates from a total of 24 sites. Of these 74 dates, 69 are dates from 21 sites within the upper Knife-Heart region, and 23 of these are dates from a total of seven sites within the KNRI.

Averaging, Correction, and Interpretation

When multiple dates are available from a given archeological context, it is generally desirable to combine or average the dates to arrive at a more accurate radiocarbon age for the dated context. A weighted average or pooled mean is computed which takes into account variations in the magnitude of the counting errors (the sigma) reported by the lab for each sample. Long and Rippeteau (1974) give procedures and guidelines for computing such a pooled mean as do Ward and Wilson (1978). Long and Rippeteau (1974:210) recommend calibration or correction of individual dates according to a dendrochronological correction curve prior to averaging, while Ward and Wilson (1978:28-30) advise against such a procedure and recommend computation of a pooled mean from uncalibrated individual dates, to be followed by calibration of this pooled mean. The recommendations and procedures of Ward and Wilson (1978) are followed here, using their formula (6) (p. 23) to compute a pooled mean which takes into account both reported counting errors and estimated calibration errors (as per Clark 1975:256) for each sample. The variance of the pooled mean (the standard deviation, squared) is computed by formula (8) in Ward and Wilson (1978:23). Ward and Wilson make it clear that this formula derives the variance of the *mean* of the group of *n* observations and is not the variance of the group of determinations. The determination of the variance of the group of determinations is much more complex and less straightforward, as discussed in Wilson and Ward (1981). Such a procedure, while perhaps giving a more realistic measure of the actual scatter of dates available from a given archeological context, was not conducted here because it was seen as yielding little change in the interpretation of the KNRI chronometric results.

Table 8.3 provides a summary of all radiocarbon dates included in the present analysis and the results of computation of the pooled mean and its associated standard deviation for these dates where two or more dates are available for any given site or batch. The individual dates and pooled means are listed in this table by site as well as by batch numbers within sites. In a few cases pooled means are computed for groups of dates from more than one batch within a given site. An example of this is at Cross Ranch Village where a pooled mean is computed for batches 15 and 16 combined. In this instance, the T' statistical test of Ward and Wilson (1978) shows no significant difference in dates for batch 15 (House 3) and batch 16 (House 7) and ceramic analysis indicates little difference in the pottery from these two batches, as well. A similar procedure involving both the T' test statistic and examination of ceramic data led to the computation of a pooled mean for batches 20 and 21 at the Hensler site (Table 8.3).

Table 8.3. Summary data on corrected radiocarbon dates from Plains Village components in the upper Knife-Heart region and other areas. Regional sites arranged from south to north along the Missouri River.

Site and Batch	Sample Number	Corrected Radiocarbon Years BP t 1/2=5568	Corrected Crosspoint Date(s) AD (Stuiver 1982)	Range at 2 Sigma, AD (Stuiver 1982)	Tentative Range Mid-point AD	Culture Historic Unit*
Pretty Point 32OL8						
5	SMU-1253	460 ± 40	1435			SVC
5	SMU-1283	515 ± 50	1415			SVC
5	Pooled Mean	484 ± 47	1430	1328-1480	1404	SVC
Lower Sanger 32OL11						
7	SMU-1276	390 ± 40	1460			HRP

Table 8.3. Continued.

Site and Batch	Sample Number	Corrected Radiocarbon Years BP t 1/2=5568	Corrected Crosspoint Date(s) AD (Stuiver 1982)	Range at 2 Sigma, AD (Stuiver 1982)	Tentative Range Mid-point AD	Culture Historic Unit*
Lower Sanger 32OL11, continued						
7	SMU-1281	350 ± 30	1500, 1615			HRP
7	SMU-1255	330 ± 50	1520, 1590 1625			HRP
7	Pooled Mean	358 ± 37	1490	1437-1639	1538	HRP
Upper Sanger 32OL12						
11	SMU-1254	620 ± 50	1305, 1320 1370, 1390			SVC?
11	SMU-1277	650 ± 50	1295, 1375			SVC?
11	Pooled Mean	635 ± 50	1300, 1370 1380	1277-1415	1346	SVC?
Cross Ranch 32OL14						
15	M-2368	420 ± 100	1445			NP
15	M-2369	590 ± 100	1330, 1350 1365, 1390			NP
16	SMU-1059	650 ± 40	1295, 1375			NP
16	SMU-1202	530 ± 50	1410			NP
15/16	Pooled Mean	575 ± 42	1330, 1345 1395	1292-1429	1361	NP
Bagnell 32OL16						
18	WIS-540	380 ± 55	1475			SVC?
18	WIS-541	375 ± 50	1480			SVC?
18	WIS-542	260 ± 60	1645			SVC?
18	Pooled Mean	342 ± 32	1515, 1610 1620	1439-1650	1545	SVC?
Flaming Arrow 32ML4						
92	SMU-1273	830 ± 70	1220			?
92	SMU-1270	1000 ± 50	1010, 1020			?
92	SMU-1297	900 ± 80	1045, 1070, 1080 1135, 1155			?

Table 8.3. Continued.

Site and Batch	Sample Number	Corrected Radiocarbon Years BP t 1/2=5568	Corrected Crosspoint Date(s) AD (Stuiver 1982)	Range at 2 Sigma, AD (Stuiver 1982)	Tentative Range Mid-point AD	Culture Historic Unit*
Flaming Arrow 32ML4, continued						
92	Pooled Mean	923 ± 47	1040, 1055, 1095 1120, 1140, 1150	997-1220	1109	?
Angus 32OL144						
95	SMU-1210	620 ± 40	1305, 1320 1370, 1390		NP	
95	SMU-1211	610 ± 50	1305, 1325, 1355 1365, 1390			NP
95	Pooled Mean	615 ± 47	1325, 1370 1390	1282-1420	1351	NP
PG 32OL148						
96	SMU-1203	700 ± 50	1285			CCP
96	SMU-1204	720 ± 50	1280			CCP
96	Pooled Mean	710 ± 50	1285	1218-1390	1304	CCP
Hensler 32OL18						
20	SMU-1278	440 ± 50	1440			HRP
21	SMU-1259	380 ± 50	1475			HRP
20/21	Pooled	400 ± 50	1455	1415-1635	1525	HRP
Mandan Lake 32OL21						
23	SMU-1274	330 ± 50	1520, 1590 1625	1438-1660	1549	HRP
25	SMU-1268	400 ± 50	1450	1415-1635	1525	HRP
27	SMU-1275	490 ± 50	1425			SVC?
27	SMU-1257	340 ± 50	1520, 1605 1620			SVC?
27	Pooled Mean	415 ± 50	1445	1412-1630	1521	SVC?
Mahhaha 32OL22						
30	SMU-1337	165 ± 30	1675, 1685 1740			KRP?
30	SMU-1342	170 ± 30	1670, 1745			KRP?

Table 8.3. Continued.

Site and Batch	Sample Number	Corrected Radiocarbon Years BP t 1/2=5568	Corrected Crosspoint Date(s) AD (Stuiver 1982)	Range at 2 Sigma, AD (Stuiver 1982)	Tentative Range Mid-point AD	Culture Historic Unit*
Mahhaha 32OL22, continued						
30	Pooled Mean	168 ± 27	1670,1740	1650-1814	1732	KRP?
32	SMU-1292	355 ± 50	1500, 1615			?
32	SMU-1262	460 ± 50	1435			?
32	Pooled Mean	408 ± 50	1450	1412-1633	1523	?
Clark's Creek 32ME1						
34	M-2366	670 ± 100	1290			CCP
34	M-2367	770 ± 110	1260, 1275			CCP
34	SMU-1286	750 ± 50	1265, 1280			CCP
34	Pooled Mean	738 ± 55	1280	1192-1386	1289	CCP
Alderin Creek 32ME4						
37	SMU-1263	300 ± 50	1535, 1635			HRP
37	SMU-1266	310 ± 50	1530, 1555 1630			HRP
37	SMU-1267	310 ± 50	1530, 1555 1630			HRP
37	Pooled Mean	307 ± 41	1530, 1555 1630	1452-1661	1557	HRP
White Buffalo Robe 32ME7						
39	SMU-731	410 ± 50	1450			HRP
39	SMU-793	240 ± 50	1650			HRP
39	SMU-795	370 ± 50	1485			HRP
39	Pooled Mean	340 ± 40	1520, 1610 1620	1440-1650	1545	HRP
40	SMU-724	700 ± 50	1285			NP
40	SMU-729	630 ± 40	1300, 1315 1370, 1385			NP
40	SMU-732	730 ± 50	1280			NP

Table 8.3. Continued.

Site and Batch	Sample Number	Corrected Radiocarbon Years BP t 1/2=5568	Corrected Crosspoint Date(s) AD (Stuiver 1982)	Range at 2 Sigma, AD (Stuiver 1982)	Tentative Range Mid-point AD	Culture Historic Unit*
White Buffalo Robe 32ME7, continued						
40	SMU-794	740 ± 50	1265, 1280			NP
40	SMU-796	580 ± 40	1325, 1345 1395			NP
40	Pooled Mean	670 ± 30	1290	1277-1389	1333	NP
Lower Hidatsa 32ME10						
48	SMU-798	310 ± 60	1530, 1555 1630			HRP
48	SMU-1011	310 ± 40	1530, 1555 1630			HRP
48	Pooled Mean	310 ± 50	1530, 1555 1630	1442-1667	1555	HRP
49	SMU-1345	390 ± 60	1455			HRP
49	SMU-1336	350 ± 30	1500, 1615			HRP
49	SMU-1012	480 ± 50	1430			HRP
49	Pooled Mean	400 ± 40	1455	1425-1630	1528	HRP
Poly 32ME407						
73	SMU-800	440 ± 50	1440	1327-1635	1481	NP?
Forkorner 32ME413						
77	SMU-1085	450 ± 30	1435			SVC
77	SMU-1086	570 ± 60	1330, 1345 1395			SVC
77	SMU-1100	450 ± 40	1435			SVC
77	Pooled Mean	478 ± 38	1430	1332-1451	1392	SVC
78	SMU-801	520 ± 50	1415	1292-1487	1390	SVC
77/78	Pooled Mean	487 ± 33	1425	1332-1448	1390	SVC
Hump 32ME414						
79	SMU-1088	525 ± 120	1415	1256-1645	1451	SVC?

Table 8.3. Continued.

Site and Batch	Sample Number	Corrected Radiocarbon Years BP t 1/2=5568	Corrected Crosspoint Date(s) AD (Stuiver 1982)	Range at 2 Sigma, AD (Stuiver 1982)	Tentative Range Mid-point AD	Culture Historic Unit*
Youess 32ME415						
80	SMU-1064	470 ± 40	1430			SVC
80	SMU-1062	510 ± 30	1420			SVC
80	SMU-1075	560 ± 50	1335, 1405			SVC
80	SMU-1077	470 ± 40	1430			SVC
80	Pooled Mean	500 ± 32	1420	1330-1444	1387	SVC
Elbee 32ME408						
74	SMU-797	440 ± 40	1440			?
74	SMU-1101	270 ± 40	1640			?
74	SMU-1103	330 ± 30	1520, 1590 1625			?
74	Pooled Mean	346 ± 36	1495, 1615	1441-1643	1542	?
Big Hidatsa 32ME12						
68	SMU-971	240 ± 30	1650			?
68	SMU-974	160 ± 50	1675, 1685, 1735			?
68	SMU-1168	350 ± 40	1510, 1615			?
68	Pooled Mean	255 ± 37	1645	1517-1780	1649	?
69	SMU-1169	180 ± 50	1670, 1745 1760, 1770	1522-1950	1736	HRP?
Big Hidatsa 32ME12, continued						
70	SMU-1197	440 ± 50	1440			SVC
70	SMU-1198	470 ± 50	1430			SVC
70	Pooled Mean	455 ± 50	1435	1333-1500	1417	SVC
Mondrian Tree 32MZ58						
87	UCR-1333	320 ± 70	1530, 1560 1630			?
87	UCR-1335	350 ± 60	1500, 1615			?
87	Pooled Mean	337 ± 58	1520, 1610	1432-1672	1552 1620	?

Table 8.3. Concluded.

Site and Batch	Sample Number	Corrected Radiocarbon Years BP t 1/2=5568	Corrected Crosspoint Date(s) AD (Stuiver 1982)	Range at 2 Sigma, AD (Stuiver 1982)	Tentative Range Mid-point AD	Culture Historic Unit*
Hagen 24DW1						
88	WIS-863	490 ± 55	1425	1295-1626	1460	?
Arzberger 39HU6						
91	M-1126	500 ± 150	1420			AP
91	M-1126a	430 ± 200	1440			AP
91	Pooled Mean	482 ± 127	1430	1278-1660	1469	AP

Note: * AP = Arzberger phase; CCP = Clark's Creek phase; NP = Nailati phase; SVC = Scattered Village complex; HRP = Heart River phase; KRP = Knife River phase.

It has been recognized for some time that the C-14 reservoir in the atmosphere has not been constant over time and that, for this reason, radiocarbon dates need to be corrected or calibrated according to a curve relating actual C-14 concentration to calendar age of wood samples which have been accurately dated by dendrochronology (see the review of developments in this area in Klein et al. 1982:103-104). It has been demonstrated that this calibration curve reflects not only long-term, cyclical fluctuations in C-14 concentrations in the atmosphere, but also relatively short-term "wiggles" or less systematic fluctuations. Recently several researchers have developed detailed correction curves or charts which are designed for relatively accurate conversion of radiocarbon ages reported by C-14 labs to true calendrical ages. Such a conversion or calibration is practically essential if there is to be any attempt to integrate chronological data derived from radiocarbon analysis with chronological data derived from independent sources, such as thermoluminescence dating or historic documentation (cf. Renfrew 1974).

Scott et al. (1984) review four of the most recently developed methods for age calibration, particularly with reference to their treatment of errors. Their comparison indicates that determination of an appropriate or accurate age range for a given C-14 date depends more on realistic treatment of errors than on which calibration curve is used. Thus, if errors are treated properly, it appears to make little difference which calibration curve is used. With this in mind, the calibration curves developed by Stuiver (1982) have been selected for use with the KNRI radiocarbon dates.[1] This choice is based in part on the fact that the curve developed by Neftel (1980), preferred by Scott et al. (1984), has not been published and was not available to the senior author, and in part on the fact that the Stuiver curves allow determination of both curve crossing points and calendar age ranges for a given C-14 date. In contrast, the tables developed by Klein et al. (1982) allow only age range determinations, and then only for dates with certain specified or assumed error values.

[1] Shortly after this chapter was written in 1985, an internationally recommended calibration curve for the period 2500 BC to AD 1950 was published in the journal *Radiocarbon* (Stuiver and Pearson 1986; Pearson and Stuiver 1986). While the computer program published along with this calibration curve (Stuiver and Reimer 1986) might have greatly enhanced the format of our presentation, the overall results of calibration by the international standard curve are thought to differ only in minute detail from the results presented here. That is, relative ordering of components and their placement within a calendrical time frame would be very similar under either the Stuiver (1982) or the *Radiocarbon* (1986, Vol. 28) calibration schemes. The 1986 computer calibration program has recently been further revised and refined on the basis of additional tree-ring data (Stuiver and Reimer 1993a, 1993b).

Scott et al. (1984:456-457) note that the errors commonly reported from radiocarbon labs with "raw" C-14 dates are usually counting errors only, and can be an unrealistically low measure of all errors combined. This same point has been made by Browman (1981:252-255) who notes that the problem is particularly critical for more recent dates on the order of 600-800 years in age or less. The consensus seems to be that use of error ranges of at least ± two sigma (twice that usually reported by the lab) will provide a much more realistic measure of the range within which the actual age can be expected to occur.

The problem of interpretation of KNRI radiocarbon dates is compounded by the fact that the short-term "wiggles" in the correction curves are quite pronounced for segments of the curve which apply to the last thousand years of calendar age, the period which is of most interest in the study of Plains Village sites. These wiggles in the curve often result in three or more curve crossings and possible central calendar dates for a single radiocarbon age determination. The possibility of having three or more central tendencies for calendar dates for a particular site, with these differing by perhaps 100 years or more, and with these lying within a two sigma range spanning as much as 200 years of calendar age, makes it particularly difficult to compare Plains Village radiocarbon dates from one context or site to another and to place individually dated sites or components in an interpretable chronological sequence.

As noted, in this report we have used Stuiver (1982) for calibration and correction of the upper Knife-Heart region radiocarbon dates. Following the recommendation of Ward and Wilson (1978:28) a pooled age or pooled mean is first computed for the group of dates from a given site or batch (Table 8.3) and a standard deviation for the mean of the group is computed (using their formulae [6] and [8], p. 23). Then a corrected or calendar midpoint(s) is determined by noting where the pooled mean date crosses a line connecting the center of the symbols in Figure 2A, B in Stuiver (1982:6-7). If a given pooled mean age crosses the calibration curve more than once, then more than one calendar age "midpoint" is recorded (a common occurrence) (Table 8.3). A corrected or calibrated calendar age range is then determined by first determining an uncorrected radiocarbon age range at the pooled mean plus two standard deviations and minus two standard deviations. The high and low age values are then plotted on Figure 3A, B in Stuiver (1982:8-9); the earliest point of intersection and latest point of intersection with the band or zone plotted in this figure is taken as the corrected age range, as reported in Table 8.3.

One of the goals in the KNRI program is to use the chronometric data to order the respective site samples or batches in a chronological sequence. We are perhaps less concerned that we know the precise calendar date of occupation of a particular site than we are that we can state the chronological position of one site or batch relative to another. Developing such a sequence is not easily accomplished when dealing with a single calendrical curve crossing for some sites, multiple calendrical curve crossings for other sites, and 100-200 year probable age ranges for virtually all sites or batches. One solution to this dilemma, perhaps not ideal, is to compute the midpoint of the corrected two sigma calendar age range associated with each site or batch pooled mean. This has the advantage of yielding a single point estimate for each batch/site which can then be placed in sequence relative to other sites. It has the disadvantage of completely ignoring differences in magnitude of likely age ranges associated with various batches, and it introduces some amount of error when the correction curve crossing point is not particularly centered within the corrected age range due to the nonlinear shape of the correction curve. Another option for producing a point estimate for each date is to use either the correction curve crossing point or the mean of multiple crossing points as this estimate; this procedure, too, can introduce bias due to the shape of the short-term fluctuations in the correction curve.

Correction curve crossing points (or means of crossing points) and corrected two sigma age range midpoints are given for each pooled mean radiocarbon date in Table 8.3. Table 8.4 provides a sequenced listing of all batch contexts dated by radiocarbon organized according to progressively increasing corrected age range midpoint values computed in the manner discussed above. This table also lists the correction curve crossing point or the mean of multiple crossing points for each pooled mean date. It can be noted that there are only minor discrepancies in the sequence of batches derived by each method. Individual calendrical age point estimates derived by the two methods differ considerably for some sites, due largely to the constantly varying, non-linear shape of the correction curve. Discussion of this sequence will occur in the final subsection of this chapter, where results of all dating procedures are considered together.

Table 8.4. Sequential arrangement of upper Knife-Heart region analytic batches based on corrected two sigma age range midpoint dates.

Batch No. and Identification		Calendar Age Range Midpoint	Correction Curve Crosspoint or Mean	Taxonomic Unit
69.	Big Hidatsa, time period 6	AD 1736	AD 1736	HRP?
30.	Mahhaha, time period 2	1732	1705	KRP?
68.	Big Hidatsa, time period 5	1649	1645	?
37.	Alderin Creek	1557	1572	HRP
48.	Lower Hidatsa, time period 5	1555	1572	HRP
87.	Mondrian Tree	1552	1583	?
23.	Mandan Lake, test 1, time period 1	1549	1578	HRP
18.	Bagnell	1545	1582	SVC?
39.	White Buffalo Robe, late	1545	1583	HRP
74.	Elbee	1542	1555	?
7.	Lower Sanger	1538	1490	HRP
49.	Lower Hidatsa, time period 6	1528	1455	HRP
20/21.	Hensler, tests 1 and 2	1525	1455	HRP
25.	Mandan Lake, test 4, time period 1	1525	1450	HRP
32.	Mahhaha, time period 4	1523	1450	?
27.	Mandan Lake, test 5, time period 3	1521	1445	SVC?
73.	Poly	1481	1440	NP?
91.	Arzberger	1469	1430	AP
88.	Hagen	1460	1425	?
79.	Hump	1451	1415	SVC?
70.	Big Hidatsa, time period 7	1417	1435	SVC
5.	Pretty Point	1404	1430	SVC
77.	Forkorner, east	1392	1430	SVC
78.	Forkorner, west	1390	1425	SVC
80.	Youess	1387	1420	SVC
15/16.	Cross Ranch	1361	1357	NP
95.	Angus	1351	1348	NP
11.	Upper Sanger, time period 4	1346	1350	SVC?
40.	White Buffalo Robe, early	1333	1290	NP
96.	PG	1304	1285	CCP
34.	Clark's Creek	1289	1280	CCP
92.	Flaming Arrow	1109	1100	?

Notes: *Taxonomic units: KRP = Knife River phase; HRP = Heart River phase; SVC = Scattered Village complex; NP = Nailati phase; AP = Arzberger phase; CCP = Clark's Creek phase; ? = unclassified.

THERMOLUMINESCENCE DATING

As noted in previous discussions, it was recognized early in planning for Phase I activities that radiocarbon dating would have limited applicability for providing chronometric information on many of the recent, post-contact age components at the major villages in the KNRI. One alternate dating procedure potentially applicable to sites in this age range is thermoluminescence (TL) dating applied to pottery sherds. To explore this possibility, the NPS contracted with Dr. David Zimmerman of Washington University, St. Louis, in 1977 to conduct a feasibility study for TL dating of pottery samples from sites in the KNRI. Zimmerman conducted this study using four sample sherds, these being three sherds from recent excavations at Sakakawea Village, which based on historic documentation would be expected to date in the period AD 1790-1834, and a single sherd from D. Lehmer's excavation at Lower Hidatsa Village with an expected age in the range AD 1675- 1780. The results of this study are reported by Zimmerman (n.d.). Zimmerman attempted to use three different TL dating methods with the sherds, and found that the high-temperature method gave good results with two sherds, that the quartz predose method gave best results for two other sherds, and that the fine-grain method was unsatisfactory for all four sherds. He concluded that a potential accuracy of ± 8 percent could be expected from TL dating of KNRI pottery sherds, and that a potential precision of ± 6 percent could be expected. For sherds in the post-AD 1675 range this would mean accuracies at two sigma of ± 20 to ± 50 years and precisions (relative ages) of about ± 15 to ± 30 years (Zimmerman n.d.:1). Zimmerman also provided detailed instructions for sample collection procedures and a cost estimate for dating additional samples.

The results of Zimmerman's feasibility study were judged by all parties to be quite encouraging. Arrangements were made to pursue a TL dating program at Washington University (WU) on a quasi-experimental basis in the coming years using techniques and methods determined to be most productive in the pilot study. Due to Zimmerman's untimely death in 1978, responsibility for the TL dating program at Washington University from that time onward was assumed by Mr. Steve Sutton. Twenty sherds from sites in the KNRI were submitted for TL dating in the fall of 1978, 10 were submitted in 1979, and 10 sherds were submitted in 1980. The results of the Washington University dating program are described in respective reports by Sutton (n.d.) and Ross and Sutton (1980, 1981). As will be discussed in the following section, a second round of TL dating was initiated with the Alpha Analytic, Inc., laboratory late in 1984. Results of both the WU and Alpha Analytic programs are summarized here.

Sample Selection

The choice of sherds submitted to WU for TL dating was determined in part by the progress from year to year in the KNRI excavation program. The 20 sherds submitted in 1978 were all derived from the 1978 testing program, with 14 of these derived from stratified contexts within a single excavation unit (AC Unit 3) at Lower Hidatsa Village, with two sherds from a single feature at the Poly site, and with four sherds derived from a single feature at the Elbee site. At the time of submittal, the full archeological content of each tested site was not known. It was assumed that much of the sequence in AC Unit 3 at Lower Hidatsa was post-contact in age and could not be dated well by C-14 means. The Poly site and Elbee site samples were thought to be pre-contact in age, and the TL samples were submitted from those loci as a back-up for C-14 dating planned at each site. Dates were derived for 18 of the 20 submitted sherds; the two undatable sherds are from the Lower Hidatsa site. The predose method alone was successful with 13 of the 18 dated sherds, and the high temperature method alone was successful with one sherd. Four sherds were successfully dated by both methods (Sutton n.d.). Identification data for the dated sherds, provenience information, and reported dating results are presented in Table 8.5.

The ten sherds submitted to WU in 1979 included four sherds from a single stratified excavation unit dug in 1977 (AC Unit 12) at Sakakawea Village and six sherds from three features excavated in 1979 in the western part of the Forkorner site. All ten of these sherds were dated; three by the predose method alone, two by the high temperature method alone, and five by both methods. The dating results are reported in Ross and Sutton (1980), and pertinent information on the dated samples and reported results is found in Table 8.5.

Ten sherds, all from 1980 excavations at Big Hidatsa Village, were submitted to WU for TL dating in the fall of 1980. All ten sherds were from deeply stratified deposits within a single excavation unit (Unit 1) in the central part of the village. Dating results are presented in Ross and Sutton (1981); three sherds were dated by the predose method alone, two by the high temperature method alone, and five by both methods. Pertinent information on the samples and dating results is presented in Table 8.5. At the time the 10 sherds from Big Hidatsa were submitted in 1980 and at the time that results were received in 1981, personnel at UND were operating under the assumption that the stratified deposits from which the samples were derived represented a time period spanning circa AD 1710 to 1845. This was based on assumptions about the date of first introduction of trade artifacts to the site and historic documentation of the time of site abandonment. With these assumptions in mind, the 10 TL dates from Big Hidatsa were judged in 1981 to be on the average more than 100 years too early (correspondence from S. Ahler to S. Sutton, September 23, 1981). Believing there to be some systematic error in the TL dating process as applied to the Big Hidatsa samples, Ahler made the decision not to submit additional samples to the WU lab for TL dating in 1981 or 1982, and the WU dating program relative to the KNRI project was terminated.

Table 8.5. Summary of results of thermoluminescence dating for pottery from sites in the KNRI and the upper Knife-Heart region.

Site and Lab Number	Material Dated	Within-Site Provenience**	Batch	Date AD	Reference
Sakakawea 32ME11					
WUTL-86a1*	body sherd	AC.11, F.39 43-58 cm sd	59	1845 ± 20	Zimmerman n.d.
WUTL-86a3*	body sherd	AC.11, L.1 0-15 cm sd	59	1840 ± 25	Zimmerman n.d.
WUTL-89g	body sherd	AC.12, L.2 15-22 cm sd	59	1815 ± 20	Ross and Sutton 1980
WUTL-86a2*	body sherd	AC.12, L.5 50-64.5 cm sd	60	1860 ± 20	Zimmerman n.d.
WUTL-89h	body sherd	AC.12, L.6 64.5-80 cm sd	60	1740 ± 20	Ross and Sutton 1980
WUTL-89i	body sherd	AC.12, F.43 120-135 cm sd	61	1720 ± 50	Ross and Sutton 1980
WUTL-89j	body sherd	AC.12, L.9 97-104 cm sd	61	1840 ± 15	Ross and Sutton 1980
Lower Hidatsa 32ME10					
WUTL-86b1*	body sherd	Lehmer U.1, L.6 5.0-6.0 ft sd	55	X 1805 ± 30	Zimmerman n.d.
WUTL-84b1	Knife River Ware rim sherd	U.3, F.4, 60 cm sd	45	1750 ± 20	Sutton n.d. Ahler and Weston 1981:51
WUTL-84b2	body sherd	U.3, F.4, 54 cm sd	45	1670 ± 25	Sutton n.d. Ahler and Weston 1981:51
WUTL-84c1	body sherd	U.3, 43-55 cm sd	45	1760 ± 15	Sutton n.d. Ahler and Weston 1981:51
WUTL-84d1	body sherd	U.3, 101-124 cm sd	46	1730 ± 20	Sutton n.d. Ahler and Weston 1981:51
WUTL-84f1	body sherd	U.3, 120-140 cm sd possibly same vessel as WUTL-84f2	46	1715 ± 25	Sutton n.d. Ahler and Weston 1981:51
WUTL-84f2	body sherd	U.3, 120-140 cm sd possibly same vessel as WUTL-84f1	46	1770 ± 20	Sutton n.d. Ahler and Weston 1981:51
WUTL-84a1	body sherd	U.2, F.16 154 cm sd	47	1705 ± 25	Sutton n.d. Ahler and Weston 1981:51

Table 8.5. Continued.

Site and Lab Number	Material Dated	Within-Site Provenience**	Batch	Date AD	Reference
Lower Hidatsa 32ME10, continued					
WUTL-84a2	Le Beau Ware rim sherd	U.2, F.16 151 cm sd	47	1655 ± 25	Sutton n.d. Ahler and Weston 1981:51
WUTL-84a3	Le Beau Ware rim sherd	U.2, F.16 159 cm sd	47	1755 ± 20	Sutton n.d. Ahler and Weston 1981:51
ALPHA-1522	Knife River Ware rim sherd	U.3, L.10 160-175 cm sd	47	1700 ± 30	unpublished
ALPHA-1523	Knife River Ware rim sherd	U.3, L.10 160-175 cm sd	47	1600 ± 40	unpublished
ALPHA-1524	Knife River Ware rim sherd	U.3, L.11 175-190 cm sd	47	1680 ± 30	unpublished
WUTL-84g1	Le Beau Ware rim sherd	U.3, 200-220 cm sd	48	1585 ± 35	Sutton n.d. Ahler and Weston 1981:51
WUTL-84h1	body sherd	U.3, L.16 250-265 cm sd	48	1595 ± 30	Sutton n.d. Ahler and Weston 1981:51
WUTL-84h3	body sherd	U.3, L.16 250-265 cm sd	48	1705 ± 20	Sutton n.d. Ahler and Weston 1981:51
Big Hidatsa 32ME12					
WUTL-101a	sherd	U.1, L.3 28-31 cm sd	65	1670 ± 25	Ross & Sutton 1981; Ahler and Swenson 1985:106
ALPHA-1901	Knife River Ware rim sherd	U.4, L.17 150-165 cm sd	65	1780 ± 20	unpublished
ALPHA-1903	Knife River Ware rim sherd	U.4, L.18 165-180 cm sd	65	1720 ± 30	unpublished
WUTL-101b	sherd	U.1, L.7 52-56 cm sd	66	1705 ± 25	Ross & Sutton 1981; Ahler and Swenson 1985:106
WUTL-101c	sherd	U.1, L.8 56-64 cm sd	66	1705 ± 35	Ross & Sutton 1981 Ahler and Swenson 1985:106
WUTL-101d	sherd	U.1, L.11 79 cm sd	66	1745 ± 20	Ross & Sutton 1981; Ahler and Swenson 1985:106

Table 8.5. Continued.

Site and Lab Number	Material Dated	Within-Site Provenience**	Batch	Date AD	Reference
Big Hidatsa 32ME12, continued					
WUTL-101e	sherd	U.1, F.61 105 cm sd	67	1645 ± 30	Ross & Sutton 1981; Ahler and Swenson 1985:106
WUTL-101f	sherd	U.1, L.18 146 cm sd	68	1665 ± 30	Ross & Sutton 1981; Ahler and Swenson 1985:106
WUTL-101g	sherd	U.1, F.91, L.1 175-239 cm sd	68	1510 ± 40	Ross & Sutton 1981; Ahler and Swenson 1985:106
WUTL-101h	sherd	U.1, F.97, L.1 175-239 cm sd	68	1540 ± 40	Ross and Sutton 1981; Ahler and Swenson 1985:106
WUTL-101i	sherd	U.1, F.97, L.2 239-264 cm sd	68	1645 ± 45	Ross and Sutton 1981; Ahler and Swenson 1985:106
WUTL-101j	sherd	U.1, F.97, L.2 239-264 cm sd	68	1590 ± 35	Ross and Sutton 1981; Ahler and Swenson 1985:106
ALPHA-1907	Knife River Ware rim sherd	U.6, L.10 70-77 cm sd	68	1690 ± 30	unpublished
Poly 32ME407					
WUTL-84i1	body sherd	U.4, F.2, 61 cm sd same vessel as WUTL-84i2	73	1595 ± 35	Ahler and Mehrer 1984:147 Sutton n.d.
WUTL-84i2	body sherd	U.4, F.2, 61 cm sd same vessel as WUTL-84i1	73	1540 ± 40	Ahler and Mehrer 1984:147 Sutton n.d.
Elbee 32ME408					
WUTL-84j1	body sherd	342NW314, F.4 38 cm sd	74	1620 ± 30	Ahler 1984:34 Sutton n.d.
WUTL-84j2	body sherd	342NW314, F.4 41 cm sd	74	1670 ± 25	Ahler 1984:34 Sutton n.d.
WUTL-84j3	body sherd	342NW314, F.4 43 cm sd	74	X 1420 ± 45	Ahler 1984:34 Sutton n.d.
WUTL-84j4	body sherd	342NW314, F.4 67 cm sd	74	1590 ± 35	Ahler 1984:34 Sutton n.d.

Table 8.5. Concluded.

Site and Lab Number	Material Dated	Within-Site Provenience**	Batch	Date AD	Reference
Forkorner 32ME413					
WUTL-89a	body sherd	180NE420, F.8, 18 cm sd, same vessel WUTL-89b	78	1490 ± 40	Ahler and Mehrer 1984:210; Ross & Sutton 1980
WUTL-89b	body sherd	180NE420, F.8, 24 cm sd, same vessel WUTL-89a	78	1480 ± 45	Ahler and Mehrer 1984:210; Ross & Sutton 1980
WUTL-89c	body sherd	180NE422, F.9, 30-65 cm sd, probably same vessel as WUTL-89d	78	1450 ± 55	Ahler and Mehrer 1984:210; Ross and Sutton 1980
WUTL-89d	Unnamed S Rim Ware rim sherd	180NE422, F.9, 30 cm sd, probably same vessel as WUTL-89c	78	X 1685 ± 30	Ahler and Mehrer 1984:210; Ross and Sutton 1980
WUTL-89e	body sherd	180NE422, F.10, 24-50 cm sd, same vessel as WUTL-89f	78	1335 ± 60	Ahler and Mehrer 1984:210; Ross and Sutton 1980
WUTL-89f	body sherd	180NE422, F.10, 28 cm sd, same vessel as WUTL-89e	78	1400 ± 55	Ahler and Mehrer 1984:210; Ross and Sutton 1980
Mahhaha 32OL22					
ALPHA-1909	Knife River Ware rim sherd	T.2, L.3	30	1760 ± 20	unpublished
ALPHA-1910	Knife River Ware rim sherd	T.2, L.3	30	1760 ± 20	unpublished
ALPHA-1911	Knife River Ware rim sherd	T.2, L.3	30	1810 ± 20	unpublished

Notes: * Age ranges only in years BP (before AD 1975) are given for dated sherds in Zimmerman n.d.; the point dates shown here are estimates derived by Ahler from the data in Zimmerman 1978.
** Provenience abbreviations: AC. = archeological context unit; T. = test unit; L. = level; F. = feature; sd = surface depth (depth below surface); U. = unit or excavation unit.
X Denotes dates excluded from further analysis on the basis of statistical tests or other reasons.

Subsequent analysis of excavation program data at Big Hidatsa Village shows this decision to have been somewhat premature. Data from a wide variety of sources indicate that the probable age span associated with the deposits dated by TL in excavation Unit 1 is more likely on the order of AD 1650-1830 (Ahler and Swenson 1985:102-112), rather than AD 1710-1845 as previously assumed. This means that the TL dates for that unit, while still somewhat earlier than expected, are not as erroneous as originally thought. In retrospect, it probably would have been productive to have continued the TL dating program with WU through at least one more cycle of 10-12 samples.

When reliable radiocarbon dates were produced for the lowermost midden horizons at Lower Hidatsa Village and when the analysis of the Big Hidatsa excavation program neared completion, it became apparent that the original estimations of temporal depth for the occupation period at Lower Hidatsa Village and at Big Hidatsa Village were probably far too short. It is now apparent that these sites were established somewhat earlier than previously thought. It also seems that trade artifacts may have been introduced into the regional sites at an earlier date than previously estimated (Lehmer [1971:131] estimated AD 1675 to be the beginning of the post-contact period, and Ahler and Weston [1981:62] estimated AD 1710 to be the date of first appearance of trade artifacts at Lower Hidatsa Village). Central to the first estimates of time depth in these sites has been the idea that Knife River ware pottery became common only after the AD 1780 smallpox epidemic as a result of the deaths of skilled potters, as hypothesized by Lehmer and Wood (Lehmer et al. 1978:183-185; Wilson 1977:97). If this hypothesis and the related assumptions are incorrect, then the chronological sequences at the village sites in the KNRI deserve complete reevaluation. A growing body of evidence indicates that Knife River ware is a distinctive pottery ware introduced into the region at a date much earlier than AD 1780 and that its use coincided for some time with the production of other wares in the KNRI villages.

To test these competing hypotheses, a second program of TL dating has been initiated using the services of Alpha Analytic, Inc., which began offering commercial TL dating in 1984. This program has focused specifically on dating of Knife River ware rim sherds from various sites in the region. Initially, three Knife River ware rim sherds from AC Unit 3 at Lower Hidatsa Village were dated. The dated sherds are the three stratigraphically lowest, unequivocal Knife River ware rim sherds of datable size in the excavated Lower Hidatsa deposits. The TL dating results are presented in Table 8.5 (ALPHA-1522 through ALPHA-1524). Based on these results, producing an average date of circa AD 1660, a series of nine additional sherds was submitted to Alpha Analytic, Inc., for TL dating. These include three Knife River ware rim sherds from time period 5 at Big Hidatsa Village, three Knife River ware rim sherds from time period 2 at Big Hidatsa Village, and three Knife River ware rim sherds from time period 2 at Mahhaha Village. Three of these nine sherds, from various contexts at Big Hidatsa Village, could not be dated. Results for the six dated sherds are presented in Table 8.5 as various ALPHA determinations.

Evaluation of Results

The primary means for evaluating the usefulness of the reported TL dating results is through statistical tests for consistency within various groups of samples. These tests can be applied in two distinctly different situations. One is the case where two or more dates have been produced on sherds from a single vessel, and where it is known or can be assumed that the same material is dated in each case. This is the "Case I" situation described by Ward and Wilson (1978:20-21) with reference to assessment of radiocarbon dates, and their formula (2) involving the computation of the T statistic having a chi- square distribution serves adequately to test the consistency of such dates. In this instance, we are assessing the reliability of the TL dating process, or the ability of the dating method to repeatedly produce a closely similar date from the same sample. The second situation involves the case where two or more dates are produced on sherds assumed to be from the same context, but which are not assumed to be from the same pottery vessel. This is analogous to Ward and Wilsons's (1978:21-24) "Case II" situation which they discuss with reference to radiocarbon dates. Their T' test statistic computed by their formula (7) is useful for conducting the test of consistency among such dates, except that all components of error factors associated with such dates may not be knowable. If it is found that the dating error reported by the TL laboratory is an unrealistic estimate of all errors associated with such dates, another estimate of additional error may have to be made to apply this statistical test using the T' statistic.

Examining first the instance of multiple dates on sherds from the same vessel, we can note by examining Table 8.5 that five possible pairs of such dates exist in the sample. There are two instances where pairs of dated sherds are judged likely to be from the same vessel (WUTL-84f1/WUTL-84f2 from Lower Hidatsa and WUTL-89c/WUTL-89d from Forkorner), based on physical characteristics, but in the absence of direct fit between sherds. There are three instances where pairs of dated sherds can be refitted into a single larger sherd or where other features leave no doubt that the sherds are from a single vessel (WUTL- 84i1/WUTL-84i2 from Poly; WUTL-89a/WUTL-89b and WUTL-89e/WUTL-89f from Forkorner). Applying Ward and Wilson's formula (2) to these cases to compute the T statistic reveals only a single instance where the null hypothesis that the paired dates derive from the same sample can be rejected, this being for the WUTL-89c/WUTL-89d pair from the Forkorner site (Table 8.5) ($T=14.07, df=1, p=<0.0001$). Inspection of all the other dates from the same context as this pair indicates that the WUTL-89d date of AD 1685 ± 30 is probably aberrant, and it is therefore excluded from further consideration.

In testing the consistency of multiple dates from various other contexts we first attempted to apply Ward and Wilson's (1978:21) formula (2) for the computation of the T statistic to each group of dates from a distinct analytical batch (Table 8.5). Use of this formula is based on the assumption that the error reported by the lab for each individual date adequately accounts for all sources of error in the TL dating situation. Such tests immediately lead to rejection of several dates and further interpretive problems. For example, the T statistic computation indicates that the pair of dates from context 60 at Sakakawea Village (WUTL-86a2 and WUTL-89h, AD 1860 ± 20 and 1740 ± 20) are internally inconsistent and cannot be considered to date the same event. A similar decision is reached for the two dates from context 61 from the same site (Table 8.5). If these dates are inconsistent with each other, which ones are in error and deserve to be excluded from consideration? Historic evidence can be used to suggest that context 60 at Sakakawea Village should date within the period AD 1800-1820 and that context 61 probably dates somewhere in the AD 1790s. Inspection of the actual TL date values indicates that none of these four dates overlaps with the expected dating periods at one standard deviation, and we are left with no logical means for choosing to retain one date as opposed to another.

One solution to this dilemma is to assume that the reported error factor is unrealistically low and to introduce a larger error value, particularly for the purposes of statistical tests of internal consistency. There is no direct way of computing this error factor, however. In the interest of following a procedure which is at least analogous to that used for the evaluation of radiocarbon dates, we have arbitrarily chosen to add an additional error factor of 50 squared to each reported error term for each date. On this basis, formula (7) for the computation of the T' test statistic is used for the test of consistency among dates from each context in Table 8.5, with the total error for each date being the sum of the reported error squared plus the added error value of 50 squared (2,500).

Using the T' statistic computed in this way, inconsistent TL dates are identified for the Elbee site context (batch 74). Inspection of the dates from that context suggests that WUTL-84j3 (AD 1420 ± 45) is the most aberrant within the group of four, and it is identified as the "outlier" to be excluded from further consideration. Computation of the T' statistic also leads to the identification of the AD 1685 ± 30 date from Forkorner (WUTL-89d) as an outlier among the group of six dates in batch 78, even if this date had not been previously rejected on the basis of it being inconsistent with a split sample date from the same vessel. Application of the T' statistical test to all other groups of dates from all other contexts (batches) identified in Table 8.5 leads to rejection of no other dates.

Evaluation and possible rejection of the TL dates by other criteria, such as inconsistency with archeological or other information as used for assessment of the radiocarbon dates, is difficult to make for individual TL dates, especially when the enlarged error factor assumed to be applicable to all TL dates is taken into consideration. Because multiple TL dates with relatively large error factors are available from virtually all contexts (batches) under consideration, it seems appropriate to combine the dates into pooled means for each batch context prior to further evaluation or interpretation relative to external archeological or historical data. One individual date, however, WUTL-86b1 from Lower Hidatsa Village (1805 ± 30), appears particularly erroneous and uninterpretable. This date is 25 years more recent than the assumed date of site abandonment, and it is derived from Lehmer's 1965 test excavation sample from the village which has very uncertain contextual association. For these reasons, this date is excluded from further evaluation.

Averaging and Interpretation

The procedure recommended by Ward and Wilson (1978:21-24) for Case II situations (their formula [6]) is used to compute a pooled mean age for each group of TL dates in Table 8.5 associated with an individual batch. In this averaging process the added error factor of 50 squared is used in addition to the error reported by the lab, resulting in relatively large standard deviations for the mean of the group of dates, as listed for each batch in Table 8.6. In Table 8.6, the pooled mean dates are organized by site and according to stratigraphy within each site having multiple batches. Also indicated in this table is the presence or absence of associated trade artifacts in excavated samples. Questionable trade artifact associations are indicated for the Elbee and Mahhaha sites. At Elbee, a piece of copper is found in the feature dated by TL, but it is unclear if it is trade copper or native copper. At Mahhaha, the TL date would suggest a likely association with trade artifacts, but fine- screened recovery sufficient to demonstrate the presence or absence of such items was not conducted during excavation at Mahhaha. Table 8.7 provides a rearrangement of the pooled mean TL dates for all batches, ordered by increasing age, to better illustrate the possible chronological relationships between batches and across sites.

Several observations can be made concerning the data in Tables 8.6 and 8.7. The three batch units from Sakakawea Village can perhaps be dated most accurately of any of the batches on the basis of historic documentation. Historic records indicate that the village was established by the 1790s and that it was abandoned for certain by 1845 (probably in 1834). All three of the pooled mean batch dates for Sakakawea Village are reasonable in terms of correlation with chronology from historic documentation and they are internally consistent as well. The high standard deviations associated with these means, however, relative to the 10-20 year increments that are probably reflected in the batch definitions, indicate that TL dating in this age site cannot contribute significantly to a more refined understanding of internal site chronology. For example, if we did not have historic documention for the dates of occupation at Sakakawea Village, we could conclude from the TL dates alone that the three batch samples could effectively be combined into a single chronologic unit and that the occupation of the site probably occurred sometime in the period AD 1775 to 1850. We are better off working from historic documentation.

Within Lower Hidatsa Village, the batch 45 and 46 pooled mean dates show a problem of inconsistency according to site stratigraphy (the basis in part for the batch definitions), but none of these dates can be pinpointed for exclusion due to the relatively large error values associated with the pooled means. From a statistical perspective, the batch 45 and batch 46 pooled mean dates are indistinguishable, again illustrating that the TL dates themselves are of little value for determining absolute internal site

Table 8.6. Summary of pooled mean thermoluminescence dates for archeological sites in the KNRI, organized by analytic batches.

Batch No.	and Identification	Pooled Mean Calendar Age	Associated Trade Artif.	Taxonomic Unit
59.	Sakakawea, time period 1	AD 1833 ± 32	+	KRP
60.	Sakakawea, time period 2	AD 1800 ± 38	+	KRP
61.	Sakakawea, time period 3	AD 1797 ± 42	+	KRP
45.	Lower Hidatsa, time period 2	AD 1729 ± 31	+	KRP
46.	Lower Hidatsa, time period 3	AD 1739 ± 31	+	?
47.	Lower Hidatsa, time period 4	AD 1687 ± 23	+	?
48.	Lower Hidatsa, time period 5	AD 1634 ± 33		HRP
65.	Big Hidatsa, time period 2	AD 1725 ± 32	+	KRP
66.	Big Hidatsa, time period 3	AD 1720 ± 33	+	KRP?
67.	Big Hidatsa, time period 4	AD 1645 ± 58	+	?
68.	Big Hidatsa, time period 5	AD 1611 ± 25	+	?
73.	Poly	AD 1571 ± 26		NP?
74.	Elbee	AD 1629 ± 34	?	?
78.	Forkorner	AD 1439 ± 37		SVC
30.	Mahhaha, time period 2	AD 1777 ± 31	?	KRP?

Notes: Taxonomic Units: KRP = Knife River phase; HRP = Heart River phase; NP = Nailati phase; SVC = Scattered Village complex.

Table 8.7. Summary of pooled mean thermoluminescence dates for archeological sites in the KNRI, in sequence by batch according to increasing age.

Batch No. and Identification		Pooled Mean Calendar Age	Associated Trade Artif.	Taxonomic Unit
59.	Sakakawea, time period 1	AD 1833 ± 32	+	KRP
60.	Sakakawea, time period 2	AD 1800 ± 38	+	KRP
61.	Sakakawea, time period 3	AD 1797 ± 42	+	KRP
30.	Mahhaha, time period 2	AD 1777 ± 31	?	KRP?
46.	Lower Hidatsa, time period 3	AD 1739 ± 31	+	?
45.	Lower Hidatsa, time period 2	AD 1729 ± 31	+	KRP
65.	Big Hidatsa, time period 2	AD 1725 ± 32	+	KRP
66.	Big Hidatsa, time period 3	AD 1720 ± 33	+	KRP?
47.	Lower Hidatsa, time period 4	AD 1687 ± 23	+	?
67.	Big Hidatsa, time period 4	AD 1645 ± 58	+	?
48.	Lower Hidatsa, time period 5	AD 1634 ± 33		HRP
74.	Elbee	AD 1629 ± 34	?	?
68.	Big Hidatsa, time period 5	AD 1611 ± 25	+	?
73.	Poly	AD 1571 ± 26		NP?
78.	Forkorner	AD 1439 ± 37		SVC

Notes: Taxonomic Units: KRP = Knife River phase; HRP = Heart River phase; NP = Nailati phase; SVC = Scattered Village complex.

chronologies and calendar year brackets to be assigned to individual batch samples. The approximate ages of the Lower Hidatsa pooled mean dates may be roughly acceptable, although the date for the batch 48 sample seems too late in light of the fact that this analytic unit lacks trade artifacts and units with trade artifacts at Big Hidatsa Village appear to date considerably earlier.

The TL date pooled mean series from Big Hidatsa Village appears to generally be 50-75 years too early for each batch sample. This estimation is based on the fact that the site is known to have been abandoned in 1845 and that the time 2 period sample lies stratigraphically very near the top of the site sequence. A date of AD 1725 for time period 2 seems too early in consideration of a known terminal date of AD 1845 for time period 1 at the site. In addition, time period 5, dated at AD 1611, is not the earliest analytic unit at the site associated with trade artifacts. Trade artifacts occur in very low frequency in time period 6 deposits at Big Hidatsa, a unit clearly earlier than time period 5 on stratigraphic grounds. It is probably unreasonable to expect trade artifacts to be detectable in the archeological record earlier than about AD 1600, and on this assumption, the time period 5 pooled mean date at Big Hidatsa is probably about 50-75 years too early.

In sum, it appears that TL dating applied in the KNRI program does not provide the degree of accuracy necessary for developing precise chronologies for various sites and units within sites. A great deal of other information, such as site stratigraphy, historic records, and relative frequencies of trade artifacts can be used just as well, and perhaps better than TL dating to develop reasonable internal chronologies, expressed in 30-50 year increments, for the major village sites in the KNRI. Even so, the TL dating program appears perhaps to provide better information for relative dating than for absolute dating. This is expressed by the fact that the TL dates indicate that the occupation at Sakakawea Village is for the most part later in time than the period of occupation at Big Hidatsa and Lower Hidatsa, and also that the periods of occupation at the latter two villages each have considerable time spans which overlap to a significant degree. These facts agree well with other information about the chronologies of the three sites derived from several other data sources. The TL dates may even provide useful information on the approximate time span associated with the various analytic batches within the sites. At Lower Hidatsa, for example, pooled mean dates for the four batch samples are separated by an average of 35 years, suggesting a time duration of roughly that length for each batch. At Big Hidatsa, an average interval of 38 years separates the pooled mean dates for each batch. The latter figure compares favorably with the 50 year span hypothesized for time periods 6 and 5 and the 45 year span hypothesized for time periods 4 and 3 at Big Hidatsa Village based on a wide array of other data (Ahler and Swenson 1985:112).

A final note can be added concerning a mistake which was made in the KNRI TL dating program. Because TL dating can be applied directly to pottery sherds, the potential exists to provide very direct information on the probable ages, or at least, relative ages of individual pottery types. This could be particularly useful information for establishing developmental sequences of pottery types in a region or for distinguishing mixed deposits and "transitional components" in a site. This potential was overlooked by UND personnel when it came time to select pottery sherds for submission to WU for TL dating. The pattern was for sample selection to occur immediately after the close of a field season, prior to complete analysis of the excavated collection from which the samples were taken. The tendency was for classifiable rim sherds to be excluded from the TL samples because of the thought that such sherds should be saved for incorporation in the stylistic analysis of pottery which had not yet been completed. In addition, most of the sherds submitted for analysis were hastily examined and poorly documented concerning typological information. None of the sherds submitted to WU were photographed prior to submission, and in the case of the Big Hidatsa series, we failed to record if rim sherds of any type were being submitted for dating. These were mistakes made during the haste of getting parts of an essentially unanalyzed collection into the hands of the TL analyst, in conjunction with the perceived need to keep the TL samples tightly sealed within airtight plastic bags. In the future, as a rule, sherds should not be submitted until analysis of the full artifact inventory has been completed, and, for sites as complex as the KNRI villages, considerably greater thought should be given to sample selection and documentation prior to submittal for dating. These procedures were implemented in the dating program conducted by Alpha Analytic, Inc.

OBSIDIAN HYDRATION DATING

A pilot program in obsidian hydration dating was initiated in 1982 when it became clear that there were sufficiently large and numerically frequent pieces of obsidian in the KNRI flaking debris samples to warrant such a study. The obsidian dating program was conducted by Dr. Joseph W. Michels of MOHLAB at State College, Pennsylvania. This research was conducted using the latest advances made by Michels and his colleagues concerning use of experimentally determined hydration rates for obsidian hydration dating (Michels et al. 1983).

A total of 14 obsidian artifacts was submitted to Michels in 1982 for obsidian hydration dating. These specimens include 13 size grade 3 unmodified flakes and one size grade 4 flake. They effectively include the largest pieces of obsidian flaking debris available in both the Sakakawea Village and Lower Hidatsa Village artifact samples. Several additional size grade 4 flakes occur in these collections, but these were not submitted due to their extremely small size. Specimens from Big Hidatsa Village were not submitted pending results of analysis of the Sakakawea and Lower Hidatsa samples. Two of the submitted specimens are from the 1976 and 1977 excavations at Sakakawea Village, and the remaining 12 specimens are from the 1978 excavations at Lower Hidatsa Village. Provenience information for all samples is provided in Table 8.8. Analytic batch associations are given for each sample in that table. Note that the Lower Hidatsa Village samples derive from deposits spanning the period from late pre- contact times (batch 48) through post-contact times (batch 44), perhaps from the AD 1500s through the late 1700s. Based on historic documentation for occupation of Sakakawea Village in the early 1800s, the Sakakawea Village samples are presumably later in age than the Lower Hidatsa samples.

Table 8.8. Summary information on obsidian hydration dating results for KNRI samples.

Site/ Batch	Catalog No.	Provenience**	Source Group	Hydration Rim, Microns	Age, Years Before 1982	Date
Sakakawea Village, 32ME11						
59	520	AC.12, L.3, 20-40 cm sd	1*	0.86 ± 0.04	278 ± 26	AD 1704
60	177	AC.8, NL.7, 80-95 cm sd	2	0.60 ± 0.04	64 ± 8	AD 1918
Lower Hidatsa Village, 32ME10						
44	107a	AC.2, L.1, 0-15 cm sd	2*	0.65 ± 0.03	75 ± 7	AD 1907
44	107b	AC.2, L.1, 0-15 cm sd	1	0.63 ± 0.03	149 ± 14	AD 1833
46	120	AC.2, L.5, 60-75 cm sd	1*	0.74 ± 0.04	206 ± 23	AD 1776
47	136	AC.2, L.7, 80-95 cm sd	2	0.63 ± 0.03	71 ± 7	AD 1911
47	148	AC.2, L.8, 95-100 cm sd	1	0.77 ± 0.06	223 ± 35	AD 1759
47	170	AC.2, L.9, 100-115 cm sd	2*	0.62 ± 0.04	69 ± 9	AD 1913
47	186	AC.2, F.16, 130-145 cm sd	1*	0.76 ± 0.06	217 ± 36	AD 1765
47	103	AC.3, L.9, 145-160 cm sd	1	0.78 ± 0.03	229 ± 18	AD 1753
47	105	AC.3, L.10, 160-175 cm sd	1	0.72 ± 0.02	195 ± 11	AD 1787
48	109	AC.3, L.12, 190-205 cm sd	1	0.55 ± 0.03	114 ± 13	AD 1868
48	157	AC.3, L.16, 250-265 cm sd	1	0.80 ± 0.06	241 ± 37	AD 1741
50	10	AC.4, L.6, 75-90 cm sd	1	0.77 ± 0.05	223 ± 30	AD 1759

Notes: * Indicates samples for which group assignment is based on results of compositional analysis by atomic absorption spectroscopy; samples not so designated were given group assignments based on optical petrographic properties.
** Provenience abbreviations: AC. = archeological context (excavation) unit; L. = level; NL. = natural level; F. = feature; cm sd = centimeters below surface.

Because obsidian hydration rates vary greatly according to the chemical composition of the obsidian artifact (determined largely by its source), it was necessary to establish the source location for the KNRI samples before an appropriate hydration rate could be applied to computation of a date based on observed hydration rim thickness in each sample. After thin sections were cut from all specimens, the chemical composition of the five largest samples in the group of 14 was determined by atomic absorption spectroscopy analysis. The results indicate that two distinct types of obsidian occur in the sample, presumably from different sources, herein identified as Group 1 and Group 2 sources (Table 8.8). Michels is confident that the Group 1 specimens are from the Obsidian Cliff source in Yellowstone Park, Wyoming (letter from J. Michels to S. Ahler, May 3, 1982). Based on this identification, an experimentally derived hydration rate for the Group 1 specimens at the KNRI was computed at 2.66 microns squared per 1000 years using an effective hydration temperature T(e) of 283.91 degrees Kelvin which was computed for the KNRI locality using air temperature data collected over a 20 year period at Beulah, North Dakota (Wilhelm 1978:124). This hydration rate was then used by Michels to compute age estimates for chemically analyzed Group 1 artifacts (catalog numbers 520, 120, and 186) as reported in Table 8.8 (letter from J.

Michels to S. Ahler, May 3, 1982). Ahler has subsequently computed age estimates shown in Table 8.8 for the remaining artifacts identified by Michels as Group 1 specimens in his May 3 letter report and in a later report (letter from J. Michels to L. Loendorf, February 17, 1983).

At the time that the original dating work was conducted in 1982, Michels could not identifiy the source for the Group 2 artifacts, and insufficient material of this type was available for determination of an experimentally derived hydration rate. Subsequently, Michels has identified an obsidian source called the Camas-Dry Creek source in Clark County, Wyoming, which he is confident can be identified as the source for the Group 2 KNRI artifacts (letter from J. Michels to S. Ahler, July 5, 1983). Samples of the Camas-Dry Creek source material have been used to develop an experimentally determined hydration rate equation (Michels 1983a) which, when used in conjunction with the KNRI locality effective hydration temperature of 283.91 degrees Kelvin, yields a hydration rate of 5.61 microns squared per 1,000 years for the KNRI Group 2 samples. Application of this hydration rate to the hydration rind thickness data reported by Michels for the Group 2 specimens yields the age estimates for the Group 2 artifacts shown in Table 8.8 (hydration rate computation and age computations were conducted by Ahler).

Examination of dates shown in Table 8.8 reveals several problems with the dating results. First, it is apparent that the dates for the Group 2 specimens are highly erroneous, with all of the computed dates falling in the AD 1900s. The most likely explanation for this problem is that these specimens have been incorrectly identified as having come from the Camas-Dry Creek source. They probably derive from a different source, which has yet a different hydration rate than the one developed for the Camas-Dry Creek material. An obsidian source near the Black Hills in South Dakota has recently been identified and studied (Michels 1983b), but Michels is certain that this material is different from both the KNRI Group 1 and Group 2 artifacts (letter from J. Michels to S. Ahler, August 8, 1982). If the Camas-Dry Creek locality is not the source for the Group 2 specimens, their source presently remains unknown. Even if we assume that the Group 2 specimens are actually Group 1 (Obsidian Cliff) specimens, the dates computed on that basis do not resolve other problems inherent in results for the other Group 1 specimens.

Second, the dates for the Group 1 specimens are generally too late (except for specimen 520 at Sakakawea Village) and as a group they also fail to exhibit a time trend corresponding to the considerable time depth thought to occur within both sites. Another way of viewing this problem is to observe that the hydration rind thicknesses measured for the Group 1 artifacts do not particularly increase according to increasing age of the batches based on stratigraphic and other data. Mean rind thicknesses for Group 1 samples by batch are: batch 59 = 0.86 microns; batch 44 = 0.63 microns; batch 46 = 0.74 microns; batch 47 = 0.76 microns; and batch 48 = 0.67 microns. It is suggested here that this problem may relate to inaccuracy in the effective hydration temperature used to compute the hydration rate for the Group 1 specimens. Monthly air temperature data may not provide an accurate basis for computing effective hydration temperatures for artifacts buried at depths ranging from a few centimeters to more than two meters below the ground surface. A two degree K (C) increase in the effective hydration temperature above the 283.91 degrees K value used here would produce computed dates approximately 21 percent younger than those reported, while a similar 2 degree K decrease in effective hydration temperature would result in dates approximately 27 percent older than those reported. Direct determination of an accurate effective hydration temperature for various subsurface loci would require a year-round field monitoring program, a task well beyond this pilot project.

In summary, the obsidian hydration dating program has provided interesting information on the obsidian sources apparently used by the villagers at the KNRI, but it has so far produced little information applicable to the problem of determining accurate intrasite chronologies for major villages in the KNRI. Given the fact that virtually all available obsidian artifacts except for a few small flake tools have been dated in this pilot study, a follow-up program would be of little value unless much larger collections were available from some future excavation program and questions of sources and effective hydration temperature determination could be resolved.

ARCHEOMAGNETIC DATING

In 1977 MWAC contracted with Dr. Daniel Wolfman of the Arkansas Archeological Survey to conduct a feasibility study of the application of archeomagnetic dating of the major village sites in the KNRI. The study focused specifically on the period AD 1675-1845, a period for which radiocarbon dating would not be particularly applicable. The archeomagnetic feasibility study was a companion study of the feasibility of thermoluminescence dating conducted at the same time (Zimmerman n.d.; see discussion in a previous subsection). The results of the feasibility study for archeomagnetic dating are reported in Wolfman (1978).

The major conclusions reached by Wolfman (1978) can be reiterated here. He notes that no master magnetic declination/inclination curve has been established directly for the region in which the KNRI lies. Because of this, the use of archeomagnetic dating for sites within the KNRI will be dependent upon (a) extrapolation of a master curve from some outside region(s) which can be used with confidence to date samples from within the KNRI, and/or (b) development of a master curve specifically for the KNRI region by means of measurement of inclination and declination in KNRI archeological samples of known chronological age.

Concerning the first possibility, Wolfman (1978:7) extrapolated declination data only for the KNRI from data collected elsewhere around the globe and concluded that during the period AD 1750-1800 there was a rapid change in magnetic declination in the KNRI region and that samples which fell in that particular period could probably be dated quite accurately. During the period AD 1675-1750 and the period AD 1800-1845 there was little change in magnetic declination in the KNRI region and dating of samples in those periods would be very difficult based on existing information. Dating during the latter two periods would be dependent upon development of reliable information on magnetic inclination, which presently is unavailable for the region.

Concerning the second possibility, that of developing a reliable inclination/declination curve for the KNRI from independently dated samples, Wolfman (1978:8) is optimistic that appropriate hearth and burned clay samples could be dated by typological and other means and that a regional geomagnetic curve could thus be developed. His optimism is based in part on his reading of Lehmer's (1971) discussion of regional chronology.

We have little comment on Wolfman's discussion of the extrapolation of magnetic curve information from an outside region for application in the KNRI. To the senior author's knowledge, the situation remains the same as in 1978, and insufficient data are available from surrounding regions to extrapolate a fully usable master curve to the KNRI region. This leaves us with only the second possibility for practical application of archeomagnetic dating in the KNRI. Experience gained in the analysis of artifact collections from the major villages in the KNRI over the past seven years leads Ahler to the conclusion that development of an accurate master magnetic curve through use of samples dated independently by typological or chronometric means will be virtually impossible. The typological composition of ceramic collections of apparently the same age seems to vary somewhat from village to village, depending on the tribal subgroup composition of each village. Pottery typology would seem to be a very imprecise basis for independent dating of archeomagnetic samples. In addition, other chronometric means which have been applied to dating samples in the major villages (C-14, TL, obsidian hydration) have so far not provided the precision and accuracy we had hoped for. Historical documentation in combination with stratigraphy remain the most precise means for dating specific samples within the major villages, and these procedures are applicable only to some of the contexts in the KNRI. We are therefore not optimistic that archeomagnetic dating will in the near future become a precise and accurate independent dating tool for use at the major village sites in the KNRI.

As a continuation of the feasibility study of archeomagnetic dating in the KNRI, an attempt was made to collect archeomagnetic samples from several hearths in KNRI during the 1981 excavation season. A hearth suitable for sampling could not be located within the Lower Hidatsa Village (although such hearths undoubtedly occur there), and one hearth was sampled at Sakakawea Village. The Sakakawea hearth, within House 16, was identified in the proton magnetometer survey of the village, and then was isolated more precisely by use of hand coring. A 2 x 2 m square was excavated over the hearth and nine cubes of hearth material were taken for purposes of archeomagnetic dating following procedures outlined in Eighmy (1980). Excavation revealed that the sampled hearth in House 16 is the earlier of two central fireplaces within the house. Based on this it is uncertain exactly when the hearth might have been last used, and it could date anywhere within the period circa AD 1800-1834. Because the actual age of this sample cannot be estimated more precisely than within a period of approximately 35 years, the sample would serve to establish only a single fairly broad point on a master curve for the KNRI, and it will not contribute particularly to absolute dating of Sakakawea Village. Accordingly, no measurements have been performed on the sample.

One fact learned during the 1981 excavation and hearth sampling at Sakakawea Village is that collection of appropriate samples from such features is not a small-scale endeavor. If excavations are conducted for this purpose alone in a major village site, one should anticipate the removal of and obligation to analyze a large body of associated archeological material and information. For example, the hearth-sampling at Sakakawea Village required a four square meter excavation area reaching a depth of circa 40 cm below the surface. This excavation yielded 10 boxes of artifacts which are yet to be fully analyzed and reported. Sampling of a similar hearth at Lower Hidatsa Village would have taken one to two weeks for fieldwork alone, and would have yielded perhaps five to ten times as large an artifact sample. Clearly, archeomagnetic sampling for that purpose alone cannot be conducted on a large scale within the KNRI, but it must be integrated with some larger-scale excavation program which anticipates and accomodates the analysis and reporting of the sizeable artifact collections and other data sets which will be forthcoming as a consequence of such endeavor.

SUMMARY AND COMPARISON OF RADIOCARBON AND THERMOLUMINESCENCE DATING

Four chronometric procedures have been used to widely varying extents for the purpose of establishing absolute chronologies for the various Plains Village sites in the KNRI and in the upper Knife-Heart region. Two techniques, archeomagnetic dating and obsidian hydration dating, have not so far produced usable results. Radiocarbon dating and thermoluminescence dating have so far produced the only substantial chronometric data sets which can be brought to bear on the problem of intravillage and regional village chronology. This situation can be expected to continue into the future until solution of certain technical problems and data limitations can occur relative to archeomagnetic and obsidian hydration dating.

Fourteen radiocarbon dates have been produced on samples of charcoal, wood, and soil from various geologic exposures in the KNRI and region (Table 8.1), in contexts generally lacking interpretable associated cultural materials. Six of these dates produced by the University of Georgia laboratory are thought to be of questionable reliability, while the remaining eight dates produced at the Southern Methodist University laboratory are thought to be more reliable and have contributed substantially to development of a model of the history of Holocene age terrace development in the area around the mouth of the Knife River (Reiten 1983).

A total of 69 radiocarbon dates and 48 TL dates considered to be reliable enough for averaging and interpretation is available from Plains Village tradition sites within the KNRI and in the upper Knife-Heart region (Tables 8.3 and 8.5). The radiocarbon dates provide chronometric data on a total of 32 individual analytic batches or archeological contexts, and the TL dates provide such data for a total of 15 analytic batches or archeological contexts. Altogether, a total of 41 individual analytic batches or archeological contexts are dated by one means or the other, with six of these 41 contexts having associated chronometric dates produced by both C-14 and TL dating procedures.

Table 8.9 provides a list of all batch dates by either radiocarbon or TL procedures, with batches for each of the major village sites in the KNRI organized by time period sequences within each site based primarily on internal stratigraphy and with batches for other sites organized according to increasingly older corrected C-14 age range midpoint calendar dates. This table provides the corrected C-14 two sigma range midpoint and the C-14 correction curve crossing point or mean of several crossing points for all batches dated by C-14 and the point estimate calendrical age for each batch dated by TL procedures. These data are taken for each batch from Tables 8.3 and 8.5. Ranges for C-14 dates in Table 8.3 and for TL dates in Table 8.5 are not reproduced in Table 8.9. Because the ranges are pertinent to comparison of the TL and C-14 dating results and to the general interpretation of the results, ranges at two standard deviations for both corrected C-14 dates and for TL dates are shown graphically in Figures 8.1 through 8.3. Batch information is arranged in these figures in the same order as it occurs in Table 8.9. These figures illustrate well the overlap between age ranges determined by the two techniques, providing some basis for comparison of results by each method.

Table 8.9 also provides a best estimate of actual calendrical age for each batch for which chronometric data are available (and for two other batches in the major KNRI sites). Also given in each case is the basis for such an age estimate. Several sources of dating information are available such as historic documentation (H), ceramic seriation and ceramic typological dating or cross-dating (C), physical site stratigraphy (S), relative frequency or density of trade artifacts versus native artifacts in sites having trade items (T), architectural patterns (A), radiocarbon dating results (C-14), and thermoluminescence dating results (TL). In some instances, the chronometric

Table 8.9. Summary of chronometric dating information and best estimates of actual chronologies for analytic batches for dated Plains Village sites relevant to the KNRI program. All dates are AD.

Batch and Identification		C-14 Calendar Age Range Midpoint	C-14 Correction Curve Crossing Point	Best TL Date Midpoint	Estimate of Age Range	Basis* for Estimate
59.	Sakakawea, time period 1	-	-	1833	1820-1845	H,S
60.	Sakakawea, time period 2	-	-	1800	1800-1820	H,S
61.	Sakakawea, time period 3	-	-	1797	1790-1800	H,S
64.	Big Hidatsa, time period 1	-	-	-	1830-1845	H,S,T
65.	Big Hidatsa, time period 2	-	-	1725	1790-1830	S,T,H
66.	Big Hidatsa, time period 3	-	-	1720	1745-1790	S,T
67.	Big Hidatsa, time period 4	-	-	1645	1700-1745	S,T
68.	Big Hidatsa, time period 5	1649	1645	1611	1650-1700	S,T,H,TL
69.	Big Hidatsa, time period 6	1736	1736	-	1600-1650	H,S,C,T
70.	Big Hidatsa, time period 7	1417	1435	-	1400-1450	C-14,C
44.	Lower Hidatsa, time period 1	-	-	-	1740-1780	H,S,T,C
45.	Lower Hidatsa, time period 2	-	-	1729	1700-1740	S,T,TL,C
46.	Lower Hidatsa, time period 3	-	-	1739	1650-1700	S,T,C
47.	Lower Hidatsa, time period 4	-	-	1687	1600-1650	H,T,S,C,TL
48.	Lower Hidatsa, time period 5	1555	1572	1634	1560-1600	C-14,S,C
49.	Lower Hidatsa, time period 6	1528	1455	-	1525-1560	C-14,S,C
30.	Mahhaha, time period 2	1732	1705	1777	1600-1700	C,S, C-14,TL
37.	Alderin Creek	1557	1572	-	1525-1600	C-14,C
87.	Mondrian Tree	1552	1583	-	1500-1650	C-14,C
23.	Mandan Lake, test 1, time period 1	1549	1578	-	1450-1525	C,C-14
18.	Bagnell	1545	1582	-	1450-1525	C-14,C,A

Table 8.9. Concluded.

Batch and Identification		C-14 Calendar Age Range Midpoint	C-14 Correction Curve Crossing Point	Best TL Date Midpoint	Estimate of Age Range	Basis* for Estimate
39.	White Buffalo Robe, late	1545	1583	-	1525-1600	C,C-14
74.	Elbee	1542	1555	1629	1520-1630	C-14,TL
7.	Lower Sanger	1538	1490	-	1525-1600	C-14,C
20./21.	Hensler, test 1, test 2	1525	1455	-	1450-1600	C-14,C,A
25.	Mandan Lake, test 4, time period 1	1525	1450	-	1450-1525	C-14,C
32.	Mahhaha, time period 4	1523	1450	-	1400-1450	C,C-14
27.	Mandan Lake, test 5, time period 3	1521	1445	-	1400-1450	C,C-14
73.	Poly	1481	1440	1571	1400-1450	C,C-14
91.	Arzberger	1469	1430	-	1350-1500	C-14
88.	Hagen	1460	1425	-	1450-1600	C,C-14
79.	Hump	1451	1415	-	1400-1450	C-14,C
5.	Pretty Point	1404	1430	-	1400-1450	C-14,C
77.	Forkorner, east	1392	1430	-	1400-1450	C-14,C
78.	Forkorner, west	1390	1425	1439	1400-1450	C-14,TL,C
80.	Youess	1387	1420	-	1400-1450	C-14,C
15./16.	Cross Ranch, H3, H7	1361	1357	-	1300-1400	C-14,C
95.	Angus	1351	1348	-	1300-1400	C-14,C
11.	Upper Sanger, time period 4	1346	1350	-	1300-1400	C-14,C
40.	White Buffalo Robe, early	1333	1290	-	1275-1350	C-14,C
96.	PG	1303	1285	-	1250-1300	C-14,C
34.	Clark's Creek	1289	1280	-	1200-1300	C-14,C
92.	Flaming Arrow	1109	1100	-	1050-1200	C-14

Notes: * Explanation of basis for dating codes: H = historic documentation; C = ceramic typology/seriation/cross-dating; S = within-site stratigraphy; T = relative frequency of trade artifacts; A = architecture patterns; TL = thermoluminescence dates; C-14 = radiocarbon dates.

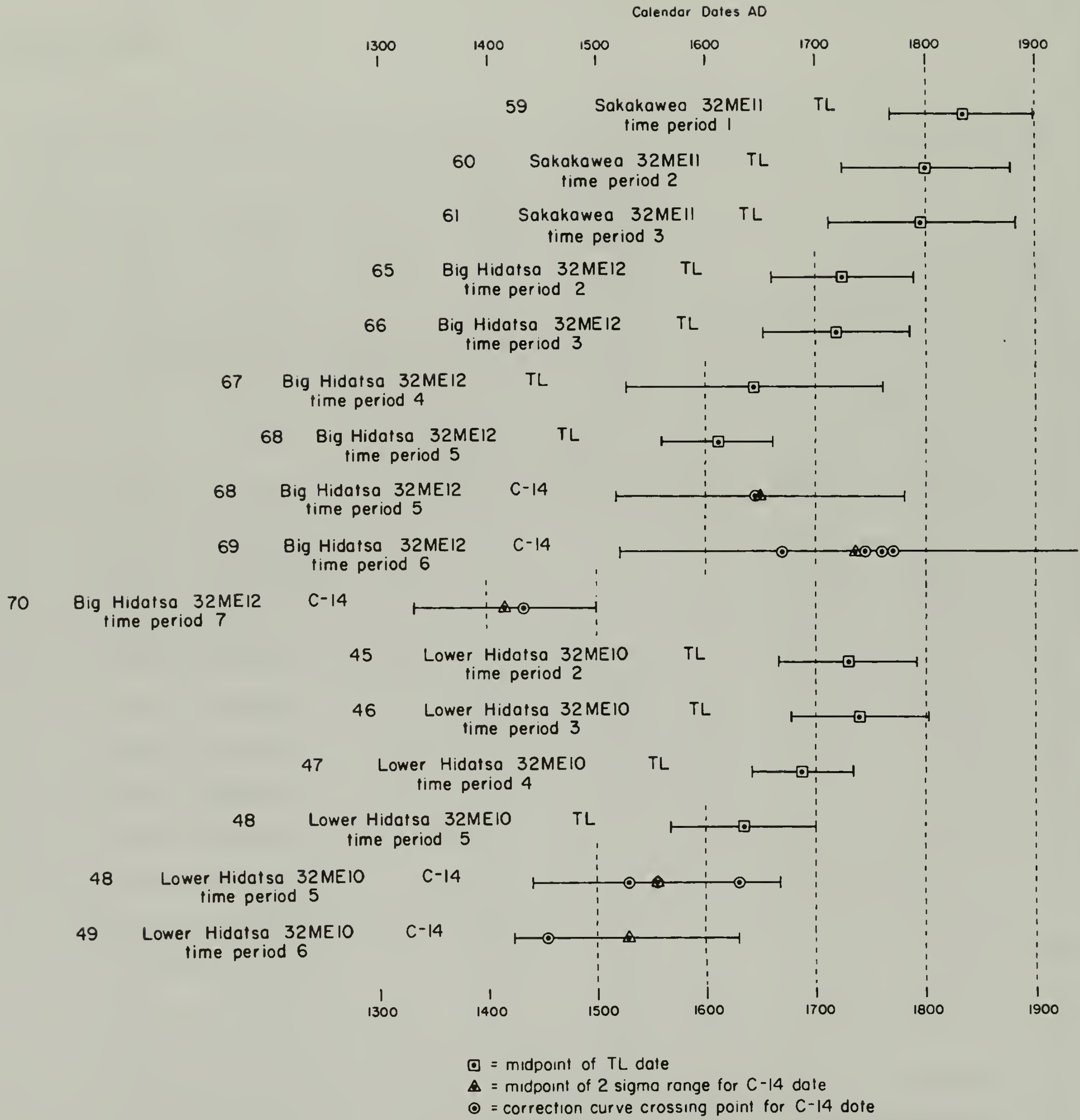

Figure 8.1. Pooled mean radiocarbon and thermoluminescence dates for analytic batches from major village sites in the KNRI, with ranges plotted at two sigma.

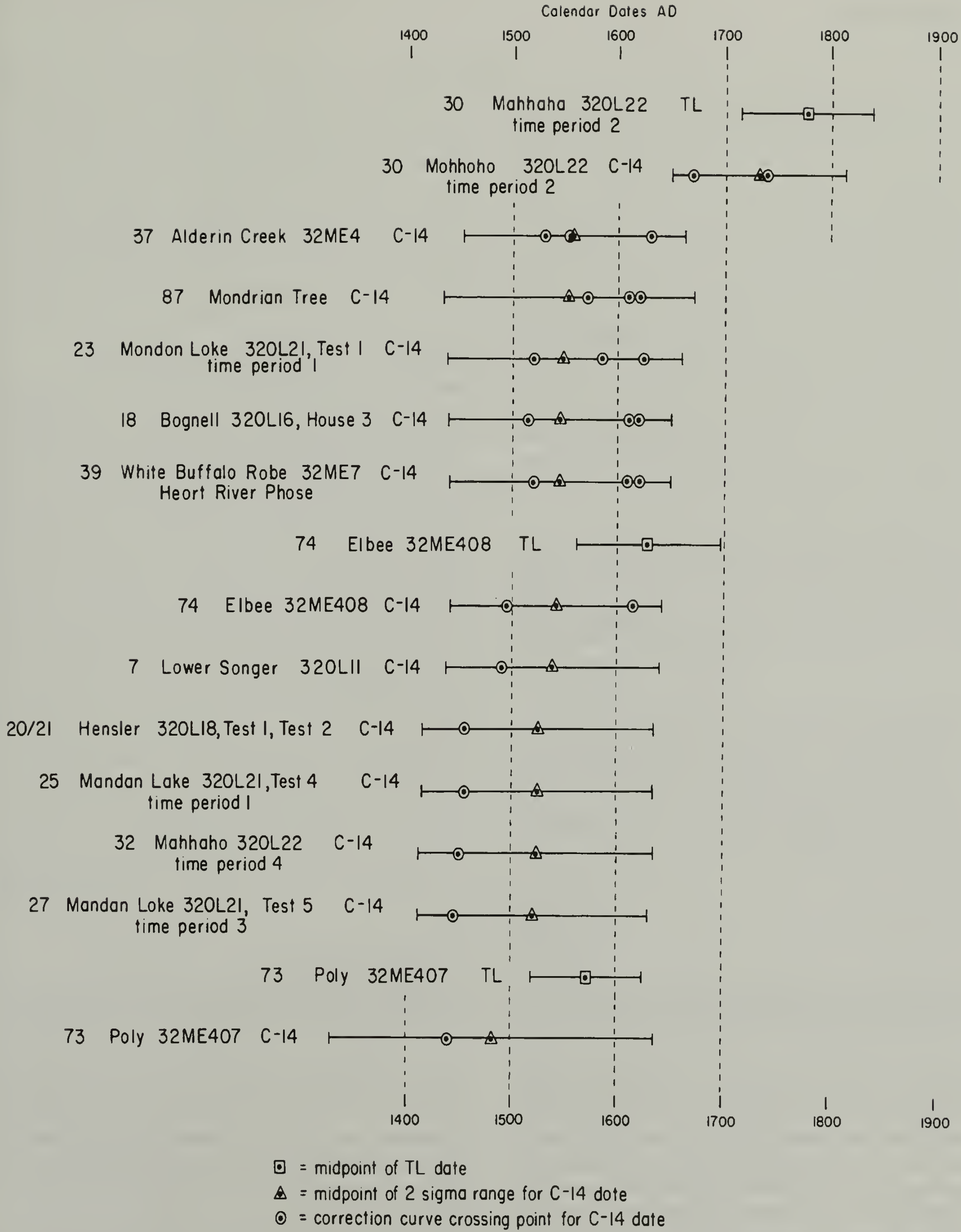

Figure 8.2. Pooled mean radiocarbon and thermoluminescence dates by analytic batch for archeological sites in the upper Knife- Heart region and elsewhere used in the KNRI comparative study, with ranges plotted at two sigma. Continued in Figure 8-3.

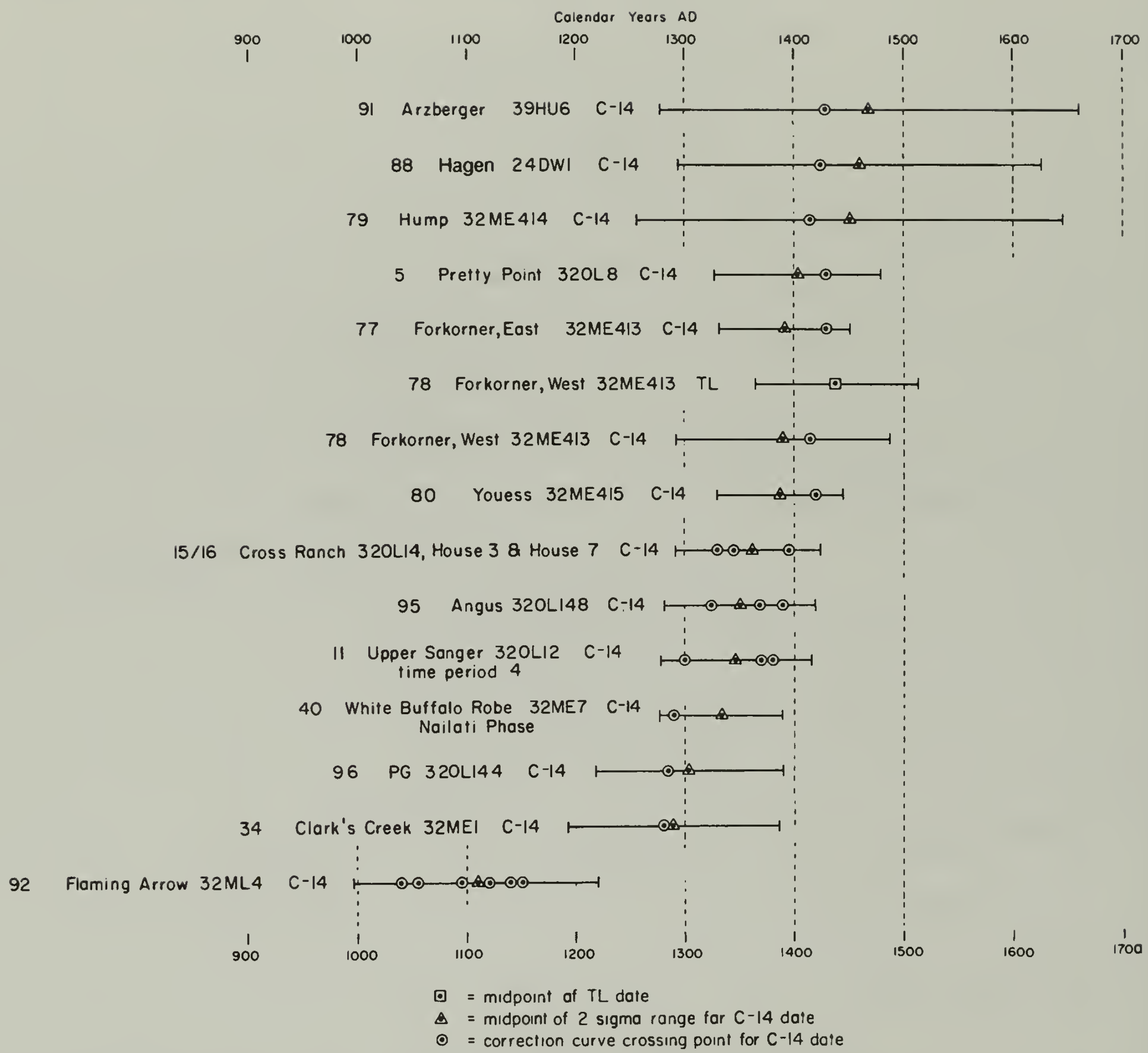

Figure 8.3. Pooled mean radiocarbon and thermoluminescence dates by analytic batch for archeological sites in the upper Knife- Heart region and elsewhere used in the KNRI comparative study, with ranges plotted at two sigma. A continuation from Figure 8- 2.

data (TL and/or C-14) have been relied upon rather exclusively for estimation of the period of occupation for a given batch. In other instances, other dating information such as historic documentation and site stratigraphy are considered as more reliable indicators of the calendrical age for a given analytic batch, and the chronometric data are considered of secondary importance or have been ignored entirely. The right-hand-most column in Table 8.9 indicates the basis for the best estimate dates in each case, giving the factors taken into consideration (H, C, S, T, A, C-14, or TL), listed in the order of their relative importance. If a factor is not listed at all, this indicates that that source of information had negligible effect on the batch age estimation process, even when such data existed.

For the major village sites in the KNRI, the definition of time period (batch) units and estimation of their likely ages has been a very complex process which has usually taken into account a wide array of sources of information. The actual sources of data used can be gained from information in Table 8.9, but full discussion of the processes used for each village is beyond the scope of this summary. The reader is referred to the original site reports (Ahler and Swenson 1985; Ahler and Weston 1981; and Ahler et al. 1980) for data pertinent to the subject. A brief synopsis of the procedures used in deriving the major village internal chronologies will be given below.

Examination of all of the information in Table 8.9 provides a ready means for assessing the congruence of chronological information from various sources and for summarizing assessments of the reliability of various chronometric results. This is best approached by looking first at the hypothesized chronology for each of the major villages, and commenting on what are considered to be the most reliable and least reliable sources of chronological data for the particular analytic batches in question. Looking first at Sakakawea Village, it can be noted that while the mean TL dates for various batches fall within the best estimates of date ranges for each batch, the TL information was actually incidental to developing these age estimates. Historic information and site stratigraphy are the major sources for chronology for the site, and the TL dates actually play no part in this process. It is seen as fortuitous that the batch mean TL dates fall within the age ranges for batches determined by other procedures, given the fact that very few of the individual TL dates fall within those ranges. The error factors associated with the TL dates are far too large for the individual or mean dates to be of use in determining the chronology of the site or of subunits within the site.

At Big Hidatsa Village, the picture is more complex, although chronometric dates still play a very minor role in determining the internal chronology of the site (cf. Ahler and Swenson 1985:86-113). The majority of the archeological deposits in the site are organized into a series of six time periods or chronologically sequential analytic units based on multivariate analysis of trade and native artifact frequency and ceramic thickness data in conjunction with internal site stratigraphy. Chronological ranges are assigned to these time periods (now batches) based on two primary considerations: 1) that trade artifacts probably first became visible in archeological sites in the region around AD 1600, and 2) that the village is known from historic records to have been abandoned in AD 1845. The intervening period from AD 1600 to AD 1845 is then segmented into six time periods based on considerations of relative frequency of trade artifacts and other considerations. TL dates associated with four of these time period units are all much earlier than the estimated dates for the periods (Table 8.9). The TL dates only serve the purpose of suggesting that the estimated time period ranges are probably not erroneously early. The midpoint of the C-14 dates for time period 5 (batch 68) is only fortuitously coincidental with the estimated temporal range for that period (Table 8.9), considering the 250+ year two sigma age range associated with the mean date. In summary, the TL dates at Big Hidatsa Village all appear to be somewhat earlier than they should be based on an array of other information. Neither the TL dates nor the radiocarbon dates from Big Hidatsa contribute significantly to development of the internal site chronology for batches 64-69.

Only in batch 70, time period 7, in Big Hidatsa Village, an apparent Scattered Village complex component, are the radiocarbon dates of value for developing an absolute chronology. The C-14 dates are used as the primary basis for suggesting an early fifteenth century date for that component (Table 8.9).

The situation at Lower Hidatsa Village is somewhat similar to that at Big Hidatsa in that the site deposits are quite deep and a continuous occupation for an extended period of time is assumed to have occurred. In the original site report, the midden deposits were segregated into three time periods having an assumed total duration of circa 100 years (AD 1680-1780; Ahler and Weston 1981:62-65). Subsequent studies have led to the recognition that at least the beginning date is erroneous, and that considerably more time depth is represented in the site. The three original temporal units have therefore been expanded into a total of six time period units (batches) while maintaining the stratigraphic integrity of the midden deposits. The two earliest time period units lack trade artifacts; associated C-14 dates are used directly to estimate the age of these analytic units (batches 48 and 49). It is in fact these C-14 dates that led to the recognition that the site chronology proposed in 1981 is erroneous. Trade artifacts first appear in batch 47, time period 4 deposits, and based on the assumption that such artifacts could first appear in the regional archeological record as early as AD 1600 and an assumed site abandonment date of AD 1780 (based on Awatixa oral traditions), the latter four time period units are each assigned 40-50 year time period increments during the interval AD 1600-1780. The mean TL date for period 2 corresponds with this age estimate, but the remaining mean TL dates are all somewhat later than the estimated ranges for each time period unit. The TL date ranges do overlap to some degree at two sigma with the estimated date ranges for each associated period, and the TL dates in conjunction with the C-14 dates serve to confirm the overall chronological range for the site archeological deposits.

In four other instances outside of the major KNRI villages, both TL dates and radiocarbon dates exist for a particular analytic batch. In the time period 2 deposits at Mahhaha (batch 30; Table 8.9) the TL dates and the C-14 dates from the same horizon are in good general agreement. The TL dates should perhaps be relied upon a little less for dating purposes because a soil sample derived directly from the site midden has not yet been processed for its contribution to thermoluminescent activity in the dated sherds. On this basis the C-14 dates are relied on more directly to estimate the age of the batch unit. A large batch range of 100 years is estimated to indicate uncertainty about the actual age of deposits in Mahhaha Village.

At the Elbee site, both the TL dates and the radiocarbon dates are widely scattered, despite the fact that all of the dated samples were collected from a single trash pit which was apparently used and filled with refuse over a very short period of time. In fact, it is likely, but not demonstrable, that some of the TL dates derive from the same pottery vessels. The TL dates and C-14 dates are in general agreement (particularly if none of the TL dates are excluded from consideration on statistical grounds-see Ahler 1984:33-38), and a relatively large age range of more than 100 years is estimated for the Elbee occupation which encompasses both the TL and C-14 determinations. The actual duration of occupation there was undoubtedly much shorter than this, but probably occurred somewhere within this time span.

At the Poly site (batch 73), the TL dates on a single vessel, while internally consistent, are not consistent with a single C-14 date from the site and the C-14 date is much more likely correct. Based on pottery typology for the site, the mean TL date is probably at least 100 years too late. Ceramic typology is in fact the primary basis for estimating the age of site deposits as being in the early fifteenth century AD.

In the west area at the Forkorner site (batch 78), the mean of several TL dates and a single radiocarbon determination are in close agreement. These dates are also in close agreement with dates on other Scattered Village complex occupations in nearby sites such as Youess, Hump, Forkorner East, and Big Hidatsa. All are relatively short-term occupations which probably occurred early in the fifteenth century AD.

All the other analytic batches listed in Table 8.9 have been dated by radiocarbon alone. As can be seen from the information in the table, for most of these components, radiocarbon dates are given primary consideration in estimation of actual dates of site occupancy. In some instances, ceramic typology and cross dating are given some priority over the available C-14 dates, particularly if only a single date exists for a batch or if the C-14 date range is quite large. The degree of confidence associated with the best estimate of each batch chronology can be inferred to some degree from the length of the estimated time range for each batch. If a range of 50 or 75 years is estimated, then we feel both that the batch has cultural integrity and that it can be dated quite well by a combination of typological and chronometric information. If the estimated date range is on the order of 100 years or more, this is an indication that we feel considerably less certain about the age and/or the cultural homogeneity of the dated archeological sample, i.e., the archeological deposits are possibly mixed and may contain more than one component; or possibly they contain a cultural component transitional between two better-recognized taxa; or perhaps the batch is from a vertically stratified sequence which is for the most part undated. Such is the case in particular for cultural deposits at Mahhaha, Upper Sanger, and possibly Mandan Lake and Hensler. Deep, stratified deposits are known to exist in the first two sites and may exist in the latter two sites, but chronological information for most of each sequence is unclear. Mahhaha is a particularly critical site, exhibiting ceramic data which suggests a time duration of at least 300 years. We cannot yet confirm, however, if this occupation was continuous in nature or occurred in a series of two or three discrete episodes separated by lengthy periods of site abandonment.

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Note: References in which an asterisk precedes the date were supported in whole or part by the Midwest Archeological Center's archeological and ethnohistorical research program for the Knife River Indian Villages National Historic Site.

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CHAPTER 9

AERIAL PHOTOGRAPHY AND MAPPING AT THE KNRI

Thomas D. Thiessen

INTRODUCTION

The Indian villages at the mouth of the Knife River have attracted the attention of archeologists for over a century. The first known visit by an archeologist to the village sites was made in October, 1883, by Theodore H. Lewis, who was employed by Alfred J. Hill of Minneapolis (Brower 1904:45). Lewis produced the first sketch maps of several of the sites (Wood 1986:49). Since that time, increasingly refined and accurate maps have been made of the archeological sites at Knife River, the most recent of them with the aid of aerial photographs and photogrammetric mapping techniques. Between 1976 and 1978, highly accurate maps were photogrammetrically produced of the major village sites as well as of the entire park; these have served as essential tools for the archeological research program. The history of those mapping efforts is briefly reviewed below, along with a short description of the resulting products.

Aerial photography and photogrammetric mapping are two of a growing array of remote sensing techniques that have been increasingly employed for archeological research over the past three decades (Lyons 1976; Lyons and Avery 1977; Lyons and Hitchcock 1977; Lyons and Ebert 1978; Lyons and Mathien 1980). The use of aerial photography in archeological research in the central and northern regions of the Great Plains, which dates back to 1946, has been comprehensively reviewed by Wood et al. (1984). Lovick and Ahler (1982:101-104) have summarized the available aerial photography for the Knife River Indian Villages through 1978.

IMAGERY AND SITE MAPS EXISTING PRIOR TO 1976

W. Raymond Wood (1986) has exhaustively reviewed the historical cartography of the region about the mouth of the Knife River. Many maps documented in that study and elsewhere (Thiessen et al. 1979; Wood 1981; Wood and Moulton 1981; Moulton 1983) depict on a small scale the relative locations of the Knife River villages and are useful for many kinds of historical studies, but do not provide the kind of large-scale detail that is necessary to study community plans or the archeological features that comprise the village sites. Far more useful for most archeological studies are maps that depict the internal details of archeological sites, and the discussion below focuses exclusively on such maps.

Several of the individual sites in the park, including all of the major villages (Big Hidatsa, Sakakawea, Lower Hidatsa), were mapped between 1883 and 1911, most of them several times (see Table 9.1) and with varying degrees of accuracy.

Lewis' sketch maps of the Sakakawea, Big Hidatsa, and Amahami village sites have never been published, but are preserved in the archives of the Minnesota Historical Society (Wood 1986:49). Although crudely drawn by today's cartographic standards, his map of Sakakawea Village clearly shows truncated lodge depressions indicating that the site was even then undergoing extensive erosion by the Knife River channel.

Early in the twentieth century, the State Historical Society of North Dakota showed interest in acquiring and preserving many of the better-preserved historic and prehistoric archeological sites in the state (Fish 1910:82). In 1906 and 1909 the Society employed experienced surveyors to produce carefully measured maps of many of these properties, and this effort included the Amahami, Lower Hidatsa, Big Hidatsa, and Sakakawea villages, as well as the Taylor Bluff Village and the now-destroyed "soldier's fortification" within the Buchfink site (Table 9.1). Showing the locations of lodge depressions, fortification ditches, and some storage/refuse pits, these maps are an invaluable record of the extent and condition of these sites as visible shortly after the turn of the century. Though this mapping project is poorly documented in the published literature (Fish 1908, 1910), several of the resulting maps are available in published and/or unpublished form (see the references in Table 9.1). The maps are preserved at the State Historical Society of North Dakota, and several of the notebooks of one of the surveyors, Frank J. V. Kiebert, are preserved at the Oliver County Courthouse in Center, North Dakota (Wood 1986:51-52).

Table 9.1. Maps of KNRI archeological sites produced prior to 1976.

Map Subject	When Made	By Whom	Location	Reproduced In
Amahami Village, 32ME8	1883	T.H. Lewis	MHS	Unpublished
	1905	Sitting Rabbit	SHSND	Libby 1906
	1909	F.J.V. Kiebert	SHSND?	Lehmer et al. 1978:Fig. 7.2 Ahler et al. 1991:95 (erroneously attributed to A.B. Stout in both references)
"Soldier's fortification"	1909	A.B. Stout and James St. Amour	SHSND	Ahler and Mehrer 1984:Figure 15 within the Buchfink site, 32ME9
Lower Hidatsa Village, 32ME10	1906	F.J.V. Kiebert and O.G. Libby	SHSND	Bowers 1965:Map 4 Lehmer et al. 1978:Fig. 5.1 Ahler et al. 1991:104
	1911	G.F. Will and H.J. Spinden	SHSND?	Will 1924:Figure 10
Sakakawea Village, 32ME11	1883	T.H. Lewis	MHS	Unpublished
	1905	Sitting Rabbit	SHSND	Libby 1906 Libby 1908:Plate III
	1906	F.V.J. Kiebert and O.G. Libby	SHSND	Bowers 1965:Map 5 Lehmer et al. 1978:Fig. 6.1
	1911	G.F. Will and H.J. Spinden	SHSND?	Will 1924:Figure 9
Big Hidatsa Village, 32ME12	1883	T.H. Lewis	MHS	Unpublished
	1905	Sitting Rabbit	SHSND	Libby 1906
	1906	F.V.J. Kiebert and O.G. Libby	SHSND	Libby 1908:Plate IV Bushnell 1922:Figure 12 Bowers 1965:Map 3
	Unknown	G.F. Will and T.C. Hecker	SHSND?	Will and Hecker 1944:Plate 3
Taylor Bluff Village, 32ME366	1909	A.B. Stout	SHSND	Ahler et al. 1983:Figure 3 Ahler 1988:Figure 4 Ahler et al. 1991:97

Note: MHS = Minnesota Historical Society; SHSND = State Historical Society of North Dakota

In 1911, George F. Will and Herbert J. Spinden revisited many of the village sites along the Missouri River and made new maps of many of them. Lower Hidatsa and Sakakawea were remapped at that time, and the resulting maps closely correspond with those produced by Kiebert a few years previous (Will 1924:Figures 9 and 10). The location of these maps is not documented in Will's report, but they may be at the State Historical Society of North Dakota. In a later publication by Will and T. C. Hecker (1944:Plate 3), a sketch map of Big Hidatsa is reproduced without a scale. Although the date of its creation and its location are not specified, the style of its execution is distinct from that of the maps made in 1911 by Will and Spinden (Will 1924:Figures 9 and 10).

The Knife River villages were also graphically depicted by a Native American informant employed by Orin G. Libby, secretary of the State Historical Society. In 1905, Libby paid a young Mandan man, Sitting Rabbit (also known as Little Owl), to prepare drawings of each of the five traditional Knife River villages of the Mandans and Hidatsas based on information provided by tribal elders (Libby 1906). Although Sitting Rabbit's drawings of the villages show much detail about community plan and the locations of cornfields and other village features, they are not based on empirical observations, but were drawn by someone who never viewed the occupied villages and are based on personal recollections and oral history gathered sixty years after the Hidatsas left the Knife River area. They do, however, contain valuable information and are worthy of reanalysis and reinterpre-tation in the light of recent archeological research at these same village sites.

None of the maps listed in Table 9.1 were based on aerial photographic imagery of the archeological sites. Prior to the park's legislative authorization in 1974 but postdating these early mapping efforts, several series of aerial photographs of the park area were made (Table 9.2; see also Lovick and Ahler 1982:Table 4). Most of these consisted of vertical black-and-white coverage routinely taken to a scale of 1:20,000 by the Agricultural Stabilization and Conservation Service (ASCS) of the U.S. Department of Agriculture. The earliest of these series, taken in 1938, starkly shows the many lodge depressions at Big Hidatsa Village largely denuded of vegetation (Reiten 1983:Figure 10; Ahler and Swenson 1985:Figure 2), presumably the result of drought conditions and perhaps overgrazing in the 1930s. A portion of one of the 1938 photographs has been published to illustrate the Stanton Mound Group (Ahler et al. 1991:25), a Woodland period mound group that exists on land recently added to the park. Subsequent ASCS coverage was taken in 1950, 1958, 1966, and 1976.

These photographs were extensively used in a recent, National Park Service-sponsored study of the geology and geomorphology of the park and the surrounding area at the mouth of the Knife River (Reiten 1983).

In 1967 (Metcalf n.d.:11), the North Dakota Highway Department took a series of 14 low-altitude, oblique-view photographs in which the lodge depressions at the major villages are highlighted by light snow cover (Table 9.2). One of these photographs, a spectacular view of the Big Hidatsa Village site, was reproduced in the National Park Service feasibility study which led to authorization of the park (National Park Service n.d.:10) and has also been used to illustrate an educational lesson plan based on the Knife River Indian Villages (Metcalf n.d.). Another view of Big Hidatsa and one of Sakakawea Village have been published elsewhere (Wood and Johnson 1980:Figure 2; Wood et al. 1984:Figure 2).

At the request of the park superintendent, the U.S. Fish and Wildlife Service in 1975 took four false color infrared vertical aerial photographs of the park. Copies of these are on file at the Midwest Archeological Center, but have essentially been superceded by extensive, lower-altitude infrared coverage of the park made in 1977 under National Park Service sponsorship.

AERIAL PHOTOGRAPHY AND PHOTOGRAMMETRIC MAPPING IN THE KNRI, 1976-1978

Even before the first archeological fieldwork was conducted in the newly-authorized National Historic Site, the need for accurate, precise maps of the park's archeological resources was obvious. Such maps would have to be constructed to document the extent and surface condition of the sites and to serve as basemaps for plotting various archeological investigations and newly discovered sites as the research program proceeded. The decision was made to develop the needed maps through the means of aerial photography and photogrammetric techniques, as a cost-effective, more practical, and more accurate alternative to traditional methods of on-the-ground surveying and mapping (Calabrese 1987; see also Chapter 1, this volume). Such techniques were in wide use in the American Southwest, where the Remote Sensing Division of the National Park Service's Chaco Archeological Center was making state-of-the-art applications of them to identify and document a wide variety of archeological resources. Consequently, a remote sensing subprogram of the Knife River Indian Villages research program was formulated and implemented. As the history and products of that subprogram have been reviewed in detail elsewhere (Wood et al. 1984:48-49; Calabrese 1987 and Chapter 1, this volume), the subprogram will be only briefly summarized below.

Table 9.2. Non-NPS-sponsored aerial photographs taken of the Knife River Indian Villages National Historic Site, 1938-1976.

Product	Sheet Numbers	Date Flown	Scale	Source	Comment
B/W vertical photos	BAO-24-4 BAO-24-6	9 Jul 1938	1:20,000	USDA, ASCS	Original, non-stable negatives were destroyed and replaced by low-resolution copies in the National Archives; BAO-24-6 coverage of 32ME12 is reproduced in Reiten 1983:Figure 10 and Ahler and Swenson 1985:Figure 2
B/W vertical photos	BAO-5G-17 BAO-5G-19	15 Oct 1950	1:20,000	USDA, ASCS	
B/W vertical photos	BAO-3V-49 BAO-4v-41 BAO-4V-42	28 Jun 1958	1:20,000	USDA, ASCS	
B/W low-oblique photos	Neg. Nos. 2166-2179	Sep 1964	N/A	North Dakota State Highway Department	Village relief accentuated by light snow cover, see Wood and Johnson 1980: Figure 2; also Wood, et al. 1984:Figure 2
B/W vertical photos	BAO-3GG-2 BAO-3GG-83	19 Sep 1966	1:20,000	USDA, ASCS	
B/W vertical	GS-VBMF-1-249 GS-VBMF-1-251 GS-VBMF-1-255 GS-VBMF-1-257	Jun 1967	Unknown	U.S. Geological Survey	Negatives are at DSC
False color infrared vertical photos	MDAP 9-62-61 MDAP 9-62-62 MDAP 9-62-63 MDAP 9-62-64	27 Jul 1975	1:24,000	U.S. Bureau of Land Management, Billings, MT	Negatives are at U.S. Fish and Wildlife Service, Bismarck, ND
B/W vertical photo	40-38057-176-111	14 Jul 1976	1:40,000	USDA	Single photo covers entire park

Note: USDA, ASCS = U. S. Department of Agriculture, Agricultural Conservation and Stabilization Service; DSC = Denver Service Center, National Park Service

Following consultation in mid-1975 with Thomas R. Lyons, then director of the Albuquerque, New Mexico-based Remote Sensing Division of the Chaco Archeological Center (see Calabrese, Chapter 1, this volume), arrangements were made for an experimental application of remote sensing techniques at Knife River. Plans were laid for Lyons' Remote Sensing Division to produce separate topographic maps of the three major villages in the park (Big Hidatsa, Sakakawea, Lower Hidatsa), as well as the southern, cultivated portion of the Sakakawea Village and a presumed cemetery area west of the Sakakawea site-five maps in all. These maps were to be photogrammetrically produced to a scale of 1 inch equals 30 feet and with a 0.5 foot contour interval. They would represent the first time that so small a contour interval would be applied to archeological sites in the Plains, where minimal relief could be expected (an earlier photogrammetric mapping effort at the Deer Creek site in Oklahoma resulted in a topographic map with a 1 foot contour interval; Wood et al. 1984:41).

The first step toward production of these maps was taken on July 24, 1976, when stereoscopic, black-and-white aerial photo coverage of the entire park was flown to a scale of 1:1,800 (Table 9.3). This was later used by the Koogle and Pouls engineering firm in Albuquerque to produce the five maps mentioned above. The resulting maps (Table 9.4) provided a very detailed record of the surface expression of house depressions and other site features, and were used to further document several kinds of investigations conducted on these sites. The Sakakawea Village map has been published in its entirety (Wood et al. 1984:Figure 19) and in part (Weymouth and Nickel 1977:Figure 5), and a portion of the Big Hidatsa Village map appears in Ahler et al. (1991:112).

The following year, on July 1, 1977, false color infrared vertical photographs were made of the entire park to a scale of 1:6,000 (Table 9.3). Produced for further study of the complex and often subtle archeological features within the park, these have not been used for mapping purposes nor have they been fully interpreted, but they exist as an invaluable resource for future study of the park's archeological resources and vegetative patterns. A color view of the Sakakawea Village from this imagery has been published in stereo pair format (Wood et al. 1984:Figure 11), and a view of the Lower Hidatsa Village appears in Ahler et al. (1991:113).

As the inventory of the park's archeological resources expanded from four previously recorded sites to over fifty newly discovered sites (see Chapter 4, this volume), the need for a parkwide topographic basemap became evident. Again with assistance from the Remote Sensing Division, the Grand Forks, North Dakota, firm of KBM, Inc. was contracted to take new aerial photo coverage of the park and produce a multi-sheet series of maps depicting the entire park to a scale of 1:1,000 and with a

Table 9.3. Aerial photographs taken of the Knife River Indian Villages National Historic Site, 1976-1988.

Product	Date Imagery Flown	Format	Scale	Location
B/W vertical photos of 32ME9, 32ME10, 32ME11, 32ME12	24 Jul 1976	40 9x9 in	1:1,800	Orig. negatives are at Koogle and Pouls Engineering, Albuquerque, NM; copy prints are at MWAC
False color vertical photos of entire park	1 Jul 1977	177 9x9 in transparencies	1:6,000	Orig. transparencies are at SWRO; infrared copy set is in KNRI collection.
B/W vertical photos of entire park	13 May 1978	39 9x9 in prints	1 in = 433 ft (1:5,196)	Orig. negatives are at DSC; copy prints are at MWAC
B/W vertical high-altitude photos of entire park	1 May 1978	6 39.5x64 in prints	1 in = 2,500 ft (1:30,000)	Orig. negatives are at KBM, Inc., Grand Forks, ND; copy prints are at MWAC, KNRI and UND
B/W low-oblique photos of the park, sites, and vicinity	13 Jul 1978	9 35 mm prints	N/A	Orig. negatives are at KNRI (KNRI-1-12 through 1-20A)
Color low-oblique photos of the park and vicinity	13 Jul 1978	59 35 mm slides	N/A	Orig. transparencies are at KNRI (KNRI-106 through 165)
Color low-oblique photos of sites 32ME10, 32ME11, 32ME12, plus many other sites in the vicinity	3 Jun 1988	265 35 mm slides	N/A	Orig. slides are at KNRI (KNRI-945 through 1209)

Note: B/W = black and white; SWRO = Southwest Regional Office, National Park Service, Santa Fe, New Mexico; UND = University of North Dakota; KNRI = Knife River Indian Villages National Historic Site; MWAC = Midwest Archeological Center; DSC = Denver Service Center, National Park Service

Table 9.4. Maps produced for the Knife River Indian Villages National Historic Site Phase I research program, 1976-1978.

Map Subject	Scale Interval	Contour	Produced From	Location
Lower Hidatsa Village, 32ME10	1 in = 30 ft	0.5 ft	1976 B/W 1:1,800 air photos	Mylar master is at SWRO; two duplicate mylars are at MWAC
Sakakawea Village 32ME11, main area	1 in = 30 ft	0.5 ft	1976 B/W 1:1,800 air photos	Mylar master is at SWRO; two duplicate mylars are at MWAC
Sakakawea Village, 32ME11, southern, cultivated area	1 in = 30 ft	0.5 ft	1976 B/W 1:1,800 air photos	Mylar master is at SWRO; two duplicate mylars are at MWAC
Sakakawea Cemetery, 32ME493 (portion)	1 in = 30 ft	0.5 ft	1976 B/W 1:1,800 air photos	Mylar master is at SWRO; two duplicate mylars are at MWAC
Big Hidatsa Village, 32ME12	1 in = 30 ft	0.5 ft	1976 B/W 1:1,800 air photos	Mylar master is at SWRO; two duplicate mylars are at MWAC
Entire park (22 sheets plus index sheet)	1:1,000	50 cm/ 19.68 in	1978 B/W 1:5,196 air photos	One mylar set marked with site boundaries is at KNRI and is also reproduced as part of Appendix B to Lovick and Ahler 1982; two mylar sets, without site boundaries, are at MWAC
Mylar overlays of 1976 B/W air photos, identifying anomalies	1:1,800	--	1976 B/W 1:1,800 air photos	Mylar masters are at SWRO

Note: B/W = black and white; SWRO = Southwest Regional Office of the National Park Service, Santa Fe, New Mexico; UND = University of North Dakota; MWAC = Midwest Archeological Center

50 cm contour interval. This coverage was flown on May 13, 1978 (Table 9.3), and a map of the entire park (Table 9.4), consisting of 22 sheets plus an index sheet, was produced (a portion of this map, showing the Sakakawea Village, is published in Wood et al. 1984:Figure 20). As the parkwide archeological inventory proceeded, site boundaries were marked on a mylar copy of this map at the University of North Dakota and this marked-up map presently serves as the archeological basemap of the park (Lovick and Ahler 1982:Appendix B; see Ahler et al. 1991:115 for an illustration of part of one of the sheets of this basemap).

Several high-altitude, black-and-white vertical aerial photographs were also taken, in which the entire park is visible in a single view (Table 9.3). These have not been used for mapping purposes, but a large print made from one of them is currently used by the park staff for orienting visitors to the park.

Three other series of aerial photographs, all of them oblique views taken from small airplanes at low altitudes, were subsequently made of individual sites in the park (Table 9.3) to illustrate talks on the research program and for other interpretive purposes. The latest set, consisting of 35 mm color slides of the major village sites in the park and its vicinity, was taken on June 3, 1988, by a professional photographer, Russ Hanson. Several of these spectacular photographs have been used to illustrate a popular book on the archeology of the Knife River Indian Villages (Ahler et al. 1991:7, 24, 32, 43, 58, 62, 85, 89, 92). A color reproduction of an infrared photograph of the Lower Hidatsa site also appears in that volume (Ahler et al. 1991:113).

INTERPRETATION OF RESULTS

The remote sensing subprogram for the Knife River Indian Villages was originally conceived as a four-step investigation (Obenauf n.d.:1-2), consisting of 1) acquisition of aerial photographic coverage of the entire park; 2) photogrammetric production of individual site maps from this imagery; 3) interpretation of the aerial photos; and 4) interpretation of the photogrammetric maps. The goal of the first part, aerial photography, was met with the black-and-white imagery taken on July 24, 1976, and the second part was completed with the production of the five site maps listed in Table 9.4.

The methods and results of the third part, interpretation of the air photos, are summarized by Obenauf (n.d.). In her study of the 1975 aerial photographs, Obenauf prepared a series of mylar overlays for a mosaic of the photos. She then formulated recognition pattern criteria for discerning individual lodge depressions. After marking all evident and suspected lodge locations on the mylar overlay, she also marked other evident anomalies as clues for further investigation on the ground. Although her mylar overlay was replicated in reproducible mylar blackline form for paper printing, it was not possible to carry her study to its logical conclusion: on-the-ground investigation and confirmation of the evident and suspected archeological features, commonly called "ground-truthing" the results of air photo interpretation. Despite the fact that a number of archeological features visible in aerial photographs were subsequently investigated by magnetic survey and test excavations, a systematic ground-truthing program could not be implemented. Project funds simply had to be used for other, higher priority activities of the overall Phase I research program. Obenauf's data still exist, however, and can still be the subject of future fieldwork in the park.

The fourth part of the original remote sensing program was to consist of interpretation of the photogrammetric maps by Thomas R. Lyons, but this apsect of the work was never completed.

As research at Knife River proceeded, the original four-step remote sensing subprogram was modified and augmented as new needs developed. Consequently, the 1977 false color infrared imagery was obtained, and new parkwide aerial photos were taken of the park in 1978 to use in the production of a parkwide topographic basemap. The Remote Sensing Division assisted with all of these subsequent aspects of the subprogram.

In conclusion, several remote sensing techniques, specifically black-and-white aerial photography, false color infrared aerial photography, and photogrammetric topographic mapping, were successfully used to map and document the archeological resources of the Knife River Indian Villages National Historic Site. Maps derived from this effort have been and continue to be invaluable tools for archeological research in the park, and have utility for non-archeological applications as well, such as planning park developments, mapping natural resources, and interpretive planning. Although the interpretive objectives of the subprogram were not fully met prior to the end of the Phase I research program, the resulting aerial photographs and maps are now a permanent part of the park's documentary record. They can serve to not only *facilitate* research in the future, but to *stimulate* future research efforts as well (i.e., they themselves can serve as the subject of research). The originally proposed final objectives of the remote sensing subprogram, interpretation of the air photo and map records, can still be achieved.

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CHAPTER 10

THE KNRI MAGNETOMETER SURVEY AND MAPPING PROGRAM

Robert K. Nickel

HISTORY

In the summer of 1976, the Midwest Archeological Center (MWAC) initiated limited archeological work at the Sakakawea Village site (32ME11). This site was the first of the major village sites to be acquired by the National Park Service for incorporation into the Knife River Indian Villages National Historic Site (KNRI). That summer Center archeologists sketched and photographed the stratigraphy exposed in the riverbank along the Knife River, established a grid system to record the location of surface features and excavation units, gathered distance and elevation data for photogrammetric mapping, and tested the feasibility of using proton magnetometers to map the archeological features within the park. Since the park's archeological remains are quite extensive, it was hoped that magnetometry would allow the mapping of subsurface features with no direct impact on the fragile archeological deposits.

At the time that the Center began work in the Knife River Indian Villages, relatively little was known (and even less was published) about the suitability of various geophysical techniques for detecting buried features on sites of Native American origin. In contrast, results of preliminary studies on archeological sites in Europe were reported in the engineering and applied geophysical literature as early as the mid-1950s (Belshé 1957). In 1958, a group of scientists at Oxford University initiated the publication of *Archaeometry*, which for the next several years served English-speaking archeologists as their principal source of information about the application of physics to archeological problems, including the use of magnetometers to map archeological sites.

By the early 1960s, both practical and theoretical knowledge regarding the application of geophysical techniques to extract information on archeological sites had greatly increased, and Irwin Scollar of the Rheinisches Landesmuseum in Bonn, Germany, had designed and built a magnetometer specifically for archeological prospecting (Scollar 1965). Numerous magnetic and resistivity surveys had been conducted in England and elsewhere in Europe. In 1961 Aitken published an introduction to the use of physics in archeology followed by another extensive compendium by Brothwell and Higgs (1963). During the mid-1960s, Scollar contributed numerous articles in English, placing them in engineering journals, in *Archaeometry*, and in the Italian journal *Prospezioni Archeologiche*, which was first published in 1965. By the middle of the decade, much of the European literature had begun to emphasize techniques for automatically recording the voluminous data gathered on archeological sites (Scollar 1968) and techniques for the computer processing of such data. Scollar (1969) wrote the best summary of computer processing of magnetic data and substantially updated this account in his recent comprehensive treatment of archeological prospecting techniques (Scollar et al. 1990).

In North America some interest in magnetic surveying of archeological sites was evidenced by the very early 1960s. Glenn A. Black and Richard B. Johnston of the Indiana Historical Society had experimented with a couple of magnetometers at the Middle Mississippian Angel Site from 1959 to 1961 (Black and Johnston 1962; Johnston 1964). Johnston also conducted a limited survey at Mesa Verde National Park in 1961 (Johnston 1964:126-127; Johnston 1965). Paul Ezell (Ezell et al. 1965) briefly reported the successful use of a proton magnetometer to locate three fired features at a prehistoric site in southern California and noted that the article by Black and Johnston (1962) was the only other report of such work that they were aware of for the U.S. Various individuals from the University Museum of the University of Pennsylvania had, since 1961, been actively collaborating with Italian colleagues in the application first of proton and then alkali vapor magnetometers at several large Etruscan and Roman sites. Although this program produced excellent results on several such sites (Lerici 1961; Ralph et al. 1968), and may have been instrumental in the formalization of the Applied Science Center for Archaeology (ASCA) at the University Museum, relatively little literature was produced on applications at North American sites.

In early 1965, the first issue of the *MASCA Newsletter* (initially issued as the *ASCA Newsletter*) was distributed and for the next several years the *Newsletter* contained brief notices (without identified authorship) of magnetic surveys, including a few surveys of sites in North and South America. In both 1969 and 1970, the MASCA team conducted magnetometer tests at the Olmec site of San Lorenzo and reported them in the *Newsletter*. Almost simultaneously, a team from the University of California Archaeological Research Facility in Berkeley conducted a magnetic survey at La Venta, also of Olmec origin (Morrison et al. 1970). By the mid-1970s, the notices in the MASCA *Newsletter* had generally become short authored articles but coverage of magnetic surveying was infrequent (e.g., Bevan 1975). The MASCA *Newsletter* evolved two more times, first in 1978 as the MASCA *Journal* and in 1988 as MASCA *Research Papers in Science and Archaeology*. However, since 1975 it has published only one or two short notes on magnetic surveying. At about this same time, *Archaeometry* also reduced its emphasis on prospecting articles in favor of concentrating them in *Prospezioni Archeologiche*.

There may have been several factors which resulted in the relative paucity of American use of geophysical surveying techniques during the 1960s and early 1970s compared to the Europeans. In general, the record which one could perceive in the American literature ranged from failure (Johnston 1965; MASCA *Newsletter* 1[2]:1; 2[2]:2; 7[1]:2) to limited success (Johnston 1964). Many of the North American applications were directed at prehistoric sites which contained features that were smaller and arrayed in a random (or less apparently regular) pattern than those which had served to best illustrate the technology's potential in Europe. Although the factors which directly affect magnetic surveying and resistivity surveying are not identical, the basic problems of archeological feature detection in most North American aboriginal sites were succinctly outlined by Carr (1977:162-163). These problems include small feature size, low susceptibility contrast between the archeological feature and the matrix in which it is buried, and variation resulting from sources which cannot be attributed to archeological processes. Scollar (1965:35) used the term *magnetic noise* to refer to this problem of non-archeological variation in readings and noted that it was a particular problem on sites which evidence strong contrast between feature and matrix. Various investigators have developed techniques in data collection and subsequent data processing to reduce the impact of noise. These and other limiting factors will be discussed in later sections on the underlying principals and the methods employed at KNRI.

Fortunately for the Knife River archeological program, interdisciplinary courses were being integrated into the anthropology curriculum at the University of Nebraska-Lincoln (UNL) during the early 1970s. John Weymouth, Professor of Physics at UNL, working with UNL anthropology professors Dale R. Henning and Peter Bleed, undertook field tests of magnetometry. This work included surveys at Central Plains village sites being investigated by UNL archeological field schools. The results of these studies provided anthropology students and UNL faculty with practical experience in magnetic surveying and, while they were not regularly published, they were reported at the annual meetings of the Plains Anthropological Society from 1973 on. The results of these projects were also incorporated in graduate seminars in archeology where both theory and practice were addressed. As a consequence of these circumstances, the UNL Department of Anthropology and MWAC had a significant pool of professional and student anthropologists available to work on archeological projects which included magnetometry.

UNDERLYING PRINCIPLES

Magnetic surveying of archeological sites depends upon the ability of the magnetometer to detect small variations (localized anomalies) in the earth's magnetic field and the ability of the analyst to differentiate those variations which result from archeological sources, from those with other origins. Since most individuals have some practical experience with magnets and magnetism, rough analogies can be drawn between some common experiences with magnetism and the phenomena on which magnetic surveying is based.

Most readers have probably seen demonstrations in which a chain of steel pins, paper clips, or iron filings has formed at the end of a small permanent magnet. In effect, the items which are intermediate between the permanent magnet and the last item in the chain are demonstrating substantial induced magnetization. When the permanent magnet is removed, the chain falls apart because the various elements no longer evidence substantial magnetism. It is also generally recognized that not all materials are equally subject to induced magnetization. That is, one would not expect to be able to form a comparable chain of brass pins, wooden match sticks, or plastic buttons.

It is probably less common for individuals to have directly observed the development of permanent magnetization when an iron object or compound is placed in a relatively strong magnetic field. Although the phenomenon is not as directly observable as the chain of pins, most of us accept that when a tape recording is made or a computer file is saved on a computer disk, the tape or disk coating becomes permanently magnetized. The magnetization is permanent in the sense that it may last for several years and the strength and polarity do not change rapidly and directly in response to fluctuations in the earth's ambient magnetic field.

Lastly, most readers are aware that the earth has a substantial magnetic field with magnetic north and south poles. This magnetic field is responsible for the movement of a compass needle and the fact that the north-seeking end of the needle will point toward the same spot no matter where the compass is placed on the surface of earth. In physics and geophysical texts the earth is represented as containing a large bar magnet with poles located near the axis about which the earth revolves.

In general, both the strength of the field and the inclination at which the flux lines approach the surface of the earth increase regularly with latitude. Across most of North America it is possible to predict the approximate strength and inclination of the magnetic field (see Figures 3 and 4 in Breiner 1973). Ideally, if magnetometer readings were obtained near the ground surface across a relatively small area (such as a hectare, or about 2.5 acres) and if the soil/geologic profile were completely uniform, then the readings would be uniform.

If an archeological feature had been excavated into this uniform soil and the material which came to fill the feature had measurably higher or lower susceptibility to induced magnetization, then the magnetometer readings obtained in proximity to the feature could be expected to be slightly higher or lower than those obtained over the uniform deposit. Likewise, if some substantial portion of the archeological feature had acquired significant permanent (remanent) magnetization, it would also make the readings taken in its vicinity higher or lower than the surrounding readings.

For soil and rock features, magnetic phenomena useful in archeological prospecting are attributable to the presence of iron-bearing compounds—primarily maghaemite (Scollar et al. 1990:388-391). Cultural processes which are known or thought to alter the amount and type of these minerals in a specific location include the introduction of substantial amounts of organic material (and related microbial activity) and the application of heat. In general, where substantial in situ soil development has occurred, the more humic top soil has greater magnetic susceptibility than the subsoil from which it developed. Because soils with measurably different susceptibility often occur within a meter of the surface, in many simple archeological features these contrasting soils are mixed or inverted, resulting in a detectable magnetic anomaly. If the feature is filled with substantial amounts of organic waste, pottery sherds, ash, or burned earth, then it may have substantially increased susceptibility and be easily detected by magnetometers.

In archeological contexts remanent magnetism is generally attributed to an episode when the material was heated to a temperature approaching 1,250 degrees Fahrenheit. The presence of remanent magnetism in archeological sites is not limited to burning, however. For example, Loose and Lyons (1976:139) attributed detectable remanent magnetism to the very gradual settling of fine grained clay particles in a prehistoric irrigation impoundment in Chaco Canyon, New Mexico. Because temperatures high enough to produce significant thermoremanent magnetism can be achieved in simple soil features which confine wood-fueled fires, hearths and kilns are among the easiest archeological features to detect with magnetometers.

Basically, a magnetometer will detect an archeological feature if the soil or stone comprising the feature differs from the surrounding soil in susceptibility to induced magnetization or if the feature possesses significant remanent magnetization.

The standard reference works by Aitken (1961, 1974), Breiner (1973), Scollar et al. (1990), and Tite (1972) provide more detailed and technical coverage of the physical phenomena on which magnetometer surveys (and most of the other current geophysical techniques) are based. Aitken and Tite provide somewhat simpler theoretical explanations and emphasize data collecting procedures, while Scollar's treatment is more technical and emphasizes post-acquisition data processing. Breiner's manual strikes an excellent balance between the underlying theory and the practical techniques used to measure and interpret magnetic signals resulting from common archeological and geological features.

KNRI MAGNETIC SURVEY METHODOLOGY

When the Center began work at KNRI, the only magnetometers which could be readily purchased and immediately applied to archeological surveying were ones which operated on the principle of proton precession. Proton magnetometers were originally designed for detecting and mapping geological formations but they require little or no modification for archeological applications. Proton magnetometers are also suitable for archeological surveys because they require a minimum of site-specific adjustment or tuning, and are highly portable. Common flashlight batteries can generally be used to power proton magnetometers, and compared to other types of magnetometers, they are inexpensive, reliable, and maintenance-free instruments. All of the magnetic mapping at KNRI was conducted with proton magnetometers. Information on the basic design of the proton magnetometer, as well as other types of magnetometers, can be found in Aitken (1974:241-2660) and Scollar et al. (1990:450-469).

Archeological applications of magnetometry always involve the measurement of the magnetic field at several different locations. This is because archeological features can only be located by identifying areas in which the field strength changes rather than by a specific value of magnetic field intensity. Even pronounced anomalies resulting from archeological features will typically affect the total reading by a small fraction of a percent. Most often, readings are taken at intervals which range from one half meter up to two meters. In some cases linear features such as buried wall segments or ditches may be adequately mapped by a few widely spaced traverses. More often, readings are taken at regular points on a grid in which the traverses or lines of readings are spaced at the same distance as the readings along a traverse. When working with a square or rectangular grid, halving the distance between the readings will quadruple the number of readings required to cover a given area. Consequently, surveys of large areas involve a compromise between very closely placed readings which yield greater detail and widely spaced readings which reduce time and expense.

Beginning with the 1976 magnetometer tests, the KNRI magnetic surveys were conducted with readings taken at one meter intervals. This spacing was selected because it was believed that it was close enough to detect magnetic anomalies produced by hearths and storage pits. It was assumed that these features would have moderate to strong susceptibility or remanent magnetism, would be a half meter or more in diameter, and would have all or a significant portion of their volume within a meter of the surface. Also, with this interval the magnetometer crew could consistently cover four 20m square survey units or *blocks* in a day and full coverage of the major villages was possible within the planned scope of Phase I investigations.

During all seasons of the KNRI magnetic survey, a consistent effort was made to compensate for the effects of variation in the local magnetic field through time so that these temporal variations would not be interpreted as manifestations of archeological features. Taking magnetic readings on a single grid point at KNRI every minute from morning to night, a generally predictable pattern would be observed. During the morning the readings would gradually decrease from the initial value and then gradually rise again in the afternoon. Although the general pattern is predictable, the absolute amount (30-50 nanotesla [nT] or gamma units) of change and the rate of change would be sufficiently variable as to cause problems in archeological surveying. It may be difficult to ascertain whether the change recorded between two nearby grid points resulted from the presence of an archeological feature or from the *diurnal variation* just described. Another form of time-dependent variation is referred to as a *magnetic storm*. These periods of magnetic disturbances caused by solar flares or other cosmic phenomena create wide fluctuations in the ambient magnetic field strength, are much greater in amplitude, and their pattern and duration are unpredictable.

The preferred solution to these problems has been to make simultaneous readings at a constant point with one sensor (the *reference sensor*) while a second sensor (the *moving sensor*) is moved from grid point to grid point. The readings of the reference and moving sensors are taken almost simultaneously, with the reference sensor recording temporal fluctuation. Because the source of both regular diurnal variation and magnetic storms is far removed from the local site, both the reference and moving sensor are presumed to be affected equally and changes seen in the readings from the reference sensor can be used to correct the values recorded by the moving sensor. In practice, the process can be as simple as systematically subtracting the reference reading from the simultaneously recorded moving reading and plotting only the differences. The KNRI magnetic surveys were conducted with pairs of similar magnetometers being cycled simultaneously to provide the necessary stationary reference values to compensate for variation in the background field during the time that the archeological sites were being surveyed.

Throughout the KNRI magnetic survey program, the field team followed the same basic data collection procedures. Working from permanent points on each master site grid, the team used a transit or engineering tapes to locate the corners of 20m grid units. They placed temporary wooden stakes at these corners and marked the coordinates on the stakes. Non-magnetic straps with meter and half-meter marks were used to establish the survey points within the 20m blocks. Two such straps, with loops at each end, were secured on the wooden corner stakes from west to east along the north and south boundaries of each 20m block. One or more additional straps with non-magnetic hooks were used as mobile straps. These were aligned with the marks on the north and south boundary straps. The crew then walked from south to north over the mobile strap taking measurements with the magnetometer at each 1m mark. After completing a 20m traverse, the crew moved the mobile strap to the adjacent marks on the boundary straps and again proceeded from south to north along the new traverse.

One modification to the standard magnetometer equipment was the attachment of a small block of non-magnetic material to the end of the sensor bottle opposite the end which contained the factory-made socket for the support staff. The attached mounting block was prepared with a threaded socket like the one built into the sensor. With this minor modification, a short leg of non-magnetic material was inserted into the bottom socket while the commercial staff was inserted into the top socket and served as a handle. In this configuration the sensor looked somewhat like an olive on a toothpick. The addition of the short leg allowed the sensor to be positioned consistently at 60cm above the site surface and carried the weight of the sensor except during the brief motion required to advance the sensor to the next 1m mark on the grid strap.

The 60cm sensor height was selected to allow archeological features in the top meter of the deposit to have a significant effect on the measured field while trying to minimize the effects of minor surface irregularities and very small fragments of modern iron that were scattered about the site on or just under the surface. Placing the sensor at a height of 2m or more would have further reduced the noise from the surface but would also have dramatically reduced the strength of the anomalies from significant archeological features—in many cases to a level below that which the instruments could detect.

Two variants on the basic field technique were employed during the several seasons of magnetic surveying. In one mode, two portable magnetometers and manual data recording were used and in the other, two base station magnetometers and a computer "data logger" were utilized. In the case of manual recording, one crew member was located at the site of the stationary reference magnetometer while a two-person crew operated the moving magnetometer. One of the members of the moving team removed all possible magnetic items (e.g., watches, belt buckles, pens) and carried the sensor for the period required to complete a survey block. The sensor carrier always stood on the same side of the sensor (south) and at arm's-length from it. The second member of this team would also remove all possible magnetic items and carried the magnetometer instrument pack. The person with the moving instrument pack would stay as far behind the sensor carrier as the length of the cable would allow (ca. 2m). By these means, the effects of the instrument, its batteries, and the crew members were minimized. As the moving team positioned their instrument, the instrument carrier would signal the reference magnetometer operator and both would cycle their magnetometers. When the reading was obtained, the instrument carrier would call out the value to the stationary unit operator who would record both values on a form. The moving pair would then go to the next grid point and the process would be repeated. At the end of a block, the individual at the reference station would have all the data recorded with reference values in one column, moving values in another, and appropriate coordinates in a third.

When the team used base station magnetometers linked to a computer, the process was similar. However, only the sensor carrier was needed for the moving sensor because it was connected by a very long cable to the base station instrument pack which was located near the stationary reference unit. One operator could cycle both magnetometers and the values were automatically transferred to the data logger and displayed. The instrument operator could inspect both values to judge whether they were reasonable and then either record them or opt to make another measurement. If the data appeared to be valid, the instrument operator signaled the moving sensor carrier to proceed to the next grid point and the process was repeated.

The development of the data logger was prompted by a desire to eliminate the labor (and associated transcription errors) required to manually enter the handwritten data into a university-based computer system. Because of the foresight of Ken Burgess, who designed and built the system as a UNL Masters thesis project, it proved to be an impressively efficient and effective tool. The data logger not only greatly facilitated the data acquisition but, with a couple of hours of programming, Ken was able to create a mapping program in the BASIC language which was capable of producing maps comparable to many of those in the final analytical reports (e.g., Weymouth 1988:Figures 7, 9, and 11). With his *Mapper* program, the results of the magnetic survey were available to the team within a few minutes after the completion of data collection. The unit also served as a telephone terminal for data transmission and even functioned as a word processor. During the several years that the data logger was used, no data were lost as a result of the operation of the unit, a fact all the more remarkable given the relatively primitive state of microcomputer technology in 1976, the thousands of miles it traveled in the back of vans, and the hot and dirty environs in which it was operated.

RESULTS

During the five seasons which followed the 1976 KNRI feasibility test, more than 14 hectares or 36 acres were magnetically surveyed at 12 sites (Table 10.1). The three highly visible main villages (32ME10, 32ME11, and 32ME12) were completely mapped and numerous other sites and localities in the park were either sampled or fully surveyed. All of the magnetic surveys have been reported and some of the data have been discussed in more than one report. For instance, the preliminary work at Sakakawea Village (32ME11) was reported by Weymouth and Nickel (1977) in the *Plains Anthropologist*. However, these data have proven to be so useful for illustrating the method and interpreting the results of magnetic surveying that they have been used in other contexts as well (e.g., Weymouth and Huggins 1985). All of the data are detailed in the 1986 (small sites) and 1988 (major villages) reports by J. Weymouth. These two reports fully summarize the magnetic data and relate them to the results of archeological excavations accomplished by Stanley Ahler's University of North Dakota crews. Throughout Phase I of the KNRI research program, several interim reports were generated by Weymouth and are referenced in the 1986 and 1988 works; however, few researchers will need to refer to more than the 1986 and 1988 reports.

Magnetic survey data, like most other archeological data, are of limited value until they are examined with reference to specific research questions. It is not possible to present here all the useful information which has resulted from the KNRI magnetic surveys but a summary of some of the results is presented below. In fact, most of the value of these data will be realized during future archeological investigations. At the simplest level, the

Table 10.1. Magnetic survey coverage of KNRI listed by site.

Site Number	Site Name	Final Report by J. Weymouth
32ME8	Amahami Village	1986
32ME9	Buchfink site	1986
32ME10	Lower Hidatsa Village	1988
32ME11	Sakakawea Village	1988
32ME12	Big Hidatsa Village	1988
32ME407	Poly site	1986
32ME408	Elbee site	1986
32ME411	Lobodi site	1986
32ME412	Hotrok site	1986
32ME493	Sakakawea Cemetery	1986
32ME496	Ramble site	1986
32ME499	Visitor center areas	1986

results can be used to look for "hot spots"—locations where substantial change occurs in the magnetic field strength. Even without an analysis of some of the more subtle or technical attributes of the anomalous readings, knowledge of the distribution of anomalies (and potential archeological features) should be helpful in planning initial excavations. The Fort Union archeological project illustrates this benefit.

A magnetic survey of the known fort area at Fort Union Trading Post National Historic Site was conducted by the KNRI magnetometer crew during the 1977 season. Since then, major excavations of the fort site have been accomplished. The excavation director found considerable value in the existing magnetometer maps (Hunt and Peterson 1988:116):

> Excavators discovered that the magnetometer survey was quite successful in predicting the location of major features in the site. Seventeen magnetic anomalies were identified by Weymouth within the area investigated during the 1986 field season and all were found to have archeological counterparts of one kind or another...Close scrutiny of the site's magnetic maps revealed many additional anomalies not addressed in Weymouth's analysis but were nevertheless found to conform to substantial features...In short, this successful application of magnetometer survey data proved that the magnetic maps can be valuable resources for estimating the approximate location and density of features within an archeological site.

One of the most obvious and first recognized benefits of the 1976 KNRI data was the detection of signatures from earthlodges constructed early in the period of occupation at Sakakawea village (32ME11). In the first phases of recording the riverbank stratigraphy it became clear from sections of burned roofing and other indications that some of the early lodges did not correspond with current topographic features. In the preliminary mapping of the 1976 data (Weymouth and Nickel 1977:117 and Figure 10), the signature of a lodge which lay partially beneath one of the current lodge depressions was clear. As the mapping program continued, it became clear that the signatures of additional early lodges could be recognized (Weymouth 1988:37, Figure 5, Table II). Certainly, the existence of physical remains of an earlier period of earthlodge construction beneath those of the last period complicates the placement of excavation units. To answer some research questions might require the type of complex stratigraphy that can be expected to occur in areas where the remains of early and late lodges intersect. For answers to other questions it might be preferable to locate excavation units in portions of the site thought to contain primarily undisturbed early lodge remains. Although the magnetic data do not offer perfect foresight, they should increase the likelihood that data relevant to the research program will be acquired with minimum cost and minimum effect on site integrity.

An artifact type frequently found in and around the KNRI villages is commonly referred to as fire-cracked rock. It was not surprising that pits containing a substantial weight (55kg) of fire-cracked rock at 32ME11 should produce a significant (7nT) anomaly (Weymouth 1988:37). During the earlier correlation of magnetic data with the results of test excavations at the Poly site (32ME407), a similar significant anomaly was found to be associated with a group of rocks. Field and subsequent laboratory testing led to the conclusion that a single large rock possessed sufficient thermo-remnant magnetism to produce a significant anomaly with a non-normal dipole signature which could be confused with that produced by a fragment of iron (Weymouth 1986:16).

Also documented in the work at the small non-village sites were some examples which illustrate the problems of weak susceptibility contrast between archeological feature, soil matrix, and magnetic noise, which were mentioned above. The magnetic survey at the Elbee site (32ME408) was situated to cover an area which would be impacted by an access road used for the stabilization of the riverbank near 32ME11. It was located in a previously cultivated area and was near an abandoned farmstead. The excavation units were concentrated in one portion of the magnetic survey area and a comparison of the excavation data and the magnetic data revealed very little correlation. This resulted from the fact that many of the features were small or partially obliterated by plowing and others had very low susceptibility contrast which would yield anomalies of about the same magnitude as the combined noise from non-archeological soil features, metal debris, and the magnetometers. Greater success might have been obtained on this and similar sites if the sensor had been lowered to ca. 30cm above the surface. This would increase strength of the signal from weak archeological features but would also increase the noise from small fragments of iron debris (Weymouth 1986:25-28).

An example of an extremely strong gradient can be seen in the magnetic data collected at the Amahami site (32ME8). The survey was conducted in close proximity to the modern Mercer County courthouse and the building produced a very substantial gradient in the magnetic data. However, through a process similar to that illustrated by Breiner (1973:14), a map of residuals from a trend surface was produced. In the residual data, the limits of the lodge floor were evident, as were hearths and other intramural features (Weymouth and Nickel 1977:113-114).

The magnetic data collected in block A in the 1978 evaluation of 32ME493 provide an excellent example of a geological anomaly. There is a pronounced but regular trend downward in the magnetic values from the southwest corner toward the northeast corner of the 20m block (Weymouth 1986:55, Figure 37). These data were also subjected to special processing (Weymouth 1986:55, Figures 37 and 38), in this instance, a mathematical process called *filtering* (Scollar 1969:78-79). In this case, a *high pass filter* was used which identifies localized areas of change while suppressing the indication of change which occurs over a broader area. Although plans for the development of the park's visitor center did not require excavation of the anomalies identified by this process, the data serve to illustrate ways in which one form of noise can be reduced.

The data from the Phase I magnetic surveys have all been mapped and, in some cases, have been subjected to specialized processing (e.g., trend surface analysis or band pass filtering). As noted above, the 1986 and 1988 reports by J. Weymouth provide comprehensive summaries of all the data. However, one of the greatest values of magnetic survey information lies in the potential to reexamine existing (i.e., previously recorded) data and apply new analytical techniques with the goal of evaluating hypotheses not yet formulated. In addition, the areas can usually be resurveyed because the magnetic survey process is non-destructive. Consequently, recommendations to use different sensor heights or alternative grid spacing in selected locations can be implemented prior to excavation.

In addition to the obvious and well documented potential for magnetic data to guide subsequent excavations, these data may also serve as the basis for the formulation and testing of archeological hypotheses which are not dependent upon subsequent excavation. Although the technique has been well established for some three decades, relatively few attempts have been made to use magnetic data as an independent line of evidence (cf. Fox 1988:72-92). Certainly at the time it was undertaken, the KNRI Phase I subprogram of magnetometer surveys resulted in the largest body of close-interval magnetic data from a complex of Native American sites. The excellent correlation between mapped magnetic data and anticipated site structure at KNRI was at least partially responsible for the 1978 evaluation and subsequent successful incorporation of magnetic surveying into the massive Dolores Archeological Program in southwestern Colorado. The KNRI magnetic survey data will continue to serve research and management needs for decades.

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REPORT CERTIFICATION

I certify that "The Phase I Archeological Research Program For The Knife River Indian Villages National Historic Site, Part 1: Objectives, Methods, and Summaries of Baseline Studies"

has been reviewed against the criteria contained in 43CFR Part 7 (a)(1) and upon recommendation of the Regional Archeologist has been classified as available.

Regional Director

10/28/93
Date

Classification Key Words:

"Available"–Making the report available to the public meets the criteria of 43CFR 7.18 (a)(1).

"Available (deletions)"–Making the report available with selected information on site locations and/or site characteristics deleted meets the criteria of 43CFR 7.18 (a)(1). A list of pages, maps, paragraphs, etc. that must be deleted for each report in this category is attached.

"Not Available"–Making the report available does not meet the criteria of 43CFR (a)(1).

DATE DUE

Painting of the three historic Hidatsa villages at the confluence of the Knife and Missouri rivers, North Dakota, made in 1904-1905 by Sitting Rabbit, a Manda Indian. Courtesy of the State Historical Society of North Dakota (accession number SHSND 673).