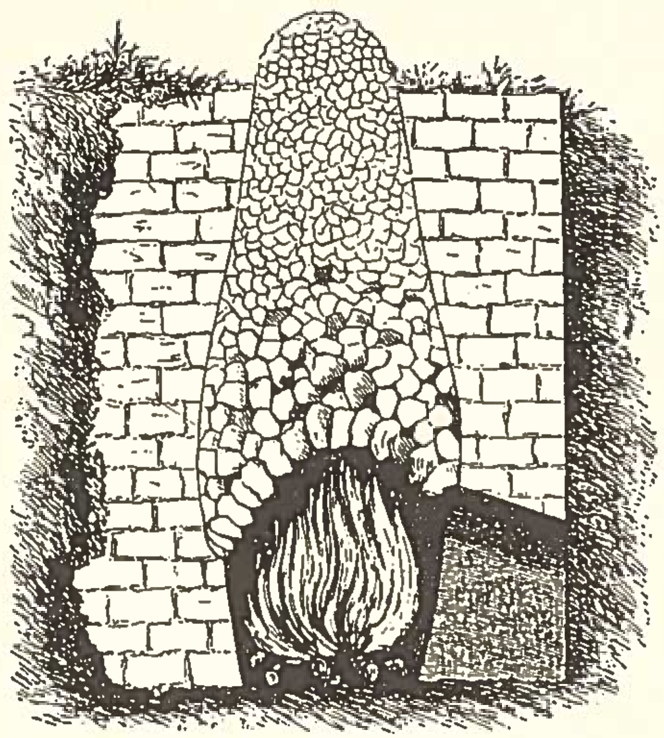
CURRENT ARCHAEOLOGICAL RESEARCH IN KENTUCKY

Volume Seven



Edited by

Charles D. Hockensmith
and
Kenneth C. Carstens

KENTUCKY HERITAGE COUNCIL

CURRENT ARCHAEOLOGICAL RESEARCH IN KENTUCKY

Volume Seven

Edited

By

Charles D. Hockensmith

and

Kenneth C. Carstens

2004

KENTUCKY HERITAGE COUNCIL
300 Washington Street
Frankfort, Kentucky 40601

This publication has been funded in part with state funds and federal funds from the National Park Service, Department of the Interior. However, the contents do not necessarily reflect the views or policies of the Department of the Interior.

This agency receives federal funds from the National Park Service. Regulations of the U.S. Department of the Interior strictly prohibit unlawful discrimination in departmental Federally Assisted Programs on the basis of race, color, national origin, age or handicap. Any person who believes he or she has been discriminated against in any program, activity or facility operated by a recipient of federal assistance should write to: Director, Equal Opportunity Program, U.S. Department of the Interior, National Park Service, P.O. Box 37127, Washington, D.C. 20013-7127.

Cover illustration: Drawing of an old fashioned "ground-hog" or temporary lime kiln (From Blatchley 1904:225, Figure 1). Reproduced courtesy of the Indiana Geological Survey, Bloomington.

PREFACE

Since its creation in 1966, the Kentucky Heritage Council has taken the lead in preserving and protecting Kentucky' cultural resources. To accomplish its legislative charge, the Heritage Council maintains three program areas: Site Development, Site Identification, and Site Protection and Archaeology. Site Development administers the state and federal Main Street programs, providing technical assistance in downtown revitalization to communities throughout the state. It also runs the Certified Local Government, Investment Tax Credit, and Restoration Grants-in-Aid programs.

The Site Identification staff maintains the inventory of historic buildings and is responsible for working with a Review Board, composed of professional historians, historic architects, archaeologists, and others interested in historic preservation, to nominate sites to the National Register of Historic Places. This program also is actively working to promote rural preservation and to protect Civil War sites.

The Site Protection and Archaeology Program staff works with a variety of federal and state agencies, local governments, and individuals to assist in their compliance with Section 106 of the National Historic Preservation Act of 1966 and to ensure that potential impacts to significant cultural resources are adequately addressed prior to the implementation of federally funded or licensed projects. They also are responsible for administering the Heritage Council's archaeological programs, which include the agency's state and federal archaeological grants; organizing this conference, including the editing and publication of selected papers; the dissemination of educational materials, such as the Kentucky Before Boone poster and booklet; and the Kentucky Archaeological Registry, which is designed to provide information of site management and protection to the owners of Kentucky's most important archaeological sites. On occasion, the Site Protection and Archaeology Program staff undertakes field and research projects, such as emergency data recovery at threatened sites.

The Fifteenth Annual Kentucky Heritage Council Archaeological Conference was held at Murray State University in Murray, Kentucky on February 28 and March 1, 1998. Dr. Kenneth C. Carstens was in charge of conference details and local arrangements. His efforts are greatly appreciated. We are also very grateful to Murray State University for graciously hosting the conference. Their excellent facilities made for a very pleasant conference. Kentucky Heritage Council staff assisting with conference proceedings included Site Protection Program Manager Thomas N. Sanders, as well as Staff Archaeologists David Pollack and Charles D. Hockensmith. Finally, the editors for this volume, Charles D. Hockensmith and Kenneth C. Carstens are to be commended for an excellent job in producing this volume.

A total of 20 papers were presented at the Fifteenth Annual Kentucky Heritage Council Archaeological Conference. Nine of those papers are included in this volume. Six additional papers were later submissions. These include "Unique Prehistoric Cultural Artifacts in the S-Bend Area of Mammoth Cave, Kentucky" by Kenneth C. Carstens and Philip J. DiBlasi; "George Rogers Clark's Fort Jefferson: An Historical Overview With Archaeological and Ethnic Considerations and Implications" by Kenneth C. Carstens and Nancy Son Carstens; "What's For Dinner? Late Eighteenth Century Subsistence Strategies at George Rogers Clark's Fort Jefferson and the Civilian Community of Clarksville, 1780-1781" by Kenneth C. Carstens; "Warrants, Surveys, and Patents at Fort Jefferson, Kentucky" by Andrew C. Kellie, Kenneth C. Carstens, and Brandon J. Kellie; "An Overview of Kentucky's Historic Lime Industry" by Charles D. Hockensmith; "Historic Lime Production in the Lower Cumberland River Valley, Livingston County, Kentucky" by Charles D. Hockensmith; and "Guns in the Bluegrass: Firearm Related Artifacts From McConnell Station (15Bb75), Bourbon

County, Kentucky" by Donald B. Ball. Figure 1 illustrates the locations of major sites discussed in this volume.

Several papers presented at the conference are not included in this volume. For the record, they are listed below in the same order as they appeared on the conference agenda: "Wickliffe Mounds After Fifteen Years: Conclusions, Speculations, and Fun Ideas" by Kit W. Wesler; "Aspects of Mortuary Structure in Wickliffe Mound Cemetery" by Hugh B. Matternas; "The Carroll County High School Archaeological Project: Investigations at the Middle Archaic Panther Rock (15Cl58) Site" by Leon Lane, Jason Venema, Carl Shields, and Sheree Richter; "In Search of Logan's Fort, Lincoln County, Kentucky" by Kim McBride, David Pollack, W. Stephen McBride, and M. Jay Stottman; "Analysis of the Human Burial Recovered from Logan's Fort" by Nick Hermann; "Fort Smith Archaeological Project, Smithland, Livingston County, Kentucky" by Kenneth C. Carstens; "The Kentucky Geographic Information System (GIS) Site File Project: An Update" by Jeanne Drapeau, Leon Lane, Nancy O'Malley, David Pollack, and Jim White; "Beneath the Asphalt: Excavations at the Louisville Convention Center (15Jf646)" by M. Jay Stottman; "Featuring the Wackenstein Site, 15Be467, Boone County" by Rebecca A. Hawkins and James C. Litkin; "Late Paleoindian/Early Archaic Adaptations at the Red Sand Site (15Ht46), Hart County, Kentucky" by Leon Lane and Melissa Gordon; and "Preliminary investigations of the Argosy Casino Project: A Preliminary Statement of Prehistoric Occupations" by Steven D. Creasman.

David L. Morgan, Director
Kentucky Heritage Council and
State Historic Preservation Officer

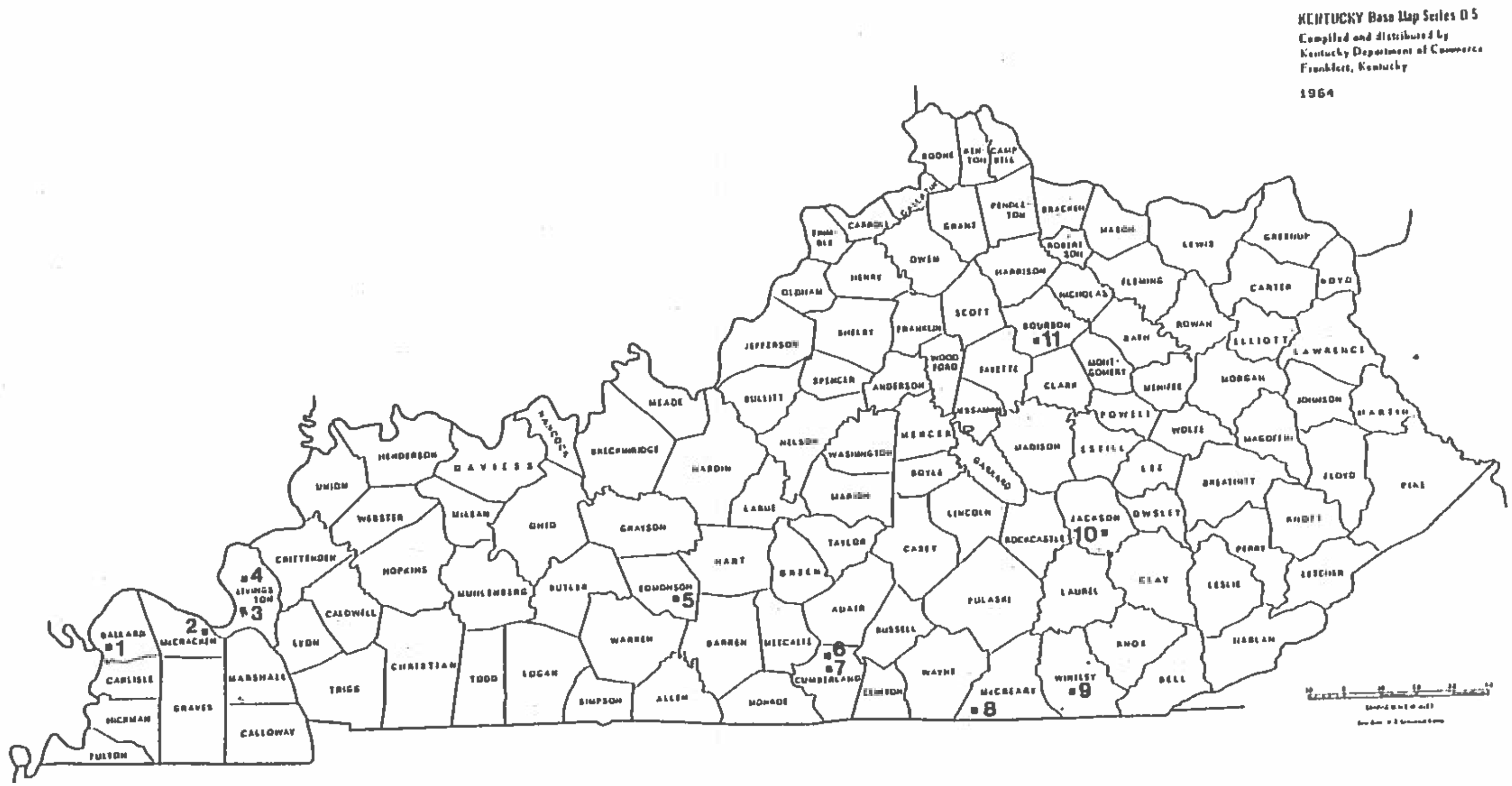


Figure 1. Sites Discussed in this Volume: 1) Fort Jefferson, 2) Paducah Brick and Tile Company, 3) Gower House, 4) Rudd Lime Kilns, 5) Mammoth Cave, 6) 15Cu31, 7) 15Cu27, 8) 15McY847, 9) Crawford-Nurre Saw Mill, 10) Cliff Palace Pond, and 11) 15Bb75.

EDITORS' INTRODUCTION

This volume contains a series of papers about very diverse topics. After careful consideration, a decision was made to organize these papers roughly chronologically by cultural period from the earliest to the latest. The papers include both prehistoric and historic topics. Papers about prehistoric topics include Archaic, Woodland, and Late Prehistoric period sites. Topics explored include site reports, biface manufacture, prehistoric fire activity, rockshelters, and unique artifacts. The historic period papers focus on Fort Jefferson, subsistence strategies, the lime industry, a saw mill, a brick yard, rock fence construction, window glass analysis, and firearm related artifacts.

The papers presented in this volume will be welcome additions to the growing body of archaeological literature in the Commonwealth of Kentucky. These papers present new information about sites from western Kentucky to southeastern Kentucky and from central Kentucky to southern Kentucky. There is also one paper from southern Illinois. Undoubtedly, researchers will cite papers included in this volume for many years to come. We express our appreciation to each of the authors for submitting the papers that comprise this volume and for their patience during the long editorial process. Special thanks is due David L. Morgan, Director of the Kentucky Heritage Council and the State Historic Preservation Officer, for his long term support of the annual archaeological conferences and the publication of edited conference volumes. Thomas N. Sanders, Manager of the Site Protection Program, provided encouragement and assistance during the preparation of this volume. David Pollack, Staff Archaeologist at the Kentucky Heritage Council, provided assistance with some computer problems encountered.

Charles D. Hockensmith
Kenneth C. Carstens

July 2004

CONTENTS

EARLY ARCHAIC BIFACE MANUFACTURE AT 15CU31

By

Andrew P. Bradbury
Cultural Resource Analysts, Inc.
Lexington, Kentucky

ABSTRACT

Excavations at 15Cu31, conducted on behalf of the Kentucky Transportation Cabinet, in Cumberland County, Kentucky, documented buried Early Archaic occupations. Tool classes represented consisted predominantly of bifacial forms. All but one of the bifacial implements exhibited manufacturing errors. An outcrop of Fort Payne chert occurs adjacent to the site and was likely the source of raw material for the prehistoric knappers in addition to gravels procured from Big Renox Creek below the site. Several analytical methods were used for the analysis of the recovered flake debris and indicate that the major use of the site was associated with tool manufacturing activities, and more specifically, the manufacture of bifacial implements. It is suggested that raw material entered the site as partially roughed out bifaces. These bifaces were further reduced on site into later stage bifaces for transport and use elsewhere.

INTRODUCTION

To assist the agency in meeting its responsibilities pursuant to Section 106 of the National Historic Preservation Act, the Kentucky Transportation Cabinet contracted with Cultural Resource Analysts, Inc. (CRA), to complete excavations at 15Cu31. Phase III excavations were conducted in May and June 1997 in conjunction with expansion of State Route 61 in Cumberland County, Kentucky. The site was situated on a low rise adjacent to the floodplain on the north side of Big Renox Creek. Cumberland County is located in the Eastern Pennyroyal physiographic region of Kentucky that is part of the Mississippi Plateau. The project area is located on the divide separating the Barren and Green River drainage basins to the north and west of the Cumberland River drainage basin. The local topography is characterized by a well-dissected rolling to hilly upland plateau (McGrain and Currens 1978). Dividing Ridge, which separates the Barren and Green Rivers, has elevations in excess of 1,000 feet (304.8 m) AMSL. The divide separating the Barren/Green Rivers and the Cumberland River has elevations in excess of 1,100 feet (335.3 m) AMSL near Sparksville. The site is located along the upper reaches of Big Renox Creek at an elevation of approximately 680 feet (207.3 m) AMSL. The topography along the Barren/Green rivers and Cumberland divide is characterized by kettle and knob karst features on the relatively broad flat-topped ridges.

The site was first identified in 1993 by archaeologists from CRA during a pedestrian survey in conjunction with expansion of State Route 61 in Cumberland County, Kentucky (Creasman 1993). Due to the presence of cultural materials occurring on the surface and the potential for buried cultural deposits, Phase II testing was recommended. The Phase II excavations were conducted during the summer of 1995 (Bradbury 1995).

During the Phase II excavations, two 50 x 50 cm units excavated on the low terrace encountered sub-plowzone archaeological deposits. These two units were expanded to 1 x 1 m units to further examine the nature and artifact content of these deposits. The units were excavated to a maximum depth of 96 cm below ground surface. Material density was greatest in the plowzone and decreased thereafter. However, increases in artifact counts were noticeable in several sub-plowzone levels. This material consisted of flake debris, cores, bifacial implements, thermal shatter, and light charcoal flecking. As Phase II investigations indicated the presence of intact subsurface cultural deposits, Phase III data recovery was recommended. Eighteen additional 1 x 1 m units were excavated during the data recovery excavations (Figure 1).

In the remainder of this paper, a summary of the excavations and analysis of the 15Cu31 materials is provided. While several sub-plowzone components were defined at the site (see Bradbury and Day 1998), only one could be confidently assigned a temporal affiliation. For this reason, only the Kirk Corner Notched materials are discussed here. As the majority of the recovered materials were chipped stone tools and debris, the focus of the paper is on this material class. Finally, it is argued that the excavation of similar low-density sites is important for a better understanding of the local prehistory.

GEOMORPHIC ASSESSMENT

In conjunction with the archaeological investigations, a geomorphic assessment of the deposits at 15Cu31 was conducted. This analysis indicated that the fine-grained sediments forming the floodplain of Big Renox Creek represent a series of overbank deposits that overlay a lag channel deposit (Morris 1998). Sediment landform associations indicate that the site is situated on an older T1 terrace (Figure 2). At the time the site was occupied, Big Renox Creek would have been located further north than its current position. Thin, discontinuous clay coatings on the ped faces of soils on the T1 suggest the development of an argillic horizon and indicates that the youngest deposits of the T1 terrace should be at least 4,000 years old or older (Foss and Collins 1987). A pebble line discontinuity was noted in this area occurring at 45 cm below surface. An increase in artifact density was noted just below this discontinuity and represents an intact soil horizon (T1a) dating to the Early Archaic period.

LOCAL CHERT RESOURCES

Of special interest to the site investigations was the occurrence of chert in close proximity to 15Cu31. A number of Mississippian aged formations outcrop in the surrounding area. A raw material survey was conducted in conjunction with the phase II excavations to identify possible sources of local raw materials (Bradbury 1995). Based on this survey, in conjunction with the local geological quadrangle map (Taylor 1964), it was determined that Fort Payne chert was generally ubiquitous in the local area. St. Louis chert and chalcedony can also be procured from sources to the north of the site area around Breeding, Kentucky (approximately 7 km). While nodule size and quality of the local Fort Payne chert varies, much moderate to high quality tool stone was available in close proximity to 15Cu31. The area in general could be described as raw material rich.

For the analysis of the 15Cu31 materials, Fort Payne chert was subdivided into three varieties: high quality (HQFP), low quality (LQFP), and fibrous (FFP). More in depth descriptions and locational information is provided in Bradbury and Day (1998; Bradbury 1995);

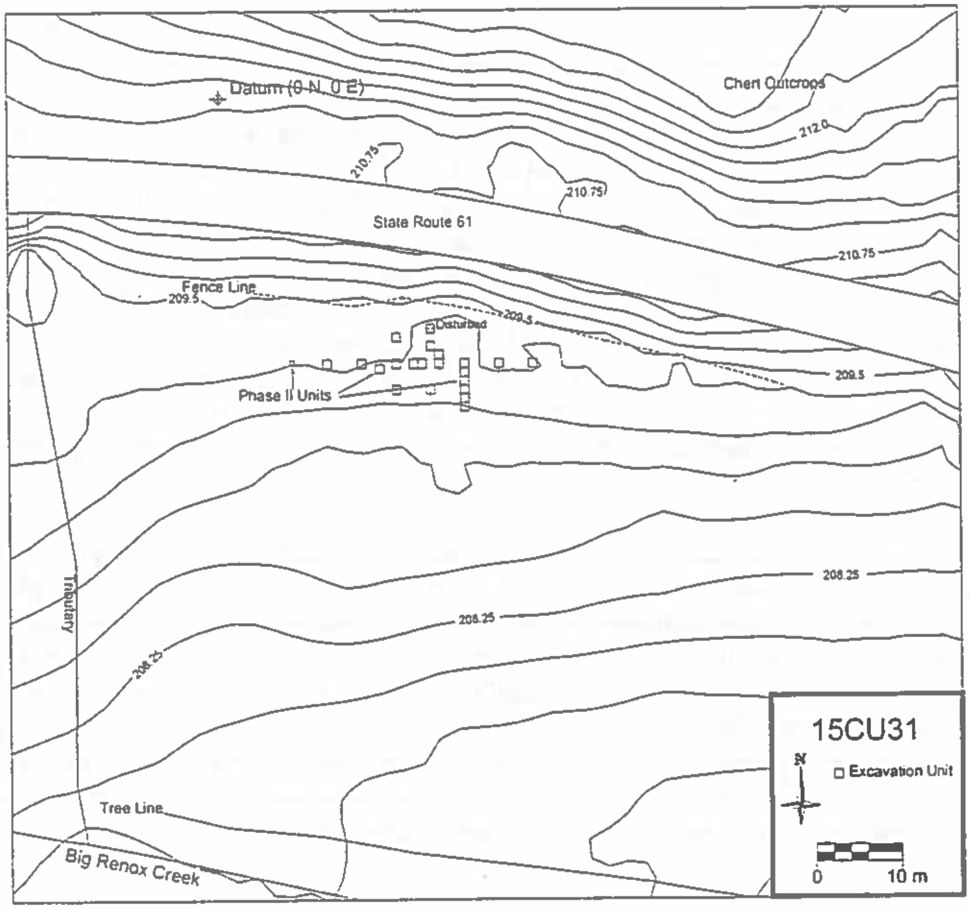


Figure 1. Schematic Plan Map of 15Cu31.

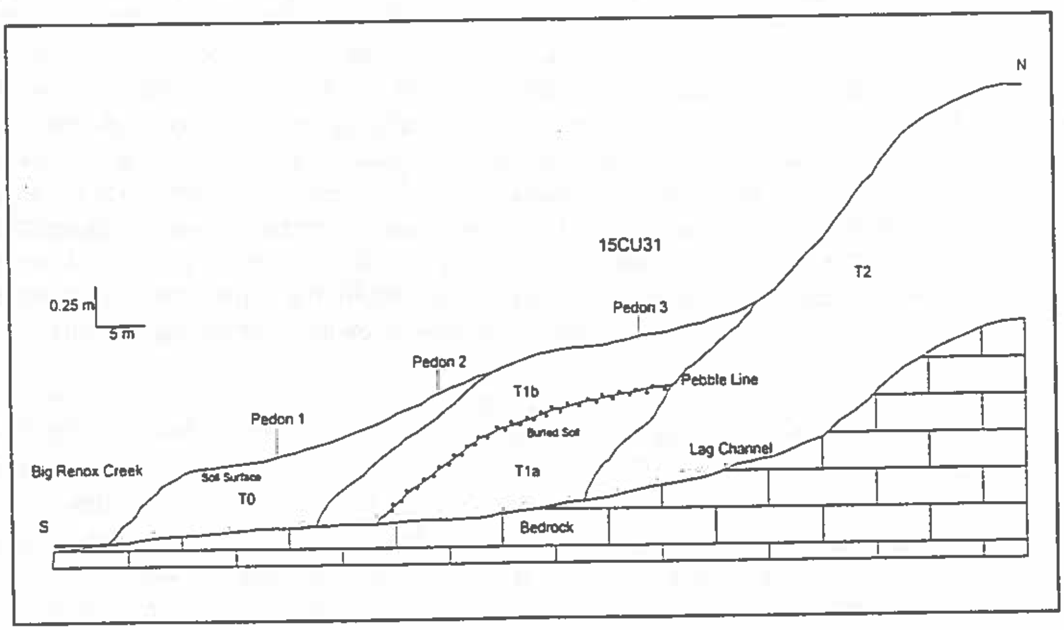


Figure 2. Cross-section of the Alluvial Deposits at 15Cu31.

therefore, only a summary is provided here. LQFP consists of Fort Payne chert that was coarse grained and generally exhibited poor fracture properties for purposes of controlled flake removal. LQFP was observed at numerous locations in and around the local area. HQFP is characterized as semi-vitreous, medium to fine-grained. This variety was observed in the archaeological samples and is likely derived from sources outside the project area, probably to the south (less than 10 km). FFP is a medium to fine grained, nearly vitreous, semi-translucent chert with numerous rod to oval shaped inclusions. This chert was collected at a number of outcrops throughout the area and is a high quality chert for purposes of controlled flake removal. An outcrop of Fort Payne chert was observed just to the north (approximately 50 m) of 15Cu31 (see Figure 1). Both FFP and LQFP were present at this location. Flakes, cores, and a few biface fragments were observed below the outcrop indicating that it had been exploited prehistorically. In addition, chert gravels are present in Big Renox Creek and in a tributary at the west end of the site. The latter sources represent an additional source of raw material for prehistoric peoples that used 15Cu31.

The availability and quality of the local resources likely played an important role in the lithic technologies of the area. Local is defined here as raw materials that could be obtained within 5 km, and in most cases, adjacent to the site. These resources consist of FFP and LQFP cherts. Extra-local sources consist of chert that could be procured from sources between 5 and 10 km from the site. These resources include HQFP and St Louis cherts and chalcedony. Given the differential quality and distribution of raw materials within the local area, there is potential for overall differences in the use of the available sources. While a number of local raw materials are sufficient for chipped stone tool production, "certain materials may be chosen over others because of differences in mechanical efficiency at hand" (Beck and Jones 1990:284).

LITHIC ANALYSIS

Based on the geomorphic investigations and archaeological evidence, four cultural components were identified at 15Cu31 (Bradbury and Day 1998). The best preserved of these components was associated with an Early Archaic occupation that was represented just below the discontinuity mentioned above. Temporal affiliation for this component was defined based on the recovery of a Kirk Corner Notched hafted biface. The remainder of this paper will concentrate on lithic artifacts associated with this component. Artifact distribution maps constructed for the site illustrated two areas of flake debris concentrations within the Kirk component. Some vertical separation was observed between these two areas. The two peaks of artifact density likely represent two separate visits to the site. Artifact analyses demonstrated that the site was used in a similar manner during both occupations (Bradbury and Day 1998). While the component may represent two separate visits to the site, both are considered as one occupation in the following analysis.

A total of 1,440 (1,814.9 g) pieces of flake debris greater than 0.25 inch (6.4 mm), 626 (63.5 g) flake debris less than .025 inch (6.4 mm), two (192.1 g) pieces of thermal shatter, 11 (2,356.4 g) cores and 15 (359.7 g) modified implements was recovered that could be assigned to the Kirk component. Of note concerning the lithic artifacts is that the three varieties of Fort Payne chert dominate the assemblage. Only 0.08% of the flake debris was classified as non-Fort Payne chert. Of the Fort Payne chert, almost 92% was FFP. Thermal alteration was not used as a part of the lithic technology at the site. As indicated by cortex type present on several artifacts and flake debris, both primary (i.e., outcrop) and secondary (i.e., creek gravels) contexts were exploited for the procurement of knappable tool stone.

FLAKE DEBRIS ANALYSIS

The flake debris analysis was conducted using three different analytical methods; a continuum based approach (e.g., Bradbury and Carr 1999; Ingbar et al. 1989; Shott 1996), mass analysis (e.g., Ahler 1989a, 1989b; Ahler and Christensen 1983) and individual flake analysis (e.g., Magne 1985; Magne and Pokotylo 1981). The main reason for the use of three methods of flake debris analysis was to allow for multiple lines of evidence to be used. Binford (1987) has argued for the use of multiple lines of evidence in archaeological investigations as a means of strengthening inferences or revealing ambiguities. This approach has also been advocated for flake debris analysis (Bradbury 1998; Bradbury and Carr 1995; Morrow 1997). Individual flake and mass analysis approaches are viewed as complementary approaches that enable the analyst to strengthen inferences based on the analyses (Bradbury and Carr 1995; Morrow 1997; Shott 1994). For example, general trends observed in mass analysis data sets can be compared to results of individual flake analysis to strengthen inference or reveal new areas for investigation. The continuum approach employed here used the method developed by Bradbury and Carr (1999). As this data has been presented in more detail elsewhere (Bradbury 1998), only a summary is provided here.

The continuum analysis indicated that all of the HQFP was the result of tool production, FFP was predominately the result of tool production (91.1%) and LQFP showed higher percentages (36%) of core reduction debris (Table 1). A chi-square test of independence (Ott 1988:249-252) shows that these differences are significant (χ^2: 17.505, Df : 2, p = .0001). Both the HQFP and FFP are over represented in tool production debris while the LQFP is over represented in the core reduction debris. This indicates the dominance of tool production, relative to core reduction, for these chert types. Additionally, it was determined that HQFP was represented by flakes occurring in the middle to late portions of the continuum, FFP by all portions of the continuum, and LQFP by the early to middle portions of the continuum (Figure 3). This is further evidenced in histograms produced for each raw material (Figures 4-6). Of note is that none of the raw materials exhibit flakes in the greater than 100% complete category (i.e., resharpening or reworking). HQFP exhibits greater percentages of flakes in the later portion of the continuum. The histogram for FFP shows that flakes represent all portions of the continuum, however, the middle portions are more highly represented. The histogram for LQFP shows a distribution in the early to middle portion of the continuum. A Kolmogorov-Smirnov test (Blalock 1972:262-264) shows that these distributions are significantly different (χ^2: 21.912, Df: 2, p < 0.001).

Table 1. Flake Debris by Raw Material from Kirk Component.

Raw Material	Count	Weight
HQFP	30	15.8 g
FFP	1303	1323.5 g
LQFP	106	475.3
St Louis	1	0.3 g
Total	1440	1814.9 g

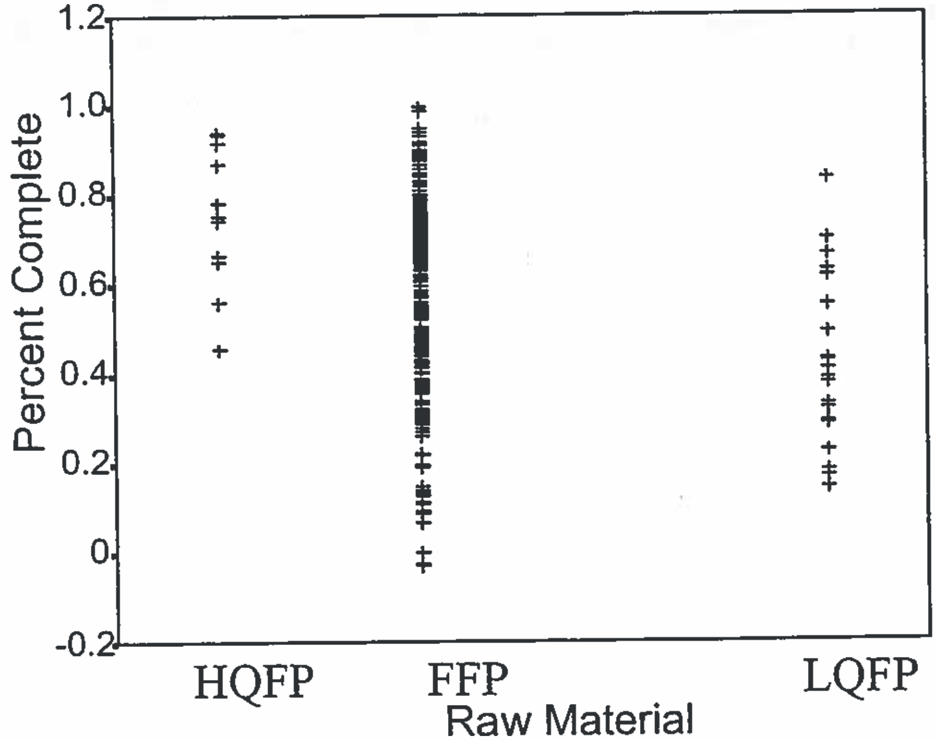


Figure 3. Percent Complete for Raw Material Types from Kirk Component.

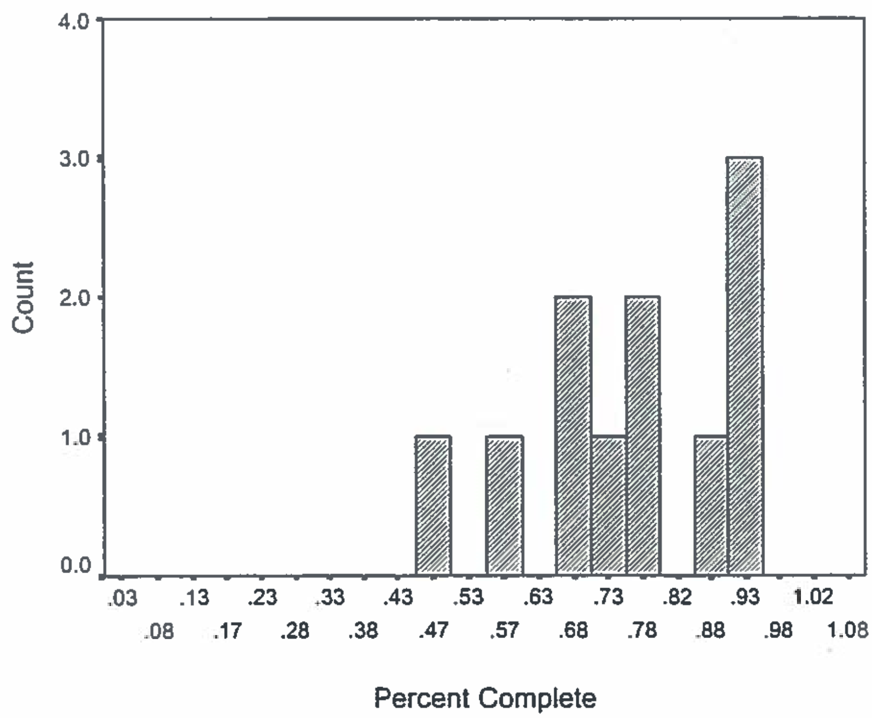


Figure 4. Histogram for High Quality Fort Payne Chert.

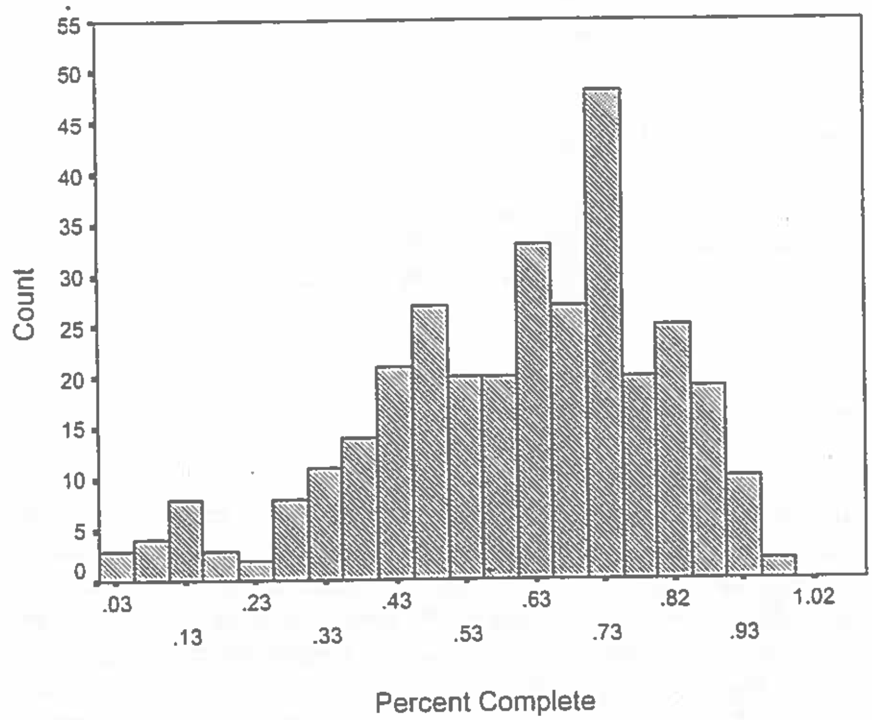


Figure 5. Histogram for Fibrous Fort Payne Chert.

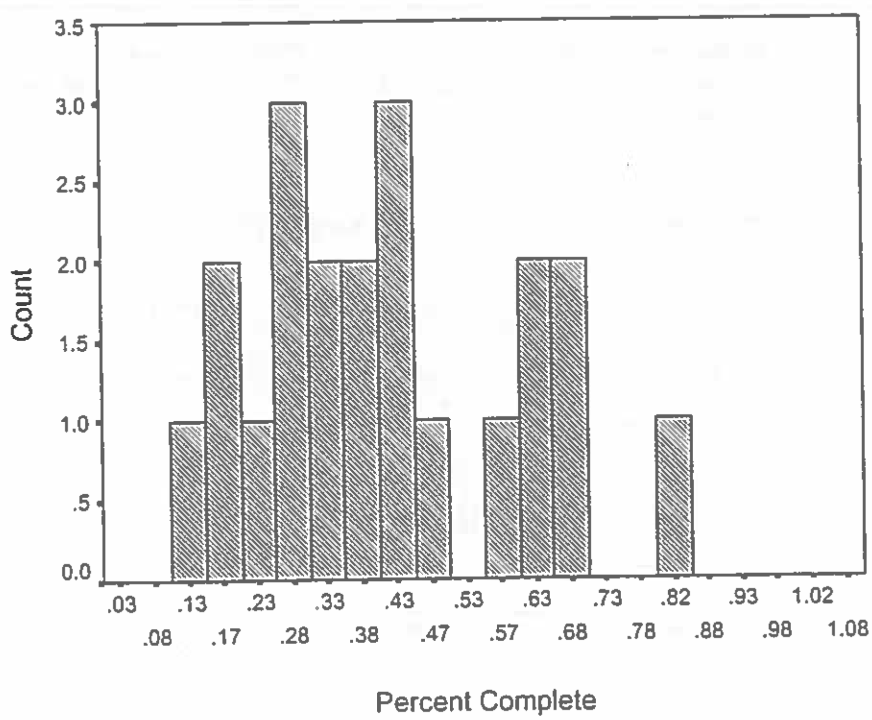


Figure 6. Histogram for Low Quality Fort Payne Chert.

Flake debris from the Kirk component was also subjected to mass analysis and individual flake analysis methods. The results of both of these analyses confirm the inferences suggested above from the continuum-based approach (see Bradbury 1998 for a more in depth discussion of these results).

To summarize the flake debris analysis, three different methods of analysis were used. All three methods indicate that tool production activities dominate the chipped stone tool assemblage. Only minor amounts of core reduction took place. Lithic reduction activities at the site appear to be focused on the production of middle to late stage bifaces of FFP chert. Additionally, these analyses indicate that raw material likely entered the site in a partially roughed out form.

MODIFIED IMPLEMENTS AND CORES

An examination of the recovered cores and modified implements (Table 2), in conjunction with the above analysis, provides further insights into the lithic technology occurring on site. Of the 11 cores recovered, eight were manufactured from FFP and three were of LQFP. Modified implement classes consist of one unifacially retouched flake, 11 biface fragments, and two hafted bifaces. One of the hafted bifaces was a Kirk Corner Notched cluster manufactured from St. Louis chert, the other was a basal fragment of a probable corner notched form manufactured from HQFP. Both of these raw materials represent chert that would have been transported from other areas. All but one of the remaining bifacial implements recovered represented the early to middle stages of biface reduction and all exhibited manufacturing errors. Several of these biface fragments exhibited cortex on both faces indicating that they were manufactured from tabular blocks of chert. This data, in conjunction with the flake debris analysis, indicates that bifaces with minimal flake removals were being transported to the site (Figure 7a). These bifaces were further reduced on-site to middle/late stage bifaces, for transport and use elsewhere (Figure 7b).

Table 2. Modified Implements and Cores from Kirk Component.

Raw Material	Cores	Flake Tool	204-1.1	204-2.1	204-3.1	204-4.1	Hafted Bifaces	Modified Total
HQFP	0	0	0	0	0	1	1	2
FFP	8	1	1	4	5	0	0	11
LQFP	3	0	0	0	1	0	0	1
St Louis	0	0	0	0	0	0	1	1
Totals	11	1	1	4	6	1	2	15

* 204 - x.x represent different classes of bifaces, the higher the number, the further in the reduction sequence.

Figure 7. Examples of Bifaces From the Kirk Component. Early Stage Biface (A), Middle to Late Stage Biface (B). Note that both are fragments that were refit.

MICROWEAR ANALYSIS

All modified implements recovered during the Phase III excavations at 15Cu31 were examined for indications of micro-scarring. Two main forms of microwear analysis are common: low magnification (e.g., Odell 1977; Odell and Odell-Vereecken 1980; Tringham et al. 1974) and high magnification analyses (e.g. Keeley 1980). The strengths and weaknesses of both methods have been discussed in detail elsewhere (e.g. Odell 1996), therefore, they will not be re-iterated here. Based on the goals of the analysis and the data set in question, the low magnification approach was chosen for the analysis.

In the low magnification microwear approach, micro-scarring on the edges of lithic implements is examined to determine: 1) if the implement was used; 2) the area of use; 3) the material being worked; 4) and the motion of use. The specific methods used for this analysis follow that of other practitioners of the approach (e.g., Odell 1977, 1996; Odell and Odell-Vereecken 1980; Tringham et al. 1974). For the current analysis, a Wolfe stereoscopic microscope with a reflective light source was employed. The microscope was fitted with 20x eyepieces and 4.5x paired objectives. The magnification was continuously variable and ranged between 14x and 90x. Implements were generally scanned for evidence of wear at 20x. Magnification was then increased or decreased as needed to more clearly view any observable edge damage.

Of the 14 implements recovered from the Kirk Corner Notched component, only three exhibited micro-scarring that could be attributed to use (Table 3). These consist of a unifacially retouched flake, a hafted biface (Kirk Corner Notched cluster), and a late stage biface fragment (Figure 8). The latter two implements evidenced micro-scarring indicative of use in a longitudinal motion on soft resistance materials (e.g., meat, hide, vegetal materials) along two edges. In addition, the hafted biface exhibited micro-scarring indicative of haft related damage and basal grinding. These data suggest that these two implements were used in butchering related activities.

Table 3. Results of Microwear Analysis.

Component	Motion	Material	# of Edges
Kirk	No Wear	NA	6 (implements)
Kirk	Longitudinal	Soft	4
Kirk	Transverse	Soft	1
Kirk	Haft	NA	1
Kirk	Prehension	NA	1
Kirk	Technological	NA	4
		Total	17

The unifacially retouched flake exhibited micro-scarring indicative of use in a transverse motion on soft resistance materials along one edge. Such use is usually associated with activities such as the scraping of hides.

The basal fragment of a hafted biface (indeterminate cluster) exhibited haft-related damage along the basal edge. All of the remaining biface fragments exhibited micro-scarring

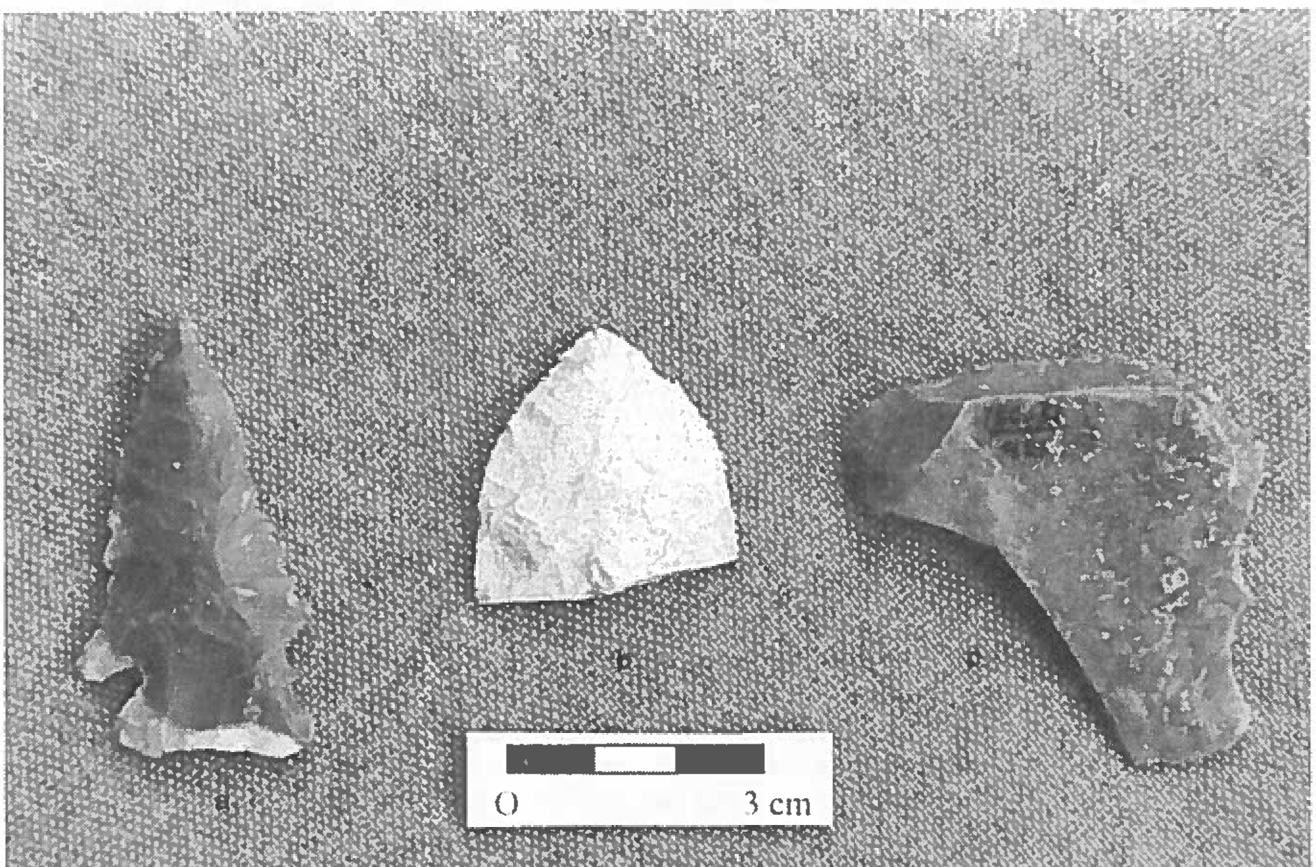


Figure 8. Modified Implements from 15Cu31 That Exhibited Use-Wear. Kirk Corner Notched Hafted Biface (A); Late Stage Biface (B); Unifacially Retouched Flake (C).

indicative of manufacturing related damage. This consists of edge grinding in conjunction with platform preparation. While three implements did exhibit use damage, it is probable that they do not represent on site activities. Their presence on site is most likely related to tool replacement activities.

DISCUSSION

Given the above data, it is of use to examine the assemblage as a whole to ascertain its place within the larger Early Archaic settlement system and general implications that the assemblage has for the lithic technology of these early hunter/gatherers.

Several conclusions can be reached concerning the differential use of chert sources and Early Archaic lithic technology in general. FFP chert appears to have been the focus of raw material procurement at 15Cu31. Nodules of FFP chert were procured from sources in close proximity, and possibly adjacent to the site area. While some nodules were brought to the site for core reduction activities, the majority of reduction was related to biface production. The latter were probably only minimally reduced prior to being brought on site. HQFP chert represented in the assemblage is most likely the result of the maintenance of finished or nearly finished tool forms. This raw material was likely procured from sources to the south of the project area. LQFP chert appears to have been used for some minor amounts of biface production in addition to core reduction.

The lithic data can be used to examine assemblage formation and site type. Magne (1985, 1989) has shown that the ratio of flake debris to tools when plotted against the percentage of late stage flake debris can be used to infer assemblage formation. Magne (1989:Figure 1) presents a heuristic devise that is useful for examining such processes. For the Kirk component, the ratio of flake debris to modified implements (57.2:1) and the percentage of late stage debris (33.9%) would put 15Cu31 in the range of tool blank manufacture with a high export rate. This conclusion is consistent with the results of the flake debris analysis.

The low diversity of modified implement classes present, the lack of formal features, almost complete lack of thermal shatter and charcoal, and the small size of the assemblage argue for a short term use of the site for a specialized purpose. Based on the tool classes represented and the amount of flake debris, the procurement of tool stone was the main activity taking place. Elsewhere (Bradbury 1998:280-283), the author estimated that between 16 and 21 bifaces were manufactured and transported from 15Cu31. Such an assemblage could have easily been created by a few knappers in a single afternoon. The site is a good example of what Binford (1980) refers to as a location. The procurement of tool stone was likely embedded (Binford 1979) within other subsistence related activities. Other researchers (e.g., Anderson 1996; Sassaman 1994) have also suggested that in raw material rich areas, such as the area surrounding 15Cu31, the procurement of raw material was embedded.

SUMMARY AND CONCLUSIONS

Analyses of materials associated with the Kirk component at 15Cu31 indicate the site represents a location where the manufacture of bifaces took place. Three different methods of flake debris analysis were used and all indicate that tool production activities dominate the chipped stone tool assemblage. Lithic reduction activities at the site appear to be focused on the production of middle to late stage bifaces of FFP. These analyses indicate that raw material likely entered the site in a partially roughed out form and left the site as more completed bifaces. In addition, it is suggested that biface production was a staged process. Initial reduction would have taken place at the source. On site activities consisted of further reducing these rough bifaces. Finally, these bifaces were transported elsewhere for further reduction/use. The procurement of raw material was likely embedded in other subsistence related activities.

Sites such as 15Cu31 are important for understanding many aspects of hunter/gatherer lifeways. The small size and fine grain nature (i.e., limited number of material classes) of such assemblages allow for a more detailed examination of a small portion of the total settlement-subsistence system and, in the case of 15Cu31, a closer look at one aspect of Early Archaic lithic technology (also see Creasman et al. 2000 for a more in depth discussion). While only a few questions were addressed in this paper, the assemblage has the potential to answer a number of other pertinent questions concerning Early Archaic lithic technology.

The identification of similar sites based on survey level data can be problematical. The small size and the low density of artifacts makes the archaeological visibility of these sites rather low. It is estimated that the total area encompassed by the main knapping area for the Kirk component covers less than 20 square meters. Differences in artifact density varied considerably between excavation units. For example, in the densest portion of the site, 262 flakes were recovered from the Kirk component in Unit 17. Three meters to the east and one meter to the south, in Unit 6, only 59 flakes were recovered from these same levels. In Unit 16, which is one meter to the north and west of Unit 17, 107 flakes were recovered from the Kirk component. Unit 10 was one meter to the south of Unit 17, but yielded only 185 flakes from the Kirk component. While only a few meters apart, the density of artifacts is considerably different. Unit 17 has 4.4 times the density of Unit 6, 2.4 times the density of Unit 16 and 1.4 times the density of Unit 10. Such a distribution is expected for cases where only a few people were involved in the knapping activities.

At the survey level, it would be easy to miss the densest portion of the site using normal field procedures (i.e., shovel tests on a 20 meter grid). Unless one were to place a shovel test in the densest area of the site, it would be easy to dismiss such sites at the Phase I level, based on the low artifact count, low diversity of artifact classes, and lack of features, as nothing more than sparse lithic scatters that are not significant. It is precisely these aspects that make this site significant (also see Creasman et al. 2000; Jefferies 1990:220 for similar arguments). The fine-grained nature of the assemblage indicates that we are not dealing with a mixed assemblage of multiple occupations, but that of both a limited nature and occupation span. In the case of 15Cu31, this occupation span was probably limited to a single afternoon. As has been demonstrated here, such sites have the potential to add to our understanding of the prehistory of an area.

The majority of the archaeological record is comprised of low-density sites that represent locations or limited-activity field camps. Those sites that are associated with lithic reduction activities have a higher archaeological visibility than many other types of locations or field camps. Rather than dismiss low density sites as merely lithic scatters, questions should be asked such as "what is the nature and context of this deposit and why does it exhibit a low density and diversity of artifacts?" It is recommended that any site exhibiting sub-plowzone artifacts be considered potentially eligible for inclusion on the National Register. At the very least, Phase II testing should be employed to further evaluate such sites by exposing a larger area and to obtain a larger sample of artifacts for analysis. Such testing programs should include a geomorphic assessment of the nature of the archaeological deposits.

ACKNOWLEDGEMENTS

This research was conducted on behalf of the Kentucky Transportation Cabinet as part of archaeological investigations conducted in conjunction with the relocation of State Route 61, Adair, Cumberland and Metcalfe counties, Kentucky (Item Numbers: 8-158.01, 8-158.02, 8-158.03). Steve Creasman and Chuck Niquette provided a number of useful comments on a draft of this paper in addition to guidance and suggestions during the excavation and analysis phases of the project.

REFERENCES CITED

Ahler, Stanley A.

1989a Experimental Knapping With KRF and Midcontinent Cherts: Overview and Applications. In *Experiments in Lithic Technology*, edited by Daniel S. Amick and Raymond P. Mauldin, pp. 67-88. BAR International Series 528. A. R. Hands, and D. R. Walker, general editors. British Archaeological Reports, Oxford.

1989b Mass Analysis of Flaking Debris: Studying the Forest Rather Than the Trees. In *Alternative Approaches to Lithic Analysis*, edited by Donald O. Henry and George H. Odell, pp. 85-118. Archeological Papers No. 1. American Anthropological Association.

Ahler, Stanley A. and Robert C. Christensen

1983 A Pilot Study of Knife River Flint Procurement and Reduction at Site 32DU508, a Quarry and Workshop Location in Dunn County, North Dakota. Department of Anthropology and Archeology, University of North Dakota, Grand Forks. Submitted to State Historical Society of North Dakota, Bismarck, Contract No. YA553-CT1-1089.

Anderson, David G.

1996 Models of Paleoindian and Early Archaic Settlement in the Lower Southeast. In *The Paleoindian and Early Archaic Southeast*, edited by David G. Anderson and Kenneth E. Sassaman, pp. 29-57. The University of Alabama Press, Tuscaloosa.

Beck, Charlotte and George T. Jones

1990 Toolstone Selection and Lithic Technology in Early Great Basin Prehistory. *Journal of Field Archaeology* 17:283-299.

Binford, Lewis R.

1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 35:255-272.

1980 Willow Smoke and Dog's Tail: Hunter-Gatherer Settlement Systems and Archaeological Site Formations. *American Antiquity* 45:4-20.

1987 Researching Ambiguity: Frames of Reference and Site Structure. In *Method and Theory For Area Research, An Ethnoarchaeological Approach*, edited by Susan Kent, pp. 449-512. Columbia University Press, New York.

Blalock, Hubert M., Jr.
1972 *Social Statistics*. Second Edition. McGraw-Hill, New York.

Bradbury, Andrew P.
1995 A National Register Evaluation of Twelve Sites in Adair, Cumberland and Metcalfe Counties, Kentucky. Edited by Myra A. Hughes. Contract Publication Series 95-69. Cultural Resource Analysts, Lexington, Kentucky.

1998 The Examination of Lithic Artifacts From An Early Archaic Assemblage: Strengthening Inferences Through Multiple Lines of Evidence. *Midcontinental Journal of Archaeology* 23(2):263-288.

Bradbury, Andrew P. and Grant L. Day
1998 *Phase III Archaeological Investigations at 15Cu27 and 15Cu31, Cumberland County, Kentucky*. Contract Publication Series 98-43. Cultural Resource Analysts, Inc., Lexington, Kentucky.

Bradbury, Andrew P. and Philip J. Carr
1995 Flake Typologies and Alternative Approaches: An Experimental Assessment. *Lithic Technology* 20(2):100-115.

1999 Examining Stage and Continuum Models of Flake Debris Analysis: An Experimental Approach. *Journal of Archaeological Science* 26 (1):105-116.

Creasman, Steven D.
1993 An Archeological Survey of the Proposed Realignment of Kentucky Highway 61, Burkesville-Columbia, in Adair, Cumberland and Metcalfe Counties, Kentucky. Contract Publication Series 93-15. Cultural Resource Analysts, Lexington, Kentucky.

Creasman, Steven D., Andrew P. Bradbury, and Jonathan P. Kerr
2000 The Archaeological Potential of Small Sites. In *Current Archaeological Research in Kentucky: Volume Six*, edited by David Pollack and Kristen J. Gremillion, pp. 25-45. Kentucky Heritage Council, Frankfort.

Foss, John E. and Michael E. Collins.
1987 Future Users of Soil Genesis and Morphology in Allied Sciences. In *Future Developments in Soil Science Research,*. edited by L. L. Boresma et al., pp. 293-299. Soil Science Society of America, Madison, Wisconsin.

Ingbar, Eric E., Mary Lou Larson, and Bruce A. Bradley
1989 A Nontypological Approach to Debitage Analysis. In *Experiments in Lithic Technology*, edited by Daniel S. Amick, and Raymond P. Mauldin, pp. 117-136. BAR International Series 528. A. R. Hands, and D. R. Walker, general editors. British Archaeological Reports, Oxford.

Jefferies, Richard W.

1990 Archaic Period. In *The Archaeology of Kentucky: Past Accomplishments and Future Directions*, Volume 1, edited by David Pollack, pp. 143-246. State Historic Preservation Comprehensive Plan Report No. 1. Kentucky Heritage Council, Frankfort.

Keeley, Lawrence H.

1980 *Experimental Determination of Stone Tool Uses: A Microwear Analysis*. University of Chicago Press, Chicago.

Magne, Martin P. R.

1985 *Lithics and Livelihood: Stone Tool Technologies of Central and Southern Interior British Columbia*. Mercury Series Paper No. 133. Archaeological Survey of Canada, National Museum of Man, Ottawa, Ontario.

1989 Lithic Reduction Stages and Assemblage Formation Processes. In *Experiments in Lithic Technology* edited by Daniel S. Amick and Raymond P. Mauldin, pp. 15-31. BAR International Series 528, A. R. Hands, and D. R. Walker, general editors. British Archaeological Reports, Oxford.

Magne, Martin P. R. and David Pokotylo

1981 A Pilot Study in Bifacial Lithic Reduction Sequences. *Lithic Technology* 10 (2-3):34-47.

McGrain, Preston and James C. Currens

1978 *Topography of Kentucky*. Kentucky Geological Survey, Series X, Special Publication 25. University of Kentucky, Lexington.

Morris, Michael W.

1998 Geomorphological Assessment of Archaeological Sites 15Cu27 And 15Cu31. In *Phase III Archaeological Investigations at 15Cu27 and 15Cu31, Cumberland County, Kentucky*, by Andrew P. Bradbury and Grant L. Day. Contract Publication Series 98-43. Cultural Resource Analysts, Inc., Lexington, Kentucky.

Morrow, Toby A.

1997 A Chip off the Old Block: Alternative Approaches to Debitage Analysis. *Lithic Technology* 22 (1):51-69.

Odell, George H.

1977 *The Application of Micro-wear Analysis to the Lithic Component of an Entire Prehistoric Settlement: Methods, Problems, and Functional Reconstructions*. Unpublished Ph.D. dissertation, Department of Anthropology, Harvard University, Cambridge, Massachusetts.

1996 *Stone Tools and Mobility in the Illinois Valley: From Hunter-Gatherer Camps to Agricultural Villages*. International Monographs in Prehistory, Archaeological Series 10.

Odell, George H. and Frieda Odell-Verreecken
1980 Verifying the Reliability of Lithic User-Wear Assessments by 'Blind Tests': The Low-Power Approach. *Journal of Field Archaeology* 7:87-120.

Ott, Lyman
1988 *An Introduction to Statistical Methods and Data Analysis*. PWS, Boston.

Sassaman, Kenneth E.
1994 Changing Strategies of Biface Production in the South Carolina Coastal Plain. In *The Organization of North American Prehistoric Chipped Stone Tool Technologies*, edited by P. J. Carr, pp. 99-117. International Monographs in Prehistory, Archaeological Series 7.

Shott, Michael J.
1994 Size and Form in the Analysis of Flake Debris: Review and Recent Approaches. *Journal of Archaeological Method and Theory* 1:69-110.

1996 Stage Versus Continuum in the Debris Assemblage from Production of a Fluted Biface. *Lithic Technology* 21: 6-22.

Taylor, Alfred R.
1964 *Geology of the Breeding Quadrangle Kentucky*. Department of the Interior, United States Geological Survey. Washington, D. C.

Tringham, Ruth, Gary Cooper, George Odell, Barbara Voytek, and Anne Whitman
1974 Experimentation in the Formation of Edge Damage: A New Approach to Lithic Analysis. *Journal of Field Archaeology* 1:171-196.

INTER-AGENCY PUBLIC ARCHAEOLOGY: ARCHAEOLOGICAL TESTING AT THE WET LEDGE ROCKSHELTER (15McY847), MCCREARY COUNTY, KENTUCKY

By

Tom Des Jean
Big South Fork National River and Recreation Area,
National Park Service
Oneida, Tennessee

ABSTRACT

Archaeologists with the National Park Service at Big South Fork National River and Recreation Area and the United States Department of Agriculture's Daniel Boone National Forest undertook an archaeological testing project at the Wet Ledge Rockshelter (15McY847) during the summer of 1996. The goals of this project were to: 1) identify relationships between 15McY847 and other rockshelters and large, open, ridgetop sites in the area; 2) to determine whether a severely looted rockshelter retained worthwhile archaeological information, and 3) do this as a Public Archaeology project using local teacher volunteers. The results of the project were all positive; information related to other sites was obtained; the looted site did retain prehistoric information, and all of the fieldwork was done by volunteers.

INTRODUCTION

The National Park Service archaeologist (Des Jean) at Big South Fork National River and Recreation Area (BISO) together with U.S. National Forest Service (NFS) archaeologists at Daniel Boone National Forest began discussing the possibility of a joint archaeological testing project in January of 1996. The initial proposal was to conduct test excavations at a rockshelter within the boundary of the BISO Recreation Area that is adjacent to a very large and dense upland lithic scatter (Figure 1). The discussion also recommended incorporating this project into current NPS/USFS programs oriented toward public archaeological education.

As the year progressed the Wet Ledge Rockshelter, RS188, was selected since it is located near a cluster of three large concentrations of flint which make up the large, upland, Watts Mountain site. The three dense scatters of flint forming this adjacent, upland site are located in the National Forest near the intersection of Chestnut Ridge and Divide Roads. The flint cluster nearest to the Wet Ledge rockshelter extends across the Divide Road onto NPS administered lands. This scatter also had been identified independently as BISO-169 by NPS during archaeological surveys of the area conducted in the late 1970s (Wilson and Finch 1980). The Watts Mountain Site (McY 522) was discovered during a U.S.F.S. logging operation. Several diagnostic tools were recovered here and at RS188, the Wet Ledge Rockshelter, which was found and collected at the same time.

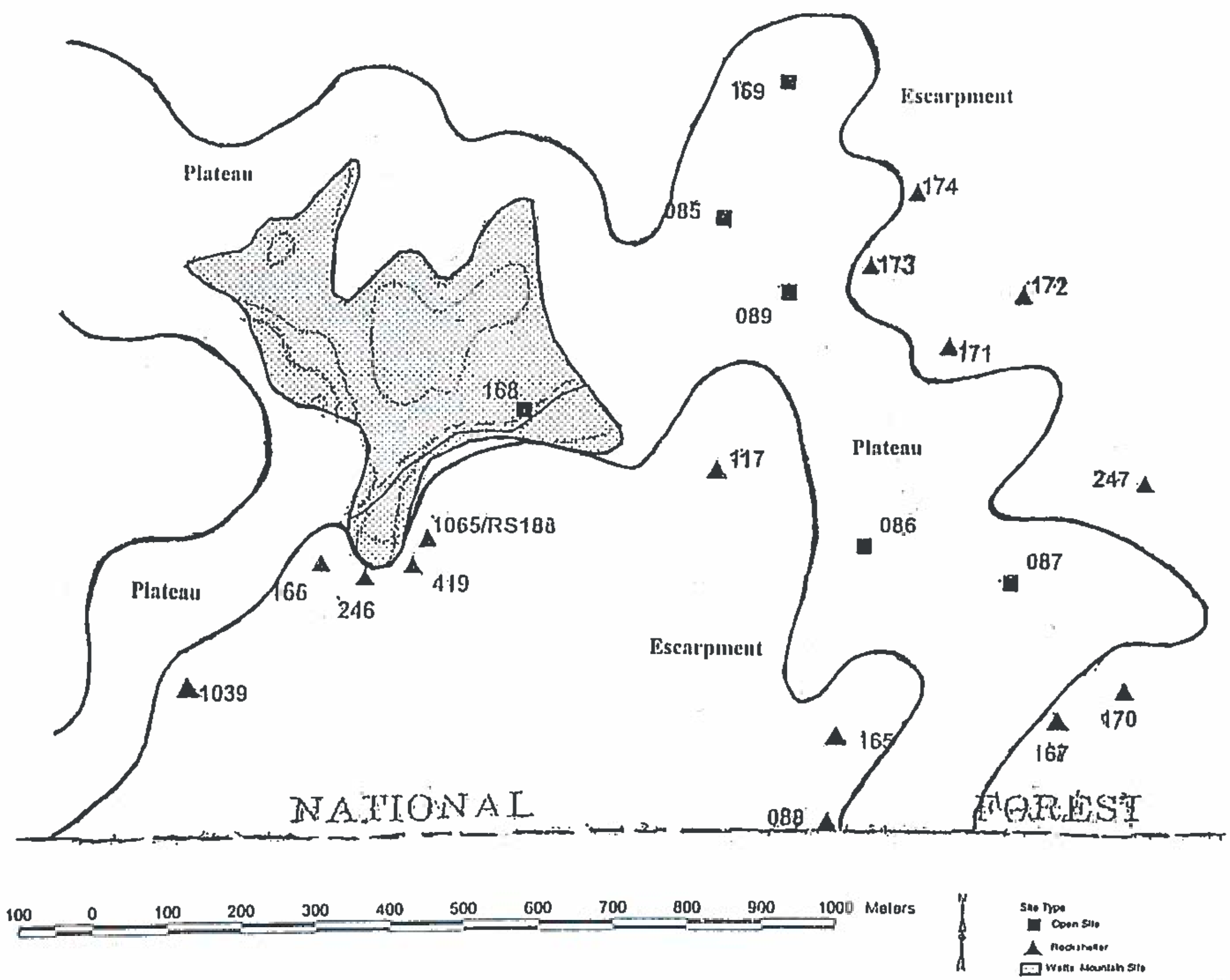


Figure 1. Stylized Map of the Watts Mountain/Hunting Camp Hollow area and sites.

The Wet Ledge Rockshelter testing project was intended to investigate the rockshelter and its associated "berm" area in order to define its archaeological relationship to the adjacent, upland, Watts Mountain lithic scatter and to other resources in the vicinity. Additionally, the testing would reveal whether this looted rockshelter retained any archaeological integrity (i.e. intact, subsurface deposits).

The project was conducted as a part of the NPS Summer Public Archaeology Program (SPAP) and the USDA, Forest Service's Public Archaeology Program. Because of time constraints and the need to complete the project during the 1996 fiscal year, local area teachers were invited to participate with the NPS and NFS archaeologists in excavating the site for one week. The largest crew excavating on site at any one time was seven people, three archaeologists and four volunteers. Usually, there were only five people participating on any given day. The Wet Ledge Rockshelter was excavated for nine days expending a total of 152 volunteer hours on this project. A trench 7 x 1m (50 cm deep) was excavated and a smaller 1 x 2 m (76 cm deep) test excavation (or sondage) was also excavated and screened inside of the rockshelter. This amounts to approximately 4.5 m^3 of soil moved and screened for artifacts and moved again to back-fill the excavations. Two other unscreened sondages were dug in the rockshelter but no cultural materials were recovered in these that would warrant spending any further excavation time.

GEOGRAPHICAL SETTING

The Big South Fork National River and Recreation Area and the Stearns District of the Daniel Boone National Forest are located on the northern extension of the Upper Cumberland Plateau. This geologic escarpment is composed of Pennsylvanian era sandstones, and conglomerates interspersed with seams of coal and shale. These formations are underlain by Mississippian era limestones including members of the Monteagle Formation like St. Genevieve limestone, which possess large nodular chert deposits. Outcrops of this formation were utilized prehistorically as lithic resource sites.

The Pennsylvanian and Mississippian formations of the Upper Cumberland Plateau weather differentially producing deep gorges surrounded by ridge and valley topography. It is this differential susceptibility to erosion that has produced many thousands of natural overhangs throughout the area, many of which were occupied prehistorically. The location of the Wet Ledge Rockshelter is at the head of a first order upland stream, a tributary to Alder Branch of Black House Creek. The occurrence of a rockshelter in this area is typical of the Upland Hollow topographic setting. In fact, this rockshelter is located in a rather large hollow about 500 m in diameter called "Hunting Camp Hollow".

FLORA AND FAUNA

According to several earlier researchers (Ferguson et al. 1986:19-22; Prentice 1993:8-10; Wilson and Finch 1980:37-39) the Upper Cumberland Plateau is characterized by several different physiographic regions or zones. However, Prentice (1993) divided this environmental setting into seven basic Topographic Provinces: Floodplain, a River Birch Terrace Forest Zone; Terrace, a Tulip Poplar-Sweetgum Forest Zone; Lower Gorge Slopes, a White Oak-Chinquapin Oak Forest Zone; Upper Gorge, a White Oak-Hemlock-chestnut Forest Zone; Bluffline, a Cedar-Pine Forest Zone; Upland Ridges, a Virginia Pine Forest Zone; and Upland Hollows, a Mixed White Oak Forest Zone. This division is more comprehensive and descriptive of the Big South Fork region and the Wet Ledge Rockshelter area in particular. The Upland Hollows Zone certainly describes the environmental-topographic setting at the Wet Ledge Rockshelter in Hunting Camp Hollow. This upland hollow is forested with mixed white oak, dogwood, and maple canopy and very little understory. About 20 m east, southeast of the Wet Ledge Rockshelter is a first order stream that supports many wet zone plant species. One notable plant that occurs with some abundance here is grass of Parnassus (*Parnassia asarifolia*). This plant is not endangered, but it is rare and seeing so much of it in bloom is exceptional.

The flora of a topographic zone determines to a large extent, what fauna will occur in an area. At the Wet Ledge Rockshelter, located in the Upland Hollow-Mixed White Oak Forest Zone, species included: deer, feral hog, gray squirrel, and raccoon. Other species of fauna included: turkey, fox, oppossum, snakes, tortoise, and skunk. Two recent arrivals, coyote (naturally expanding its range) and black bear (12 have been experimentally released) are also known to be in the area.

Many other faunal species are present in the Upland Hollow setting including many associated with micro-climates that allow smaller animals to thrive. One such micro-climate occurs along the dripline of rockshelters. Here several endangered species of plants and the green tailed salamander are known to occur.

PREVIOUS ARCHAEOLOGY

Hunting Camp Hollow, where site RS188, the Wet Ledge Rockshelter, is located, contains several prehistorically-occupied rockshelter sites and adjacent open upland sites. The occurrence of all of these sites, several which were occupied at approximately the same time, indicates continuity of occupation throughout the Archaic and Woodland periods. Unfortunately, all of the rockshelter sites have been severely looted, and the upland, ridgetop sites have been impacted by more then 120 years of historic wagon and motorized vehicle traffic. The latter impacts have been quite severe following the introduction of four-wheel drive "jeep" type vehicles since the late 1940s.

There are three other rockshelter sites in the Hunting Camp Hollow: Spike Rockshelter (15McY 869), ARPA Gap/Wet Sandy Rockshelter (15McY 386), and the Overhead Rockshelter (RS189). The Spike Rockshelter was the center of a significant Archaeological Resources Protection Act violation case in 1988. All of the rockshelters in Hunting Camp Hollow have been severely looted. Additionally, southwest of this site is another large hollow containing a small, looted rockshelter, the Overknoll Site, and the severely looted Bobwire Rockshelter (15McY847).

Adjacent to Hunting Camp Hollow are two open, upland sites, the Intersection open site (15McY381) and the Watts Mountain Site (15McY522). The latter site is that part of the Watts Mountain Site that was identified by the NPS as occurring across (south of) the Divide Road and extending over into Big South Fork. The Chestnut Ridge Intersection open site probably does as well.

FIELDWORK

Prior to the fieldwork it was decided that all excavations were to be hand dug and all soil passed through 6.4 mm mesh screen. Excavations were to be excavated in 10 cm arbitrary levels in the first test unit and all subsequent test units were to be dug in 10 cm levels within identified natural zones. Test units would be excavated to a depth that was culturally sterile or until pedologic evidence or field judgment indicated that no substantial benefit could be gained from continuing. Sondages (un-sifted excavations) were planned to be dug in the Wet Ledge Rockshelter with the hope of locating undisturbed soil strata. When or if the sondages encountered intact strata, then measurements and screening of excavated soil would begin. Any features that were found would be excavated separately and the soil removed to the lab for fine screening. A volumetric determination of large amounts of feature fill other then soil, for example burned sandstone, was estimated by filling a 5-gallon bucket and discarding the material on site.

The first task at the Wet Ledge Rockshelter was to select areas for excavations and to establish a primary datum. Test units were placed within a large flat area just beyond the berm or "dripline" of the rockshelter. It was assumed that this open flat area was potentially undisturbed. Also it may have been a place where prehistoric peoples performed various tasks that would leave a lot of material evidence over time. A Transit Station (TS) was established 2 m south of a large red oak tree directly in front (east) of the south side of the Wet Ledge Rockshelter. Next excavation units were laid out on the flat level area beginning 4.00 m and 130° from the transit station (Figure 2).

RESULTS OF EXCAVATIONS

The Summer Public Archaeology Program began on Monday August 5th, 1996 with two archaeologists and one volunteer. Heat and bugs were a constant annoyance, but the work progressed. The next step was to map the site. As this was done, the single volunteer performed a surface collection of the site. As the Summer Public Archaeology Project progressed, a continuing coterie of volunteers allowed the excavations to expand and all of the goals of the SPAP were met.

SONDAGE TESTING

One of the methods used to locate intact strata at site was to dig unscreened sondages or shovel test holes at likely looking locations through looter backdirt piles. Three of these unscreened tests were dug, and the dirt and materials from them were sorted. Many looter discards or "culls" were recovered but since they were found out-of-context they were treated as General Surface Collection materials. Sondage 3 was excavated to a depth of 42 cm below surface where an intact stratum of dark brown, silty sand midden soil was encountered. At this level the relatively rounded 40 x 40 cm shovel test was expanded to become Test Unit 5, a 1 x 2 m screened test unit.

SONDAGE 1. This unscreened test was approximately 50 x 50 cm and excavated just west of Test Unit 4, the last test in the long 7 m x 1 m trench. A lot of material and artifacts were found throughout this test, which was finally terminated after digging well into undisturbed subsoil. The artifacts recovered were all found in the looter's backdirt and include: One Big Sandy I base, two scrapers, one piece of rusted metal can, 194 flint flakes, two Projectile Point/Knife fragments, one hafted scraper, one ovate scraper, two bifaces (one possible Adena Stemmed point), ten chalcedony flakes, and one piece of daub.

SONDAGE 2. This excavation was located approximately midway between Sondage 1 and Sondage 3. It measured about 50 x 50 cm at the base of a looter's pit. No significant materials were found. It was excavated into sterile, undisturbed rockshelter soil.

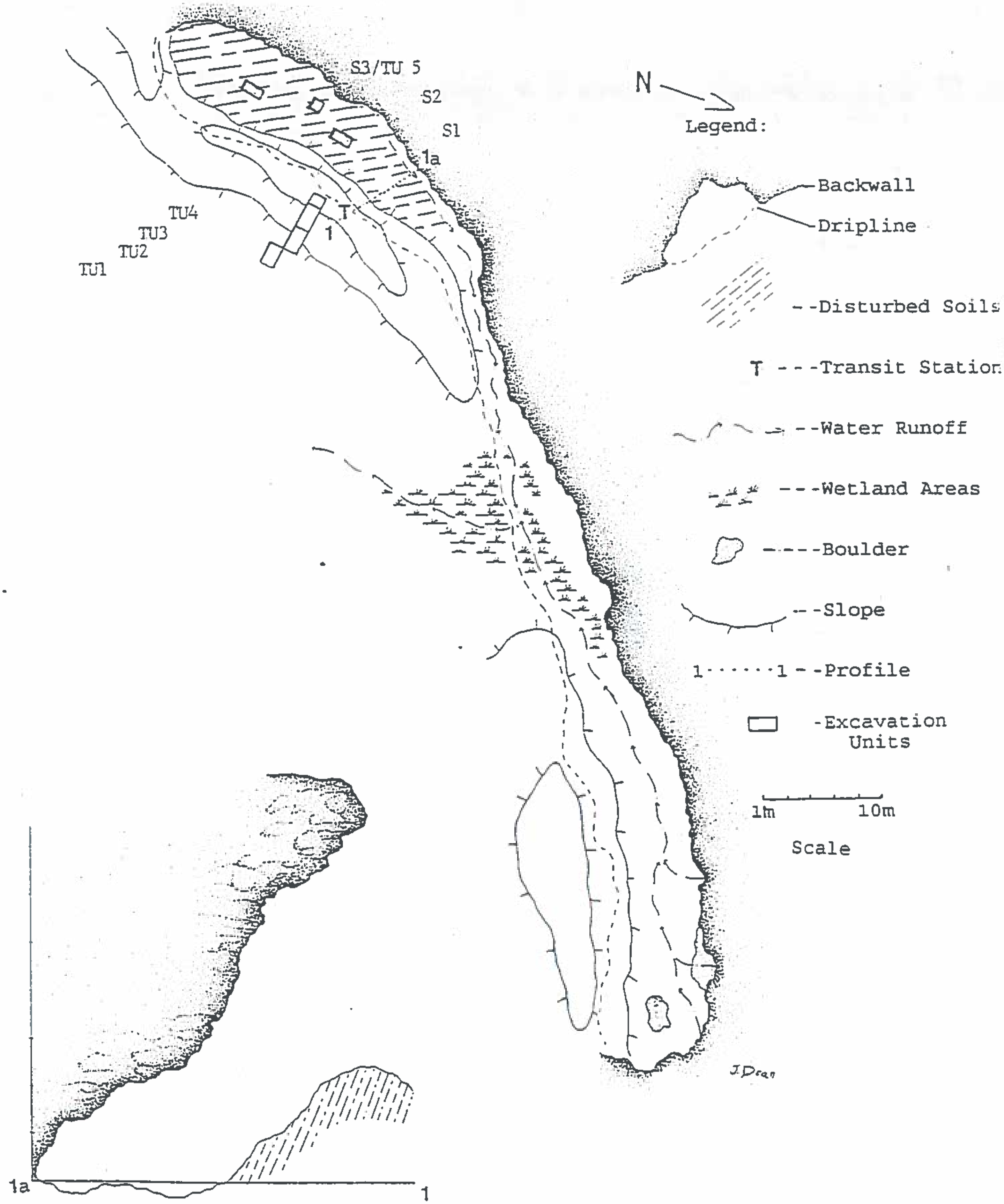


Figure 2. Plan Map (top) and Profile (bottom left) of the Wet Ledge Rockshelter.

SONDAGE 3. This test measured 50 x 50 cm and was excavated south of Sondage 2 and Test Unit (trench). Disturbed soils were encountered to a depth of 42 cmbs where intact zones of prehistoric midden began to appear. The upper 42 cm (looter's backdirt) contained numerous artifacts, which are discussed below. At 42 cm, the unit was terminated and Test Unit 5 was created and mapped in its place.

TEST UNIT 1. The northwest corner of Test Unit 1 was located at 7 m east and 3 m south of the transit station on the open flat area in the front of the rockshelter. No concentrations of materials or features were found. Along the east wall of Level 3, an Adena stemmed projectile point was found. Unfortunately, the base of this artifact was sliced off and was not recovered. Excavation in the unit continued to a depth of about 50 cm. Since only one very small flake of flint was found at this level, excavations were terminated. No other diagnostic materials were contained in this unit. The lack of cultural features at what was suspected to be a promising area convinced us to try a more northerly placement of our tests. However, we still wanted to produce a large, at least 50 cm x 7 m profile of the "flat area", so we continued excavations in a westerly direction while maintaining a common profile line with Test Unit 1.

TEST UNIT 2. After the disappointing results of excavating Test Unit 1, the next unit was offset 1 m north of the northeast corner of Test Unit 1, and extended in a westerly direction between two small oak trees on the berm of the rockshelter. This test unit was excavated to approximately 50 cmbs, at which depth flint debitage disappeared. One feature (Feature 1) was found in this unit at 4 cm below surface. Burned wood fragments as well as charcoal confirmed that Feature 1 was not very old and indicates that it was most probably a burned tree. Level 4 in Zone "C" produced 39 flakes of flint. However, by the bottom of Level 5, only twelve pieces of very small retouch debitage were recovered. Excavations in this unit were terminated after Level 5.

TEST UNIT 3. This test was located as the excavation plan dictated, west and in line with TU-2. Beginning at about 5 cmbs burned sandstone and flint were encountered. The burned sandstone appeared much more densely concentrated in the south center of this 1 x 2 m test unit and at the base of Level 1 (defined and treated as Feature 2). The feature bottomed out in Level 3. Excavations continued for three more levels. At the base of Level 6 in the damp tan sand zone (designated Zone C) and the damp tan sand and orange lined percolation zone (designated Zone D) the excavations halted. It is curious to note that while only one flint flake was found in Level 4, the subsequent two levels in Zone C produced 18 and 36 flakes respectively. Despite this increase in artifact density, time was waning and excavations were terminated at the base of Level 6. This decision was prompted by the absence of flint at the zone C/D interface and limited time.

TEST UNIT 4. The final unit in the east-west trench was Test Unit 4. This test was directly between two moderately sized oak trees and right at the dripline of the rockshelter. Although this test unit held great promise, excavations to 1 m in depth produced no appreciable increase in the amount of artifacts recovered and no features were found. Excavations were terminated at 50 cmbs, the base of Level 5, when chert became small and infrequent.

TEST UNIT 5. Excavations inside the overhang of the rockshelter produced the most diverse and dense concentrations of artifacts recovered during the SPAP project. This was especially true of Test Unit 5. This excavation began as Sondage 3 but at about 40 cm an intact prehistoric occupation stratum was found and the shovel test was expanded to become Test Unit 5. The prehistoric occupation stratum covered only the southwest corner and along the eastern wall of the unit. Eventually, however, the eastern one half and the southern quarter of this unit were found to contain intact deposits as well. Three 10 cm levels of this remaining intact midden soil were excavated from 42 cmbs down to approximately 62 cmbs. Stemmed and notched bifaces and various stone tools were discovered in the remnants of this stratum. Fragments of charcoal collected throughout Level 1 in Test Unit 5 were eventually split into two C-14 samples and submitted for long-count radiocarbon assays. Both samples were very small but one sample was composed of mixed wood charcoal and the other was composed of burned hickory hull charcoal. The former sample (Beta 96791) produced a date of 5100 B.P. ±70 and the latter (Beta 96792) a date of 5210 B.P. ±130. This stratum also produced many flint tools and debitage and some bone fragments. Diagnostic, and chronologically sensitive tools from the levels in this undisturbed midden include a Stanley Stemmed point (Figure 3), dating 8,000-7,000 B.P. (Justice 1987:97-99) and two Table Rock Cluster type points that resemble Bottleneck-Stemmed points (Figure 3a), dating 5770-5000 B.P. (Justice 1987:124-126). The projectile point characteristics of these artifacts overlap the type descriptions for many Late Archaic Notched Tradition type points (Des Jean and Benthall 1994) like the Merom-Matanzas-Lamoka types (Justice 1987:119-122,130-132), the Swan Lake (Cambron and Hulse 1975:120; also see Lithic Type 82 point, Faulkner and McCollough 1973:110), the Troublesome point (Prentice 1992:40), and other varieties. As Justice (1987) notes, Middle Archaic period Matanzas points are probably ancestral to a continuum of notched varieties.

Prehistoric pottery also was recovered from Test Unit 5, as was a small piece of limestone tempered plain pottery. This potsherd probably dates to the Early Woodland period, but because it was found in the surface level of the "intact" prehistoric midden stratum, it is obviously an intermixed artifact. The radiometric age determinations and the point types that were associated with it date considerably earlier.

There were numerous diagnostic artifacts recovered from the mixed levels excavated in Test Unit 5. These artifacts consist of lithics, ceramics, and bone. The artifacts discarded by looters over the years in this area of the Wet Ledge Rockshelter include seven sidescrapers, six blades, one biface, and one Projectile Point/Knife. Discarded ceramic artifacts include one piece of limestone-tempered, plain pottery and one piece of sand-tempered, cordmarked pottery. A very interesting piece of burned daub with a finger impression was found within the mixed deposits of Test Unit 5 (Figure 4).

<u>FEATURE 1.</u> This small and shallow dark stain was identified as a possible feature at the bottom of Level 1 in Test Unit 2. At that point several fist-sized cobbles of burned sandstone had been removed and a large piece of charcoal was found *in situ* within the sandstone dirt matrix. Although, level one contained burned sandstone and occasional occurrences of charcoal flecks and flint throughout, Feature 1 was a pocket of all of this material in the southeast corner. Once this feature had been defined, mapped, and photographed, we began to excavate it. The charcoal flecked matrix and small chunks of burned sandstone contracted into a linear, "root-like" stain, which disappeared within 4 cm. As charcoal was removed from this feature it became clear that some of what was initially identified as charcoal included burnt wood. At that time it was decided to continue to excavate this as burned root and no longer treat it as a cultural feature.

<u>FEATURE 2.</u> This feature was located in Test Unit 3 and resembled Feature 1 in color and composition. Test Unit 3 contained the same soil and type of matrix as Test Unit 2, sporadic occurrences of burned sandstone, charcoal flecks, and flint throughout. Feature 2 was identified as a large concentration of burned sandstone at the base of Level 1 in the south central area of Test Unit 3 (Figure 5). One of the large cobbles of burned sandstone contained two possible nutting "cups" on its surface and was surrounded by many pieces of burned sandstone. Charcoal flecking

Figure 3. Artifacts Excavated from Test Unit 5 at Wet Ledge Rockshelter.

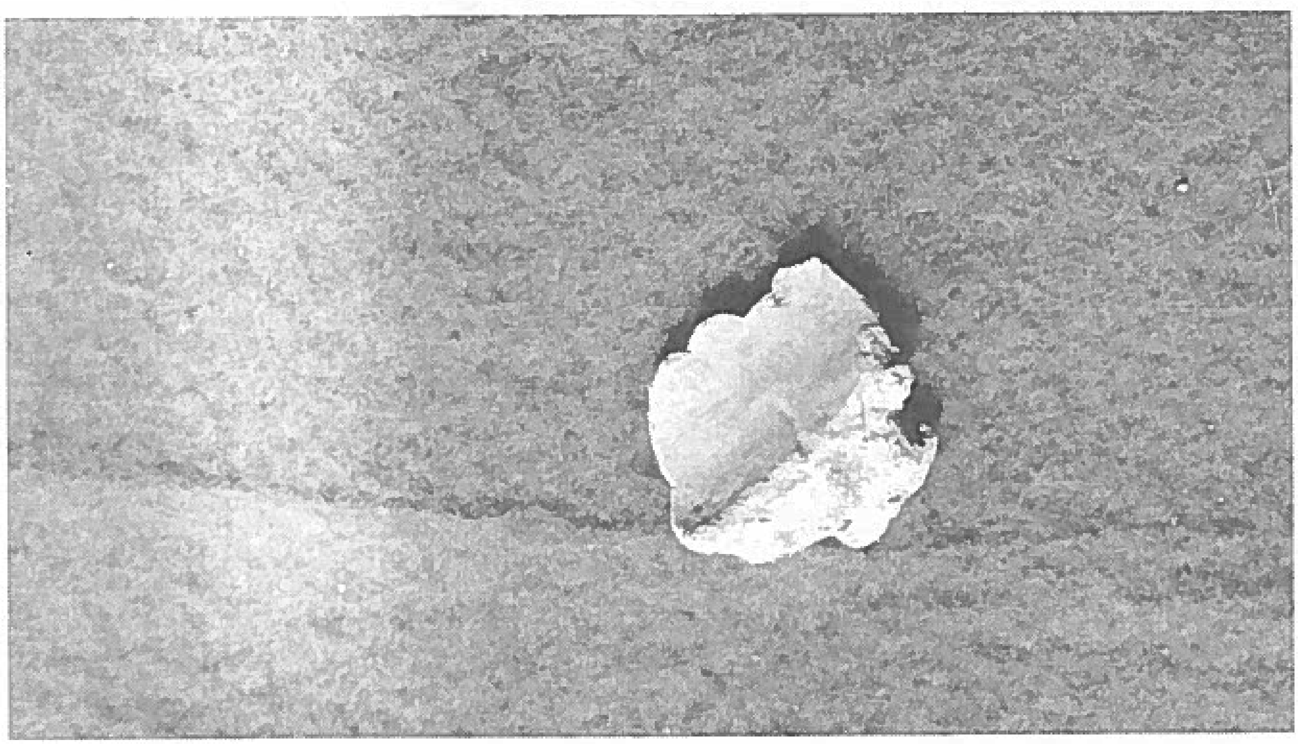


Figure 4. Finger impression in Daub fragment from Test Unit 5 at Wet Ledge Rockshelter.

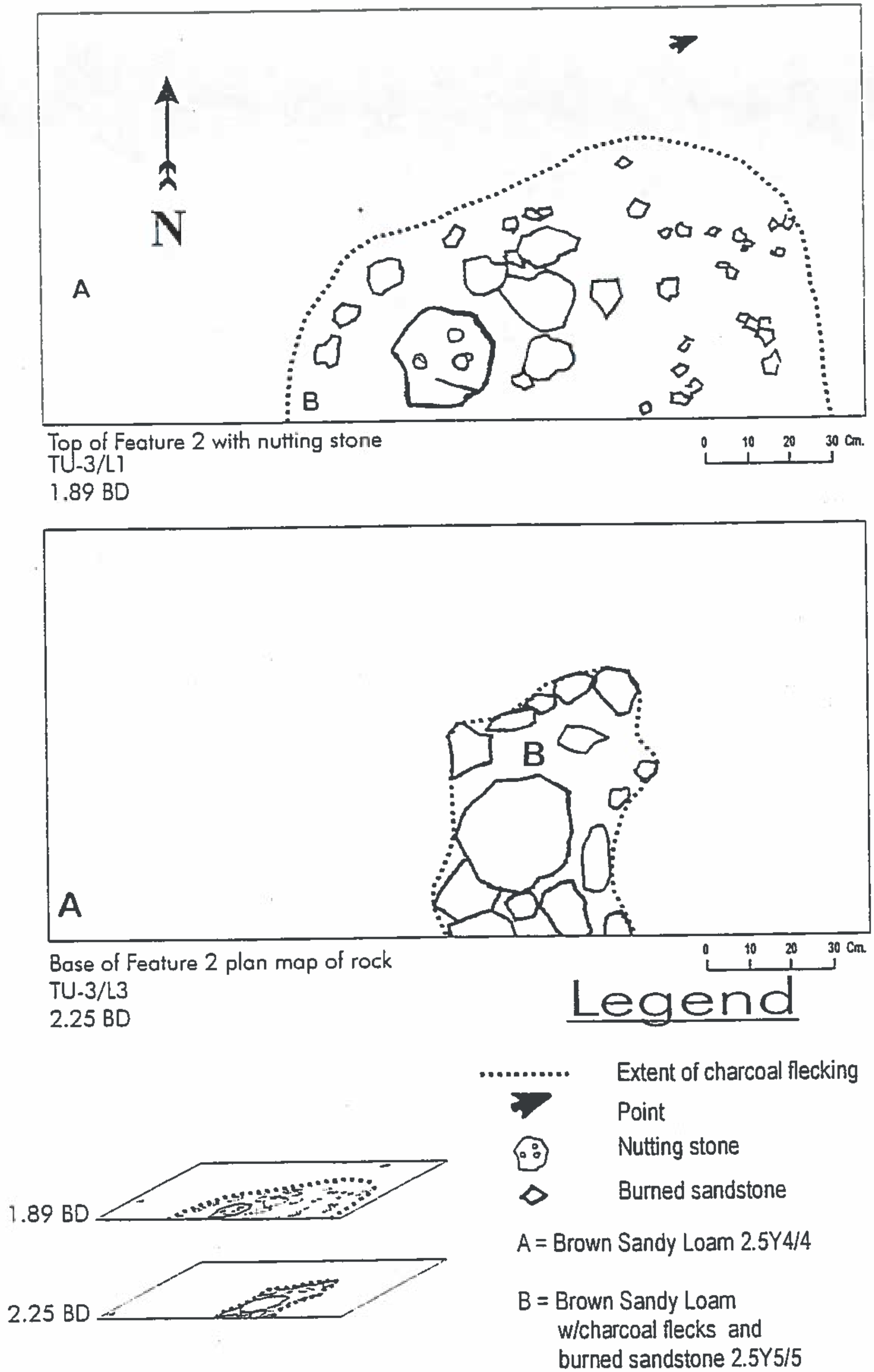


Figure 5. Planviews of Feature 2, at top and bottom, in Test Unit 3 at Wet Ledge Rockshelter.

and flint chips were more concentrated in Feature 2 than in the rest of Level 2 in Test Unit 3. A total of four pieces of chert debitage, 12 pieces of charcoal, 28 liters of soil fill, and about 18.9 liters of burned sandstone was recovered from Feature 2. It is noteworthy that none of the soils surrounding Feature 2, above it, through it, or below it, exhibited any discoloration (iron oxidation) from the fires that obviously oxidized the sandstone fragments. It may be that these burned sandstone rocks represent secondary use for nut processing after they had been removed or tossed from the Wet Ledge Rockshelter where they may have been discarded. A Late Woodland, Hamilton point, dating 1500-1000 B.P. (Justice 1987:229), found 25 cm north-northeast of Feature 2 at approximately the same depth (1.89/cm bs), is consistent with the early Late Woodland period origin attributed to this feature.

A number of small charcoal samples were collected from Feature 2 in the field and from the feature fill soil taken to the lab. Two of these samples were submitted to Beta Analytic for a radiocarbon assay. The sample collected from the topmost soils of Feature 2 (Beta # 96789) were dated to, 1380 ±50 B.P., producing a calibrated date of A.D. 660; the charcoal sample collected from soils below the burned sandstone (Beta # 96790) of Feature 2 dated to 1650 ±80 B.P., producing a calibrated date of A.D. 415. These determinations reveal that an early Late Woodland occupation is the origin for this nut-processing feature. It also may be that the dated sample collected from below Feature 2 is charcoal from earlier activities that became covered by discarded burned sandstone.

SUMMARY AND CONCLUSIONS

Generally speaking, the Upper Cumberland Plateau was a very attractive area for prehistoric Native American hunters and gatherers for many thousands of years. Even by the Late Woodland period, after the development of agriculture, when many groups had settled in the large river valleys of the Southeast, the area of Hunting Camp Hollow continued to attract transhumant prehistoric hunters who relied on its abundant natural resources. The artifacts found in the Hunting Camp Hollow area alone represent much of the entire prehistoric cultural history of the Upper Cumberland Plateau and the rest of the Southeast. The "Logistical Mobility" settlement strategy identified for the Southeast (Chapman 1985; Custer et al. 1986) also was operating in this area and is reflected in the establishment of "base camps" in rockshelters with special use camps occurring on the ridge tops. The artifacts collected from the open ridge top sites are hunting related materials found at locations where access to several drainages and spur ridges maximized hunter and gatherer subsistence. Rockshelters, on the other hand, have produced artifacts which represent numerous activities as well as hunting related artifacts identical to those types found at the special use camps. The transition from Paleoindian period culture to Archaic period culture is reflected in the occupation and settlement of the Upper Cumberland Plateau and this Logistical Mobility settlement system is evident even into the Late Woodland period.

Prehistoric settlement patterns have been a major focus on the Upper Cumberland Plateau throughout the last two decades. All of these analyses have assumed a basic transhumant hunter-gatherer, subsistence economy for the prehistoric Native American cultures here. Each bit of research has produced statistically valid models that have been tested and refined. Early work at the Big South Fork NRRA tested multivariate-patterning schemes in an attempt to identify prehistoric selection criteria for open site and rockshelter site locations. These tests produced statistically valid selection criteria for open sites: slopes of less than 10%, and for rockshelters 100 m^2 or less in a size range of about 145 m^2, proximity to water of (Ferguson et al. 1986:170-203). These settlement data were further refined by Prentice (1992:37, 1994) who proposed a settlement model with >90% reliability for open site selection at major ridge/spur ridge intersections and selection of slopes of <7%. Differences between prehistoric open sites as a result of environmental and topographic setting were expected but have not occurred. Pace and Hays (1986:33-34) and Prentice (1993) tested terrace areas which were expected to produce remains related more to aquatic resources but instead produced remains identical to those found on the open, upland sites. All of the research here produced diagnostic lithic and ceramic materials representing prehistoric settlement spanning 10,000 years.

Much of the prehistoric occupation identified for the Upper Cumberland Plateau is represented at the Watts Mountain-Hunting Camp Hollow-Bobwire Hollow Area. The recovery of Big Sandy I points from the Watts Mountain, Spike Rockshelter, and the Wet Ledge Rockshelter sites attest to the presence of Early Archaic Native American hunting activities from 10,000 to 8000 B.P. Finding an Early Archaic Kirk Corner Notched point (9500-8900 B.P.) at the Watts Mountain site also indicates that there was significant cultural diversity in this area during Early Archaic times. Stanley Stemmed points (8000-7000 B.P.) found at the Watts Mountain Site, and the Spike and Wet Ledge Rockshelters indicate a continuity of hunting and gathering activity from the Early Archaic into the Middle Archaic periods. The Tablerock Cluster type points, Bottleneck points and the Ledbetter points (5770-5000 B.P. and 4500-3000 B.P. respectively) discovered at the Wet Ledge and Spike rockshelters reflect the continued use of base camp locations in the Watts Mountain-Hunting Camp Hollow area during the Late Archaic period. Prehistoric occupation during this time is also supported by the discovery of the intact midden soils in Test Unit 5, which have been dated to 5210 B.P. and 5100 B.P.

The discovery of prehistoric ceramics and two possible Adena Stemmed points (2800-2300 B.P.) from the Wet Ledge Rockshelter illustrates again, a continuity of occupation in this area from transitional Archaic hunters and gatherers into times of more intensive, transhumant occupations by Woodland period groups. The recovery of a Madison point (1200-500 B.P.) from the Spike Rockshelter and a Hamilton point (1000-500 B.P.) from the Wet Ledge Rockshelter, together with a shell tempered sherd from Spike Rockshelter and shale/siltstone tempered sherds from both the Spike and Wet Ledge Rockshelters reveals that this area continued to attract hunting and gathering groups into the Late Woodland/Mississippian periods. The "nutting stone area" of Feature 2, which dated to A.D. 660, provides further evidence of this. The feature not only identifies a Late Woodland period occupation it also suggests that these groups were here processing nuts in the fall of the year. The A.D. 415 date recovered from the base of Feature 2 may be indicative of earlier Middle Woodland period activities.

The faunal materials recovered from throughout the excavations and the site were sparse and all were found in mixed contexts. We can, however, gather some information from this material. The primary species represented was whitetail deer (*Odocoilius virginiana.*). There were many fragments of unidentifiable calcined and plain bone fragments of large mammal. Pieces of unidentifiable calcined and plain pieces of bone from smaller mammals were also recovered. Three fragments of bird bone were recovered and one of these was turkey (*Melegarus gallipovo*). A piece of unidentifiable turtle carapace and several eastern box turtle (*Terrapene carolina*) fragments were identified in the materials collected from looter's backdirt. Two pieces of unidentifiable freshwater mussel (*Unionidae, sp.*) were recovered as was one small land snail shell (*Stylommatophor, sp.*). The mussel fragments were perhaps the most surprising species to be found since the Wet Ledge Rockshelter is about 6 km (3.5 mi) from the nearest habitat for these animals.

There were 15 pieces of burned hickory shell (*Carya, sp.*) collected from mixed contexts and eight pieces of hickory collected from intact contexts. Numerous small fragments of wood charcoal was recovered, most of it in mixed contexts but no attempt was made to identify it.

The floral and faunal materials were all reduced to very small fragments most likely as a result of trampling subsistence by-products underfoot. Once nutmeats had been removed from the hulls these were undoubtedly used for fuel and the ash discarded; after animal bone was cracked open, to extract marrow or to get pieces for manufacturing bone tools, those discards became waste as well. The animal and plant materials recovered from the excavations at the Wet Ledge Rockshelter, even though mainly from mixed contexts, support evidence developed by other researchers in the region (Ahler 1967; Cowan et al. 1981; Des Jean 1989, 1993; Ison 1997; Pace and Hays 1991; Prentice 1992, 1996), that hunter-gatherers on the Upper Cumberland Plateau were maximizing seasonal resources, targeting deer and other animals that came to feed on oak-hickory mast in the late summer through early winter. The prehistoric inhabitants were also taking advantage of the mast themselves. Recent research, though, may change the accepted views about transitional Late Archaic to Early Woodland period subsistence practices.

Recent excavations in several rockshelters in the region and in the Red River Gorge, and the Kentucky River-Station Creek areas of Kentucky, have yielded evidence of plants and early cultigens which illustrate that transitional Late Archaic period cultures were already manipulating plant foods and developing more reliable food resources (Gremillion 1993, 1996; Gremillion and Ison 1992; Fritz 1995; Ison 1997; Smith 1992). Fossil pollen data collected from a pond near Cliff Palace Rockshelter on the Daniel Boone National Forest, located on the Northern periphery of the Upper Cumberland Plateau within the Kentucky River drainage also reflects vegetation changes occurring during the Late Archaic-Early Woodland transition. These environmental changes are best explained as resulting from a transition in subsistence practices, from strictly hunting and gathering to hunting and gathering plus incipient agriculture. The data reveals a significant shift from a primarily fire intolerant forest canopy to a mixed, primarily fire tolerant forest canopy (Delcourt and Delcourt 1997). This change in plant exploitation strategies hastened the transition from nomadic or transhumant subsistence practices to semi-nomadic or even settled village life in many areas.

Although the Red River Gorge and Kentucky River-Station Camp rockshelters are found in similar topographic settings on the Upper Cumberland Plateau, and are located about 83 km north-northeast of the Big South Fork, no evidence for transitional Archaic-Early Woodland cultigens has been found at the Wet Ledge Rockshelter. Future research may produce that evidence here.

The collection of three sherds of White Granite ceramic ware (ironstone china) from the surface of the Wet Ledge Rockshelter underscores the fact that Historic period use of this site may begin as early as 1840 when these ceramic types began to be manufactured (Miller 1991:9-10). However, the continuous use of these wares into the present makes it more likely that these three artifacts are of more recent, probably post-1930s, vintage.

In conclusion, it should be evident that this Inter-Agency project was decidedly successful; relationships to upland, open sites in the Hunting Camp Hollow region were identified; intact occupation zones were identified in an otherwise "looted" rockshelter, and interested teacher volunteers got the opportunity to understand archaeology through hands-on excavations.

REFERENCES CITED

Ahler, Stanley A.

1967 The Faust Shelter (40MO8). Manuscript on file, McClung Museum, University of Tennessee, Knoxville.

Cambron, James W. and David C. Hulse

1975 *Handbook of Alabama Archaeology: Part I Point Types*, edited by David L. DeJarnette. Archaeological Research Association of Alabama.

Chapman, Jefferson

1985 Archaeology and the Archaic Period in the Ridge and Valley Province. In *Structure and Process in Southeastern Archaeology*, edited by Roy S. Dickins, Jr. and H. T. Ward, pp. 135-153. University of Alabama Press.

Cowan, C. Wesley, H. Edwin Jackson, Katherine Moore, Andrew Nikelhoff, and Tristine L. Smart

1981 The Cloudsplitter Rockshelter, Minifee County, Kentucky: A Preliminary Report. *Southeastern Archaeological Conference Bulletin No. 24:60-75.*

Custer, Jay F., Dennis C. Curry, and Joseph N. McNemara

1986 Prehistoric Settlement-Subsistence Systems in Greyson County, Virginia. *Quarterly Bulletin of the Archaeological Society of Virginia* 41:113-141.

Delcourt, Paul A. and Hazel R. Delcourt

1997 Report of Paleological Investigations, Cliff Palace Pond, Jackson County, Kentucky, in the Daniel Boone National Forest. USDA Forest Service, Daniel Boone National Forest Winchester, Kentucky.

Des Jean, Tom P.

1989 *The Summer Public Archaeology Program at The Big South Fork National River and Recreation Area: Site Reports*. National Park Service, Big South Fork National River and Recreation Area, Tennessee.

1993 *The Oil Well Branch Road Site, Testing and Excavation: 1993.* National Park Service, Big South Fork National River and Recreation Area, Tennessee.

Des Jean, Tom P. and Joseph L. Benthall

1994 A Lithic Based Prehistoric Cultural Chronology of the Upper Cumberland Plateau. *Tennessee Anthropologist 19(2):114-147.*

Faulkner, Charles H. and Major C. R. McCollough

1973 *Introductory Report of the Normandy Reservoir Salvage Project: Environmental Setting, Typology, and Survey.* Normandy Archaeological Salvage Project, Volume No.1. Report of Investigation No. 11. Department of Anthropology, University of Tennessee.

Ferguson, Terry A., Robert A. Pace, Jeffery W. Gardner, and Robert W. Hoffman

1986 *Final Report of the Big South Fork Archaeological Project: Survey, Testing and Recommendations*. Department of Anthropology, University of Tennessee, Knoxville.

Fritz, Gayle J.
1995 New Dates and Data on Early Agriculture: The Legacy and Complex Hunter-Gatherers. *Annals of the Missouri Botanical Garden 82:3-15.*

Gremillion, Kristen J.
1993 Plant Husbandry at the Archaic/Woodland Transition: Evidence from the Cold Oak Shelter, Kentucky. *Midcontinental Journal of Archaeology 18:162-189.*

1996 Early Agricultural Diet in Eastern North America: Evidence From Two Kentucky Rockshelters. *American Antiquity 61:520-536.*

Gremillion, Kristen J. and Cecil R. Ison
1993 Terminal Archaic and Early Woodland Plant Utilization at the Cold Oak Shelter. In *Upland Archaeology in the East: Symposium IV*, edited by Michael B. Barber and Edward B. Barfield, pp. 121-123. Cultural Resource Management Report No. 92-1. USDA Forest Service Southern Region, Atlanta.

Ison, Cecil R.
1991 Prehistoric Upland Farming Along the Cumberland Plateau. In *Studies in Kentucky Archaeology*, edited by Charles D. Hockensmith, pp. 1-10. Kentucky Heritage Council, Frankfort.

1997 Personal Communication. Daniel Boone National Forest. Morehead, Kentucky.

Justice, Noel D.
1987 *Stone Age Spear and Arrow Points of the Midcontinental and Eastern United States: A Modern Survey and Reference.* Indiana University Press, Bloomington.

Miller, George L.
1990 A Revised Set of CC Index Values for Classification and Economic Scaling of English Ceramics. *Historical Archaeology* 25:1-25.

Pace, Robert A. and Christopher Hays
1991 Perspectives on Prehistoric Settlement in the Cumberland Plateau: The View from Station Camp. *Tennessee Anthropologist* 16 (2):92-115.

Prentice, Guy
1992 *Big South Fork National River and Recreation Area Archaeological Resource Survey: 1990 and 1991 Field Seasons.* Southeast Archaeological Center, National Park Service, Tallahassee, Florida.

1993 *Big South Fork National River and Recreation Area Archaeological Resource Survey: 1992 Field Season.* Southeast Archaeological Center, National Park Service, Tallahassee, Florida.

1996 Personal communication. Southeast Archaeological Center, National Park Service. Tallahassee.

Smith, Bruce D.

1992 *Emergence of Agriculture*. Scientific American Library, New York.

Wilson, Robert C. and Dennis W. Finch

1980 The Big South Fork National River and Recreation Area: Phase I Archaeological Reconnaissance Survey in McCreary County, Kentucky, Pickett, Fentress, Scott and Morgan Counties, Tennessee. Manuscript on file, Big South Fork NRRA, Tennessee.

EXCAVATIONS AT 15CU27: A ROCKSHELTER IN SOUTH-CENTRAL KENTUCKY

By

Jonathan P. Kerr,

Andrew P. Bradbury,

and

Grant L. Day
Cultural Resource Analysts, Inc.
Lexington, Kentucky

ABSTRACT

On behalf of the Kentucky Transportation Cabinet, Cultural Resource Analysts conducted data recovery excavations at 15Cu27, a small, stratified rockshelter in Cumberland County, Kentucky. Excavations revealed the presence of intact cultural deposits reaching a depth of approximately 85 cm below the current ground surface. Upper levels at the site consisted of occupations dating to the Late Woodland and Late Prehistoric periods as indicated by the presence of Small Triangular Cluster hafted bifaces and shell-tempered and Elk River-like or Pisgah-like quartzite tempered ceramics. The upper levels of the shelter also produced Hamilton-like limestone tempered ceramics similar to those recovered from other Late Woodland sites in the region. Another assemblage of limestone or grit (dolomite?) tempered sherds similar to several Middle Woodland types found in this region was situated stratigraphically below. Occupations at the base of the shelter were associated with the Terminal Archaic/Early Woodland period. Terminal Archaic Barbed Cluster hafted bifaces and shale tempered, predominantly fabricmarked, pottery were associated with these occupations.

To assist the Kentucky Transportation Cabinet in meeting its responsibilities pursuant to Section 106 of the National Historic Preservation Act, the agency contracted with Cultural Resource Analysts, Inc., to complete data recovery excavations at 15Cu27, a prehistorically occupied rockshelter (Bradbury and Day 1998). The excavation was undertaken in conjunction with the proposed realignment of Kentucky Highway 61 in Cumberland County, Kentucky. Archaeologists from Cultural Resource Analysts first identified the site in 1993 during a pedestrian survey (Creasman 1993) and conducted test excavations there during the summer of 1995 (Bradbury 1995).

Site 15Cu27 was located about 16 m east of Kentucky Highway 61 at the base of a discontinuous bluffline. The bluff was only about 3 m above the floodplain of Big Renox Creek located west of the highway. The site consisted of two small rockshelters located just north of a break in the 5 m high limestone bluff. The larger of the two overhangs produced cultural material. The larger overhang measured 7 m in length and 3 m at its deepest point. The shelter was 2 m in height at the dripline. The ground surface was level in the main area of the shelter, and became steep and rocky to the south. The talus slope in front of the shelter formed a narrow flat bench about 2 m in width. Level ground in the main shelter area covered about 15 m^2.

The smaller shelter was located about 10 m north of the larger one and about 1 m up the face of the bluff. It was 1.5 m wide and 2 m deep. A thin layer of duff and wind blown sand covered the rock floor of the smaller shelter.

In this paper, we describe the excavations conducted at the shelter and the subsequent analyses. We summarize previous research conducted at the site and describe the material remains recovered. The following sections present an examination of site formation processes, site structure, occupation intensity, and site use. Ultimately, the material remains and the site itself are placed into a functional and cultural context.

PROJECT AREA DESCRIPTION

Cumberland County is located in the Eastern Pennyroyal physiographic region of Kentucky, which is part of the Mississippi Plateau. The site is located near the divide separating the Barren and Green River drainage basins to the north and west and the Cumberland River drainage basin to the south. The topography of this area consists of a well dissected rolling to hilly upland plateau (McGrain and Currens 1978). Kettle and knob karst features are present in the region.

PREVIOUS RESEARCH AT 15CU27

Previous work at 15Cu27 began when the proposed Kentucky Highway 61 realignment project was surveyed, resulting in the recording of 27 archaeological sites including 15Cu27 (Creasman 1993). During the survey, cultural material was observed on the surface of the shelter, the majority of which occurred in the eastern, eroded, portion of the shelter. The material recovered during the survey included flake debris, an adze or celt, and a pottery sherd. The pottery consisted of a cordmarked body sherd that was 10-11 mm thick. The temper was unsorted, coarse quartzite or sand. It was tentatively identified as an Early Woodland Watts Bar ceramic (Lewis and Kneberg 1957). Two screened shovel probes were excavated in the shelter. One was excavated to a depth of 50 cm without encountering the subsoil or bedrock. Flake debris, several pieces of possible fire-cracked rock, and a deer-sized phalange were recovered. The second probe was excavated to a depth of 22 cm where dense rock rubble was encountered. Small and large pieces of fire-cracked rock and flake debris were found. There did not appear to have been any evidence of looting or other large-scale disturbances to the site.

The site subsequently underwent limited test excavations. Four 1 x 1-m units, numbered 1 through 4, were excavated (Figure 1). All units were excavated in 5 cm arbitrary levels to allow for more precise stratigraphic control. Feature 1 was encountered in Unit 3. The feature consisted of a roughly circular area of lighter colored, ashy soil. The feature extended into the

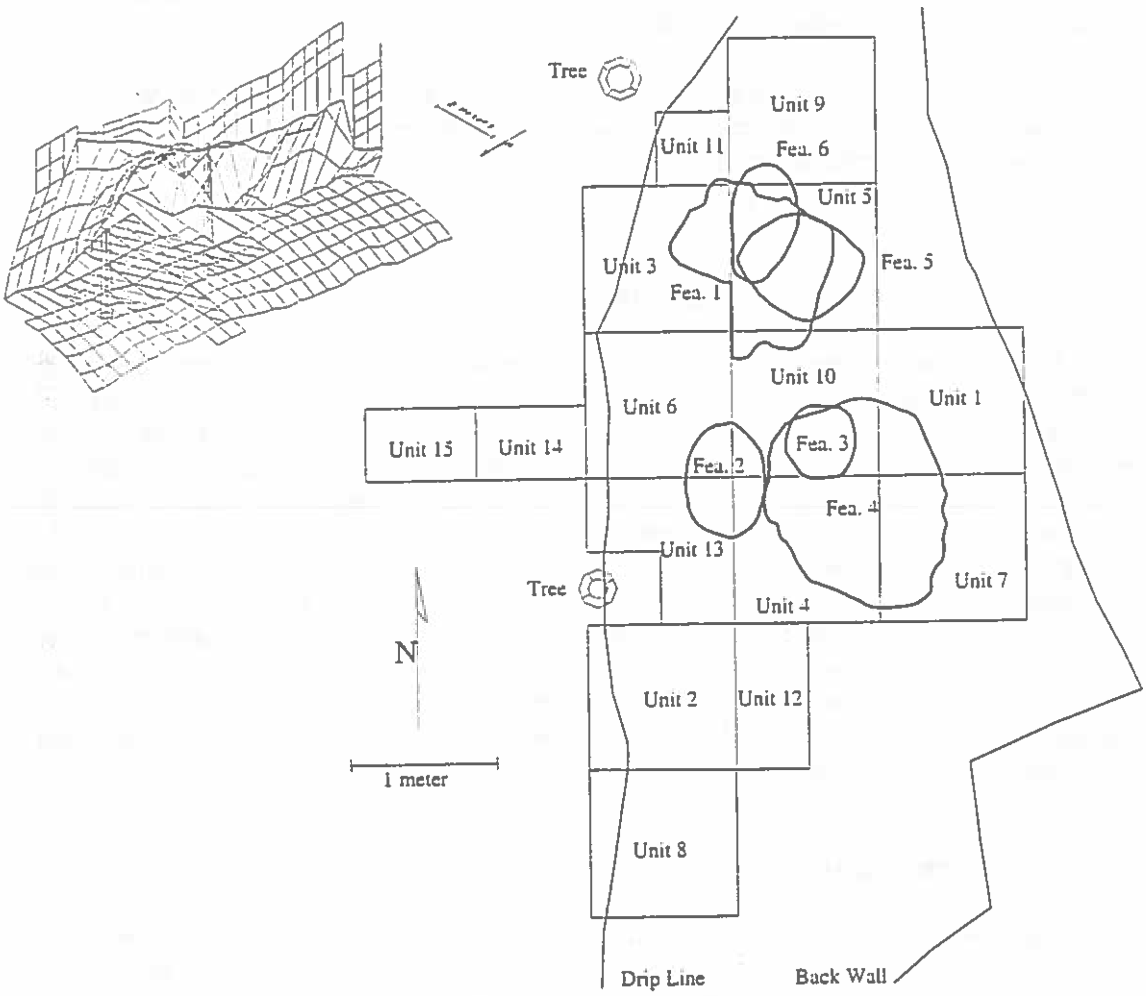


Figure 1. Plan View Map of Unit and Feature Locations at 15Cu27.

east wall of the unit. The northern portion of Unit 4A revealed a similar lens of soil, however, no discernible outline was observed.

Soils in the shelter ranged from loose silt mixed with roof fall in the interior to sandy silt with less rock towards the talus slope. The deposits ranged in depth from 55 to 85 cm. Cultural material occurring within these deposits included lithic flake debris, cores, and modified implements, ceramics, as well as botanical and faunal remains. Also identified in the assemblage were a few fragments of human skeletal material. Temporally diagnostic artifacts included two Late Woodland/Late Prehistoric Small Triangular Cluster hafted bifaces, and Late Prehistoric and Woodland ceramics. The Late Prehistoric ceramics consisted of a single shell tempered sherd recovered near the surface. The Woodland ceramics included limestone, quartzite, grit (dolomite?), or shale tempered varieties with plain, cordmarked, or fabricmarked surface treatments. They were found throughout the levels of the units excavated.

Material density varied greatly between levels and between units. Some levels had only a few artifacts while others had moderate amounts. The presence of artifacts throughout the levels indicated periodic occupation of this location, with the peaks in artifact density possibly indicating occupation that was more intensive.

RESULTS OF DATA RECOVERY

During data recovery at the site, 11 more whole or partial 1 x 1-m units, numbered 5 through 15, were excavated (Figure 1). All units were excavated in 5 cm arbitrary levels or natural levels when appropriate. In an effort to maintain tighter spatial control over the data, each 1 x 1 m unit was excavated by quadrants. Furthermore, all temporally diagnostic artifacts and formal tools were piece-plotted in hopes that the various occupational surfaces that were encountered could be separated and interpreted. Piece plotting of the materials allowed for defining soil horizons as well as feature boundaries. Excavation and analysis identified three main components and each was treated as a single analytical unit. Late Woodland and Late Prehistoric materials represented the upper levels of the shelter. Stratigraphically below were distinct Middle Woodland occupations followed by Terminal Archaic/Early Woodland occupations. Data recovery identified the remaining portion of Feature 1, as well as five additional features, including a human burial (Feature 6). Material classes recovered consisted of faunal, botanical, ceramic, lithic, and human remains.

FEATURE DESCRIPTIONS

Excavations at the site uncovered six features (Figure 1). The data recovery excavations revealed the remaining portion of Feature 1 identified during test excavations and five (Features 2-6) additional features. All of the features were completely excavated.

Feature 1 was encountered at 98 cm below the site datum (bd) (level 5) in Unit 3 during the phase II excavations. The remaining portion of Feature 1 was encountered in Unit 5 during the phase III excavations. The feature exhibited two zones. Zone 1 consisted of an irregularly shaped area of ashy sediment in a thin lens. It was restricted to a small area at the top of the feature. This portion of the feature consisted of a shallow basin filled with dark gray (10YR4/1) very ashy loam (Munsell 1990). In addition, it contained, charcoal, burned nutshell, bone, limestone tempered ceramics, a Small Triangular Cluster hafted biface, and flake debris. The other zone was considerably larger in plan view. It also was an irregularly shaped area of ashy sediments, but it was considerably thicker. This zone contained roof fall, fire-cracked rock, shell tempered and grit (dolomite?) tempered ceramics, burned clay, flake debris, charcoal, and bone. The fill of this zone consisted of a very dark grayish brown (10YR3/2) ashy loam (Munsell 1990). It was likely that this feature represented two separate superimposed features. Based on its depth below surface and associated diagnostic artifacts, Feature 1 was associated with the Late Woodland/Late Prehistoric occupation of 15Cu27 and likely represented a surface hearth.

Feature 2 originated at 109 cm bd (level 5) in Units 6, 10 and 13. It consisted of an oval shaped area of dark gray (10YR3/1) sandy loam (Munsell 1990). The feature had a basin shaped profile and cultural materials in the fill included fire-cracked rock, burned clay, bone, and flake debris. The soil at the base of this feature appeared burned. Based on depth below surface, Feature 2 was assigned to the Late Woodland/Late Prehistoric occupation of 15Cu27. This feature likely represented a surface hearth.

Feature 3 was encountered at 105 cm bd (level 4) in Unit 10. The feature was circular in plan view and basin shaped in profile. The fill in Feature 3 was a grayish brown (10YR5/2) ashy loam (Munsell 1990). The cultural remains associated with Feature 3 included ash, bone, shell, fire-cracked rock, charcoal, burned clay, a Small Triangular Cluster hafted biface, and flake debris. Based on its depth below surface and associated diagnostic artifacts, Feature 3 was associated with the Late Woodland/Late Prehistoric occupation of 15Cu27. A sample of carbonized material from Feature 3 produced an uncorrected radiocarbon date of 1500 ± 70 B.P. (Beta-114710; wood charcoal). This feature likely represented a surface hearth.

Feature 4 was encountered at 155 centimeters bd (level 14) in Units 7 and 10 during the Phase III excavations. After defining the feature in Unit 7, Units 1 and 4 were trowel-scraped and the feature was defined in these units. Due to the darkness of the surrounding matrix and the lack of light in the shelter, Feature 4 was not defined until level 11. However, based on the refitting and distribution of ceramics, Feature 4 likely originated in level 7. The feature consisted of an oval shaped area of dark brown (10YR3/2) silt loam (Munsell 1990). The base of the feature was basin shaped. Cultural materials recovered from Feature 4 consisted of flake debris, modified implements, ceramics, burned clay, and bone. Ceramics recovered from Feature 4 indicated that the feature was first excavated during the Terminal Archaic/Early Woodland occupation of the shelter. Later, during the Middle Woodland occupation, the feature was re-excavated. A sample of carbonized material from Feature 4 returned an uncorrected radiocarbon date of 2230 ± 60 B.P. (Beta-114711; wood charcoal). This feature likely represented a large storage pit.

Feature 5 consisted of a circular shaped shallow basin filled with dark brown (10YR2/2) silt loam (Munsell 1990). The top of the feature was at 116 cm bd (level 6) in Unit 5. Cultural material recovered from the feature consisted of faunal material, flake debris, botanical remains, burned clay, and limestone and grit (dolomite?) tempered ceramics. Based on its depth below ground surface and associated artifacts, Feature 5 was assigned to the Middle Woodland occupation of 15Cu27. This feature likely represented a small storage pit.

Feature 6 was a human burial. The burial pit was oval shaped and was encountered at 135 cm bd (level 10) in Units 5 and 9. The fill consisted of a very fine grained silt loam with limestone inclusions, mollusk shell, animal bone, burned clay, and flake debris. Several undisturbed limestone blocks largely defined the pit margins; probably the result of pre-interment roof falls. It seemed that the feature was either opportunistically dug between limestone slabs or that stone was removed, where possible, to provide depth to the feature. The deposit containing human remains appeared to encompass no more than the bottom 12 cm of the feature. The individual most likely was buried in a "sitting" or "vertically flexed" position. Based on its stratigraphic position, Feature 6 was likely associated with Terminal Archaic/Early Woodland use of the shelter. A sample of carbonized material from Feature 6 produced an uncorrected radiocarbon date of 2020 ± 80 B.P. (Beta-107300; wood charcoal).

RADIOCARBON DATES

Three samples of carbonized materials were submitted to Beta Analytic for radiocarbon determination. All dates reported below are uncorrected. No additional dates were possible due to the low density of datable material. The three dates obtained provided a general indication of the length of occupation of the shelter. One date was obtained for each of the three cultural components identified in the shelter. Again, from latest to earliest these were Late Woodland/Late Prehistoric, Middle Woodland, and Terminal Archaic/Early Woodland.

A sample of wood charcoal from Feature 3 was radiocarbon dated to 1500 ± 70 B.P. (Beta-114710). This sample underwent extended counting due to the low final-carbon weight. Ceramics recovered from this feature were limestone tempered and cordmarked. They were similar to Late Woodland Hamilton Cord Marked ceramics.

The sample of wood charcoal from Feature 4 was radiocarbon dated to 2230 ± 60 B.P. (Beta-114711). This is a good late Early Woodland date for the area. Ceramics recovered from Feature 4 included shale tempered, fabric and cordmarked sherds. These were similar to the Swannanoa and Watts Bar Series types. The radiocarbon date likely represented the initial construction date for this feature and was associated with the Terminal Archaic/Early Woodland component at the shelter.

A sample of wood charcoal from Feature 6 was radiocarbon dated to 2020 ± 80 B.P. (Beta-107300). Unfortunately, no diagnostic artifacts were recovered from the feature that would help to corroborate the date. Several grit (dolomite?) tempered sherds were recovered from levels immediately above this feature and in Feature 5. Due to the intrusion of Feature 5 into Feature 6, it was possible that the carbonized material actually originated in Feature 5. This date was associated with the Middle Woodland component at the shelter.

SUBSISTENCE REMAINS

Subsistence remains recovered from the shelter consisted of faunal and botanical materials. In general, subsistence remains were rather limited from all three of the cultural components. A number of animal species represented at the shelter, such as rabbit and squirrel, were likely the result of animal predation, notably owls (Davenport 1998). The mechanism by which some of the other species were deposited may also be in question; however, humans more than likely deposited the deer and aquatic gastropods remains at the site. The Late Woodland/Late Prehistoric component produced higher amounts of deer remains than the other two components. A low diversity or domination of one species (i.e., deer) argues for a specialized procurement activity. The faunal materials present indicated a short-term occupation, probably during the fall or winter.

Results of the botanical analysis indicated that all of the occupations used only arboreal fruits, predominately walnut and hickory (Crites 1998). There was no evidence for the use of domesticated plants or food production. Such plants are known for a number of other sites in the region (e.g., Cowan 1978; Cowan et al. 1981; Gremillion 1993, 1996, 1997). The lack of these remains at 15Cu27 was likely a reflection of how the shelter was used. Based on the botanical analysis, Crites (1998) suggested that human activity at 15Cu27 did not include food production based on weedy/grass/forb plants. The plant remains indicated the site functioned as a short-term occupation occurring during the fall or winter. In contrast to sites where bulk processing of nuts took place (e.g., Stafford 1991), the density of nut remains at 15Cu27 was very low. In addition, no tools associated with the processing of nuts (i.e., pitted cobbles) were recovered. Based on these data, the limited amounts of arboreal fruits at the shelter probably represented a supplementary food source consumed during the occupation.

CERAMIC REMAINS

The site produced a small assemblage of sherds, representing a small number of vessels. Of the 384 ceramic artifacts recovered from the site during testing and data recovery investigations, 149 were analyzed; the remainder was less than one square cm in size.

The ceramic analysis demonstrated that the most recent use of this site was during the Late Prehistoric period. This was based on the recovery of three shell tempered sherds from Feature 1 and the uppermost levels in the northern end of the shelter. One sherd had a plain surface while the other two exhibited eroded exterior surfaces. Two smoothed cordmarked, quartzite tempered sherds also were possibly deposited during this general period (Figure 2, c). They were recovered from the upper levels of the shelter, but closer to its southern end. They were remotely similar to Elk River Cordmarked (Faulkner 1968) or Pisgah Cordmarked (Dickens 1981) ceramics. The former type was defined for assemblages from Early Mississippian Mason Phase sites within the Tims Ford Reservoir located on Elk River in south-central Tennessee. The latter were found on the Mississippian Pisgah phase sites of the Appalachian Summit.

The site produced eighteen limestone tempered cordmarked sherds. The analysis identified two potential vessels represented by these sherds. One group representing one vessel was secondarily smoothed, had thick cord diameters with cords that were widely spaced, and had a relatively thin body sherd thickness (Figure 2, b). They were found in Feature 1 and the upper levels of the rockshelter in the northern portion of the shelter. This group was comparable to Late Woodland ceramics found in the region. The only named type in the region that remotely resembled these ceramics was Hamilton Cord Marked (Lewis and Kneberg 1946). Ceramics found at the Hiwassee Island site led to this type's definition, but it occurs throughout central and eastern Tennessee.

The other group of limestone tempered cordmarked sherds had cordmarkings that were usually not secondarily smoothed, had thin cord diameters with cords that were closely spaced, and exhibited relatively thick body sherd measurements (Figure 2, a). These sherds were found in all areas of the shelter and in levels below the other limestone tempered sherds and the Late Prehistoric sherds. This group was comparable to Candy Creek Cordmarked (Lewis and Kneberg 1946), Flint River Cordmarked (Heimlich 1952), Rough River Cordmarked (Schwartz and Sloan 1958; Schwartz et al. 1958), and Mills Cordmarked (Kerr 1995). The first three are limestone tempered while Mills Cordmarked is a sandstone and/or siltstone tempered pottery type. All of the types are late Early to Middle Woodland ceramics found in central and eastern Tennessee, the Middle Tennessee River valley, the Rough River drainage of western Kentucky, and the Upper Cumberland River valley, respectively.

The ceramic assemblage included 37 grit (dolomite?) tempered cordmarked sherds and one grit (dolomite?) tempered fabricmarked sherd. Like the Middle Woodland limestone

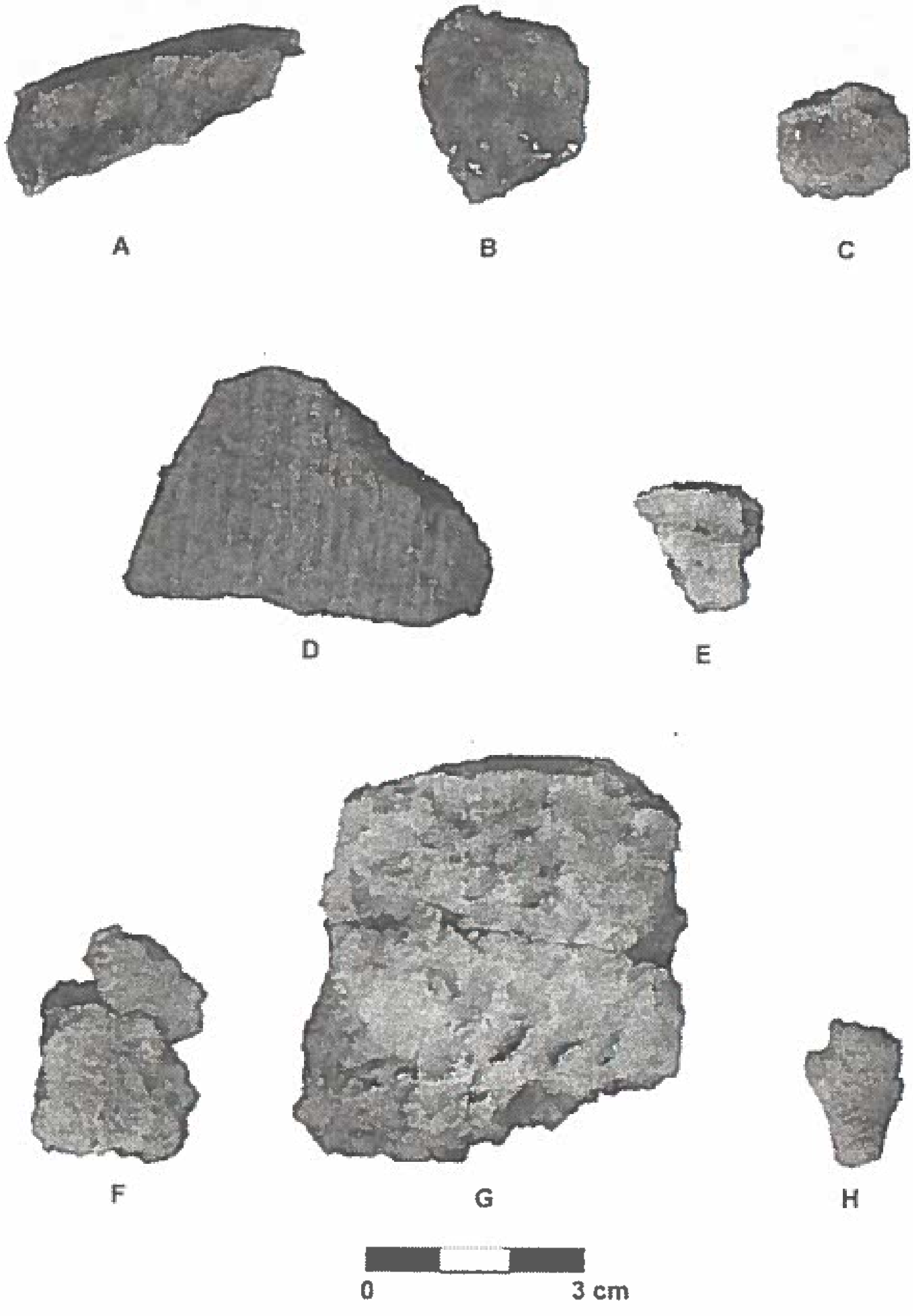


Figure 2. Representative Ceramics Recovered From 15Cu27. Limestone tempered, cordmarked (A-B); Quartzite tempered, cordmarked (C); Grit (dolomite?) tempered, cordmarked (D); Grit (dolomite?) tempered, fabricmarked (E); Shale tempered, cordmarked (F); Shale tempered, fabricmarked (G); and possible pipe fragment (H).

tempered sherds, they were recovered from all areas of the shelter and in levels below the Late Woodland limestone tempered sherds and the Late Prehistoric sherds. They also were found in Features 1, 4, and 5. Disturbances may have caused their presence in the first two features. Other than the difference in temper type, this pottery was very similar to the late Early to Middle Woodland limestone tempered pottery found at the shelter, both in thickness and surface treatment. The cordmarkings on the vessel were thin and generally were not secondarily smoothed (Figure 2). There are no defined grit (dolomite?) tempered ceramic types for this region, but this pottery was similar to what Railey (1990) described for early Middle Woodland ceramics of the Upper Cumberland. It may have been superficially related to Candy Creek Cordmarked (Lewis and Kneberg 1946), Flint River Cordmarked (Heimlich 1952), Rough River Cordmarked (Schwartz and Sloan 1958; Schwartz et al. 1958), or Mills Cordmarked (Kerr 1995).

The site produced 42 shale tempered fabricmarked sherds. They were situated within Feature 4 and in levels below all the other ceramic groups. The fabric structure was very coarse and the individual cords were very thick (Figure 2). The surface treatment was similar to net or knot roughened markings found on ceramics in Virginia (Evans 1955). Railey (1990) described Early Woodland ceramics of the Upper Cumberland as thick and grit (quartzite?) tempered with cordmarked or fabricmarked surfaces. Named Early Woodland fabricmarked ceramics in the region include Swannanoa (Keel 1976), Watts Bar (Lewis and Kneberg 1957), and Long Branch (Haag 1939). The first two types dated only to the Early Woodland period. Long Branch fabricmarked pottery, which was first produced by 600 B.C., continued to be manufactured through the Middle Woodland period. Swannanoa pottery primarily is found in the Appalachian Summit area and Watts Bar and Long Branch ceramics have been recovered from sites in central and eastern Tennessee. Swannanoa and Watts Bar Series pottery were tempered with quartzite and the Long Branch was tempered with limestone. The use of shale as the primary tempering agent in the 15Cu27 assemblage was probably due to its relative abundance in the area and its availability to local potters. Interestingly, the sherds in this group also included limestone, quartzite, and grit (dolomite?) inclusions in their paste. Other than slight differences in tempering materials, the sherds were most similar to Swannanoa and Watts Bar ceramic types.

Finally, five shale tempered smoothed cordmarked sherds were recovered from Feature 4. These sherds contained quartzite and grit (dolomite?) inclusions in their paste, similar to the fabricmarked sherds. The sherds were most similar to Early Woodland Swannanoa and Watts Bar Cordmarked and late Early to Middle Woodland Candy Creek Cordmarked types.

LITHIC ARTIFACTS

Two main forms of analysis were used for the classification of flake debris recovered from 15Cu27; mass analysis and individual flake analysis. The main reason for the use of two methods was to provide multiple lines of evidence. Binford (1987) argued for the use of multiple lines of evidence in archaeological investigation as a means of strengthening inferences or revealing ambiguities. Several researchers (Bradbury and Carr 1995; Morrow 1997) have also advocated this approach for flake debris analysis. Individual flake (i.e., reduction stage) and size grade (i.e., mass analysis) analyses are seen as complementary approaches that enable the analyst to strengthen inferences based on the analyses (Bradbury and Carr 1995; Morrow 1997; Shott 1994:102-103). For example, general trends observed in data sets derived through mass analysis can be compared to results of individual flake analysis to strengthen inferences or reveal new areas for investigation.

Mass analysis (e.g., Ahler 1989a, 1989b; Ahler and Christenson 1983) was used to classify all flake debris recovered during test excavations and data recovery. Mass analysis is a form of flake debris analysis that focuses on size, shape, and cortex characteristics of batches of flake debris as a means for measuring and quantifying variation in flakes debris aggregates (Ahler 1989a, 1989b; Ahler and Christensen 1983). In the mass analysis approach, all flake debris is size graded by passing flakes through a series of nested screens of varying mesh sizes (.25 inch - .635 cm, .50 inch – 1.27 cm, .75 inch – 1.905 cm, and 1 inch - 2.54 cm in the current analysis). The flakes in each size grade were then counted and weighed by raw material type. Finally, within each size grade the number of cortical flakes for each raw material type present was recorded.

In addition to the mass analysis, the flake debris recovered from four excavation units was examined by more intensive individual flake analysis. Individual flake analysis recorded six attribute dimensions for each flake. These dimensions were size grade, weight, portion, platform configuration, reduction stage, and cortex cover. Within each dimension were several possible attribute states. The reduction stage determination was based on the work of Magne (1985; Magne and Pokotylo 1981). Size grade was determined by passing the flakes through a series of nested wire screens ranging in size from 1.0 inch (2.54 cm), .75 inch (1.905 cm), .5 inch (1.27 cm), to .25 (.635 cm) inch. All flakes greater than .25 inch (.635 cm) were examined. Debris less than .25 inch (.635 mm) was counted and weighed with no further attributes recorded.

All modified implements recovered during the data recovery excavations underwent low magnification microwear analysis. The specific methods used for this analysis followed that of other practitioners of the approach (e.g., Odell 1977; Odell and Odell-Vereecken 1980; Tringham et al. 1974). For the current analysis, a Wolfe stereoscopic microscope with a reflective light source was employed. The microscope was fitted with 20x eyepieces and 4.5x paired objectives. The magnification was continuously variable and ranged between 14x and 90x. Implements were generally scanned for evidence of wear at 20x. Magnification was then increased or decreased as needed to view more clearly any observable edge damage.

Of special interest concerning prehistoric use of the area was the occurrence of chert bearing formations. The bedrock of the study area consisted of Ft. Payne, Salem/Warsaw, and St. Louis limestones, in stratigraphic order from bottom to top. In his description of these formations, Taylor (1964) noted the occurrence of chert within each formation. Some of these cherts would have been of economic importance to prehistoric groups in the area. The Fort Payne formation was the most extensive chert bearing formation. The analysis recognized three varieties of Fort Payne chert: Fibrous Fort Payne (FFP), Low Quality Fort Payne (LQFP), and High Quality Fort Payne (HQFP). The low quality variety included Fort Payne chert that was coarse grained and generally low quality for purposes of controlled flake removal. LQFP was observed at numerous locations in and around the local area. A semi-vitreous, medium to fine-grained quality characterized HQFP. The archaeological samples only contained this material. The source of this material was likely from sources outside the project area, probably to the south. FFP was a medium- to fine-grained, nearly vitreous, semi-translucent chert with numerous rod- to oval-shaped inclusions. A number of outcrops throughout the area produced this chert. Experiments with FFP revealed it was a high quality chert for knapping purposes.

The Late Woodland/Late Prehistoric component at the site evidenced an almost complete reliance (over 99 percent of identified cherts) on locally occurring Fort Payne cherts for chipped stone tool manufacture. The analyses indicated a slightly higher amount of tool production debris than core reduction debris. Both the mass analysis and reduction stage data pointed to this conclusion. Thermal shatter also was recovered in moderate quantities and likely represented hearth activity.

The Late Woodland/Late Prehistoric component produced almost equal numbers of cores and bifacial implements. Most bifaces were representative of the later stages of biface manufacture. These included 16 small triangular cluster hafted bifaces (Figure 3). All but one of these was broken. Of interest concerning the hafted bifaces, HQFP represented nearly half of these specimens. This material was likely procured to the south of the project area and represented implements that were manufactured elsewhere.

Microwear analysis indicated that approximately 60 percent of the identified wear on the triangular hafted bifaces was related to damage resulting from use as a projectile. A few distal and medial sections of small thin bifaces also exhibited such damage. These likely represented arrow points that were imbedded within the carcass of an animal that was killed and became deposited at the shelter after the animal was butchered (cf. Keeley 1982). In several cases, these fragments exhibited thermal damage indicating that they were likely cooked along with the meat. Motions that were longitudinal to the working edge, and on soft resistance materials, represented the second most (21.5 percent) observed wear pattern. This wear most likely resulted from tools used during animal processing. Evidence from the faunal analysis indicated that deer were being completely processed at the shelter. The results of the microwear analysis also indicated that at least some processing of these animals was occurring on-site. The analysis indicated that the majority of the Late Woodland/Late Prehistoric lithic assemblage reflected a narrow range of activities that related, in many aspects, to each other (i.e., procurement/processing of animals).

As was the case with the Late Woodland/Late Prehistoric component, locally available cherts were almost exclusively used for chipped stone tool manufacture in the Middle Woodland and Terminal Archaic/Early Woodland components. The Middle Woodland assemblage exhibited almost equal amounts of tool production and core reduction debris, as well as cores and modified implements. In the Terminal Archaic/Early Woodland assemblage, core reduction increased. With respect to tools, the Terminal Archaic/Early Woodland assemblage contained equal numbers of cores and modified implements. These included two Terminal Archaic Barbed Cluster hafted bifaces (Figure 3, bottom row).

Few of the modified implements from either of the earlier components exhibited use related damage. Of the two specimens from the Middle Woodland component, one exhibited damage related to use in a longitudinal motion on soft resistance materials, the other was used in a transverse motion on medium resistance materials. Only one implement from the Terminal Archaic/Early Woodland component exhibited use related damage. This Terminal Archaic Barbed cluster hafted biface exhibited longitudinal motion wear from an indeterminate resistance material.

HUMAN REMAINS

The shelter contained a single human burial (Feature 6, a concentration of partially articulated skeletal elements). In addition, several disarticulated, isolated human skeletal elements were recognized. The latter were recovered from six excavation units and two additional features. The skeletal material was likely associated with the Middle Woodland or Terminal Archaic/Early Woodland use of the shelter. Based on the skeletal material recovered, three individuals were identified (Matternes 1998). The one in Feature 6 consisted of a probable male, 35 to 45 years old. The others, scattered throughout the excavation, included a child from birth to 6 months old, and an adult that could not be sexed. The individuals displayed relatively good health with little infectious

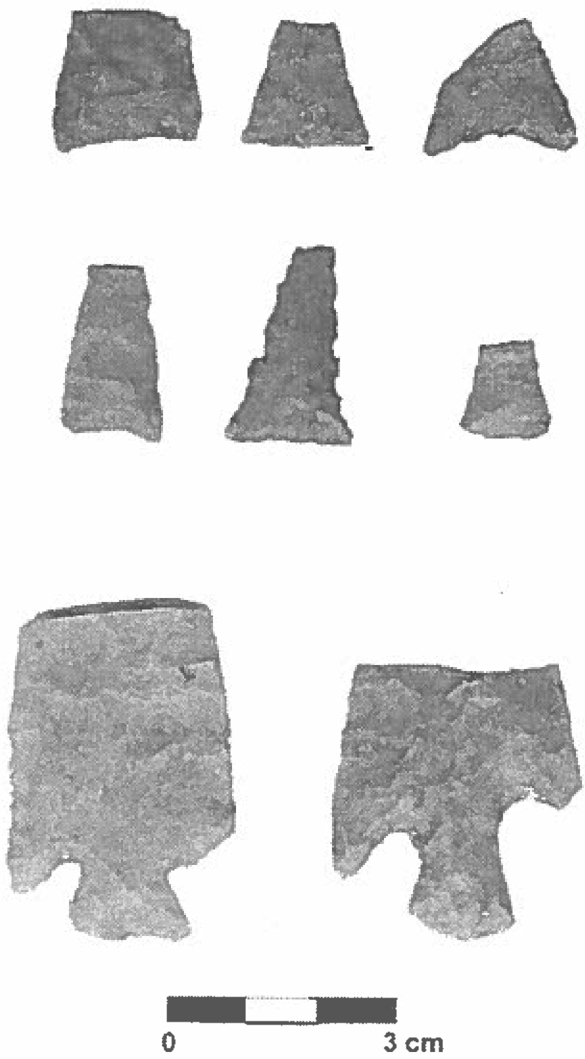


Figure 3. Small Triangular Cluster and Terminal Archaic Barbed Cluster Hafted Bifaces Recovered From 15Cu27.

disease, but some evidence of degenerative disease. The general state of health observed in the individuals was typical of populations of the Early to Middle Woodland period.

DISCUSSION

The above sections have summarized the results of the individual artifact analyses. Additional analyses conducted in conjunction with the investigations of the shelter included an examination of site formation processes, an examination of site structure, diversity analysis to determine occupation intensity, and additional examinations of site use. Below are summaries of these analyses. The original contract report provides more in-depth discussions of these topics (Bradbury and Day 1998).

LATE WOODLAND/LATE PREHISTORIC

The results of the analyses concerning occupation intensity indicated that Late Woodland/Late Prehistoric use of the shelter was likely short-term in nature. Lines of evidence that indicated this included the relatively low diversity of lithic remains, the low amounts and diversity of subsistence remains, the few numbers and types of features, the haphazard distribution of features and artifacts, and the relatively few ceramics. In contrast, small, Late Prehistoric sites that exhibit a residential component (e.g., Bradbury 1997; Smith et al. 1993; Smith and Moore 1994, 1996) contain a greater diversity of tools, ceramic forms, and subsistence remains. Residential sites also exhibit organized site structure and maintained or cleaned areas.

The data indicated that during the Late Woodland/Late Prehistoric period the shelter served as a short-term field camp (using Binford's 1980 term) focusing on specialized procurement. The results of the faunal and lithic analyses demonstrated that the processing of deer, procured nearby, was likely the focus of activities at the site. While this may have been the focus, the Late Woodland/Late Prehistoric occupants likely conducted other minor activities. One activity included the initial reduction of knappable stone, also procured nearby, probably to export as cores. The maintenance of tools used during hunting forays was likely an additional activity conducted at the shelter. Based on the results of this study, it was likely that the shelter was used intermittently over a long span of time (ca. 200-300 years) during the Late Woodland/Late Prehistoric period.

MIDDLE WOODLAND AND TERMINAL ARCHAIC/EARLY WOODLAND

The Middle Woodland and Terminal Archaic/Early Woodland components of the shelter were somewhat more complex than the Late Woodland/Late Prehistoric occupations. Part of this may have been related to probable mixing of these two components to some extent. Additionally, prehistoric use of the shelter likely was responsible for some of the complexity. These two components were thought to represent similar uses of the shelter, thus they are discussed together.

Part of the difficulty in examining these two components lie in conflicting data. Based on the presence of a large storage pit (Feature 4), the burials, and ceramics, one would expect a residential component to be present in the site. Concerning the skeletal material, the presence of both adults and infants indicated to Matternes (1998) that the deposits at the shelter were not exclusively the result of specialized work crews, but that of residentially mobile populations. In contrast to this data, however, results of the botanical, lithic, and faunal analyses, the diversity analysis, and the examination of site structure all indicated a more logistical, short-term use of the site.

Given these somewhat contradictory findings, it is suggested that the large storage pit (Feature 4) and the burials (Feature 6 and scattered remains) may not be related to residential occupation/use of the shelter during the Middle Woodland and Terminal Archaic/Early Woodland periods. Rather, Feature 4 and the burials may have represented distinct uses of the shelter that may, or may not, have been related to other activities undertaken at the site.

Feature 4 may have represented a cache (to use Binford's 1980 term) where food items (most likely nuts and/or dried meats) and ceramics possibly would have been stored in anticipation of later use. The use of a rockshelter for such purposes was sensible, since mobile people using the area would have easily identified it. Evidence for such a use of the shelter came from several sources. First, the results of the botanical analysis noted that, while features accounted for less than 27 percent of processed Middle Woodland matrix, these contexts yielded over 58 percent hickory and 68 percent walnut shell (Crites 1998). Second, a greater amount of animal remains were found outside feature contexts. Furthermore, most of the animal remains within features were small sized animals and were likely not associated with human use of the shelter (Davenport 1998). Therefore, it was possible that the occupants of the site haphazardly discarded the bones from processed fauna on the floor of the shelter, and stored dried meats in the feature. Alternatively, it was possible that Binford's (1978) idea of toss zones accounted for these differences. This idea posed that small remains are found in and around features while large remains were tossed from the main activity area. Third, Feature 4 produced the vast majority of Woodland ceramics, with few being recovered from unit contexts (Kerr 1998). In addition, all refits were between sherds within Feature 4 and no refits were made between sherds from feature and unit contexts. Therefore, these ceramics, while whole, were potentially stored in the feature. Lastly, the distribution of artifacts within the shelter, the position of Feature 4, and the indications that refuse at the site was in primary context, was a sign that the Middle Woodland and Terminal Archaic/Early Woodland occupations were short-term. For example, the greatest density of artifacts occurred in the central back portion of the shelter. This was typically the sleeping area in cases where people used rockshelters as residential sites (Walthall 1998). Feature 4 was located in this area. Due to spatial constraints, the feature could not have be used during the time other activities were being conducted at the site. Finally, the distribution of the materials at the site reflected that they were in their original location when dropped and the shelter floor was not cleaned or maintained.

With regards to the burials, Clay (1998) argued that the lack of a larger number of burials at the shelter meant that the shelter was purposefully chosen to segregate its dead from the larger society. Further, Clay (1998) suggested that the partial skeletons represented individuals that were buried, and then later removed for burial at another location. In both cases, the use of the shelter as a place of burial was separate from other uses of the shelter.

The above data, while certainly not conclusive, indicate that the storage pit and burials represented different phenomena for prehistoric use of the shelter, compared to the remainder of the cultural material associated with the Middle Woodland and Terminal Archaic/Early Woodland occupations. In this regard, there appeared to be at least four separate uses of the shelter during the Terminal Archaic/Early Woodland to Middle Woodland periods. The first was the use of the shelter as a cemetery. The second would be as a cache. Third, the shelter would have served as a temporary field camp, possibly as a hunting camp. Lastly, initial reduction of knappable stone from a nearby resource, for export as cores, was a final site activity. All four uses likely took place during this span of time, but represented different, and possibly unrelated, aspects of the total settlement-subsistence system of the groups involved.

SUMMARY AND CONCLUSIONS

Excavations at 15Cu27 documented prehistoric occupations from the Terminal Archaic through the Late Prehistoric periods. The types of use of, and activities undertaken at, the shelter varied over this period. During the Terminal Archaic/Early Woodland to Middle Woodland periods the data suggested that the shelter was used: 1) as a cemetery; 2) as a cache site; 3) as a temporary field camp, possibly as a hunting camp; and 4) as a knapping locale. Some of these activities potentially may have taken place during the same relative period, while others, especially the burial, probably represented specific, focused use of the shelter.

During the Late Woodland/Late Prehistoric period, the shelter served as a short-term field camp only. These data indicated activities focusing on specialized procurement such as procurement and processing of deer. Other minor activities likely conducted during this occupation were the procurement and processing of knappable stone and the maintenance of tools used during hunting forays. Based on the recovered material, it was likely that the shelter was used intermittently over a long span of time during the Late Woodland/Late Prehistoric period.

ACKNOWLEDGMENTS

The Kentucky Transportation Cabinet provided funding for these archaeological investigations, which were conducted prior to the relocation of Kentucky Highway 61, Adair, Cumberland, and Metcalfe Counties, Kentucky. Steve Creasman and Chuck Niquette provided guidance and suggestions during the excavation and analysis phases of the project. The authors acknowledge Gary Crites, Hugh Matternes, Chris Davenport, and R. Berle Clay for their parts in the research.

REFERENCES CITED

Ahler, Stanley. A.

1989a Experimental Knapping with KRF and Midcontinent Cherts: Overview and Applications. In *Experiments in Lithic Technology*, edited by Daniel S. Amick and Raven P. Mauldin, pp. 67-88. BAR International Series 528. A. R. Hands, and D. R. Walker, general editors. British Archaeological Reports, Oxford.

1989b Mass Analysis of Flaking Debris: Studying the Forest Rather than the Trees. In *Alternative Approaches to Lithic Analysis*, edited by Donald O. Henry and George H. Odell, pp. 85-118. Archeological Papers No. 1. American Anthropological Association.

Ahler, Stanley A. and Robert C. Christenson

1983 *A Pilot Study of Knife River Flint Procurement and Reduction at Site 32DU508, a Quarry and Workshop Location in Dunn County, North Dakota*. Department of Anthropology and Archeology, University of North Dakota, Grand Forks. Submitted to State Historical Society of North Dakota, Bismarck, Contract No.

YA553-CT1-1089. Copies available from State Historical Society of North Dakota, Bismarck.

Binford, Lewis R.
1978 Dimensional Analysis of Behavior and Site Structure Learning from the Eskimo Hunting Stand. *American Antiquity* 43:330-361.

1980 Willow Smoke and Dog's Tail: Hunter-Gatherer Settlement Systems and Archaeological Site Formations. *American Antiquity* 45:4-20.

1987 Researching Ambiguity: Frames of Reference and Site Structure. In *Method and Theory for Area Research, an Ethnoarchaeological Approach*, edited by Susan Kent, pp. 449-512. Columbia University Press, New York.

Bradbury, Andrew P.
1995 *A National Register Evaluation of Twelve Sites in Adair, Cumberland and Metcalfe Counties, Kentucky*. Edited by Myra A. Hughes. Contract Publication Series 95-69. Cultural Resource Analysts, Lexington, Kentucky.

1997 The Mississippian Occupation of the Pitts Site (40Ho12) Houston County, Tennessee. *Tennessee Anthropological Association Newsletter* 22 (1):2-11.

Bradbury, Andrew P. and Philip J. Carr
1995 Flake Typologies and Alternative Approaches: An Experimental Assessment. *Lithic Technology* 20 (2):100-115.

Bradbury, Andrew P. and Grant L. Day
1998 *Phase III Archeological Investigations at 15Cu27 and 15Cu31, Cumberland County, Kentucky*. Contract Publication Series 98-43. Cultural Resource Analysts, Lexington, Kentucky.

Clay, R. Berle
1998 Mortuary Activity at 15Cu27: a Review of Interpretations and a Summary of Data. In *Phase III Archeological Investigations at 15Cu27 and 15Cu31, Cumberland County, Kentucky*, by Andrew P. Bradbury and Grant L. Day, pp. 169-178. Contract Publication Series 98-43. Cultural Resource Analysts, Lexington, Kentucky.

Cowan, C. Wesley
1978 Seasonal Nutritional Stress in a Late Woodland Population: Suggestions from Some Eastern Kentucky Coprolites. *Tennessee Anthropologist* 3:117-128.

Cowan, C. Wesley, H. Edwin Jackson, Katherine Moore, Andrew Nickelhoff, and Tristine L. Smart
1981 The Cloudsplitter Rockshelter, Menifee County, Kentucky: A Preliminary Report. *Bulletin* of the *Southeastern Archaeological Conference* 24:60-76.

Creasman, Steven D.
1993 *An Archeological Survey of the Proposed Realignment of Kentucky Highway 61, Burkesville-Columbia, in Adair, Cumberland and Metcalfe Counties, Kentucky*. Contract Publication Series 93-15. Cultural Resource Analysts, Lexington, Kentucky.

Crites, Gary D.
1998 Botanical Remains from 15Cu27. In *Phase III Archeological Investigations at 15Cu27 and 15Cu31, Cumberland County, Kentucky*, by Andrew P. Bradbury and Grant L. Day, pp. 69-78. Contract Publication Series 98-43. Cultural Resource Analysts, Lexington, Kentucky.

Davenport, Christian
1998 Faunal Remains from 15Cu27. In *Phase III Archeological Investigations at 15Cu27 and 15Cu31, Cumberland County, Kentucky*, by Andrew P. Bradbury and Grant L. Day, pp. 101-114. Contract Publication Series 98-43. Cultural Resource Analysts, Lexington, Kentucky.

Dickens, Roy S., Jr.
1981 Cherokee Prehistory: The Pisgah Phase in the Appalachian Summit Region. 2nd printing. University of Tennessee Press, Knoxville.

Evans, Clifford
1955 *A Ceramic Study of Virginia Archaeology*. Bulletin No. 160. Bureau of American Ethnology, Smithsonian Institution, Washington, D.C.

Faulkner, Charles H.
1968 The Mason Site (40FR8). In *Archaeological Investigations in the Tims Ford Reservoir, Tennessee, 1966*, edited by Charles Faulkner, pp. 12-141. Report of Investigations No. 6. Department of Anthropology, University of Tennessee, Knoxville.

Gremillion, Kristen J.
1993 Plant Husbandry at the Archaic/Woodland Transition: Evidence from the Cold Oak Shelter, Kentucky. *Midcontinental Journal of Archaeology* 18:161-189.

1996 Early Agricultural Diet in Eastern North America: Evidence from Two Kentucky Rockshelters. *American Antiquity* 61:520-536.

1997 New Perspectives on the Paleoethnobotany of the Newt Kash Shelter. In *People, Plants, and Landscapes: Studies in Paleoethnobotany*, edited by Kristen J. Gremillion, pp. 23-41. University of Alabama Press, Tuscaloosa.

Haag, William G.
1939 Pottery Type Descriptions. *Newsletter of the Southeastern Archaeological Conference* 1 (1):10-11, 13, 17.

Heimlich, Marion D.
1952 *Guntersville Basin Pottery*. Museum Paper No. 32. Museum of Natural History, University of Alabama, Tuscaloosa.

Keel, Bennie C.
1976 *Cherokee Archaeology: A Study of the Appalachian Summit*. University of Tennessee Press, Knoxville.

Keeley, Lawrence H.
1982 Hafting and Retooling: Effects on the Archaeological Record. *American Antiquity* 47:798-809.

Kerr, Jonathan P.
1995 Prehistoric Ceramic Analysis. In *Archeological Investigations at the Mills Site (15BL80), Bell County, Kentucky*, by S. D. Creasman, pp. 9-1 to 9-9. Contract Publication Series 94-66. Cultural Resource Analysts, Lexington, Kentucky.

1998 Prehistoric Ceramic Analysis. In *Phase III Archeological Investigations at 15Cu27 and 15Cu31, Cumberland County, Kentucky*, by Andrew P. Bradbury and Grant L. Day, pp. 79-100. Contract Publication Series 98-43. Cultural Resource Analysts, Lexington, Kentucky.

Lewis, Thomas M. N. and Madeline D. Kneberg
1946 *Hiwassee Island: an Archaeological Account of Four Tennessee Indian Peoples*. University of Tennessee Press, Knoxville.

1957 The Camp Creek Site. *Tennessee Archaeologist* 13 (1):1-48.

Magne, Martin P. R.
1985 *Lithics and Livelihood: Stone Tool Technologies of Central and Southern Interior British Columbia*. Mercury Series Paper No. 133. Archaeological Survey of Canada, National Museum of Man, Ottawa, Ontario.

Magne, Martin P. R. and David Pokotylo
1981 A Pilot Study in Bifacial Lithic Reduction Sequences. *Lithic Technology* 10:34-47.

Matternes, Hugh B.
1998 Human Skeletal Remains and Mortuary Deposits at 15Cu27. In *Phase III Archeological Investigations at 15Cu27 and 15Cu31, Cumberland County, Kentucky*, by Andrew P. Bradbury and Grant L. Day, pp. 157-168. Contract Publication Series 98-43. Cultural Resource Analysts, Lexington, Kentucky.

McGrain, Preston and James C. Currens
1978 *Topography of Kentucky*. Special Publication No. 25. Kentucky Geological Survey and the University of Kentucky, Lexington.

Morrow, Toby A.
1997 A Chip off the Old Block: Alternative Approaches to Debitage Analysis. *Lithic Technology* 22:51-69.

Munsell
1990 *Munsell Soil Color Charts*. Revised edition. Macbeth, Division of Kollmorgen Instruments, Newburgh, New York.

Odell, George H.
1977 *The Application of Micro-wear Analysis to the Lithic Component of an Entire Prehistoric Settlement: Methods, Problems, and Functional Reconstructions.* Unpublished Ph.D. dissertation, Department of Anthropology, Harvard University, Cambridge, Massachusetts.

Odell, George H. and Frieda Odell-Verreecken
1980 Verifying the Reliability of Lithic User-Wear Assessments by 'Blind Tests': The Low-Power Approach. *Journal of Field Archaeology* 7:87-120.

Railey, Jimmy A.
1990 Woodland Period. In *The Archaeology of Kentucky: Past Accomplishments and Future Directions*, Volume 1, edited by David Pollack, pp. 247-374. State Historic Preservation Comprehensive Plan Report No. 1. Kentucky Heritage Council, Frankfort.

Schwartz, Douglas W. and Tacoma G. Sloan
1958 *Excavation of the Rough River Site, Grayson County 12, Kentucky*. Submitted to U.S. National Park Service Regional Office, Richmond, Virginia. Copies available from the U.S. National Park Service, Department of the Interior, Southeastern Region, Richmond, Virginia.

Schwartz, Douglas W., Tacoma G. Sloan, and John W. Walker
1958 Appraisal of the Archaeological Resources of the Rough River Basin, Kentucky. Ms. on file, Museum of Anthropology, University of Kentucky, Lexington.

Shott, Michael J.
1994 Size and Form in the Analysis of Flake Debris: Review and Recent Approaches. *Journal of Archaeological Method and Theory* 1:69-110.

Smith, Kevin E., Charles P. Stripling, and Michael C. Moore
1993 The Brick Church Business Park Site (40DV301): Salvage Excavations at a Mississippian Hamlet. *Tennessee Anthropologist* 18:94-116.

Smith, Kevin E. and Michael C. Moore
1994 Excavation of a Mississippian Farmstead at the Brandywine Pointe Site (40DV247), Cumberland River Valley, Tennessee. *Midcontinental Journal of Archaeology* 19 (2):198-222.

1996 Mississippian and Community Patterns on the Cumberland River, Tennessee: Recent Investigations of Small Mississippian Farmsteads. In *Proceedings of the*

14th Mid-South Archaeological Conference, edited by Richard Wallings, Camille Wharey, and Camille Stanley, pp. 49-68. Panamerican Consultants, Special Publications No. 1.

Stafford, C. Russell
1991 Archaic Period Logistical Foraging Strategies in West-central Illinois. *Midcontinental Journal of Archaeology* 16:212-246.

Tringham, Ruth, Gary Cooper, George Odell, Barbara Voytek, and Anne Whitman
1974 Experimentation in the Formation of Edge Damage: A New Approach to Lithic Analysis. *Journal of Field Archaeology* 1:171-196.

Walthall, John A.
1998 Rockshelters and Hunter-Gatherer Adaptation to the Pleistocene/Holocene Transition. *American Antiquity* 63:223-238.

PREHISTORIC FIRE ACTIVITY AND FOREST STRUCTURE ALONG THE CUMBERLAND PLATEAU

By

Cecil R. Ison

and

William E. Sharp
USDA-Forest Service
Daniel Boone National Forest
Winchester, Kentucky

ABSTRACT

Unlike many areas of the United States, the southern Appalachian Highlands are almost solely dependent on anthropogenic fires for affecting changes in plant and animal species composition. Although the extensive use of fire by American Indians has been recognized from the earliest European observers, it is somewhat difficult to determine the impact prehistoric fires had on forest structure. By examining the fossil and charcoal evidence from Cliff Palace Pond with the archaeological record recovered from surrounding sites, a 9,500 year record of the vegetational development can be established for the Escarpment zone of the Cumberland Plateau within Eastern Kentucky. This record indicates that anthropogenic fires played a pivotal role in shaping the forest structure, especially after the transition from a hunting and gathering economy to one based on swiden agricultural practices.

INTRODUCTION

Current issues facing many land managing agencies including the U.S. Forest Service such as maintaining biological diversity, restoring old growth, and promoting ecological function and balance, have required the agency to redefine its land management mission toward a more holistic vision of ecosystem sustainability. The problem the Forest Service faces in managing for ecological sustainability is to determine what framework of the ecosystem to manage. To many Americans, the National Forests should be managed in a wilderness state where "endless forests, black, untrodden, silent as the grave, covered the land" (Hedrick 1933:5). This perception is bolstered by the direction given by Congress when the Wilderness Act was established. One of the management objectives of the Wilderness Act is to "*Maintain wilderness in such a manner that ecosystems are unaffected by human manipulation and influences so that plants and animals develop and respond to natural forces.*" How then, does the Forest Service manage an area that has been unaffected by human manipulation? The answer is that it doesn't nor will it ever be able to.

Regardless of the language of the Wilderness Act or the erroneous, romantic perception that the eastern woodlands was a forest primeval, essentially untouched by man as many early writers described, the eastern woodlands have continually changed. In most cases the change evolved under the directing hands of countless people. Since the Pleistocene, there are few places that have not been affected by people. The forests as we now know them in Kentucky, have been manipulated by human factors since the beginnings of the human experience over 13,000 years ago. The Indian and later, early historic stewardship by Old World colonists helped determine forest structure, the quality of habitat as well as species composition and distribution.

In an ecological approach to land and resource management, the human influence must always be taken into consideration. Without an understanding of historical ecological processes and the impact the human factor had on the landscape, attempts to make recommendations to the management of today's ecosystem studies will be inadequate. Only by combining the historical and archaeological record with the input of natural resource specialists will land management planners be in a position to manage forest systems more appropriately. Through the cooperative efforts of natural and cultural resource studies at the Cliff Palace Pond Site in Jackson County, a new and much needed insight into the role of fire in determining the eastern Kentucky forest's structure has emerged.

FIRE HISTORY

Why study the role and history of fire? Until fairly recently, fire in the forests of the southern Appalachian highlands was viewed as a destructive agent for most species. Furthermore, it has been only within the last 30 years that natural resource scientists and managers have begun to recognize that fire disturbances are an important factor in promoting population and community diversity in most ecosystems (Martin 1990). Wildland fires have been determined to be an integral part of ecosystems across North America and the recurring fire disturbances are essential to the functioning of these systems (Mutch 1995).

Lightning is the only natural cause of forest fires in the southern Appalachians (Martin 1990). In this region, lightning fire occurrence is less than five fires per one million acres and usually occur after May when the sap is up. These fires usually lack the intensity necessary to affect plant species composition (Barden and Woods 1974). Therefore, unlike many areas across the U.S., the southern Appalachian highlands is almost solely dependent on anthropogenic fires for affecting changes in plant and animal species composition. Anthropogenic environmental change dates from the moment *Homo erectus* acquired the ability to start and stop fires (Pyne 1994) and within the southern Appalachian highlands when the first Paleo Indians entered upon the landscape. Although the extensive use of fires by American Indians has been recognized from the earliest European observers it is somewhat difficult to add insight into Indian-land relationships prior to European influence.

Pollen analysis is one effective technique for reconstructing the vegetational history of an area. Vegetational reconstructions based solely on the geologically deposited pollen grains however, cannot determine the causal factors for the change. Archaeological resources on the other hand, often contain enormous amounts of ethnobotanical remains that provide insight into how the American Indians selected and propagated plant food resources but lack the spatial framework to extract a record of how the human groups affected their environments. By examining both the fossil pollen and charcoal evidence from Cliff Palace Pond with the archaeological record, a 9,500 year record of the vegetational development has been established for the escarpment zone of the Cumberland Plateau. This record clearly illustrates how the aboriginal use of fire has modified the landscape, especially after the emergence of plant domestication.

Rockshelters within the escarpment zone of the Cumberland Plateau in eastern Kentucky have revealed rich sequences of ethnobotanical remains documenting a significant center for early plant husbandry and domestication of native plants during the Terminal Archaic and Woodland cultural periods (Ford 1985; Fritz 1995; Gremillion 1996; Jones 1936; Smith 1989, 1992). Despite the fact that these early plant husbandry exercises formed the basis for the first truly agricultural economies in the Eastern United States, the impact on ecological events and processes have not been satisfactorily explained.

These early forest farming practices depended almost entirely upon the aspect of fire for success. The dependency on fire combined with the available technology during the Terminal Archaic dictated the landforms which would be modified for agricultural use. Ison (1991) suggests the hillside plots on the upper slopes near the rockshelters were more beneficial over the narrow floodplain plots for forest farming. The use of fire on hillside plots would have been much more effective over floodplain settings for several reasons. Among these are: 1) the greatly reduced fuel moisture on upland plots would have resulted in a more intense burn; 2) a greater nutrient release from the more intense burn would have temporarily increased the fertility of the garden plot; 3) shading and forest plant competition would be not be as severe on slopes as it is along floodplain environs and, 4) the crops would be closer to the residence and could be more easily protected from predation by animals. Analysis of the Cliff Palace Pond sediments provided an avenue to test Ison's (1991) upland farming hypothesis.

CLIFF PALACE POND

Cliff Palace Pond is a small woodland pond perched along the crest of an isolated, flat-lying remnant of plateau within an otherwise maturely dissected terrain within the Western Escarpment Section of the Northern Cumberland Plateau Physiographic Province (Smalley 1986). This plateau interfluve, known locally as Keener Point, is flanked 0.9 km to the north by the narrow South Fork floodplain and 0.9 km to the east by the War Fork, both minor tributaries to the northward flowing Station Camp Creek, in turn tributary to the Kentucky River. The plateau is flanked by steep sandstone cliffs of Pennsylvanian age. The north-south oriented pond is situated in a small saddle near the western edge of the summit and is surrounded by a mat of Sphagnum moss. The pond has a total catchment area of 50 x 100 m (0.5 ha). The pool fluctuates 55 cm vertically, between the autumn low-water stage (area less than 1 m x 1 m) and late winter and the spring high-water stage (15 m x 30 m).

As part of an ongoing program to determine the relationship of forest composition to natural and human-influenced fire regimes, the Daniel Boone National Forest conducted pollen and charcoal analysis of the Cliff Palace Pond sediments (Delcourt and Delcourt 1997a). In the fall of 1996, a 142 cm sediment core was recovered from the pond using a square-rod Livingstone piston sampler and a Davis sampler. From this sediment core, pollen and charcoal extraction followed a standard procedure. After the pollen and charcoal was extracted, formal analysis was conducted. Analysis included identifying pollen grains and charcoal to the nearest taxon practicable as well as measuring charcoal particles by size.

One of the oldest and still most important methods used for environmental reconstruction is the retrieval; identification and counting of fossil pollen grains (Butzer 1982:173). By knowing which plants were present and their relative quantities, it is possible to draw conclusions about the climatic and environmental conditions prevailing at the time of deposition (Faegri and Iversen 1989). Quantification of charcoal particles by both size and quantity can be employed as an indicator of past fire histories. For example, charcoal fragments less than 10μ are considered as indicators of regional fires; those greater than 50μ are assumed to have been generated from forest fires within the immediate vicinity.

A suite of five radiocarbon samples were processed in order to place the stratigraphic levels in absolute chronological sequence. These samples were dated by Beta Analytic, Inc. radiocarbon laboratory using the AMS (accelerator mass spectroscopy) method. The AMS technique is designed to provide dates on extremely small samples that are not large enough for dating by standard count methods. Unfortunately the radiocarbon dates revealed several apparent stratigraphic reversals. For example, the lowest sample recovered from the stratum at 148-149 cm below water surface yielded a modern datem (post A.D. 1950). Other dates were suspect based on the pollen assemblages.

Contamination of the radiocarbon samples could have occurred for a variety of reasons. The periodic drying of the pond during extreme droughts may have permitted the encroachment of buttonbush into the area where the core was recovered thus allowing for contamination by the roots. Dates obtained soley by the AMS method also should be viewed with caution. Rossen and Dillehay (1996) provide convincing arguments where AMS dates which conflict with those provided by the standard count method or the stratigraphically defined cultural sequence should be discarded. They suggest it is more useful to utilize numerous lines of evidence in dating depositional environments.

As a result of the unreliable radiocarbon dates, site chronology was developed using regional pollen time lines extrapolated from well developed sites (Delcourt and Delcourt 1986; Wilkens et al. 1991) as well as ethnobotanical evidence from the immediate environs (e.g. Cowan et al. 1981; Gremillion 1993). Six stratigraphic layers were placed in firm synchronic age classes based on corresponding well dated pollen diagrams elsewhere. For example, the stratum at 36 cm is considered to date circa A.D. 1800 based on the historic increase of *Ambrosia* (ragweed) associated with EuroAmerican land clearance, and by the appearance of *Rumex* (dock) introduced from EurAsia. At Jackson Pond located approximately 150 km west of Cliff Palace Pond, the historic rise of Ambrosia was radiocarbon dated at 120 yr. B.P. (Wilkens et al. 1991:227). As another example, at Cliff Palace Pond the mid-Holocene decline of *Tsuga* (hemlock) occurs at the 60 cm stratum. This decline is time-synchronous throughout hemlock's range in the eastern United States (Davis 1981) and has been directly dated at Saltville, Virginia at 4,800 B.P. (Delcourt and Delcourt 1986).

PALEOECOLOGY OF CLIFF PALACE POND

The pollen and charcoal record from Cliff Palace Pond demonstrates that this portion of the Escarpment Zone of the Cumberland Plateau has been forested continuously since at least the early Holocene (Early Archaic cultural period). The composition of the forests, has however,

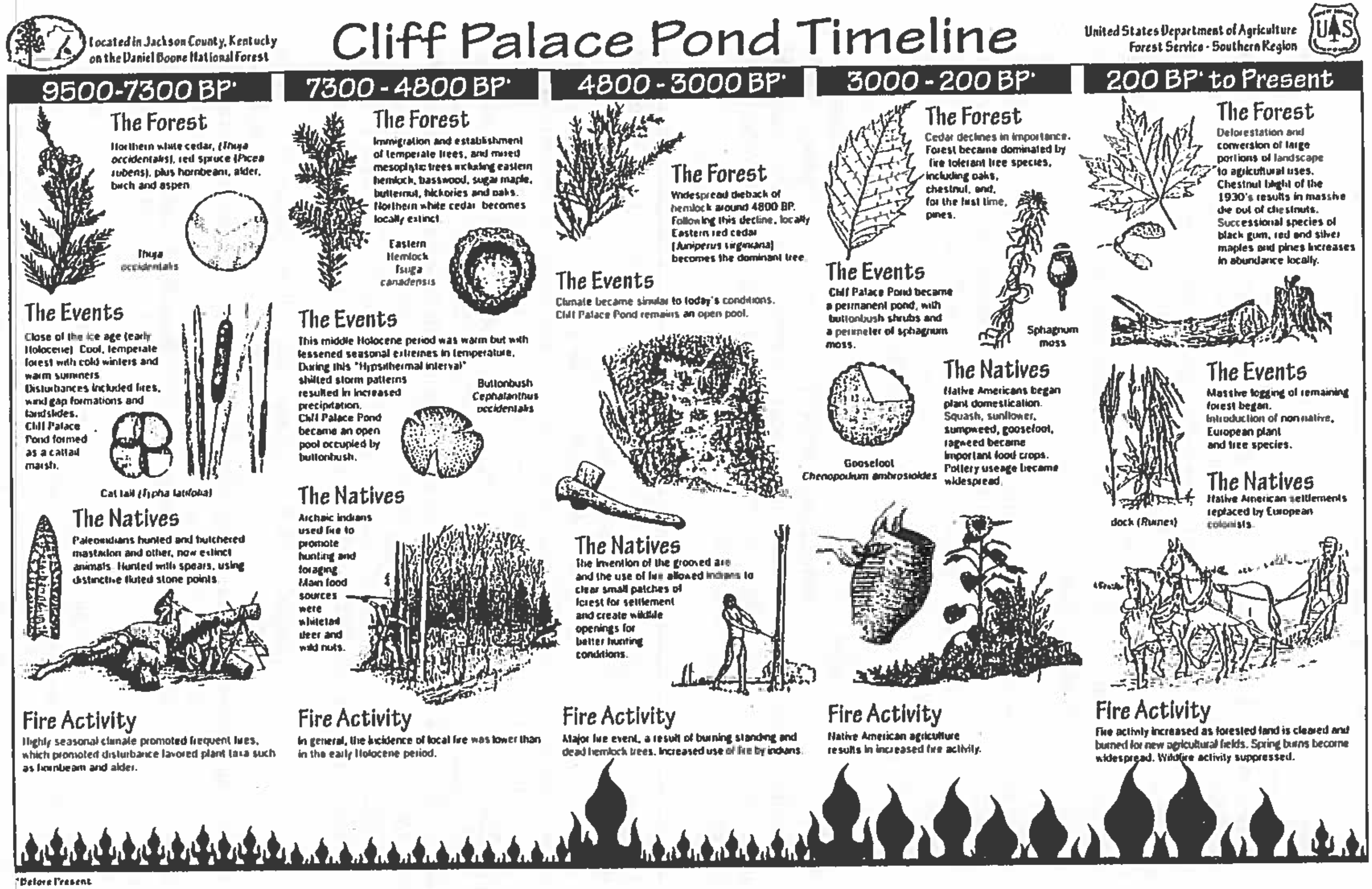


Figure 1: Cliff Palace Pond Timeline. Flames at the bottom reflect fire intensity based on quantification of charcoal particles within sediments.

changed dramatically through the past 9,500 years in response to a combination of factors including climate change and both prehistoric and historic human activities (Figure 1).

In the early Holocene interval (9500 to 7300 B.P.), forests near Cliff Palace Pond were composed of cool-temperate to boreal trees including spruce (probably red spruce, *Picea rubens*). The vegetation was dominated by cedar, probably northern white cedar (*Thuga occidentalis*), which occurs as disjunct outlier populations today on cliff faces in the southern Cumberland Plateau of Tennessee (Braun 1950). Northern white cedar would have been favored by the highly seasonal climate (cold winters, warm summers) characteristic of the early Holocene (Kutzbach and Guetter 1986) and the calcareous soils of mid to lower slopes. Hornbeam (*Ostrya/Carpinus* type), alder (*Alnus rugosa* type), birch (*Betula*) and aspen (*Populus*), all grew in the vicinity of Cliff Palace Pond in the early Holocene.

Highly seasonal climates of the early Holocene would have promoted a disturbance regime that included frequent fire, wind gap formation, and geomorphologically unstable landscapes in which landslides may have been frequent (Delcourt and Delcourt 1997c). These environmental conditions would have promoted disturbance-favored plant taxa such as hornbeam (Delcourt and Delcourt 1994) and alder (Delcourt and Delcourt 1997c).

The middle Holocene interval (7300 to 4800 B.P.) was the time of immigration and establishment of temperate trees in southeastern Kentucky, and mixed mesophytic forest communities including hemlock, basswood, sugar maple, butternut, hickories, and oaks established on mid and lower slopes near Cliff Palace Pond, replacing northern white cedar, which became regionally rare and locally extinct.

The middle Holocene interval was warm but with lessened seasonal extremes in temperature (Kutzbach and Guetter 1986). In the midwestern United States, the middle Holocene "Hypsithermal Interval" was a time of warmth and drought and increased fire frequency, promoting prairie grassland that spread eastward at the expense of forest. The zonal flow of westerlies correspond with the eastward expansion of a wedge of Pacific Airmass that dominated year around. This blocking Pacific Airmass served to contain the northward incursions of the Maritime Tropical Airmass to the southeast. As a result, the typical position of storm tracks would have been displaced into southeastern Kentucky, resulting in a time of increased precipitation within the central and southern Appalachian Mountains (Delcourt and Delcourt 1987). Locally, Cliff Palace Pond changed from an early Holocene cattail marsh to a middle Holocene open pool occupied by buttonbush. In general the incidence of local fires was lower than in the early Holocene as a result of the increased precipitation.

At the end of this interval, hemlock declined from approximately six percent of the forest composition to total absence at Cliff Palace Pond. This was probably in response to infestation by hemlock looper, which caused widespread die back of the hemlocks throughout its range in eastern North America 4800 years ago (Davis 1981). Coincident with the hemlock decline in the Cliff Palace Pond is a large peak of the charcoal accumulation rates (CHAR) indicating a major fire event. This fire event is interpreted as the burning of standing and fallen dead hemlock trees.

Following the hemlock decline and the catastrophic fire, cedar pollen increased dramatically in the pollen record, probably representing extensive stands of eastern red cedar (*Juniperus virginiana*), which would have occupied the calcareous soils of mid-slopes as well as possibly the fire-scorched sandstone ridge top. The hemlock decline is also reflected in the cultural deposits of the nearby Cloudsplitter Rockshelter, where Tsuga pollen values dropped from 80% at 7000 yr. B.P. to 2% at about 4500 yr B.P. (Cowan et al. 1981).

Between 3000 and 200 B.P., Cliff Palace Pond became a permanent pond occupied by buttonbush shrubs and with a perimeter of sphagnum moss, indicating an increase in mean annual precipitation and more equable distribution of precipitation throughout the year. Cedar declined dramatically in importance; its demise was followed briefly by a succession to ash, probably including the calciphile blue ash (*Fraxinus quadrangulata*). Subsequently, the forests surrounding the pond became dominated by oaks (*Quercus*), chestnut (*Castenea*) and for the first time, pines(*Pinus*).

Pollen grains of both cultigens within the "eastern agricultural complex" and weedy or ruderal species such as ragweed that invade forest openings made by human activities appear within the record. Although relatively large pollen grains of wild grasses (probably including *Andropogon*, which would have grown in the open understory of ridge top pine stands) were identified, no maize pollen was identified from Cliff Palace Pond sediments. The reporting of maize pollen identified from the deposits of Cliff Palace Cave (15Ja41) situated immediately below the pond is therefore questionable. The maize pollen dated at circa 3000 B.P. (Tankesley 1981) is much earlier than maize documented from other southeastern North American sites (Fritz 1995).

Paradoxically, during the late-Holocene time of climatic cooling and increased precipitation, the forest near Cliff Palace Pond was dominated by fire-adapted taxa. The charcoal record during this time period demonstrates a major increase in large charcoal particles indicating local fires occurred on the ridge top surrounding the pond. The ridge top vegetation may have consisted of a relatively open canopy of pitch pine (*Pinus rigida*), with an understory of heaths and flowering dogwood (*Cornus florida*).

During the past 200 years, a series of changes in forest composition occurred following EuroAmerican settlement of Eastern Kentucky. After A.D. 1800, a major increase in ragweed accompanied deforestation and conversion of large portions of the landscape to agriculture. Species introduced from Europe included dock *(Rumex)*. Chestnut declined after about A.D. 1930, and successional red maple (*Acer rubrum*), silver maple (*A. saccharinum*), black gum (*Nyssa sylvatica*) and Diploxylon pines including Virginia pine (*Pinus virginiana*) increased in abundance locally around Cliff Palace Pond.

ARCHAEOLOGY OF SITES SURROUNDING CLIFF PALACE POND

The cliffs surrounding Keener Point impeded free intercourse between the summit and the adjacent, deeply entrenched stream valleys. Erosion of the less resistant sandstones have formed numerous overhangs, beneath which lie large, semicircular recesses extending far back into the cliffs. A partial survey of the Cliffline surrounding Keener Point documented nine prehistorically occupied rockshelters. An "Indian Staircase" consisting of a series of foot or toe hole steps, pecked into the steeper sections of the sandstone outcrop, provided access to the ridge top along the western end of the ridge spur (Figure 2). On top of the summit, Cliff Palace Pond is surrounded by a large, open prehistoric site. Diagnostic artifacts recovered during the initial documentation of this site indicate the site was minimally occupied during Middle and Late Archaic periods.

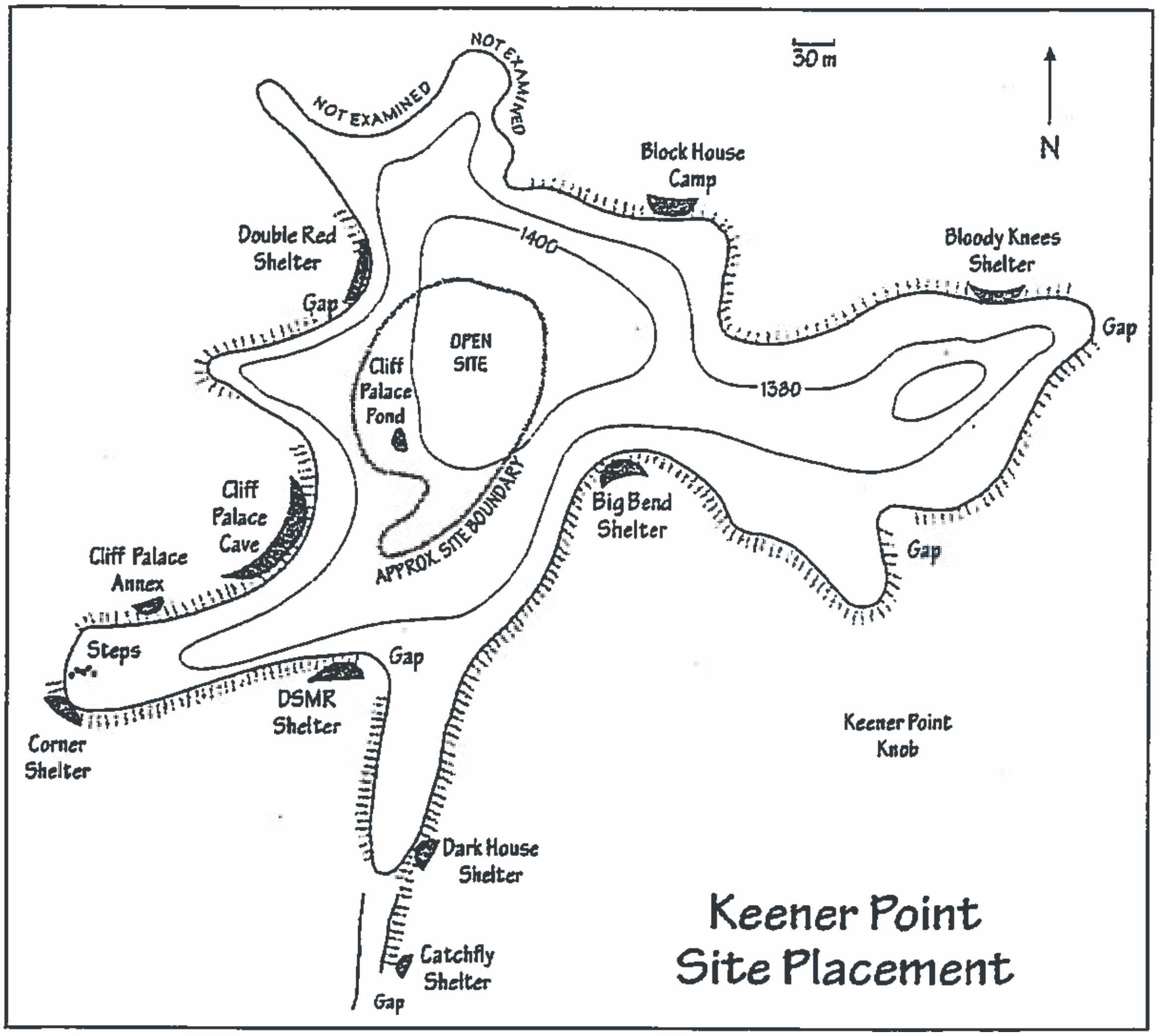


Figure 2: Keener Point Site Placement in Relation to Cliff Palace Pond.

Two of the larger Keener Point rockshelters exhibit deposits containing faunal elements, quantities of charcoal, burned soil, and artifacts dating from the Archaic, Woodland, and Fort Ancient Periods. Excavations by Tankersley (1981) at Cliff Palace Cave (15Ja41) on the west side of Keener Point, revealed a series of seven hearth features and a single postmold. A radiocarbon date of 1050 B.C. ± 75 (Uga - 3300) was obtained from one of the features. In addition, the presence of a petroglyph at the site suggests ritualization processes and changing social relations were an integral component of those living there. During the Terminal Archaic, Ison (1996) postulates that horticulture may have been an impetus for changing the basic cultural orientation of many groups living within the Escarpment Zone of Eastern Kentucky. Clusters of petroglyph sites coincide with early plant domesticates. Ritualization processes involving the formation of rituals related to the newly incorporated food resources may have evolved in order to "regularize their exploitation" within a supernatural context (Coursey 1976). For example, Fritz (1996) postulated that the plant processing activities identified at an Ozark rockshelter might have been closely related to the rock art production found at the site.

The Dark House Shelter (15Ja59), located on the opposite side of Keener Point is the other site containing deep cultural deposits. Recent excavations revealed 0.7 m of intact ash and cultural midden remaining near the backwall. The artifacts recovered represent occupational episodes of the Archaic, Woodland and Fort Ancient periods. However, a charcoal sample taken from the base of the midden produced a radiocarbon age of 2760 ± 60 B.P. (Beta-126497), suggesting the most intensive use of the shelter started sometime between 1020 and 805 B.C. (calibrated results of radiocarbon age at 2 sigma, 95% probability). Greater residential stability is often linked to food production subsistence strategies. If this is the case at Dark House, the radiocarbon date probably marks the beginning of more long-term occupations associated with the use of domesticated or semi-domesticated native cultigens. It is tempting to interpret the radiocarbon date from Cliff Palace Cave in a similar manner. Obviously, these two shelters were very important to the prehistoric people of the Keener Point area.

With one exception, the eight remaining rockshelters contain prehistoric remains of undetermined age consisting entirely of lithic debris from stone tool production and/or maintenance. In many of these shelters the identifiable artifact assemblages may be the results of poor preservation and in others diagnostic artifacts may have been previously removed by artifact collectors. Artifacts from one of the shelters, 15Ja414 (DSMR), are unusual due to the large size of and quantity of flakes present. While faunal remains, charcoal, etc. may have been present at one time, the absence of these artifact types along with the absence of a midden accumulation indicates short term occupations or specialized use sites. The single dateable exception tends to support such an interpretation. This exception is a small shelter (15Ja 406 – Catchfly) with shallow deposits. Recovered from the overhang were a few retouch flakes and a broken Middle Archaic style projectile point. Deposits at this site are conjectured to represent a single short term episode.

Even with the limited data available, it is possible to reconstruct a summary of the archaeology of Keener Point. Located in the headwaters of Station Camp Creek, the Keener Point area has good quality chert available from the St. Genevieve and St. Louis limestones exposed at lower elevations and an abundance of natural rockshelters making it very attractive to the earliest hunting and foraging people to enter the region. That it was visited during the Archaic period and possibly earlier on a fairly regular basis is attested to by the remains found in all usable overhangs surrounding Keener Point and the open site on top of the knob which surrounds Cliff Palace Pond.

By the Early Woodland period, at least two of the shelters were occupied more intensively, probably reflecting a decrease in residential mobility associated with a greater reliance on native cultigens grown in small hillside garden plots. Ideally suited to disturbed habitat on slopes, these native, weedy crop species introduced plant husbandry into the basic hunting and foraging subsistence economy of the region. Increased reliance on corn and a tendency toward more nucleated communities by the beginning of the Fort Ancient period, reduced the amount of time the Keener Point shelters were annually occupied, but the shell tempered pottery and the small triangular projectile points are clear evidence that the sites continued to be used, probably as seasonal hunting camps.

Changes in forest composition and fire regimes identified at Cliff Palace Pond can be correlated with archaeological evidence. While the rise in fire activity after 4800 B.P. is due in large measure to the burning of the standing and fallen hemlock trees it is also due in part to the wide scale use of the grooved axe. This technological invention enabled the Native Americans to girdle and fell small patches of forest for various economic reasons. For example, replicative experiments using stone axes indicate that about 200 m^2 of forest could be cleared in about four hours (Spurr and Barnes 1973:487). Fire also appears to have been exploited to improve wildlife habitat for better hunting.

Following this major fire episode, the size and quantity of charcoal within the core record at Cliff Palace Pond remains fairly level until about 3000 B.P. At this temporal juncture not only does the charcoal rise dramatically for the first time since the hemlock die-off, but the presence of a suite of pollen grains representing ruderal plants such as ragweed that invade forest openings made by human activities and native cultigens within the "eastern agricultural complex" appear for the first time.

This evidence is in line with the slash and burn agricultural techniques that would have been employed by the prehistoric farmers to clear their upland garden plots. Archaeological evidence recovered from rockshelter sites such as Cloudsplitter and Cold Oak where early cultigens have been recovered (cf. Cowan et al. 1981; Gremillion 1993) within Late Archaic contexts also support this shift in environmental exploitation. At both these sites the suite of cultigens representing the Eastern Agricultural Complex undergo a dramatic increase after about 3000 B.P. The rise in the charcoal record at Cliff Palace supports the premise that fire (slash and burn agriculture) was the primary method of preparing the small hillside garden plots.

The interaction of prehistoric human activities and forest dynamics on the landscape surrounding Cliff Palace Pond took place by the way of the interrelationships among cultural use of fire, cultivation of plants and forest succession. The changes upon the landscape for the most part, occurred very gradually over hundreds or thousands of years. The transition from one forest type to another was so gradual that for those who didn't keep diaries, logs, or oral traditions, the change was never noticed. It is only through the archaeological remains collaborated with pollen and charcoal evidence from Cliff Palace Pond that the murky waters of past forest conditions become clear.

CONCLUSIONS

In the beginning of this paper the question was asked "how does the U. S. Forest Service manage an area that has been unaffected by human manipulation?" The answer was that it can't.

The point that we have strived to illustrate is to dispel the myth the pristine natural world lacked any major human impacts. Science in many instances takes a back seat to what people want to perceive as truth. This is especially true for those who adhere to the belief that the New World, at the time of contact with the first Europeans represented a wilderness paradise, a virtual Eden of bounty. The source for this idyllic image lies in part with the romantic eighteenth and nineteenth century literature created by Cooper, Hawthorne, Longfellow and the like (Neumann 1994).

These picturesque approaches to the landscape placed emphasis on the senses as the source of what one knows. Vision, being the most important of the senses and those who pursued the picturesque sought to provide the mind with maximum stimulation (Jackle 1977:11). James Hall (1828) summarized this influence when he penned "Blame me not for yielding, amid such scenes, to the influence of feeling, and giving up my whole soul to wild, and warm, and visionary fancies. It is a humiliating reflection that our sweetest hours are those which are least connected with the realities of life".

Management of ecosystems requires an understanding of the complexities which make up the system. The development of policies designed to manage ecosystem cannot be developed using cultural myths regardless of the appeal of the myths. The key is to provide sound arguments based on empirical evidence. In the long term, only sound science will provide information needed to make rational decisions on what direction we will head in the management of our ecosystems.

Finally, the value of the Cliff Palace Pond pollen and charcoal sediments cannot be determined in isolation. Management of the environment requires an understanding of what happens within a complex system. There are simple answers to the management of complex systems and they are *all wrong*! The value of these sediments can only be found in the relationship of Cliff Palace Pond to other sites and in the overall body of knowledge they provide.

REFERENCES CITED

Barden, L. S. and F.W. Woods

1974 *Characteristics of Lightning Fires in Southern Appalachian Forests.* Tall Timbers Fires Ecology Conference 13:345-361.

Braun E. Lucy

1950 *Deciduous Forests of Eastern Northern America* (reprinted 1974). Hafner Press, New York.

Butzer, Karl W.

1982 *Archaeology as Human Ecology: Method and Theory for a Contextual Approach.* Thames and Hudson, New York.

Coursey, D. G.

1976 The Origins and Domestication of Yams in Africa. In *Origins of African Plant Domestication*, edited by Jack R. Harlan, Jan M. J. DeWet, and Ann B.L. Stemler. Molton, The Hague.

Cowan, C. Wesley, H. Edwin Jackson, Katherine Moore, Andrew Nickelhoff, and Tristine L. Smart

1981 The Cloudsplitter Rockshelter, Menifee County, Kentucky: A Preliminary Report. *Southeastern Archaeological Conference Bulletin* 24:60-75.

Davis, M. B.

1981 Outbreaks of Forest Pathogens in Quaternary History. *Proceedings of the IV International Palynological Conference, Lucknow* (1976-1977) 3:216-227.

Delcourt, Paul A. and Hazel R. Delcourt

1986 Late Quaternary Vegetational Change in the Central Atlantic States. In *The Quaternary of Virginia - A Symposium Volume*, edited by J. N. McDonald and S. O. Bird, pp. 23-25. Virginia Division of Mineral Resources Publication 75, Charlottesville, Virginia.

1987 *Long-Term Forest Dynamics of the Temperate Zone, Ecological Studies* 63. Pringer-Verlag, New York.

1994 Postglacial Rise and Decline of *Ostrya virginiana* (Mill.) K. Koch and *Carpinus caroliniana* Walt. In "Eastern North America: Predictable Responses of Forest Species to Cyclic Changes in Seasonality of Climates". *Journal of Biogeography* 21:137-150.

1997a Report of Paleocological Investigations, Cliff Palace Pond, Jackson County, Kentucky, in the Daniel Boone National Forest. Report submitted to USDA Forest Service, Daniel Boone National Forest, Winchester, Kentucky (Contract No. 43-531A-6-0389).

1997b Prehistoric Human Use of Fire on Southern Appalachian Landscapes. *Conservation Biology* (in press).

1997c Conservation of Biodiversity in Light of the Quaternary Paleoecological Record: Should the Focus be on Species, Ecosystems, or Landscapes? *Ecological Applications* (in press).

Faegri, Knut and J. Iverson

1989 *Textbook of Pollen Analysis*. John Wiley and Sons, New York.

Ford, Richard I.

1985 The Processes of Plant Food Production in Prehistoric North America. In *Prehistoric Food Production in North America*, edited by Richard I. Ford, pp 1-18. Anthropological Papers No. 75, Museum of Anthropology, University of Michigan, Ann Arbor.

Fritz, Gayle, J.

1995 New Dates and Data on Early Agriculture: The Legacy of Complex Hunter-Gathers. *Annals of the Missouri Botanical Garden* 82:3-15.

1996 *Plants and Petroglyphs: Archaeological Remains from the Narrows (3CW35).* Report submitted to the Arkansas Archaeological Survey, Fayettville.

Gremillion, Kristen J.

1993 Plant Husbandry at the Archaic/Woodland Transition: Evidence from the Cold Oak Shelter, Kentucky. *Midcontinental Journal of Archaeology* 18:162-189.

1996 Early Agricultural Diet in Eastern North America: Evidence from Two Kentucky Rockshelters. *American Antiquity* 61:520-536.

Hall, James

1828 *Letters from the West; Containing Sketches of Scenery, Manners, and Customs; and Anecdotes Connected with the First Settlements of the Western Section of the United States*. Henry Colburn, London.

Hedrick, Ulysses Prentiss

1933 *A History of Agriculture in the State of New York.* American Century Series, 2nd edition, New York.

Ison, Cecil R.

1991 Prehistoric Upland Farming along the Cumberland Plateau. In *Studies in Kentucky Archaeology*, edited by Charles D. Hockensmith, pp. 1-10. Kentucky Heritage Council, Frankfort.

1996 Hominy Holes, Petroglyphs and the Cogswell Phase: Rethinking Terminal Archaic Sedentism. Paper presented at the 53rd Annual Meeting of the Southeastern Archaeological Conference, Birmingham, Alabama.

Jakle, John A.

1977 *Images of the Ohio Valley: A Historical Geography of Travel, 1740 to 1860.* Oxford University Press, New York.

Jones, Volney H.

1936 The Vegetal Remains of Newt Kash Hollow Shelter. In *Rock Shelters in Menifee County, Kentucky*, by William S. Webb and William D. Funkhouser, pp. 147-165. Reports in Archaeology and Anthropology 3 (4). University of Kentucky, Lexington.

Kutzbach, J. E. and P. J. Guetter

1986 The Influence of Changing Orbital Parameters and Surface Boundary Conditions on Climate Simulations for the Past 18,000 Years. *Journal of Atmospheric Science* 43:1726-1759.

Martin, William H.

1990 The Role and History of Fire in the Daniel Boone National Forest. Report on file at USDA Forest Service, Daniel Boone National Forest, Winchester, Kentucky.

Mutch, Robert W.

1995 Need For More Prescribed Fire: But a Double Standard Slows Progress. Paper presented at the Environmental Regulation and Prescribed Fire Conference, Tampa, Florida.

Neumann, Thomas W.

1994 The Structure and Dynamics of the Prehistoric Ecological System in the Eastern Woodlands: Ecological Reality Versus Cultural Myths. Paper presented at the Symposium on Late Woodland Archaeological Research in the Middle Atlantic. Middle Atlantic Archaeological Conference, Ocean City, Maryland.

Pyne, Stephen J.

1994 Maintaining Focus: An Introduction to Anthropogenic Fire. *Chemosphere* 29 (5):889-911.

Rossen Jack and Tom D. Dillehay

1996 Ancient Cultigens or Modern Intrusions?: Evaluating Plant Remains in an Andean Case Study. *Journal of Archaeological Science* 23:391-407.

Smalley, Glendon W.

1986 *Classification and Evaluation of Forest Sites on the Northern Cumberland Plateau.* USDA Forest Service General Technical Report SO-60, Southern Forest Experiment Station, New Orleans, Louisiana.

Smith, Bruce D.

1989 Origins of Agriculture in Eastern North America. *Science* 246:1566-1571.

1992 Prehistoric Plant Husbandry in Eastern North America. In *Origins of Agriculture: An International Perspective*, edited by C. Wesley Cowan and Patty Jo Watson, pp. 101-120. Smithsonian Institution Press, Washington, D.C.

Spurr, Stephen H. and Burton V. Barns

1973 *Forest Ecology*. The Roland Press Company, New York.

Tankersley, Ken B.

1981 Cliff Palace Cave, Site Number 15Ja41, Jackson County, Kentucky. Kentucky Archaeological Site Survey Form. Form on file at USDA Forest Service, Daniel Boone National Forest, Winchester Kentucky.

Wilkins, Gary, Paul A. Delcourt, Hazel R. Delcourt, Frederick W. Harridan, and Mansion R. Turner

1991 Paleocology of Central Kentucky Since the Last Glacial Maximum. *Quaternary Research* 36:224-239.

UNIQUE PREHISTORIC CULTURAL ARTIFACTS IN THE S-BEND AREA OF MAMMOTH CAVE, KENTUCKY

By

Kenneth C. Carstens
Department of Geosciences
Murray State University
Murray, Kentucky

and

Philip J. DiBlasi
Department of Anthropology
University of Louisville
Louisville, Kentucky

ABSTRACT

Two unique archeological artifacts (a cane flute and a charcoal pictograph) were found in the S-Bend area of Mammoth Cave in 1978. The artifacts were found during a Phase I reconnaissance in a portion of the cave system proposed for a self-guided tour by the National Park Service. Near them was a previously reported pictograph found in the vicinity during the early nineteenth century. In this paper we address the significance of these Early Woodland prehistoric cultural materials found within the S-Bend area of Mammoth Cave.

INTRODUCTION

Mammoth Cave National Park is located in south-central Kentucky, primarily in Edmonson and Hart counties, in a geological area known as the Central Kentucky Karst. The Flint-Mammoth cave system in Mammoth Cave National Park is both the world's longest cave and a World Heritage site. Beneath a 109 km^2 surface area in, and extending outside of, Mammoth Cave National Park, are more than 560 km of interconnected mapped passageways, all existing within five levels of cave development. Archaeological reconnaissance within the Flint-Mammoth cave system has demonstrated that prehistoric Native Americans explored at least 35 km of the cave passages during their subterranean exploratory and economically-exploitive pursuits.

In 1978, Patty Jo Watson and Kenneth C. Carstens (1982) were hired by the Southeast Archaeological Center of the National Park Service to conduct an archeological survey of eight surface areas in Mammoth Cave National Park and to perform an archeological reconnaissance within a portion of Historic Mammoth Cave. The cultural resource reconnaissance and inventory between Star Chamber and Violet City (Figure 1) in Mammoth Cave demonstrated that prehistoric cultural activities were extremely intensive in that area of the cave. Indeed, the great rooms of Wright's Rotunda and Chief City, as well as the passages connecting them, demonstrate that those areas may have been some of the most heavily, prehistorically traveled areas within Mammoth

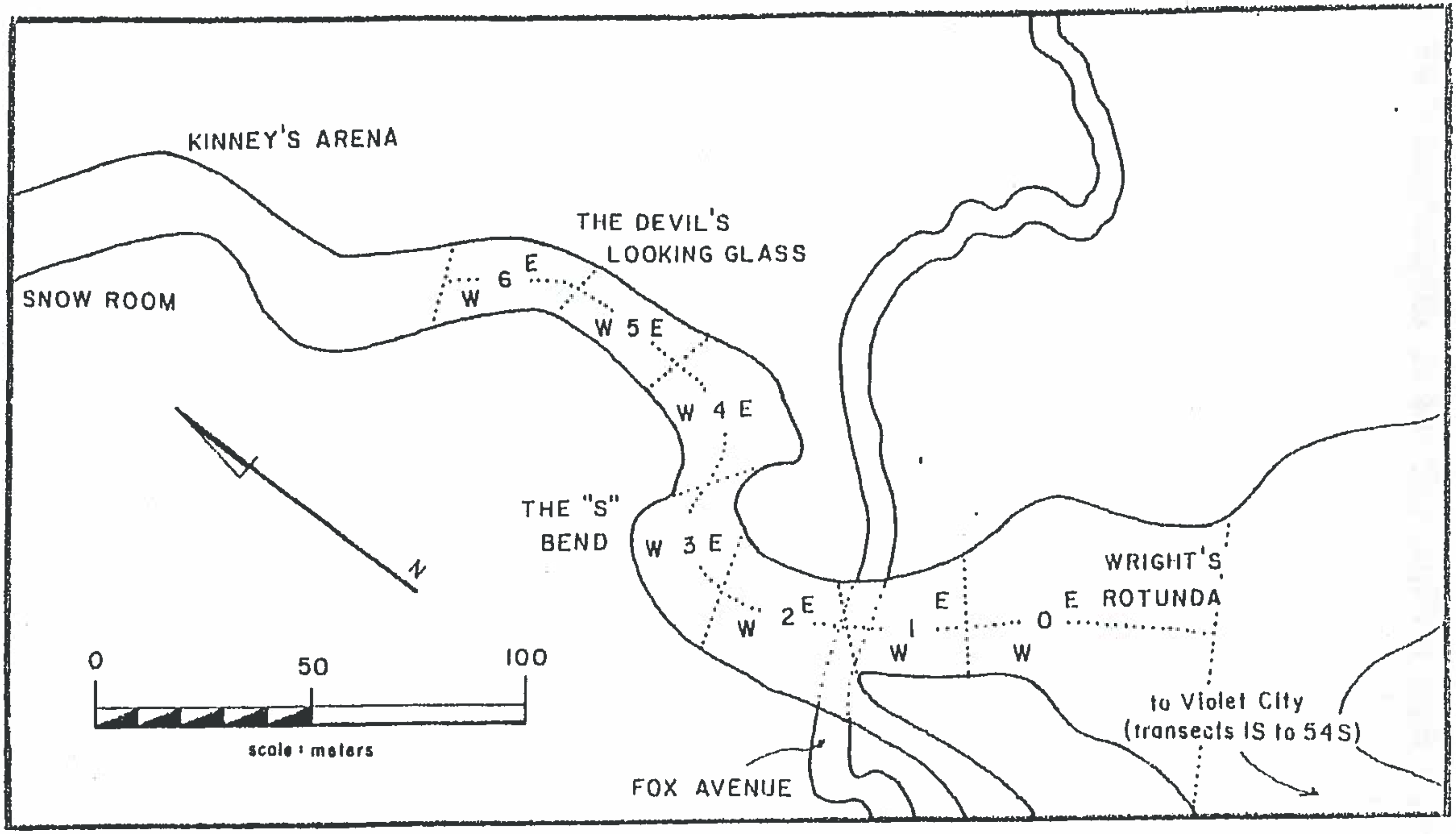


Figure 1. "S"-Bend Area in Main Cave at Mammoth Cave. Flute found in Reconnaissance Transect 3E, Devil's Looking Glass in 5E.

Cave. The nature of that activity has been studied by several archaeologists since the turn of this century, such as Nelson (1917, 1923), Pond (1935, 1937, 1938), Schwartz (1958a-g, 1960, 1965), Watson (et al. 1969, 1974), Watson and Carstens (1982), and Crothers and Ward (1995). In particular, the work by Watson and her associates (et al. 1969), reveals that prehistoric cultural activity within the interior of the Flint-Mammoth cave system focuses on mining certain cave minerals (e.g., gypsum, mirabilite, selenite and satin spar) (Munson et al. 1989; Tankersley 1996), and general cave exploration. Habitation areas within the cave were restricted to the entry chamber or Vestibule area (Nelson 1917; Watson et al. 1969; 1974). Radiocarbon dating some of the prehistoric cultural remains from those activities reveal that the temporal duration of prehistoric cave mining and exploration was primarily limited to the Early and Middle Woodland periods for the Flint-Mammoth Cave system, ca. 1500 B.C. to A.D. 400. Several radiocarbon determinations taken from cultural materials and from an aboriginal body (historically known as "Lost John") found in Upper Mammoth Cave, exhibit a similar temporal assignment for prehistoric cave activity (Crothers et al., 2002.; Kennedy 1990, 1996; Kennedy and Watson 1997; Watson 1974: 236). The kinds of artifacts, types of cultural activities, and the types of locations of cultural materials found during reconnaissance trips between Star Chamber and Violet City in Mammoth Cave demonstrate similarities between cultural activities, temporal assignments, and artifact types with other caves in the Mammoth Cave area and throughout the Central Kentucky Karst in southern Indiana, Tennessee, northern Alabama, and Mississippi.

In a previous, but non-intensive, systematic survey of the passage between Violet City and Star Chamber, Watson (1974:183-186) described the general condition, frequency, type, and nature of prehistoric cultural materials observed during her reconnaissance. A portion of her observations about that part of Upper Mammoth is presented here (Watson 1974:183-186):

> On May 28 (1970) a trip was made from the Violet City Entrance to the Historic Entrance in the main cave...Much of the route between the present-day Violet City Entrance and the Historic Entrance of Mammoth Cave has long been commercialized...From the Violet City Entrance one descends a long flight of steps (Albert's Stairway) past a set of spectacular domes and enters Kamper 's Hall, then Ultima Thule and Anzer's Hall. The area around the domes and shafts is wet and if there was aboriginal activity here, the evidence has been destroyed by water. However, beginning in Anzer's Hall and continuing the length of Mayme's Stoopway are remains left by aboriginal cavers: cane fragments, scattered bits of charcoal, charcoal smudges on the walls, and occasional evidence of mining on both sides of the commercial trail way...A small room in the breakdown at one side of Mayme's Stoopway has been partly mined and contains a scatter of cane and charcoal. At Hain's Dome gourd fragments are lying on a flat rock beside the trail ... Some of the walls of the dome are mined...the dome shows remains of Indian traffic: cane, charcoal, smudged walls and ceilings. There is a [an aboriginal climbing] pole leaning against the wall and more traces of mining as well as cane and charcoal fragments at St. Catherine City. A low crawlway leading off the main passage just north of St. Catherine City contains cane fragments. Chief City is a huge room --like much of the rest of the cave-- with piles of breakdown rock and on and among which the aboriginal debris is strewn. Near the trail was found a 15 cm. long, two-strand, Z-plied grass cord...According to local Kentuckians, the quantity of Indian materials...in Chief City was once very great, so great that early (Cave) guides used to heap it up and ignite it to light the big room for the benefit of tourist parties. In 1935, the Mammoth Cave mummy --Lost John-- was found on a ledge near Chief City.

> There are mining tools near the west wall of Bryan's Pass between Chief City and Potter Hall. Some smudges are present on the west wall of Potter Hall but other remains are scarce here. In Wright's Rotunda there is further evidence of mining as well as a scatter of cane and charcoal. Another mining tool is lying on the breakdown at the east wall of the S-Bend, and there are [human] paleofecal specimens nearby. There is evidence of mining of the east wall and on an alcove in that wall in the S-Bend area. In Kinney's Arena there is a large pile of cane against the east wall where someone has collected together several [human] paleofecal fragments and pieces of torch or firewood ties...Also there are two *Gerardia* seed pods and half of a hickory nut shell...Farther along, in the vicinity of the Snow Room, is a large fragment of warty squash (17 x 12 cm., walls 6-8 mm thick), and there are [human] paleofecal specimens along both east and west walls. There is another [aboriginal climbing] pole near the western wall of the Snow Room. Beside the trail on a ledge someone has placed a [human] paleofecal fragment and the peduncle end of a large gourd (24 x 19.5 cm with walls 4 mm thick). There are traces of mining as well as cane and charcoal fragments from Kinney's Arena through the Snow Room. Beyond this point, aboriginal remains are sparse and then cease altogether, having been obliterated by the intense nineteenth century and early twentieth century activity (including trail building and saltpeter mining) near the Historic entrance.

The 1978 intensive and systematic resurvey of the passages between Violet City and Star Chamber in Mammoth Cave by Carstens and Watson (1978) revealed that: (1) Watson's earlier observations about the intensity of prehistoric traffic and use in Mammoth Cave were essentially correct; (2) the majority of prehistoric cultural materials occurs between Anzer's Hall and Snow Room; (3) the majority of cultural materials consist of burned and unburned twigs and wood, and charred and uncharred split and cut cane; (4) most of the prehistoric activity was oriented toward cave mining (mostly gypsum) and exploration; and (5) nineteenth and early twentieth century cultural activities have, in some places, severely altered the cultural context of a considerable quantity of prehistoric cultural materials, especially between Snow Room and the Historic entrance. Also, the 1978 survey revealed additional prehistoric artifact categories that are relatively rare in the Eastern United States, e.g., unionid shell scrapers, aboriginal charcoal drawings, and a cane flute, or flageolet (Alfred Dittert, Arizona State University, personal communication, 1994). Cane flutes are rarely reported from the Eastern Woodlands. (A distinction is made here between one-tone bone whistles and pan pipes, which are relatively common, and cane or wooden flutes or flageolets that have multiple holes for generating multiple and harmonic tones.)

Carstens and Watson quantified the prehistoric materials they encountered during their 1978 survey for the area between Wright's Rotunda and the Snow Room in Upper Mammoth Cave in order to demonstrate the intensity of prehistoric cultural materials encountered during the 1978 reconnaissance (Figure 1). That area (Wright's Rotunda to Snow Room) is only 180 m in length, yet in 1978, over one thousand items of prehistoric origin were located, measured, described, and categorized. Cultural materials in the cave were left in situ. Because of the fragile nature of the artifacts, Watson and Carstens (1982) concluded that increasing public traffic flow through this section of Mammoth Cave, even if supervised or semi-supervised, would be extremely hazardous to the preservation of what is one of the most significant prehistoric artifact assemblages in North America. Watson and Carstens recommended the proposed self-guided tour between Star Chamber and Violet City not be allowed to occur. The National Park Service concurred with the recommendation. A more recent, and exacting, multi-year study, by the National Park Service, currently supervised by George Crothers and Bob Ward, in conjunction with Earth Watch volunteers, is mapping artifact categories into classes of artifact data. Sokkia MAP and AUTOCAD are being generated that show artifact densities by classes of artifacts (Crothers and Ward 1995). Crothers and Ward (1995) conclude that, despite historic disturbances to the Main Cave, patterns of prehistoric use are still evident for portions of the Main Trunk of Mammoth Cave.

THE S-BEND AREA

About 180 m north of Wright's Rotunda, but south of the Snow Room, is a geological feature called "S-Bend," where, as the name suggests, the Main Trunk passage of Mammoth Cave takes the form of an "S" (Figure 1). In cross-section, the trunk passage at S-Bend is oval with ceiling breakdown littering the floor along the east and west walls. Thus, the floor curves or slopes upward to meet the ceiling. The nineteenth and twentieth century tourist paths wind between the two breakdown zones, some five to eight meters below an upper ledge of breakdown along the eastern wall. Strewn among the breakdown are numerous evidences of prehistoric activity, including human paleofecal specimens, 43 charred cane and stick torch fragments, three pieces of bark fragments, three areas of gypsum mining observed on the walls of the cave, one hearth area, one hammerstone, three areas of smudge or stoke marks on the cave wall, and two unionid shell scrapers. In all, more than 90 artifacts representing 13 different artifact classes have been discovered and documented, all within only one of the three sampling areas comprising the S-Bend area. Also recorded in the 1978 general S-Bend area were two charcoal pictographs and one cane flute.

THE PICTOGRAPHS

Two charcoal pictographs are known in Historic Mammoth Cave. One, known since the 1830s, is on an upright breakdown slab called "The Devil's Looking Glass" (Lee 1835). This pictograph is about 50 m north of the S-Bend area (Figure 2). Unfortunately, none of the early 19th century descriptions detail the drawing, and the pictograph has been extensively damaged by historic signatures. Only two recognizable elements appear to be present in the lower right corner of the slab: a broad zigzag shape and an almost anthropomorphic (human?) or zoomorphic form (spider?) (Figure 3). Because of the extensive historic damage to these pictographs, it is difficult to discern much detail about the drawings, and it is unclear from the historic descriptions whether the feature known as the "Devil's Looking Glass" refers to the charcoal drawings or to the unusual vertical slab of ceiling breakdown. [The term "looking glass" is twentieth century vernacular for a hand-held mirror (Webster 1852:675).] It is clear that the charcoal illustrations are beneath all of the historic signatures, some of which date to the 1830s.

Fifty meters to the south of this feature, on a high ledge along the eastern wall of the S-Bend, and about 5 to 8 m south of the flute, is another pictograph, drawn with charcoal, discovered during the 1978 survey (Figure 4) (Watson and Carstens 1979, 1982). The drawing is dissimilar from other Mammoth and Salts cave drawings described by DiBlasi (1996). This pictograph appears to consist of two principal elements. The first is a rectilinear form composed of three uprights that are transversely sectioned by multiple parallel lines. The second is a zigzag composed of three parallel lines terminating in several circles at the ends. Carstens has suggested that both the spiral-shaped tube and the rectilinear shapes could be "early cave maps," reflecting both the large Main Trunk passage route and a possible connection route between Upper and Middle Mammoth Cave. However, a comparison of modern cave maps of the S-Bend area with this element has yet to resolve this question.

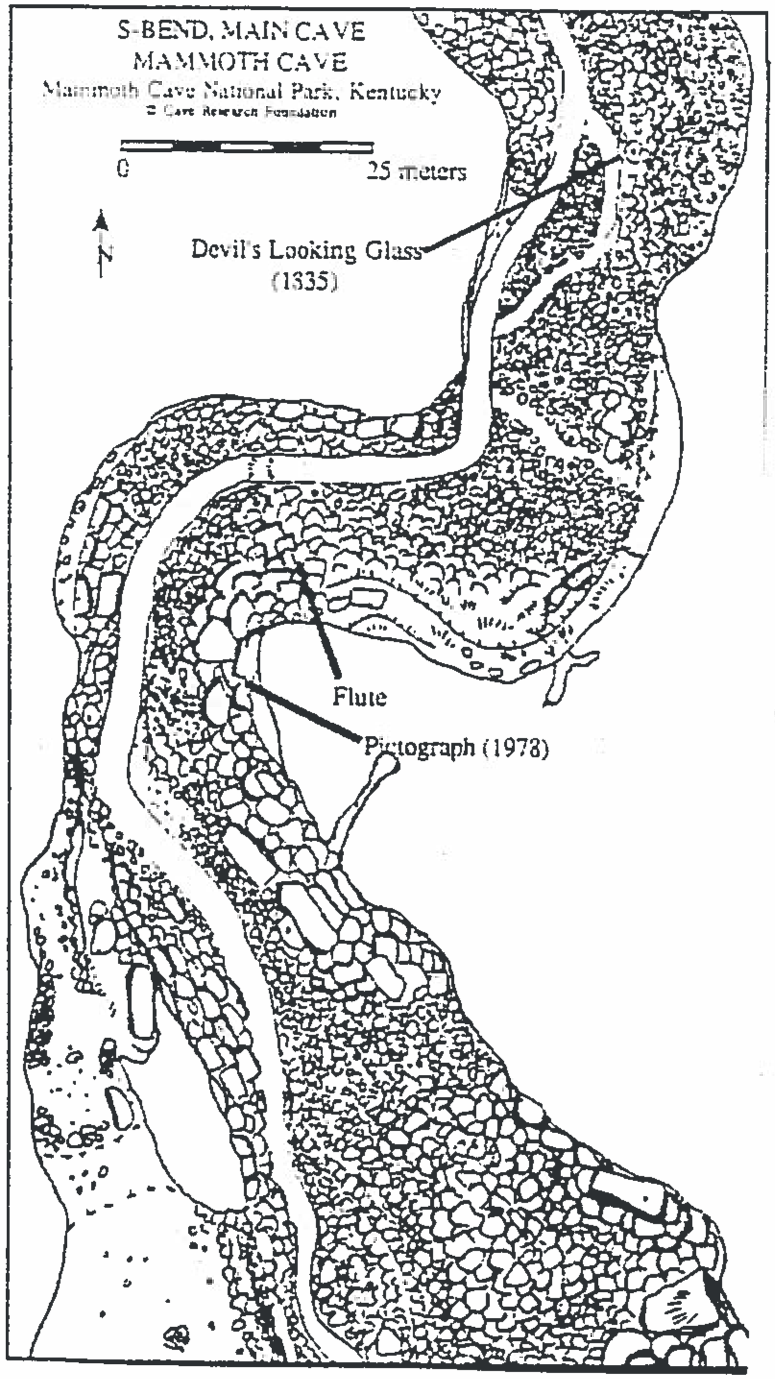


Figure 2. Cave Research Foundation Map Depicting Location of Pictographs and Flute in Mammoth Cave's "S"-Bend Area.

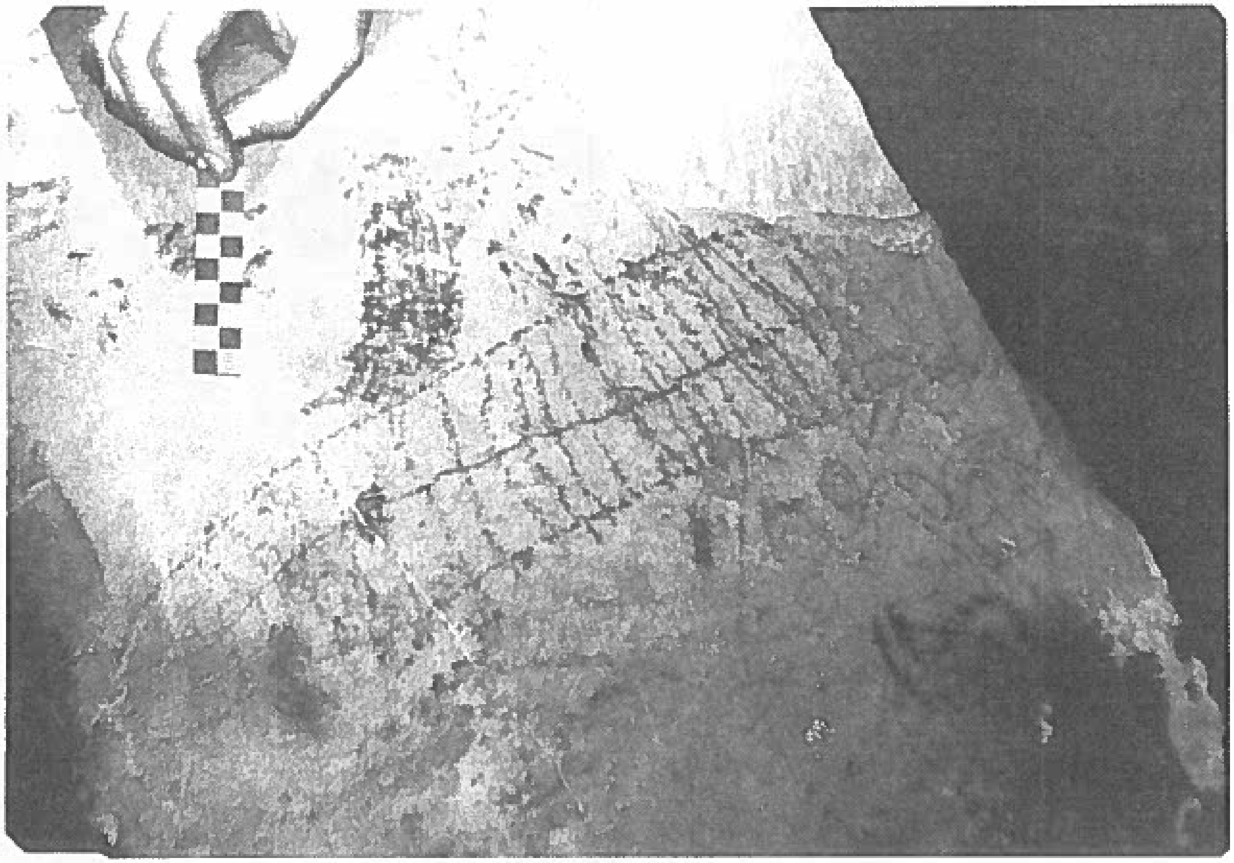


Figure 3. Devil's Looking Glass Pictograph in the Main Cave at Mammoth Cave. Vertical dimension is approximately two meters.

Figure 4. "S"-Bend Curve Pictograph in Main Cave at Mammoth Cave.

THE FLUTE

The flute, or flageolet, is located within a small breakdown "room" about 5 m north of the pictograph. Entrance to the small triangularly-shaped breakdown room is from the north. The breakdown room is not on the same upper ledge as is the pictograph, but it is about 4 m above the floor of the main trunk passage. The room measures about 1 m high at its peak and 75 cm wide at its base. On the floor of the room were four fragments of cane (*Arundinaria gigantea*). All of the cane fragments, including the flageolet, exhibit charring on at least one of their ends, suggesting these fragments of cane were used as torch materials; one cane fragment had been split longitudinally while two other fragments appeared to have been cut. The fourth, and largest fragment of cane, exhibits four complete small holes in an alternating pattern on either side of an imaginary center line that extends down its length (Figure 5). All four dorsal "finger holes" are located within one growth segment of the cane. The four finger holes are spaced 0.33, 0.29, and 0.37 cm apart and average about 0.725 cm in diameter. The "mouth piece" to the flageolet could not be found and was not in association with the flute. The overall incomplete length of the instrument is 40.3 cm. The diameter of the flute averages 1.75 cm. No weight for this broken, desiccated flute was recorded in 1978. Several fragments of historic cultural debris (charred cotton torch heads) were associated with the prehistoric cane flute. Indeed, the proximal portion of the flute exhibited evidence of charring, possibly from a modern cave torch. Otherwise, these artifacts appear to be undisturbed and may represent an area where a portion of a cane torch was re-made in the cave. It does not appear that the incomplete flageolate was brought into the cave for purposes of playing. Rather it is hypothesized that the broken flageolate was a part of dried cane debris at an open site where, once broken, it was gathered together with other bundles of cane for purposes of cave illumination.

DISCUSSION

No other published references to *cane flutes* are known or have been discovered east of the Mississippi River, although several references to single-tone bone whistles from post-Woodland-aged sites, and to copper pan-pipe whistles from Middle Woodland sites in burial and habitation contexts of the Eastern Woodlands, have been reported previously. As an example, Alexander Clark Bullitt's (1844) description of Fawn Hoof, an essicated individual found near Mammoth Cave, includes the following description:

> ...two whistles about eight inches long made of cane, with a joint about one third the length; over the joint is an opening extending to each side of the tube of the whistle, these openings were about three-fourths of an inch long and a quarter of an inch wide, and had each a flat reed placed in the opening. The whistles are tied together [like a pan pipe], with a cord wound around them.

Similarly, a cane flute from the Ozark Plateau at Breckenridge Rockshelter, similar to the Mammoth Cave S-Curve example, was reported and illustrated by Harrington (1971). Breckenridge is a multi-component site with Archaic through Mississippian cultural deposits. A cane whistle, also reported and illustrated by Harrington (1971), was found in nearby Bushwhack Rockshelter. Unfortunately, the cane whistle recovered from Bushwhack is no more precisely placed in time than the flute observed at Breckenridge.

Bone, wood, and even slate whistles appear to be more common among the late prehistoric and early historic period Plains cultures (Anderson and Semken 1980), the prehistoric Archaic

Figure 5. Proximal portion of cane flute from "S"-Bend Area at Mammoth Cave.

through later Anasazi cultures of the Southwest and intermontane area (Mike Adler, personal communication, 1994; Morris 1959; Bakkegard and Morris 1961), and late prehistoric Fort Ancient cultures in the eastern Woodlands (Charles Niquette, personal communication, 1994; Penelope Drucker, personal communication, 1994). Jerome Traver (1984) investigated and analyzed acoustics of 77 prehistoric bone flutes and whistles from the eastern U.S. ranging in age from 2500 B.C. to A.D. 1600. Traver found that the instruments had no common scale, suggesting there was no structured prehistoric musical scale in the eastern United States. Traver (1984:89) observed that: (1) there was a significant increase in notes and combinations of notes through time; (2) there was an increase in instrument frequency through time; and (3), there was a decrease in instrument size through time. Cultural contexts for use of flutes has varied, but most often they have been associated with courting and warring behavior (Hall 1995), as accompaniments for mortuary contexts (Bakkegard and Morris 1961; Morris 1959), in mythology (Alfred Dittert, personal communication, e.g. the southwestern flute player, *Kokopelli*), and in fertility rites.

In her discussion of 35 radiocarbon dates from Mammoth and Salts Cave, Mary Kennedy (1990, 1996) clearly states that the majority of documented aboriginal activities within the Flint-Mammoth Cave system occurs within the Early Woodland period, clustering around the early seventh century B.C. DiBlasi (1996), in his discussion of prehistoric drawings in the Central Kentucky Karst, hypothesized an Early Woodland artistic tradition that was more geometric in composition than the more natural and representational zoomorphic and anthropomorphic Mississippian mud glyphs of eastern Tennessee (Faulkner 1986). The broken and burned cane flute was apparently brought into the cave for lighting purposes, not for purposes of making music. But the cultural context for the prehistoric Mammoth Cave activity, of which the flute and pictographs are a part, argues for an Early Woodland use of these highly unusual organic artifacts.

ACKNOWLEDGEMENTS

The authors thank Patty Jo Watson (Washington University, St. Louis) for reading and commenting on an earlier draft of this paper. Also we thank the many individuals who responded by e-mail, facsimile, and letter to Carstens' initial (1994) inquiry about flutes/flageolets in the *SAA Bulletin* and *SEAC Newsletter*. The research for this project was carried out in 1978 at Mammoth Cave National Park. Finally we thank the past and present officials at Mammoth Cave National Park, the staff at the Southeastern Archeological Center in Tallahasse, Murray State University, the University of Louisville, and the Cave Research Foundation.

REFERENCES CITED

Adler, Mike
    1994 Personal Communication faxed to Kenneth Carstens, Southern Methodist University, Dallas, October 14, 1994.

Anderson, Duane C. and Holmes A. Semken, Jr. (editors)
    1980 *The Cherokee Excavations: Holocene Ecology and Human Adaptations in Northwestern Iowa*. Academic Press, New York.

Bakkegard, B. M. and E. A. Morris
    1961 Seventh Century Flutes from Arizona. *Ethnomusicology* 5 (3):184-186.

Bullitt, Alexander Clark

1844 *Rambles in the Mammoth Cave, During the Year 1844, By A Visitor*. Reprinted in 1985, Cave Books, Saint Louis, Missouri.

Carpenter, Edmund

1956 The Irvine, Cornplanter, and Corydon Mounds, Warren County, Pennsylvania. *Pennsylvania Archaeologist* 26 (2):89-115.

Crothers, George, C. Faulkner, J. Simek, P. Willey, and P. J.Watson

2002 Woodland Cave Archaeology. In *The Woodland Southeast*, edited by David Anderson and Robert Mainfort, pp. 1-27. University of Alabama Press, Tuscaloosa.

Crothers, George and Robert Ward

1995 The National Park Service/Earthwatch Cultural Resource Survey: Discerning Patterns of Prehistoric Activity in Main Cave Despite 200 Years of Historic Use. In *Proceedings of Mammoth Cave National Park's Fourth Science Conference*, Mammoth Cave.

DiBlasi, Philip J.

1996 Prehistoric Expressions from the Central Kentucky Karst. In *Of Caves and Shell Mounds*, edited by Kenneth C. Carstens and Patty Jo Watson, pp.40-47. University of Alabama Press, Tuscaloosa.

Dittert, Alfred E., Jr.

1994 Personal Communication to Kenneth Carstens, Arizona State University, letter.

Drooker, Penelope B.

1994 Personal Communication to Kenneth Carstens, Harvard University Peabody Museum, October 20, 1994, letter.

Faulkner, Charles H. (editor)

1986 *The Prehistoric Native American Art of Mud Glyph Cave*. University of Tennessee Press, Knoxville.

Fritz, Gayle

1986 *Prehistoric Ozark Agriculture*. Doctoral Dissertation. Department of Anthropology, University of North Carolina, Chapel Hill.

Hall, Robert L.

1995 *An Archaeology of the Soul: North American Indian Belief and Ritual from the Perspective of Calumet Ceremonialism, Mourning, and Spirit Adoption*. University of Illinois, Chicago.

Harrington, Mark R.

1971 *The Ozark Bluff-Dwellers*. Indian Notes and Monographs, Vol. 12. Museum of the American Indian, Heye Foundation, New York.

Kennedy, Mary C.

1990 *Radiocarbon Dates from Salts and Mammoth Caves, Mammoth Cave National*

Park, Kentucky: An Analysis of the C-14 Process and the MCNP Dates. Master's thesis, Department of Anthropology, Washington University, St. Louis.

1996 Radiocarbon Dates from Salts and Mammoth Caves. In *Of Caves and Shell Mounds*, edited by Kenneth C. Carstens and Patty Jo Watson, pp. 48-81. University of Alabama Press, Tuscaloosa.

Kennedy, Mary C. and Patty Jo Watson
1997 The Chronology of Early Agriculture and Intensive Mineral Mining in the Salts Cave and Mammoth Cave Region, Mammoth Cave National Park, Kentucky. *Journal of Cave and Karst Studies* 59:154-159.

Lee, Edmund F.
1835 *Map of Mammoth Cave, with Notes*. James and Gazley, Cincinnati.

Moore, Elizabeth A.
1994 Personal Communication to Kenneth Carstens, Smithsonian Institution, Washington, D.C., November 1994, e-mail.

Morris, Elizabeth A.
1959 Basketmasker Flutes from the Prayer Rock District, Arizona. *American Antiquity* 24 (4):406-411.

Morse, Karen J.
1969 Flageolets. Unpublished Ms., AN 365. Department of Anthropology, Arizona State University, Tempe.

Munson, P., K. Tankersley, C. Munson, and P. Watson
1989 Prehistoric Selenite and Satinspar Mining in the Mammoth Cave System, Kentucky. *Midcontinental Journal of Archaeology* 14 (2):119-145.

Nelson, Nels C.
1917 Contributions to the Archaeology of Mammoth Cave and Vicinity, Kentucky. *Anthropological Papers*, Vol. 22, Part I. American Museum of Natural History, New York.

1923 Kentucky: Mammoth Cave and Vicinity. Ms. on file, American Museum of Natural History, New York.

Niquette, Charles
1994 Personal Communication to Kenneth Carstens, Lexington, July 26, 1994, e-mail.

Ong, Lana
1971 Bone Flutes, Flageolets, and Whistles. Unpublished Ms., AN 365. Department of Anthropology, Arizona State University, Tempe.

Pearce, Robert J.
1994 Personal Communication to Kenneth Carstens, University of Western Ontario, November 24, 1994, letter.

Pond, Alonzo
1937 Lost John of Mammoth Ledge. *Natural History* 39:174-6.

1935 Report of Preliminary Survey of Important Archaeological Discovery at Mammoth Cave, Kentucky. *Wisconsin Archeologist* 15:27-35.

1938 Death Posed a Tableau. *University of Chicago Magazine*, June:7-9, 24.

Saemisch, Letty
1969 Bibliography on Bone Whistles. Unpublished Ms., AN 365. Department of Anthropology, Arizona State University, Tempe.

Sartwell, Carla A.
1967 The Bitsitsi Whistle. Unpublished Ms., AN 365, Department of Anthropology, Arizona State University, Tempe.

Schwartz, Douglas W.
1958a An Archaeological Report on Physical Remains from Mammoth Cave National Park. Ms. on file, Mammoth Cave National Park Library, Mammoth Cave National Park, Mammoth Cave.

1958b Archaeological Report on Materials in the John M. Nelson Collection from Mammoth Cave National Park. Ms. on file, Mammoth Cave National Park Library, Mammoth Cave National Park, Mammoth Cave.

1958c Archaeological Survey of Mammoth Cave National Park. Ms. on file, Mammoth Cave National Park Library, Mammoth Cave National Park, Mammoth Cave.

1958d The Archaeology of Mammoth Cave National Park. Ms. on file, Mammoth Cave National Park Library, Mammoth Cave National Park, Mammoth Cave.

1958e Description and Analysis of Museum Materials from Mammoth Cave National Park. Ms. on file, Mammoth Cave National Park Library, Mammoth Cave National Park, Mammoth Cave.

1958f Report on Two Radiocarbon Dates from Mammoth Cave National Park. Ms. on file, Mammoth Cave National Park Library, Mammoth Cave National Park, Mammoth Cave.

1958g Sandals and Textiles from Mammoth Cave National Park. Ms. on file, Mammoth Cave National Park Library, Mammoth Cave National Park, Mammoth Cave.

1960a Archaeological Survey of the Nolin River Reservoir. Ms. on file, Museum of Anthropology, University of Kentucky, Lexington.

1960b Prehistoric Man in Mammoth Cave. *Scientific American* 203:130-40.

1965 *Prehistoric Man in Mammoth Cave*. Interpretive Series No. 2. Eastern National Park and Monument Association, Mammoth Cave.

Tankersley, Kenneth B.
1996 Prehistoric Mining in the Mammoth Cave System. *In Of Caves and Shell Mounds*, edited by Kenneth C. Carstens and Patty Jo Watson, pp. 33-39, University of Alabama Press, Tuscaloosa.

Tratebas, Alice M.
1994 Personal Communication to Kenneth Carstens, BLM-Wyoming, January 14, 1995, letter.

Traver, Jerome D.
1994 Personal Communication by fax to Kenneth Carstens, Williamsburg, August 12, 1994.

Turff, Gina
1985 Personal Communication to Kenneth Carstens, Trent University, Ontario, January 12 and February 8, 1995, letters.

Watson, Patty Jo (editor)
1974 *The Archaeology of the Mammoth Cave Area*. Academic Press, New York.

Watson, Patty Jo
1969 *The Prehistory of Salts Cave, Kentucky*. Reports of Investigations No. 16. Illinois State Museum, Springfield.

Webster, Noah
1852 *An American Dictionary of the English Language*. George and Charles Merriam, Springfield, Massachusetts.

Willoughby, Charles C.
1922 The Turner Group of Earthworks Hamilton County, Ohio. *Papers of the Peabody Museum of American Archaeology and Ethnology*, Harvard University, Vol. VIII, No. 3. Cambridge, Massachusetts.

Wintemberg, W. J.
1948 The Middleport Prehistoric Village Site. *National Museum of Canada, Bulletin No. 109*, Anthropology Series, No. 27.

THE MILLSTONE BLUFF SITE: A FIRST APPROXIMATION

By

Brian M. Butler
Center for Archaeological Investigations
Southern Illinois University, Carbondale
Carbondale, Illinois

and

Charles R. Cobb
Department of Anthropology
Binghamton University
Binghamton, New York

ABSTRACT

The Millstone Bluff site is an unplowed late Mississippian village in the upper Bay Creek drainage in southern Illinois. A multi-year research effort has focused on it and nearby sites, seeking to document Mississippian lifeways in the interior hill country north of the Ohio River and to understand Millstone's place in the larger dynamics of the late Mississippian world of the lower Ohio Valley. Preliminary results of four years of work at Millstone Bluff and the nearby Hayes Creek site are presented. The Millstone Bluff settlements appear to represent an intrusion into a largely uninhabited hinterland at ca. A.D. 1300 and persisting until at least A.D. 1450. The interior movement of the Millstone Bluff polity seems to be related to the demise of Kincaid as the region's dominant political structure.

INTRODUCTION

In the 1990s Southern Illinois University and Binghamton University have been engaged in a long-term study of Mississippian lifeways in the uplands of southern Illinois. The larger focus of this research has been what might be termed an exercise in "political geography"- -the roles played by geography, landscape, and the environment in the development of the political economy of Mississippian upland communities. As more and more researchers are demonstrating, there are numerous exceptions to the archtypical Mississippian setting, represented by large, rich floodplains with easy access to fertile agricultural soils and varied terrestrial, avian and aquatic resources. A significant number of habitations are now known to occupy localities once thought to be inhospitable to a sustained Mississippian presence.

For a number of decades, Millstone Bluff (11Pp3), one of these upland "anomalies," has captured the imagination of local residents and archaeologists in southern Illinois (Dearinger 1963). The site is an unplowed Mississippian village occupying a prominent hill in the rugged uplands of the eastern Shawnee Hills of southern Illinois. A Late Woodland occupation is also present, for which reason the site is included among the region's Late Woodland "hill forts" (Brieschke and Rackerby 1973), but that component is relatively minor and will not concern us further here. From a distance the hill resembles a Mississippian mound (albeit one of huge proportions), a fact which may in part account for the site selection. Although small Mississippian camps are commonly found scattered throughout upland areas, most are presumed to be transitory occupations related to the extraction of upland resources such as game or raw materials. Millstone Bluff, however, is a substantial settlement with a formal site plan and features characteristic of long term villages.

The SIUC field school investigated Millstone Bluff during the summers of 1996, 1997, and 1999. In 1998 the field school examined a small, and presumably related, village site about 5 km southeast of Millstone Bluff. In 1998 and 1999 additional survey work was undertaken in nearby creek valleys to identify additional Mississippian habitation sites. This research has begun to expand our notions about the variability encompassed by Mississippian settlement systems in the region. Furthermore, it underlines the importance of upland sites in the regional dynamics of Mississippian chiefdoms. In this paper, the results of the three seasons at Millstone Bluff are summarized, and a first approximation of important aspects of the site is provided.

REGIONAL SETTING

To place Millstone Bluff and its environs in a larger context, it is first necessary to review briefly both the physical and archaeological setting in southern Illinois and the lower Ohio Valley. Extreme southern Illinois is bounded by the converging Mississippi and Ohio rivers (Figure 1). The floodplains of both contain extensive Mississippian settlement systems, and it seems likely that upland settlement was greatly influenced by regional dynamics involving floodplain polities. One of the best known areas of the lower Ohio Valley is the Black Bottom locality with the large multi-mound center of Kincaid and a hierarchical settlement system of villages, hamlets, and farmsteads (Muller 1986, 1997). Other mound sites on the Illinois side of the Ohio are few and typically small, but a series of small mound centers have been documented on the Kentucky side (Kreisa 1995).

Archaeologists have long known that Mississippian groups inhabited the hill country between the Ohio and Mississippi rivers, although the nature and scope of settlement are still problematic. Upon first inspection, the region seems uninviting for late prehistoric populations because of the rugged topography. The Shawnee Hills constitute most of the hill region of southern Illinois. The topography of the Shawnees ranges from rolling hills to rugged ridges and bluffs. There are no major drainages that cut through the hill country, but three abut it: the Big Muddy and Saline rivers to the north and the Cache River-Bay Creek corridor to the south. Work at the Dillow's Ridge site in Union County, Illinois, has documented a large, long term residential presence in the immediate vicinity of the Mill Creek chert source area (Cobb and Butler 1996; Thomas 1997). The existence of the chert source dictated the location of Dillow's Ridge and related sites, but in the case of other sites the attraction is less obvious. The real question is why any sizeable Mississippian group was in a remote interior setting with seemingly marginal agricultural potential. Other than Dillow's Ridge, few interior Mississippian sites have been investigated in the region, so the uplands have not played any role in models of Mississippian Tradition dynamics in the lower Ohio Valley.

Paul Kreisa and Berle Clay have offered different perspectives on the rise and fall of Mississippian chiefdoms along the lower Ohio, particularly in the Kincaid "sphere" centered around the Tennessee-Cumberland confluence with the Ohio River. Kreisa (1995) argues that a pattern of large and small mound centers along the river reflects the spread of the influence of large centers. The establishment of the smaller, so-called "secondary centers" in the A.D. 1200s occurred somewhat later in time than Kincaid-which emerged two centuries earlier (Butler 1991). Kreisa posits that the secondary centers were satellites that further extended the influence of the big sites after the latter had

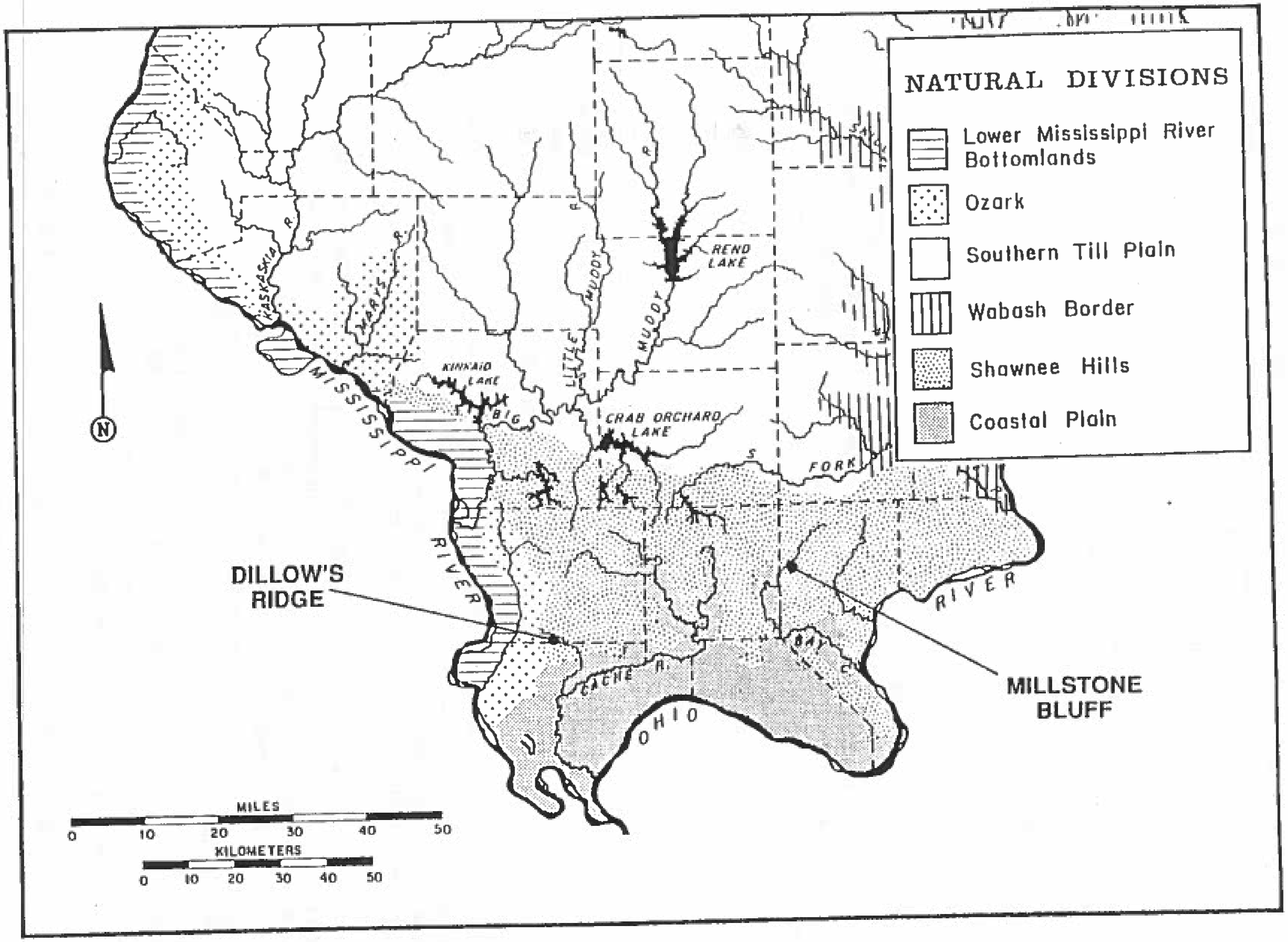


Figure 1. Location of the Millstone Bluff and the Dillow's Ridge Sites.

consolidated their local power base. Clay (1997), on the other hand, maintains that the radiocarbon evidence demonstrates that the larger centers were waning at the time that secondary centers began to proliferate. Clay believes that mound construction at the big sites slowed dramatically by the end of the 1200s, and their resident populations diminished greatly. He argues that the proliferation of small mound centers after 1300 is a reflection of the decline of the major regional mound centers and a reassertion of autonomy by smaller local groups. The Ohio Valley picture is further complicated by the rise of the Angel site, which appears to be Kincaid's successor as a dominant political entity, albeit in a different segment of the valley-above the Wabash confluence. The Angel site, however, represents a different developmental sequence than Kincaid. The Angel site does not appear to have become a major center until around A.D. 1300, but like Kincaid, the site appears to be abandoned by ca. A.D. 1450 (Hilgeman 1992). Angel was the focal point of an extensive settlement hierarchy along the river, but, unlike the Kincaid area, there were no secondary mound centers (Munson 1999).

These studies have moved the debate beyond static models of Mississippian political structures and settlement patterns. They recognize the volatility of Mississippian systems: one view sees a move toward greater regional integration through time, and the other sees greater local autonomy and the decline of the great centers. Upland settlements have not factored seriously into this debate, because of the paucity of data from interior areas adjoining the Ohio River. Our research at Millstone Bluff and in the interior uplands of southern Illinois is intended to fill this blank and broaden the parameters within which we model chiefdom dynamics along the lower Ohio. The excavations at Millstone were designed to answer preliminary questions about the nature of intrasite organization, chronology, and relationship to contemporary occupations in the lower Ohio Valley.

SITE DESCRIPTION

Millstone Bluff lies within the Shawnee Hills physiographic division, an east-west band of heavily dissected hill country that spans southern Illinois. The site is located on the top of an isolated mesa-like hill, which is an erosional outlier of the highest and most rugged portions of the Shawnee Hills immediately to the north. The site is in the headwaters of the Bay Creek drainage. Millstone Bluff is about 20 km (13 miles) directly northwest of the Ohio River. The hill stands about 320 feet (98 m) above the adjacent creek valley to the north and over 250 feet (76 m) above the rolling uplands that border the hill to the south (Figure 2). The top of the hill is ringed by a broken sandstone escarpment that ranges from 5 to 10 m in height, a fact which prevented modern cultivation. Above the escarpment, the hill rises an additional 8 m to a small level apex roughly 35 m across.

Millstone Bluff displays a formal site plan with a central plaza located at the crest of the hill. The plaza is about 1,000 m^2 (Figures 3 and 4). A series of visible house depressions encircle the plaza in several tiers. There are two very large basins, one at the northwest corner of the plaza (Basin 15) and the other at the southern end (Basin 2), which does not front directly on the plaza. The total site area, including all of the surface above the sandstone escarpment, is about 16,000 m^2, while the core area, including the plaza, house depressions, cemetery, and most of the artifact scatter, is between 6,000 and 7,000 m^2. Stone box graves existed on the east flank of the hilltop, but they have been systematically looted over the past century by pot hunters and are largely destroyed. Of particular note, three groups of Mississippian rock art are found on horizontal sandstone slabs on the north edge of the escarpment (Wagner and McCorvie 1997).

The placement of the stone box graves is intriguing. The discovery of all verified stone box graves on the east side of the site reflects a specific preference by the occupants, as topographic conditions would have made their placement easier on the west and south sides. From the remnants of

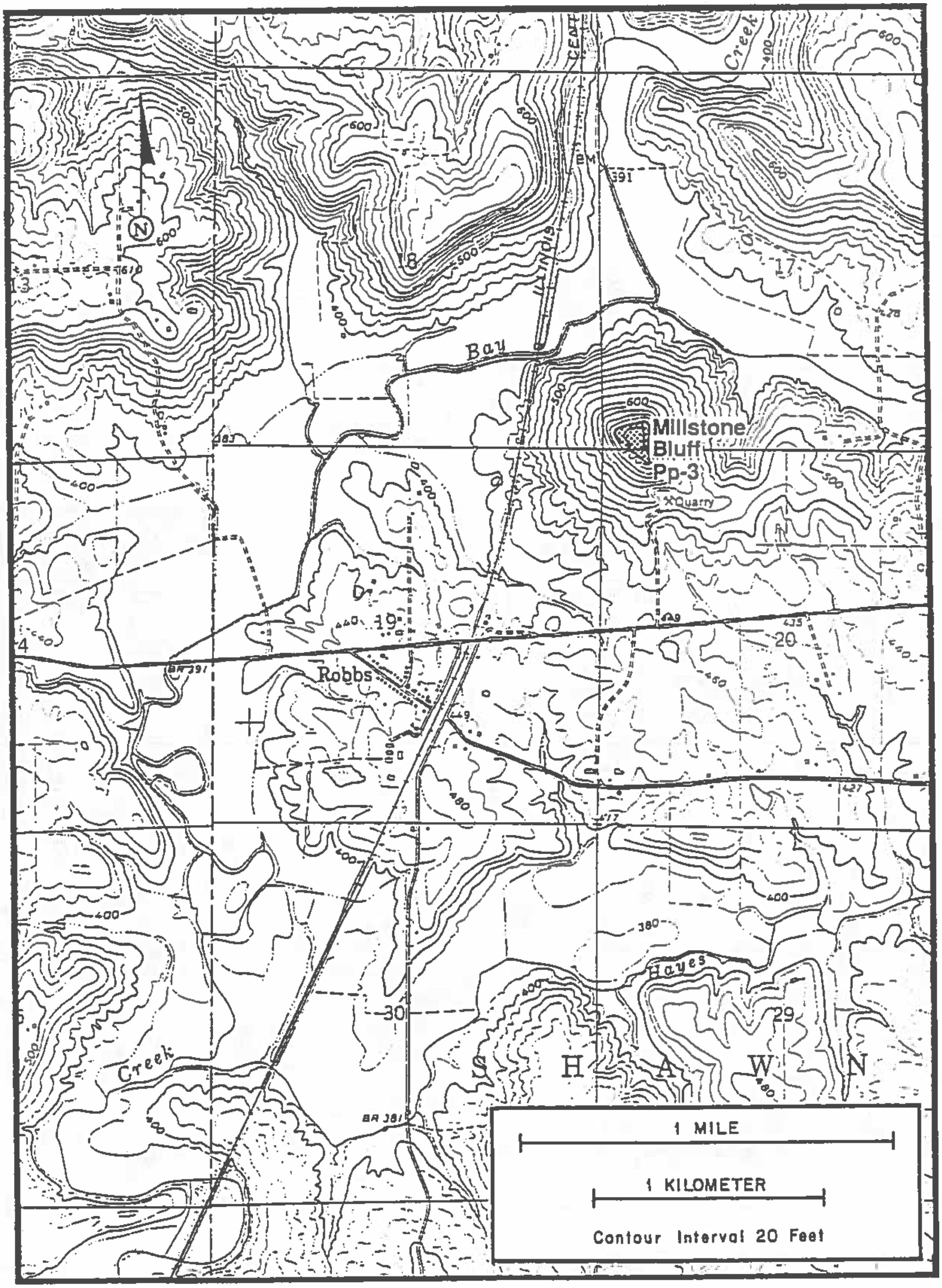


Figure 2. Topographic Setting of Millstone Bluff. Adapted from the 1962 Glendale 7.5 Minute Quadrangle.

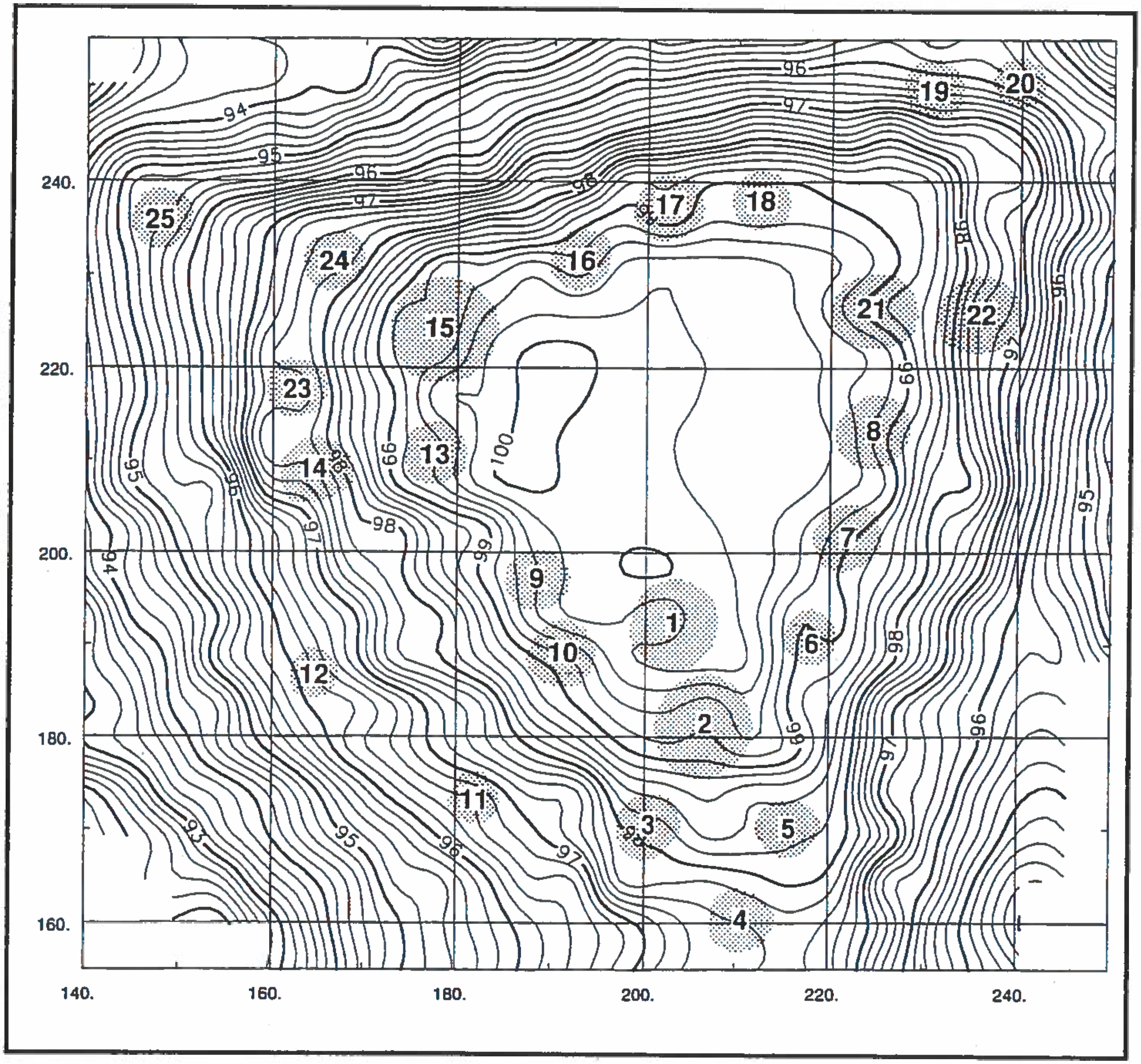


Figure 3. Topographic Map of the Millstone Bluff Site Showing the Numbered Basins. Grid scale is 20 m; contour interval is 20 cm.

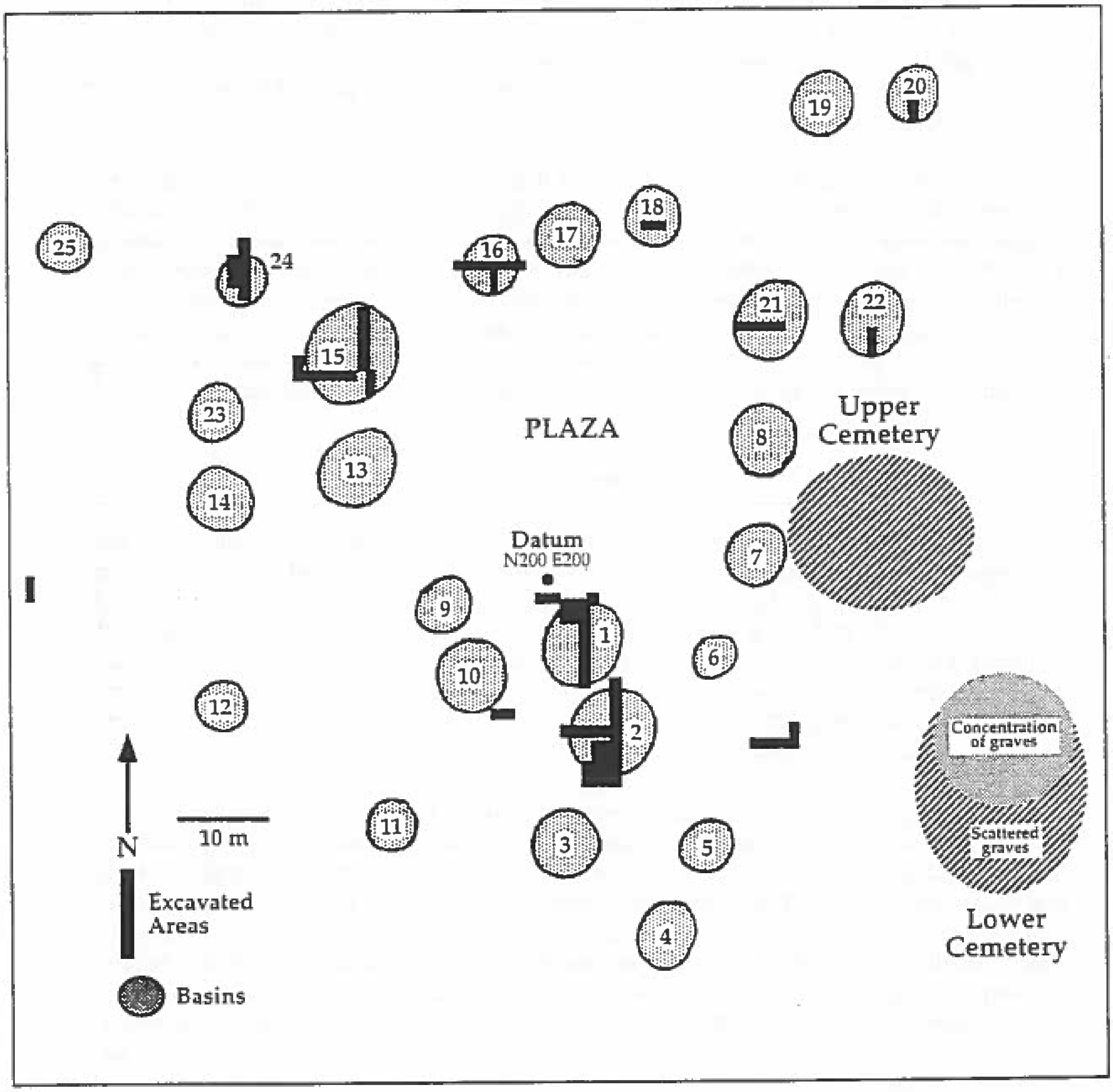


Figure 4. Plan Map of the Millstone Bluff Site Showing Key Features and Excavated Areas.

the graves, most appear to have been oriented on a general east-west axis with, one presumes, the head to the west and facing east. Although they have been previously described as a single cemetery, the stone box graves actually comprise two closely spaced but distinct cemeteries. One group is located high on the slope, on a lobe extension immediately adjacent to Basin 7. The second group is located on a bench surface downslope to the southeast, at an elevation that is *below* the level of a refuse dump (see below) that occupies part of the bench surface immediately to the west. Perhaps because of the small size of the lobe, the upper cemetery is very crowded with stone boxes in close proximity and with some indication of earlier graves being disturbed by later ones. The lower cemetery, situated on a gently sloping bench surface, appears to have more widely spaced graves. The centers of the two cemeteries are separated vertically by about 3.5 m and laterally by about 30 m, although their edges come within about 15 m of one another. The two burial areas imply different social units; certainly, the elevation differential, with one set of graves immediately adjacent to the plaza-side basins and the other below a refuse dump, has to say something about rank or status differences, even if a chronological difference is involved.

The SIUC field schools represent the first professional excavations at Millstone Bluff. Previous work had been limited to a mapping project in the early 1970s by SIUC archaeologists (Johnson and Rackerby n.d.), and small-scale coring conducted by U.S. Forest Service archaeologists in the 1980s. Prior to the 1996 season, R. Berle Clay conducted a very successful magnetic susceptibility survey over about 70% of the core area. A grid of 111 hand-held auger tests was executed at 5 and 10 m intervals over most of the core area of the site. Excavations have consisted of small-scale trench and block excavations which total just over 97 m^2. The emphasis of the excavations has been on the house basins, complemented by excavations in selected extramural areas.

RESULTS

At present 25 depressions have been defined and numbered, and one or two more may exist at the margins of the site. These may be obscured by slope wash and will require excavation to verify. All but two of the basins, numbers 19 and 20, are clearly associated with prehistoric structures. The latter are two small rock-filled depressions off the northeast corner of the plaza. Figure 5 is a frequency distribution of basin areas. The basin dimensions and areas are calculated as rectangles, since the structures are themselves rectangular. In all cases documented by excavation to date, the basin dimensions substantially exceed the dimensions of the houses built within them, as the wall trenches are offset some distance inside the edge of the basin.

What these numbers clearly illustrate is that there are three well-defined size classes in the basins, and presumably, structures. At the top are the two very large basins, 2 and 15, which are for all intents and purposes, the same size at 115 m^2, and which are almost twice as large in area as the next largest basin, Basin 1. Both 2 and 15 have been tested and in each case, the largest structure is at least 7 m across. At the bottom of the size distribution are the previously noted Basins 19 and 20, with areas of less than 18 m^2. These basins are anomalous both in size and contents and do not appear to represent conventional habitation structures. Basin 20 was tested and it may not be a structure at all. All other basins fall in a broad middle range with areas from 28 m^2 (Basin 25) to near 60 m^2 (Basins 1, 13, and 21). These 21 basins have a mean area of 39 m^2, a fact that argues for wall lengths consistently in the 5 m range with a few reaching 6 m or more.

Over three seasons portions of nine basins have been excavated, usually by trenching across to locate opposing ends of a structure within a basin. The three largest basins (1, 2, and 15) have been tested as well as five medium-to-small basins (16, 18, 21, 22, and 24) and one of the very small basins

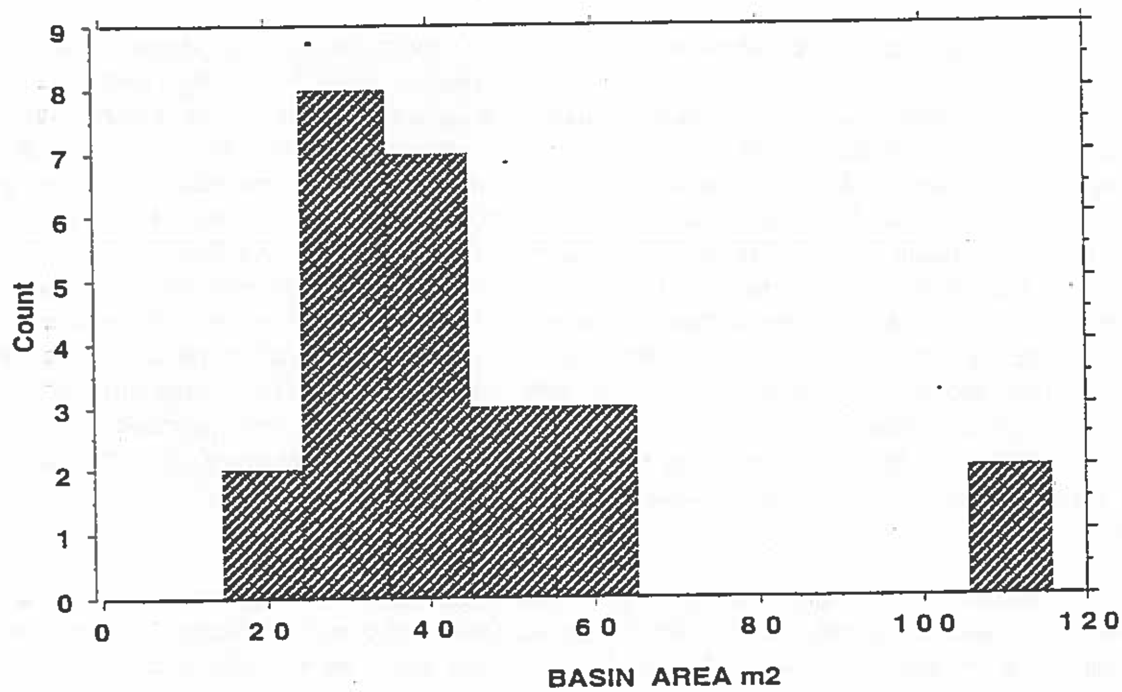


Figure 5. Frequency Distribution of Basin Areas Millstone Bluff.

(20). Not surprisingly, most of the basins displayed evidence for multiple rebuildings. Basin 2 (Figure 6) contains the largest number of structures with five (perhaps 6) identified, although one of those structures predates that extant basin. Superimposed structures within the basins tended to closely overlap one another, rather than being offset greatly. An examination of the map of the core area suggests several dimensions of variability (e.g., size, location) among the basins, which we have tried to capture with a selective sampling strategy. All structures identified to date are rectilinear wall trench constructions.

Almost every excavation within or adjacent to a house basin has encountered remains of house constructions that predate the visible basin features. It is now apparent that the village did not begin as a few houses and gradually expand to create the plan evident today; rather, the village appeared more-or-less full blown in the initial phase, with a plaza and structures adjacent to it. There is some shift of structure locations through time; however, and not all the visible basins represent contemporaneous structures. At least one earlier structure basin was filled in and buried at the south edge of Basin 10, leaving no surface indications. Excavations at this location identified a thick refuse deposit with the edge of a house basin at the bottom. Two different structure orientations have been identified. Some structures are orthogonal to the site grid (oriented on the cardinal axes) whereas others are rotated from 20° to 40° off that grid. More of the early structures tend to have this latter orientation, but some late ones do, as well, and there is as yet no clear spatial or temporal pattern in this regard.

It has long been a subject of speculation whether the very large structures represent some form of special-use facilities, such as ceremonial buildings. To date neither of the two large basins (2 and 15) has revealed any unusual architectural characteristics, other than large size, but the areas excavated are small. Another substantial structure (at least 6 m along one wall) was built at the beginning of the occupation in roughly the location of Basin 1, so at least one large structure was built initially on the plaza (Feature 41, Figure 7). Basin 1 is a later construction, but its structures appear to be in the same size range. Both Basin 2 and 15 (Figure 8) belong to the latter half of the occupation sequence, and it is possible that Basin 2 may have replaced Basin 1. Structure size *per se* does not necessarily indicate differences in social rank or status, as there is a general regional trend for structures to become larger through time (Hargrave 1991: 60). On the other hand, the position of these structures adjacent to the plaza and the recovery of red cedar remains from Basin 15 may indicate that these large buildings are more than simple domiciles. Red cedar was a wood with symbolic and ritual importance to many Native American groups, and excavations at the Kincaid site as well as the American Bottom have documented its extensive use in architectural settings suggestive of ceremonial use (Cole et al. 1951; Emerson 1997).

The smallest documented structures are about 4 m square, more typical of many of the domestic houses identified on other Mississippian sites. One example is the first of the five structures in Basin 2, a structure that predates the large basin complex and is carbon dated at ca. A.D. 1300 (calibrated, Beta 96506). The other was in Basin 24 (Figure 9), which is unusual in its downslope location and the lack of evidence for rebuilding. Although undated, this structure is also thought to be early for a number of reasons. The fact that the Basin 24 structure was not rebuilt suggests some consolidation of house locations after the initial phase of the occupation. Other early structures have been dated in Basins 1, 16, and 21 but not enough area was exposed to estimate house dimensions.

Various features were evident within structures, including hearths, post pits, and possible storage features. Some of the post pits were quite large, attesting to the need for substantial internal supports for the larger buildings. A cylindrical storage pit (Feature 48) was found outside of Basin 1, and similar but smaller features were found inside of Basins 21 and 24. Such features are typically not used for storing maize in the Southeast, and they are not common on Mississippian sites along the

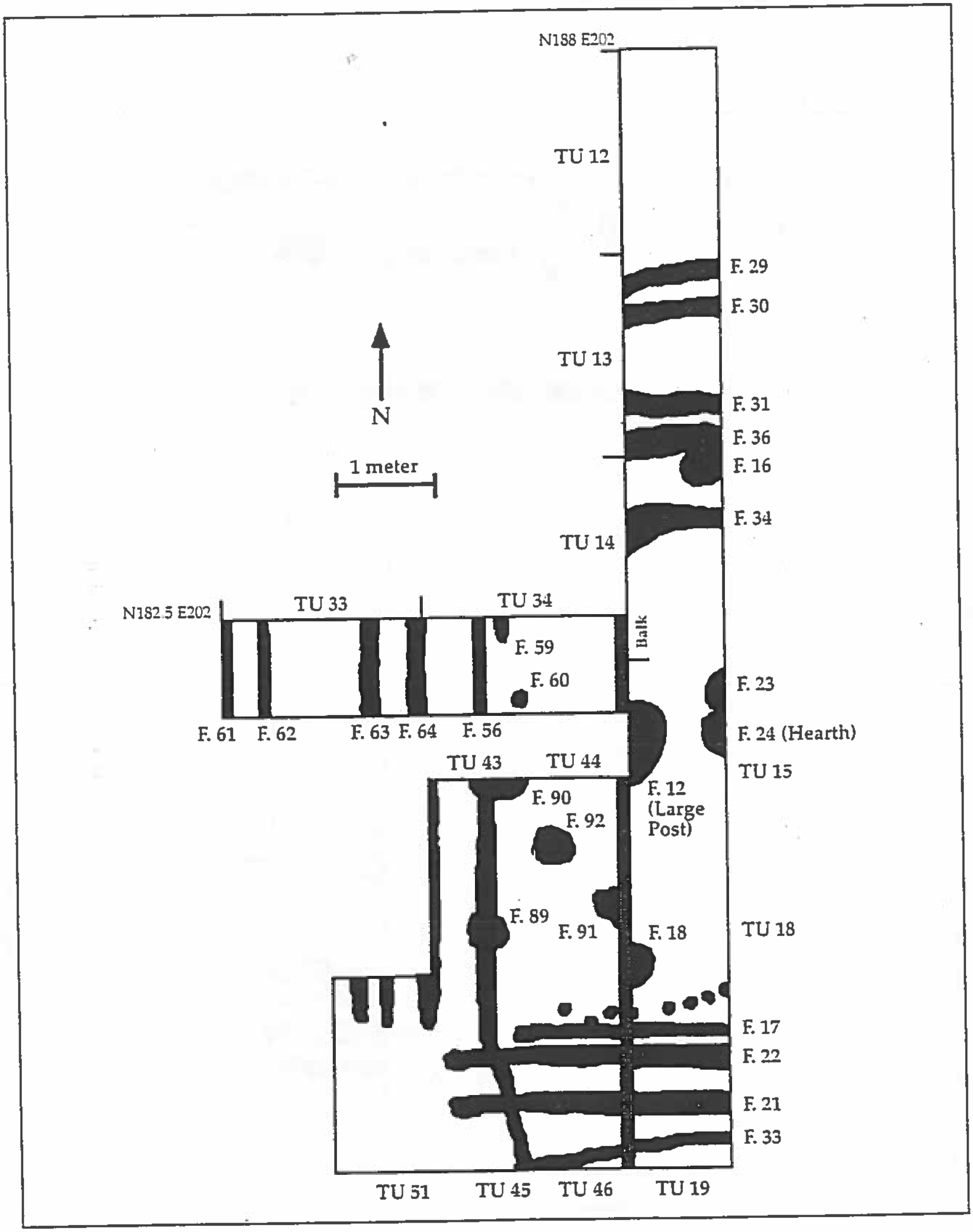


Figure 6. Plan Map of Basin 2 Excavations.

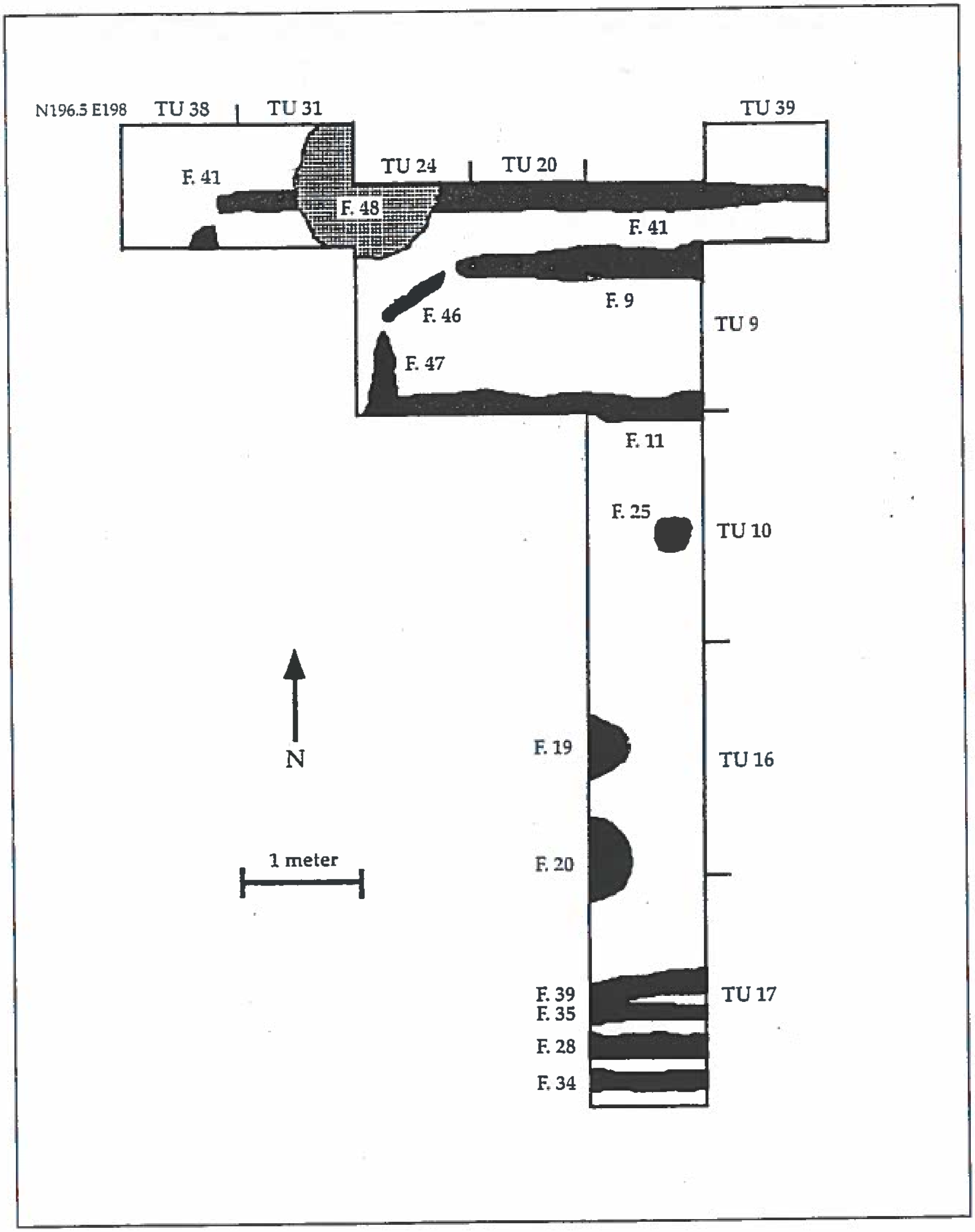


Figure 7. Plan Map of Basin 1 Excavations.

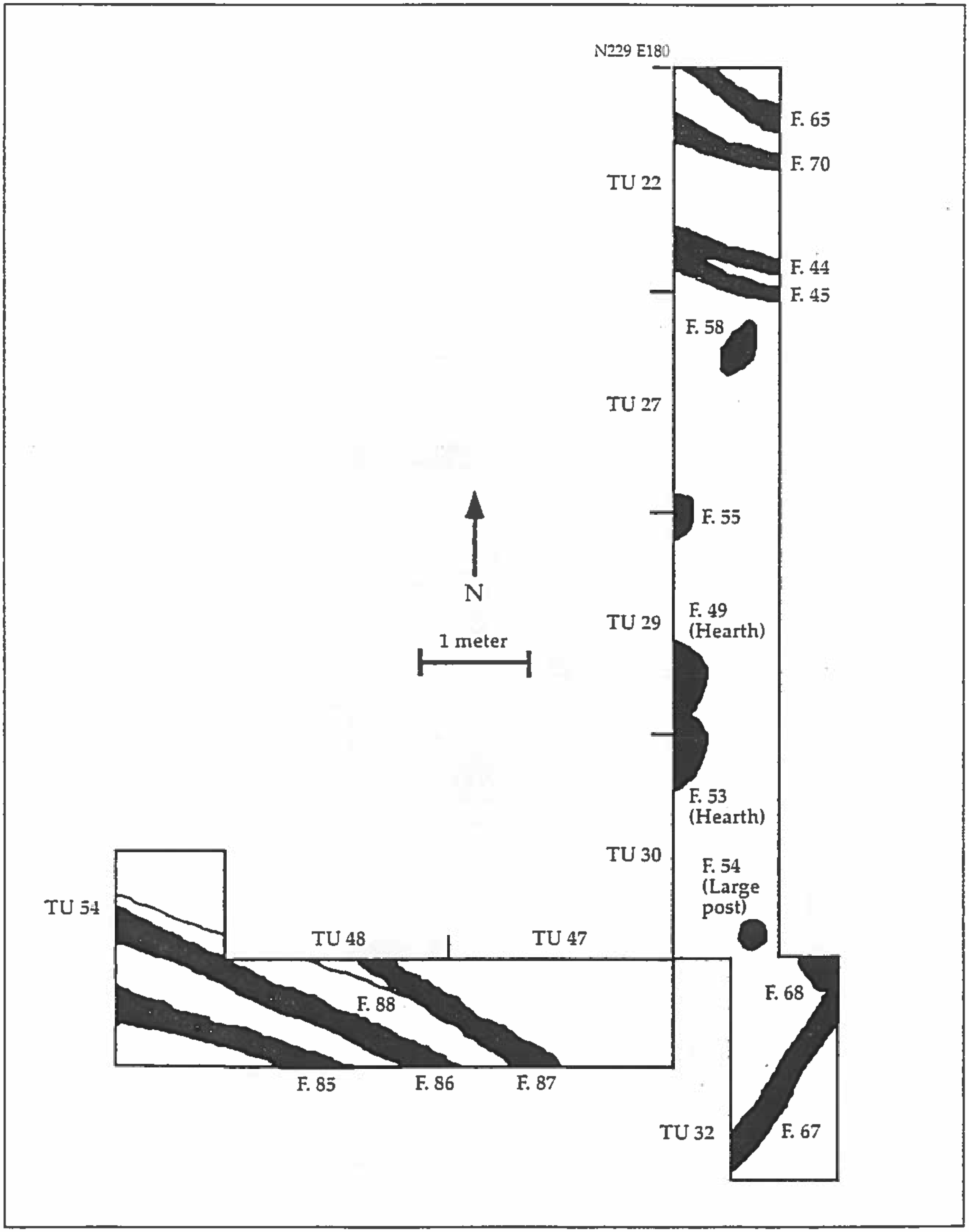


Figure 8. Plan Map of Basin 15 Excavations.

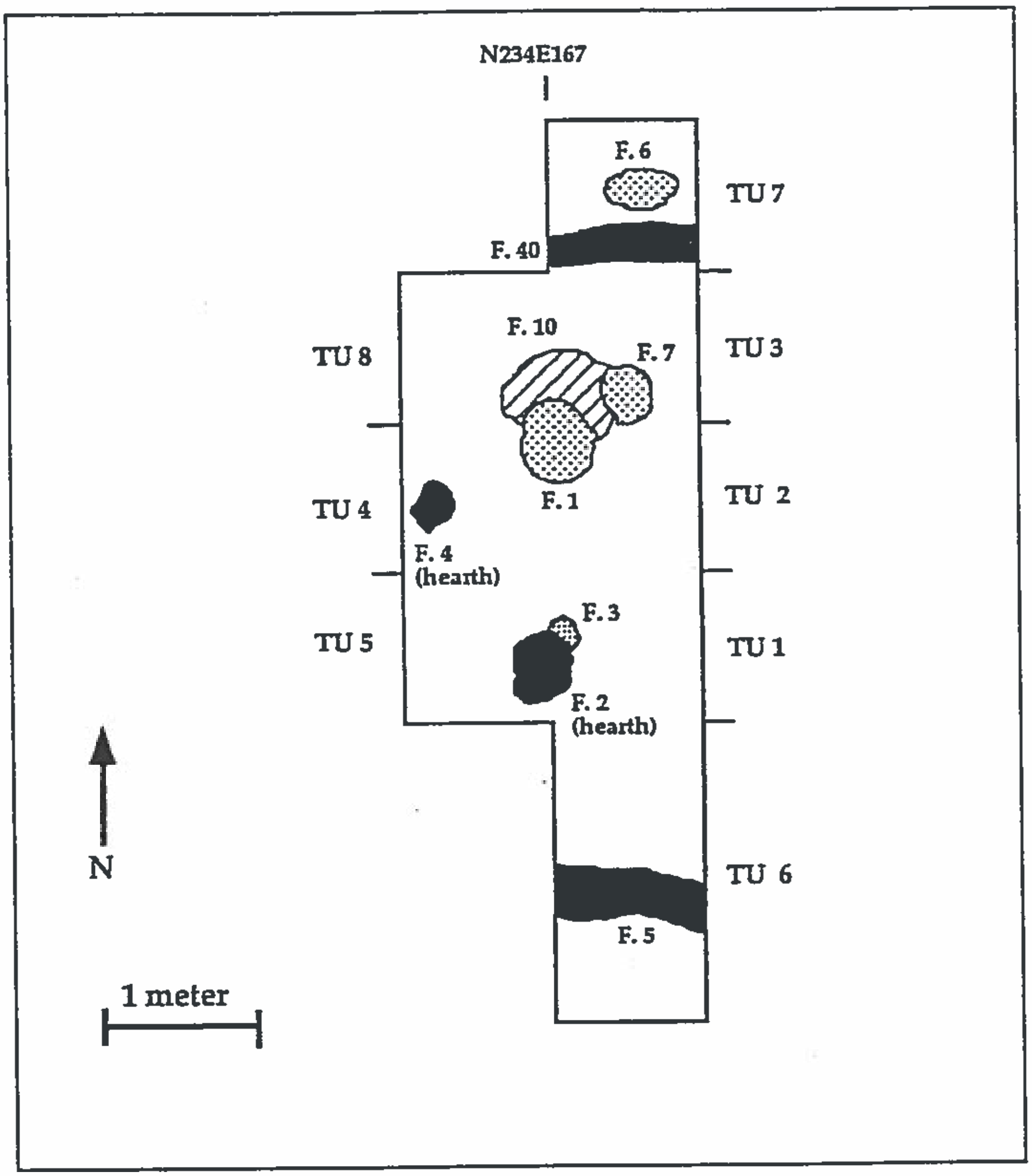


Figure 9. Plan Map of Basin 24 Excavations.

lower Ohio; one wonders if such features indicate a more "Woodland" kind of life style in these interior areas. Some house basins contain post-abandonment refuse deposits, but all of the floors exposed to date are extremely clean, containing very small numbers of tiny artifacts. Many of the structures were also burned. The combination of burned structures with nearly sterile floors indicates to us that houses were abandoned in an orderly manner, and then subsequently rebuilt or used for refuse disposal.

With one exception, no notable artifact caches or assemblages have been recovered from the site, beyond that typically found on most Mississippian sites in the larger region. The lone exception is a group of four miniature ceramic vessels found in a small heap of refuse lying on in the fill of Basin 18. A fifth miniature vessel was found in a refuse deposit next to a wall trench in the large corner basin, Basin 15 (Figure 10).

The magnetic susceptibility data indicate that some of the basins have significant concentrations of daub incorporated in the earthen fill outside the wall trenches. This was verified by excavation in Basins 1 and 2. The daub appears to represent remnants of heavy clay insulation that was fired in the demolition of the structure and then was incorporated into the deposits forming the edge of the basins. The extensive use of daub is not typical of the surrounding region, and it is interesting to ponder whether the heavy cladding was a necessary adaptation to the exposed hilltop location.

Refuse is distributed very unevenly over the site. For the most part, only a thin surface scatter of debris exists around and between the house basins, but there are some concentrated dumps. Some abandoned house basins were used as refuse areas. Augering on the east flank of the hill located a 50 to 70 cm thick midden extending about 20 to 25 m along a level bench below Basins 6 and 7. This midden, which lies adjacent to the two cemeteries, was tested in 1997 and 1999 and produced a large sample of well preserved faunal remains and other debris. There is a distinct notch in the hill slope above this midden. Excavations showed that this notch was created by digging into the slope for borrow during the initial phase of occupation.

Cultural materials include a full range of domestic debris and artifacts. Stone tools include arrowpoints, adzes, knives, scrapers, and hoe remnants. Most of the chert is from the Kinkaid and Degonia formations readily available near the site. Mill Creek and Kaolin cherts, from the western Shawnee Hills, are well represented but very heavily recycled, and there are a few pieces of Dover chert from the lower Tennessee-Cumberland area. The ceramics include a full range of vessel forms and rim types consistent with the age of the site. The ceramic assemblage is remarkably plain and undecorated, even by Mississippian standards.

CHRONOLOGY

There are now 16 radiocarbon dates from the site (Figure 11), eight from Beta Analytic and eight from the University of Arizona AMS laboratory. All but two of these appear to accurately reflect the range of occupation. The dates indicate that the settlement began between A.D. 1275 and 1300 (calibrated) and lasted at least until A.D. 1450. Some uncertainty remains in regard to the initial date because the AMS dates, as a group, appear to be slightly earlier than the radiometric dates. Initial occupation contexts dated with radiometric dates suggest a start date of A.D. 1300, whereas similar contexts yielded AMS dates in the 1260s and 1270s.

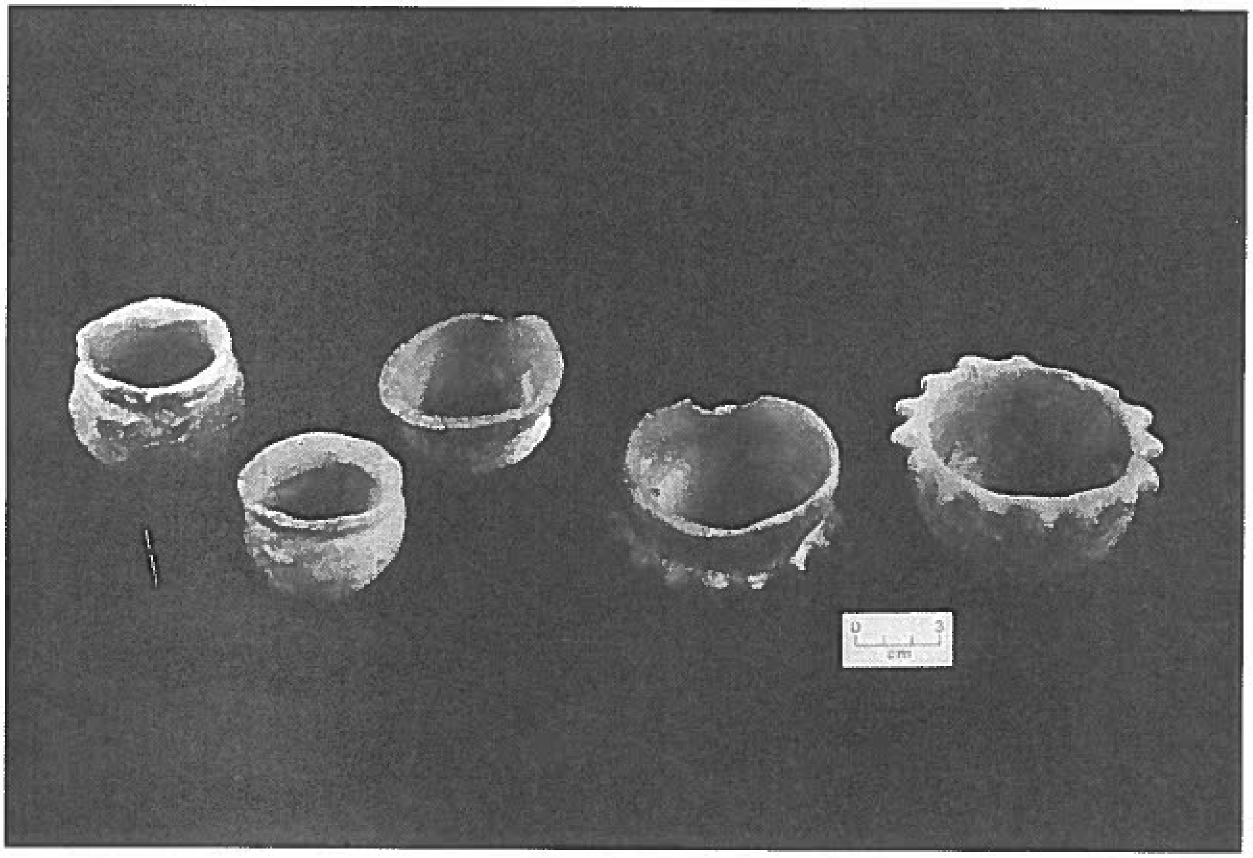


Figure 10. Miniature Vessels From Millstone Bluff. Specimen at right is from Basin 15 and all others are from Basin 18.

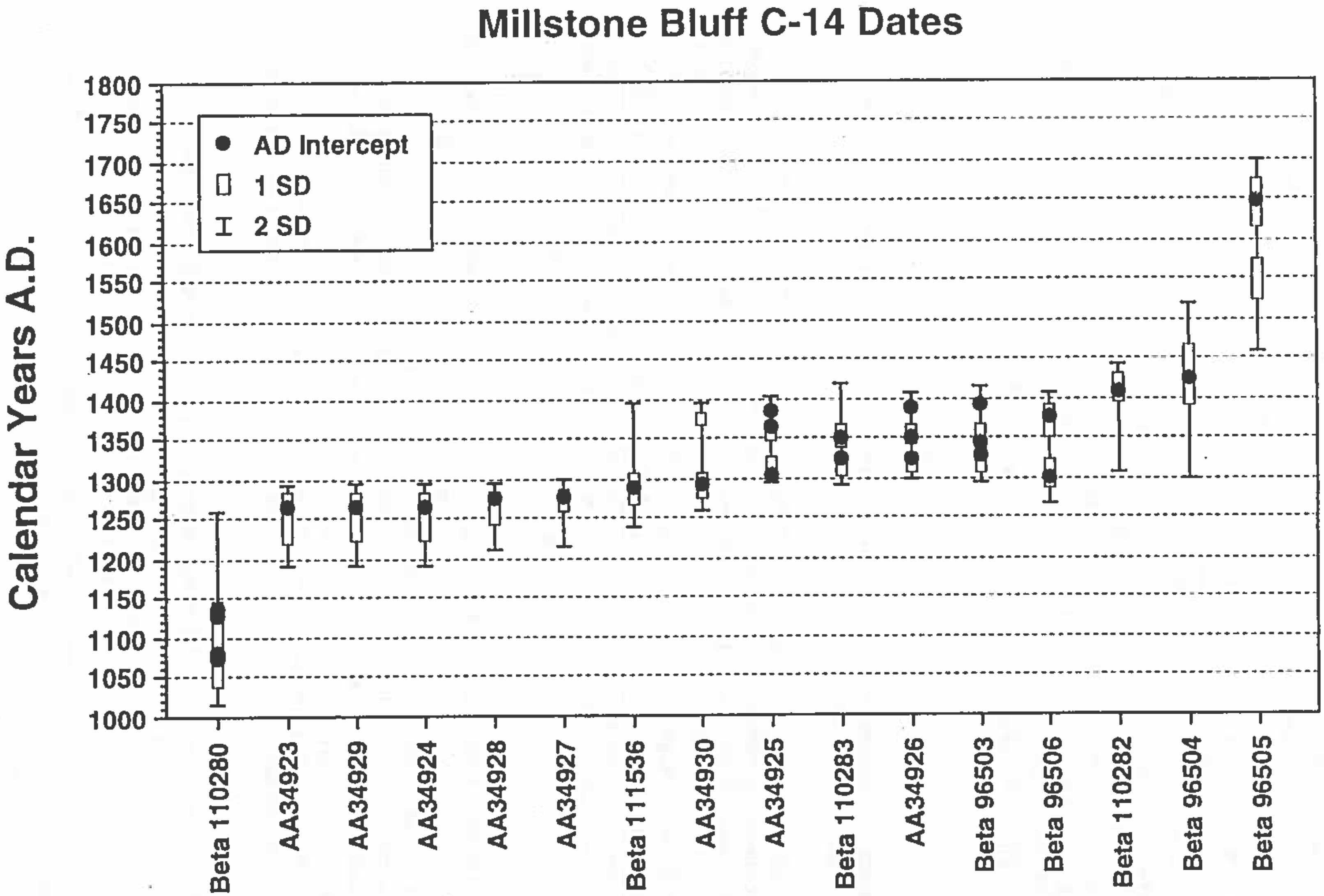


Figure 11. Calibrated Radiocarbon Dates from Millstone Bluff. Dates calibrated with CALIB v. 4.1.2. Intercepts determined by Method A. Method B. used to access probability distributions of multiple ranges. Graph shows all one-sigma ranges that account for more than 30% of the area under the curve.

The two suspect dates are both radiometric assays. One date from Basin 15 (Beta 110280) seems too early. The sample derived from burned materials associated with the first structure in Basin 15. The composite calibrated one sigma range (Calib 4.1.2 Method B, Stuiver and Reimer 1993) is from A.D. 1038 to 1186, a result not supported by any other evidence from the site, although a true age at the upper limit of the two sigma range (ca. A.D. 1260) is possible. We suspect that there is an old wood problem, especially since the sample in question was a piece of red cedar. The youngest date (Beta 96505), from the second major structure complex in Basin 2 (Features 31 and 36; Figure 7) has a calibrated intercept of A.D. 1648, a result that is not realistic, based on everything we presently understand about the regional sequence. The date has multiple ranges, however, and the earliest one sigma range (with 45% contribution to the probability) is more reasonable at A.D. 1510 to 1599 (2 sigma of A.D. 1458 to 1697) (CALIB 4.1.2, Stuiver and Reimer 1993). The sample could possibly date a much later terminal occupation, but as this is the only date whose one sigma ranges fall well after A.D. 1450, it must be viewed with suspicion as an unconfirmed outlier.

CONCLUSIONS

Given the incomplete state of analysis, many key observations must wait, but some preliminary statements are possible.

1. What type of settlement was Millstone Bluff with regard to site function? There are other late prehistoric sites in the vicinity, although not of the same size or complexity as Millstone. The site clearly represents a long term settlement (ca. 200 years) with all the appropriate features and debris of a permanent occupation. Was Millstone Bluff a nodal community within a larger settlement system, serving some kind of political function? The authors think so. It should be emphasized that Millstone Bluff was not an isolated village in the Mississippian hinterlands. There is a series of ostensibly late Mississippian sites in the adjacent tributaries of the upper Bay Creek watershed. This settlement cluster represents what we call the Millstone Bluff polity, a population of several hundred people dispersed in small settlements with Millstone Bluff as its largest and principal settlement.

A short distance to the southeast of Millstone is the Hayes Creek site (11Pp199), another village. To the west in the Cedar Creek drainage, survey has identified a number of small habitation sites, apparently farmsteads, and some scattered occurrences of stone box graves. The Kavelman site (11Js153), near the upper end of the valley, appears to be somewhat larger (ca. 3,000 m^2), perhaps a hamlet or small village (Rudolph 1977). In the Max Creek drainage to he west, a tributary of Cedar Creek, there are two reported instances of stone box graves, but no habitation site has yet been located. The authors believe, and there is some survey and collector information that supports this, that there are additional Mississippian habitation sites in the lower segment of Cedar Creek and in its tributary Max Creek, as well as further down on Bay Creek to near Grantsburg, about 12 km southwest of Millstone Bluff.

Small stone box grave cemeteries, often placed in low mounds, are linked to these occupations, but are generally not associated directly with habitation sites. Rather, they are located from a few hundred meters up to a kilometer distant from the habitation sites, typically situated along the valley margins near areas of tillable floodplain. Millstone Bluff is the only exception to this pattern. An additional cemetery has been identified on the edge of the Bay Creek floodplain about one km northwest of Millstone (Wagner et al. 1992). It should be noted that all the stone box grave mounds and cemeteries are small and contain only a modest number of graves; they cannot possibly account for all the resident population.

The known and suspected settlements of the Millstone Bluff polity (Figure 12) are contained within an area whose maximum dimensions are roughly 18 km (E-W) by x 10 km (N-S). These dimensions fit well with Hally's (1993) observations on the typical spatial dimensions of simple chiefdoms. The Millstone Bluff cluster also compares favorably with a well documented interior drainage polity-the Peter Creek complex in south central Kentucky (Lowthert et al. 1998)-although its principal settlement, the Jewell site, did have a platform mound. There is no definite platform mound in the Millstone Bluff area, but the hill at Millstone may be a natural stand-in for one. We strongly suspect that the terrain feature of Millstone Bluff had long term symbolic importance to populations in the region dating back to Late Woodland times, and it is probably no coincidence that the principal settlement occupies a terrain feature that resembles a very large platform mound. In effect, why build one if you can live on one?

The site location, in conjunction with the plaza, architectural variability, rock art, and cemeteries, certainly suggest a central political and ceremonial role for the Millstone Bluff site. The picture, however, is complicated by the nearby Hayes Creek site. This site, together with a small outlier, comprise the only definite Mississippian habitation sites identified in the Hayes Creek valley east of Millstone. It was tested in 1998 and proved to be another substantial village site-and only 5 km southeast of Millstone. Hayes Creek is a small formal village of roughly 1 hectare with a circular or U-shaped midden and small plaza. Although its surface area is greater than the core site area of Millstone Bluff, it did not have as many contemporaneous structures. The limited investigations did identify an unusually large wall trench structure (ca. 12 x 8 m) that is significantly larger than any at Millstone Bluff. The site may have also had a low substructure mound; there is an artificially built-up area at the north end of the site, but it is not presently clear if the feature is the remnants of a low mound or merely an attempt to raise a section of living surface above a perched water table. A stone box grave mound existed about 600 m east of the site. Four radiocarbon dates indicate that the site is essentially contemporaneous with Millstone. Hayes Creek was a surprise in that we did not anticipate a large nucleated settlement so close to Millstone Bluff. More importantly, the nature of that site certainly suggests that the social and political structure of the Millstone Bluff polity may be more complicated than we anticipated.

2. What kind of adaptation to upland environs is represented by the Millstone Bluff community? The detailed floral and faunal data are not yet available, but we anticipate that the subsistence data will indicate a diet less dependent on maize and other cultigens than main-valley Mississippian sites and strongly focused on large mammals, with few fish or aquatic animals. Maize is known to be fairly ubiquitous in the flotation samples from the site but is present only in small quantities and highly fragmented. We are very interested in a comparison between Millstone and nearby habitation sites, and we hope to clarify this relationship in data from the excavations at the Hayes Creek site.

Although permanence is suggested by the plaza, extensive rebuilding, and cemeteries, could there still be major fluctuations in the history of the site? We think Millstone Bluff does represent a continuous, multi-generational occupation, but multiple occupations with periods of abandonment cannot be totally excluded. The fact that the site was located a long way from its agricultural fields may have some effect of the size of the resident population during warm months. It is possible that some portion of the population may have resided in field camps in the adjacent valleys during the growing season or, at least, did not always return to the site on a daily basis.

3. One of the more intriguing observations was, quite literally, staring everyone in the face. Wagner and McCorvie (1997) have described the site's rock art, which consists of over 30 identifiable glyphs, including a number of Southeastern Ceremonial Complex motifs (birdmen, falcons, bilobed arrow, cross-in-circle, serpents, and others) as well as one of the few known examples of a maize plant

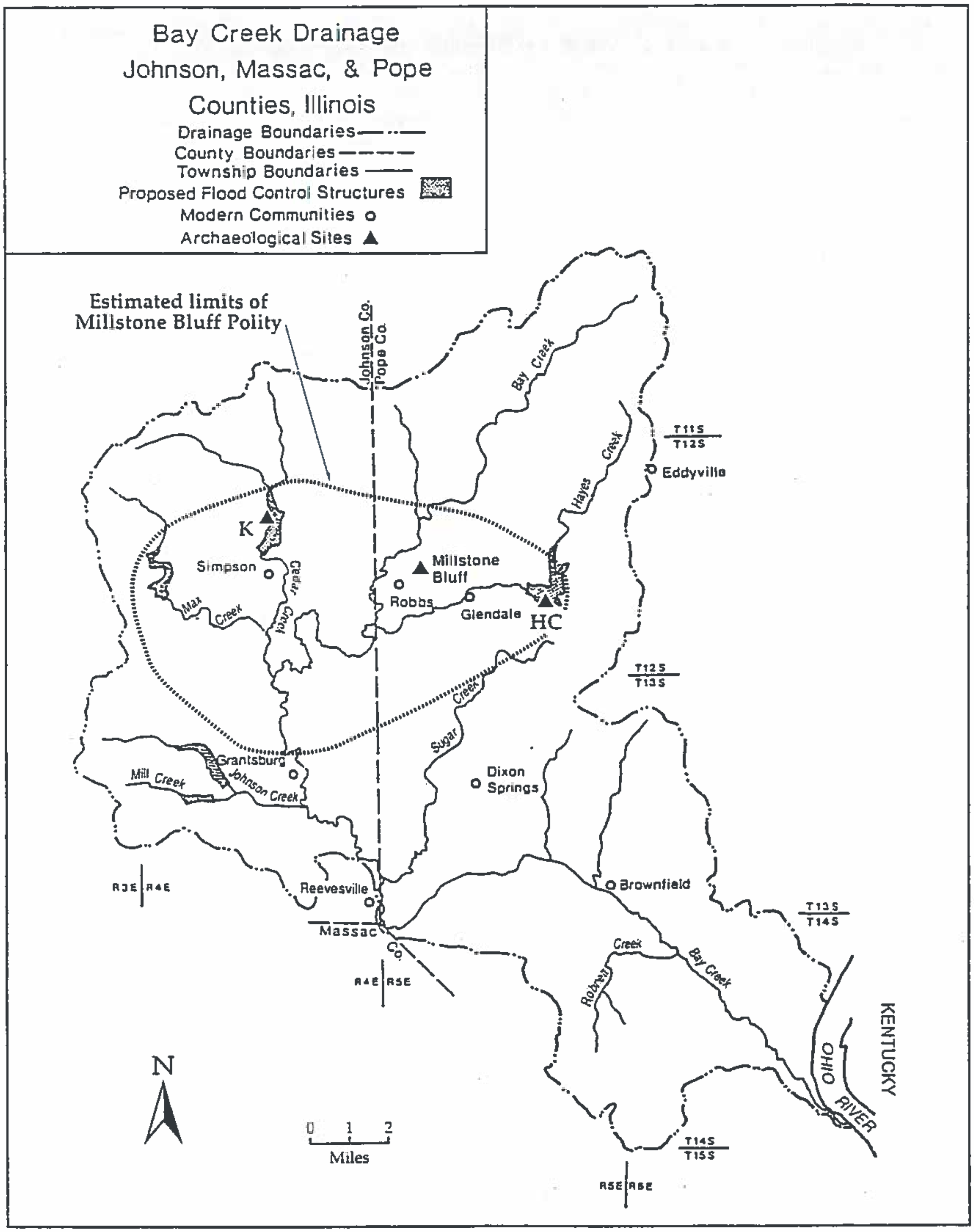


Figure 12. Map of Bay Creek Drainage and the Extent of the Millstone Bluff Polity. Adapted from Rudolph (1977: Map 2). HC is the Hayes Creek site and K is the Kavelman site.

depicted in Eastern Woodlands rock art. Millstone Bluff is the only known case of a large corpus of rock art directly associated with a major Mississippian settlement. The important point is the highly unusual public manner in which the rock art is displayed at the site. In the southern Midwest and Southeast, Mississippian rock art is typically found in caves and rockshelters in remote locations, substantial distances away from significant settlements. The makers of the Millstone Bluff glyphs did not use the many rock overhangs around the base of the escarpment, which would have been typical locations for rock art in the region. Instead, they chose three horizontal rock surfaces on the north edge of the site. The north side faces the nearest floodplain and water sources, and was probably the side from which the site was most often approached. Such a conspicuous presentation of potent symbols suggests that the village leadership felt that it had something to prove and was willing to expend some symbolic capital, so to speak, in an uncharacteristically public validation of status or power. Such an act becomes understandable in the context of the establishment of a new settlement in a previously unoccupied area, especially on a terrain feature that already may have had a history of strong symbolic associations, i.e. its earlier use as a Late Woodland "stone fort" or ceremonial enclosure.

4. What reasons lie behind the population movement to the uplands manifested by Millstone Bluff? Obviously, we do not have a definitive answer to that, but it is now clear that the late Mississippian Period in the lower Ohio Valley was politically volatile. Key to understanding the question of population movement is addressing whether the movement of peoples was a regional phenomenon or was restricted to a small group at the Millstone Bluff locality? Archaeologists assume that settlements fissioned on a regular basis, but the presence of an upland settlement system centered on Millstone Bluff speaks to a very different dynamic.

The radiocarbon dates show that the site is a late occupation whose inception falls around the time of cessation of mound building at Kincaid (Butler 1991) and when villages and mound centers along the lower Ohio are beginning to undergo significant changes in both population size and power relationships (Clay 1997; Williams 1990). In that sense, Millstone seems to conform to the regional pattern of significant changes that begin to become evident in the archaeological record around A.D. 1300.

The architectural and organizational aspects of the site argue against a slow growth scenario. Instead, the village seems to have appeared more-or-less at full size and persisted for a time before dwindling away. The authors believe that the Millstone settlements do represent the intrusion of a small polity into an area that previously had been used only for seasonal exploitation. The available evidence also suggests that this population arrived with a chiefly hierarchy (or at least a minimal elite structure) still intact, at least in the beginning. The general location of settlements was probably dictated by available areas of viable agricultural lands and the existence of an overland trail between the Ohio and Mississippi rivers-historically known as the Kaskaskia-to-Golconda trace (McCorvie and Morrow 1994). Millstone Bluff, Hayes Creek, and Kavelman are all located along or very near this historical route. The selection of Millstone Bluff for the principal site doubtless reflects the dramatic topography and defensive potential of the hill, but may also involve a prior history of symbolic importance attached to this terrain feature.

Key questions remain to be answered about Millstone Bluff and surrounding occupations, but what is apparent is that Mississippian populations were making a commitment to the southern Illinois hill country at the end of the 13th Century A.D. The appearance of the Millstone Bluff polity on the interior is a result of the political and environmental uncertainties associated with the decline of the Kincaid polity as the dominant regional political structure. The concomitant rapid rise of the Angel-based paramount chiefdom further upstream may have increased the political tensions in the lower valley segment. Millstone Bluff appears to be one of the fragments of the periphery of the Kincaid polity. Whether it reflects a move to a safer area away from the Ohio River or a perceived need for new "Lebensraum" (or both), we do not know. The area they settled was not *terra incognita* but rather a well-known hinterland that had been seasonally exploited for centuries. Perhaps this group, or its leaders, had some ancestral ties or claim to the area. In fact, it is possible that this population's ancestors were the Late Woodland people that once occupied these interior valleys, but were then drawn down to the Ohio River in early Mississippian times where they were incorporated into Kincaid's expanding sphere of influence.

Millstone Bluff fits within the recognized pattern of general abandonment of much of the Lower Ohio region by ca. A.D. 1500 (Williams 1990). It persists into the beginnings of the Caborn-Welborn phase (Pollack and Munson 1996; Pollack 1998), the only well defined protohistoric cultural unit in the region. Caborn-Welborn represents a shift of settlement formerly focused around the Angel site upstream, into the Ohio floodplains around and adjacent to the mouth of the Wabash River. So far, however, no Caborn-Welborn ceramics, or any other artifacts indicative of Caborn-Welborn contact have been found at the site. Indeed, if the Millstone Bluff settlements were extinguished by around A.D. 1450, one would scarcely expect any. What is clear is that in the wake of Kincaid's decline, a series of smaller polities, ostensibly representing simple chiefdoms of varying sizes, emerge but remain as separate entities and potential competitors. To quote Berle Clay, "Whatever the political form of 'classic' Mississippian, it is clear that on the Lower Ohio River a structure had in some sense run its course by A.D. 1300, if not earlier. It was being replaced by different forms" (Clay 1997: 30). There is no reemergence of a larger scale political hierarchy, at least one that can be traced to a particular central site. The interior enclave of Millstone Bluff appears to last longer than many other groups in the area, but why the region is ultimately abandoned and where these people go are not yet known.

Much more remains to be learned about Millstone Bluff and its related settlements as the research proceeds. As is evident from the preceding discussion, investigations to date have been highly informative on a number of fronts. For this reason we believe that continued research in the uplands promises to enlighten us not only about variability in Mississippian adaptive strategies, but also about the dynamics of Mississippian political geography in the broader region.

ACKNOWLEDGMENTS

This research has been funded in part by the USDA Shawnee National Forest through its Challenge Grant program and by a grant from the National Science Foundation (NSF SBR-9807157).

REFERENCES CITED

Butler, Brian M.

1991 Kincaid Revisited: The Mississippian Sequence in the Lower Ohio Valley. In *Cahokia and the Hinterlands*, edited by Thomas E. Emerson and R. Barry Lewis, pp. 264-273. University of Illinois Press, Urbana.

Clay, R. Berle

1997 The Mississippian Succession on the Lower Ohio. *Southeastern Archaeology* 16:16-32.

Cobb, Charles R. and Brian M. Butler
1996 The Organization of Production for Exchange on a Mississippian Village and Lithic Workshop. Paper presented at the 61st Annual Meeting of the Society for American Archaeology, New Orleans.

Cole, Fay-Cooper, Robert Bell, John Bennett, Joseph Caldwell, Norman Emerson, Richard MacNeish, Kenneth Orr, and Roger Willis
1951 *Kincaid, A Prehistoric Metropolis.* The University of Chicago Press, Chicago.

Dearinger, Lowell A.
1963 Millstone Knob, Ancient Scenic Hill in Pope County Played Host to Prehistoric Man and Early Illinois Pioneers. *Outdoor Illinois* 2 (5): 4-14.

Emerson, Thomas E.
1997 *Cahokia and the Archaeology of Power.* University of Alabama Press, Tuscaloosa.

Hally, David J.
1993 The Territorial Size of Mississippian Chiefdoms. In *Archaeology of Eastern North America, Papers in Honor of Stephen Williams*, edited by James B. Stoltman, pp. 143-168. Archaeological Report No. 25. Mississippi Department of Archives and History, Jackson.

Hargrave, Michael
1991 *A Selectionist Perspective on Change in Late Prehistoric (A.D.600-1400) Domestic Architecture in the American Bottom Region of southern Illinois.* Unpublished Ph.D. dissertation, Department of Anthropology, Southern Illinois University, Carbondale.

Hilgeman, Sherri L.
1992 *Pottery and Chronology at the Angel Site, A Middle Mississippian Center in the Lower Ohio River Valley.* Unpublished Ph.D. dissertation, Department of Anthropology, Indiana University, Bloomington.

Johnson, Jay K. and Frank Rackerby
n.d. Millstone Bluff: Spatial Analysis of a "Stone Fort" in Southern Illinois. Manuscript on file, Center for Archaeological Investigations, Southern Illinois University, Carbondale.

Kreisa, Paul
1995 Mississippian Secondary Centers along the Lower Ohio River Valley: An Overview of Some Sociopolitical Considerations. In *Current Archaeological Research in Kentucky: Volume 3*, edited by John F. Doershuk, Christopher A. Bergman, and David Pollack, pp. 161-177. Kentucky Heritage Council, Frankfort.

Lowthert, William, Carl Shields, and David Pollack
1998 *Mississippian Adaptations along the Barren River in South Central Kentucky.* Research Report No. 1. Kentucky Archaeological Survey, Lexington.

McCorvie, Mary R. and Carol Morrow
1994 Layers of Trails: Transportation Corridors Through Southern Illinois. Paper presented at the 1994 Ohio Valley Urban and Historic Archaeology Symposium,

Shakertown at Pleasant Hill, Kentucky.

Muller, Jon D.
1986 *Archaeology of the Lower Ohio River Valley.* Academic Press, Orlando.

1997 *Mississippian Political Economy.* Plenum Press, New York.

Munson, Cheryl A.
1999 Perspectives on the Angel Phase Settlement System. Paper presented at the Midwestern Archaeological Conference. East Lansing, Michigan.

Pollack, David
1998 *Intraregional and Interregional Relationships of the Late Mississippian Caborn-Welborn Phase of the Lower Ohio River Valley.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Kentucky, Lexington.

Pollack David and Cheryl A. Munson
1997 Caborn-Welborn Ceramics: Inter-site Comparisons and Extra-regional Interaction. In *Current Research in Kentucky, Volume Five*, edited by Charles D. Hockensmith, Kenneth C. Carstens, Charles Stout, and Sara J. Rivers, pp. 163-202. Kentucky Heritage Council, Frankfort.

Pollack, David and Jimmy A. Railey
1987 *Chambers (15ML109): An Upland Mississippian Village in Western Kentucky.* Kentucky Heritage Council, Frankfort.

Rudolph, James L.
1977 *Level 2 Investigations in the Bay Creek Watershed (Pope and Johnson Counties, Illinois).* Archaeological Service Report No. 52. University Museum, Southern Illinois University, Carbondale.

Stuiver, M. and P. J. Reimer
1993 Extended 14C Database and Revised CALIB Radiocarbon Calibration Program *Radiocarbon* 35: 215-230.

Thomas, Larissa A.
1997 *Hoe Production and Household Production at Dillow's Ridge: Gender Division of Labor and the Place of Production for Exchange in Mississippian Economy.* Unpublished Ph.D. dissertation, Department of Anthropology, State University of New York, Binghamton.

United States Geological Survey
1962 *Glendale, Ill.* 7.5 Minute Topographic Map. United States Geological Survey, Washington D.C.

Wagner, Mark L., Charles Foor, T. Sandefur, Jane K, Johnson, and Steve Titus
1992 *An Archaeological Survey of 5,938 Acres of the Shawnee National Forest, 1991.* Cultural Resources Management Report No. 172. American Resources Group, Ltd. Carbondale, Illinois.

Wagner, Mark L. and Mary R. McCorvie
1997 Late Mississippian Petroglyphs at the Millstone Bluff Site in the Shawnee Hills of Southern Illinois. Paper presented at the 54th Annual meeting of the Southeastern Archaeological Conference, Baton Rouge, Louisiana.

Wesler, Kit W.
1991 Ceramics, Chronology, and Horizon Markers at Wickliffe Mounds. *American Antiquity* 56:278-290.

1997 The Wickliffe Mounds Project: Implications for Late Mississippi Period Chronology, Settlement and Mortuary Patterns in Western Kentucky. *Proceedings of the Prehistoric Society* 63:261-283.

Williams, Stephen
1990 The Vacant Quarter and Other Late Events in the Lower Valley. In *Towns and Temples Along the Mississippi*, edited by David Dye and Cheryl Cox, pp. 170-180, University of Alabama Press, Tuscaloosa.

GEORGE ROGERS CLARK'S FORT JEFFERSON: AN HISTORICAL OVERVIEW WITH ARCHAEOLOGICAL AND ETHNIC CONSIDERATIONS AND IMPLICATIONS

By

Kenneth C. Carstens
Anthropology Program
Murray State University
Murray, Kentucky

and

Nancy Son Carstens
Department of History
Murray State University
Murray, Kentucky

ABSTRACT

In April, 1780, Col. George Rogers Clark's Illinois Battalion began constructing an American outpost (named Fort Jefferson) and a civilian community (named Clarksville), near the Mouth of the Ohio River in present day Ballard County, Kentucky. In this paper, an historical account of that Virginian outpost is presented along with anthropological implications and considerations about the site's military, ethnicity, architectural, and economical characteristics.

INTRODUCTION

On April 20, 1780, Col. George Rogers Clark wrote to Captain John Dodge in Kaskaskia stating that he (Clark) had arrived the previous day at the Mouth of the Ohio and that Dodge should send all of his quartermaster stores from Fort Clark in Kaskaskia to the soon-to-be built Fort Jefferson (James 1972, I: 417-418). Although this Clark-to-Dodge letter is cited frequently as the origin of Fort Jefferson, historical references foreshadowing the construction of the fort actually begin in 1777 in correspondence between Virginia Governor Patrick Henry and Spanish Governor Bernardo Galvez in New Orleans (Henry 1777; Kinnaird 1949: 241).

In that correspondence, Henry stresses the need to protect the joint interests of Virginia and Spain from Great Britain. To facilitate that protection, Henry proposed to Galvez that Virginia construct a fort near the Mouth of the Ohio. Although it would be a Virginian fort, Henry stated that the site would help guard American and Spanish trade on the Ohio and Mississippi Rivers (Henry 1777). To an extent, Governor Henry was truthful. Virginia did have trading interests with Spain, and did need commodities and slaves from Spain (Henry 1777). Furthermore, in 1777, France had not committed overtly to the American rebellion, and although unlikely, it was conceivable that France and Britain might block the westward trade of Virginia (see English 1896; James 1972, I; Waller 1976).

Virginia did have a vested interest for establishing a military presence at the Mouth of the Ohio, but not for exactly the same reasons that Henry had written Galvez. Virginia's early 17th century charter to lands west of the Appalachians was insignificant if Virginia could not enforce its' paper claim to that land (Carstens 1993, 1986; Hening 1823, I). However, a Virginian fort at the Mouth of the Ohio could help Virginia justify through possession her chartered claim, and the presence of the fort would help check the flow of arms, munitions and deserters going down the Mississippi to British Indian allies, especially the Chickasaw and Chocktaw (supported through the British Southern Indian Department in Pensacola) and to British held positions at Natchez and Manchac (Carstens 1989; O'Donnell 1973; Wright 1975). More importantly, in 1777, when Fort Jefferson was being planned, Clark's successful Kaskaskia and Vincennes campaigns had not yet occurred. Therefore, a fort at the southern-most-point of the Illinois Country, would give Virginia a stronghold from which to launch raids into a potentially hostile French- and British-held Illinois land.

Bureaucratic and military problems within the eastern campaigns slowed Virginia's planning process for the West between 1777 and 1779. However, by January of 1780, Governor Patrick Henry had been replaced by Thomas Jefferson as the new governor of Virginia, and Clark had taken the western (Kaskaskia to Cahokia), and eastern portions (Vincennes, Indiana), of the Illinois country (James, ed. 1972, I). Although Virginia now had a small military presence at the confluence of the Ohio and Mississippi to strengthen her chartered-claim, she still needed an overt sign of permanence in that area to legitimize her seventeenth century claim to the West.

The influx of many Virginians into the Ohio Valley in 1780 lent added support to Virginia's cause. Also, the Virginian legislature approved Henry's 1777 plan and Jefferson selected George Rogers Clark, a boyhood friend of Jefferson's, to enact the project (James 1972, I:386-391). With the arrival of Clark and his Illinois Battalion at the Mouth of the Ohio in April, 1780, Virginia began its first legislatively-sanctioned settlement west of the mountains (neither Harrodsburg or Boonesboro were sanctioned by the Virginia legislature). Moreover, Clark would use Fort Jefferson as his base of operations and economic hub for the Illinois Battalion—even though he, himself, was rarely present at the post. In his absence, Captain Robert George commanded Fort Jefferson and oversaw the day-to-day activities of the adjacent civilian community of Clarksville.

DISCOVERY OF FORT JEFFERSON DOCUMENTATION

The significance of Fort Jefferson is more than geographical placement. It represents one of the few archaeological sites that we know was occupied by Clark's Illinois Battalion (Carstens 1986, 1991b). The site's occupation between 1780-1781 had a profound effect on the future of the Illinois County and the settlement of Kentucky (English 1896, I). Yet, prior to 1982, little information had been published about Fort Jefferson due to a lack of records.

In 1781, Clark sent John Dodge to Richmond, Virginia, the new seat of Virginian government along with more than 20,000 receipts, vouchers, letters, and ledgers itemizing Clark's Illinois and Fort Jefferson campaigns. Unfortunately for Clark --and history--those documents became lost in Richmond, not to be rediscovered until 1927 when they where found by E. G. Swem, a Virginian archivist (Swem 1927). But few historians (Meeker 1976) realized the importance of those papers and the 20,000 documents remained essentially ignored until Ken Carstens "rediscovered" them in 1983. After two trips to the Virginia State Library, Archives Division in 1983 and 1984, more than 4,000 of those 20,000 documents were identified as originating at Fort Jefferson. By 1985 the Fort Jefferson documents had been transcribed and duplicated and reorganized into two publishable volumes (Carstens 1999, 2000). Included within the Fort Jefferson collection were economic vouchers, receipts, letters, medical inventories, musical scores, quartermaster inventories, court of inquiry and court martial proceedings, accounts of battles, economic exchanges and devaluation rates, letters, as well as a plethora of other tidbits of previously unknown history, including insight into the ethnicity of Fort Jefferson and its very diverse cultural population (Carstens 1990, 1991a, 1995; Virginia State Library, Archives Division, Unpublished George Rogers Clark Papers, Boxes 1-50, Richmond, Virginia, hereafter VSA, Box#).

THE FORT JEFFERSON POPULATION COMPOSITION

First and foremost, the military and civilian populations of Fort Jefferson varied greatly, by number, ethnicity, and social position, all of which should be visible in the archaeological record. At times, as many as 550 people occupied the site; at other times as few as 100 persons were present (Harding 1981; VSA, Boxes 48-50) at the site. The composition of the named population at Fort Jefferson includes 225 non-commissioned men and officers of Clark's Illinois Battalion, representing one company of artillery, one of dragoons, and four of infantry. Twenty-four individuals occupied important military and civilian support roles (such as, commissaries, quartermasters, interpreters [French, Spanish, and several Native American tongues], doctors, and members of the Indian Department) (VSA. Boxes 48-50).

The civilian population includes 40 named families (the name of each adult male per household is known, however, only 25 names of the married females were recorded). Twenty of the 40 households had a combined total of 33 children of which there is a record –this number is, I think, greatly underestimated (Carstens 1999). As an example, the Young and McMeans families' had 19 children between them. How typical was that number of children for the other 38 families at Fort Jefferson?

Other individuals present at the site, but not necessarily having their names or exact numbers recorded include transient person (traders, expresses, messengers), 65 Native Americans collectively representing the Kaskaskia, Peori, Kickapoo, Sauk, Ottawa, and Piankashaw, acted as hunters for the garrison. Also, there was an unspecified number of Blacks present at Fort Jefferson (VSA, Boxes 48-50 primarily). The Black population consists of at least two named individuals, who were free, skilled laborers (artificers), and a least seven slaves (including a family of three) who belonged to certain officers and prominent members of the White civilian population (VSA, Boxes 48-50). Interestingly, Alvord (1909) states that the 1780 population of 1,000 persons at Kaskaskia (60 miles [97 km] north of Fort Jefferson) was nearly evenly divided among Blacks (slaves) and Whites (owners), yet few Blacks at Kaskaskia are named individuals. Might the same be true of the White Virginian slave owners? Could there have been a slave population numbering into the hundreds at Fort Jefferson? We think it is possible and the archaeological record should reflect a strong ethnic division between Black, White, and Red at this Virginian outpost (Carstens 1999).

Beyond the obvious anthropological and archaeological importance attached to social stratification, the preceding population characteristics for fort and community are significant because nineteenth and twentieth century historians have stated that no more than 35 individuals were present at Fort Jefferson, and that those present were White (Collins 1924). What has become obvious by examining the "missing" Fort Jefferson papers is that Clark's Illinois Battalion was much more ethnically diversified, including Blacks (both slave and free), Whites (Spanish, French, and Americans/Virginians), and Native Americans (principally Kaskaskian

Indians, but others too), more so than historians have reported previously. Economic transactions, transferal of ethnically-related trade goods (e.g., French faience, Spanish majolica, etc.) with Spanish/French New Orleans, Spanish/French St. Louis (Pancore), and the French communities of Kaskaskia, Ste. Genevieve, Phillipe, Cahokia, and Vincennes, and the implementation of culturally-derived building practices (e.g, French construction techniques [post in ground or post on sill] vs. English construction, clapboard, vs. Native African construction), collectively and archaeologically make Fort Jefferson ethnically diverse (Seineke 1980).

STRUCTURAL COMPOSITION OF FORT JEFFERSON

The archaeological remains of Fort Jefferson have not been found --yet! But from the Fort Jefferson records we know that the physical components of Fort Jefferson include a 100 ft. (32 m) square fort with two, raised artillery bastions located at opposite angles; a picket-style stockade (or curtain) with rammed earth; at least one garrison or barracks for non-commissioned troops made from the timber from six batteau; three wooden storehouses --one of which had a basement or cellar; three houses for officers, at least one of which had a separate kitchen; a powder magazine with an "iron gate"; a two room privy of framed construction; one blacksmith shop; one guardhouse, and at least one well with windlass (the well was lined with plank boards for the initial 12 feet) (Carstens n.d., 1993, 1997; Draper Manuscripts n.d., 1M11; VSA Boxes 17; 48-50).

East of the fort was the civilian community of Clarksville, which consisted of 101 in lots. Additional protection for the civilians was offered from three blockhouses, each mounting two pound swivels in conjunction with musket and rifle fire. Two of the blockhouses were built on the northerly-located upland ridges, while the third was positioned at the southern end of the civilian community. The blockhouse doubled in function, serving too as residences for the guard and for a prominent citizen and his family (Carstens n.d., 1993). Also outside the fort was a saw pit, a boat mooring area on Mayfield Creek, several log houses within the platted community, a cemetery (containing the earthly remains of 38 individuals with coffins and another 20 persons without coffins who were buried in burial shrouds only), and a commons area in which turnips and corn were raised. These latter agricultural fields amounted to 47 acres (19.02 ha) (Figure 1) (Carstens n.d.).

Although a very active, populous, and important military and civilian stronghold, Fort Jefferson and the civilian community were short-lived. On June 8, 1781, just 416 days after its beginning, the garrison and population abandoned this strategically-placed outpost. While actively garrisoned, Fort Jefferson had functioned as the hub for the distribution of munitions, men, and merchandise for the Illinois Country (Carstens 1990; Seineke 1980). Likewise, it influenced, and was influenced by, the cultural characteristics found in the Illinois Country in 1780, including differing architectural features, economic systems, and other material cultural goods and cultural traits of the French, Spanish, English, Native American, and Black cultures – all of which were present at this military outpost and civilian community in the Middle Mississippi valley.

SPHERES OF INTERACTION

A careful examination of Fort Jefferson archival records provides considerable insight into the cultural spheres of military, social, and economic interaction occurring throughout the Illinois Country, New Orleans, and Fort Jefferson (Carstens 1990; James 1929). The following

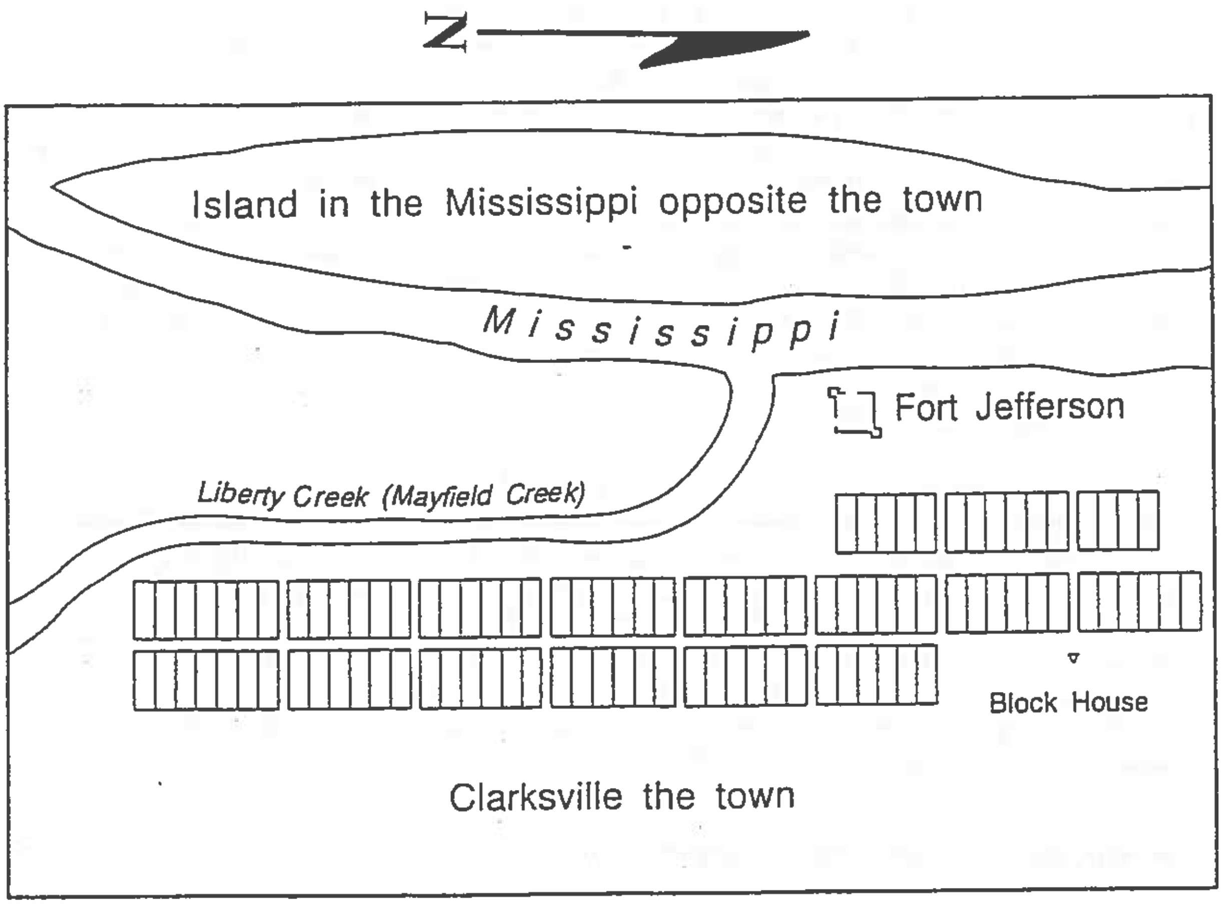


Figure 1. Re-drawn William Clark Map from 1780 (source: Draper Manuscripts, 1M11).

paragraphs briefly examine aspects of those topics to illustrate potential intra- and inter-site studies that will guide future fieldwork and analyses at Fort Jefferson.

MILITARY CONSIDERATIONS

Fort Jefferson personnel participated in numerous military actions, varying from defensive encounters at the post, to long distance defensive (Battle of St. Louis, May, 1780) and offensive battles (Shawnee Campaign, August, 1780). In addition, short-term retaliatory raids against the Chickasaw originated at the post (Carstens 1989, 1997; McDermott 1980). Although the archaeology of Fort Jefferson may offer some insight into military engagements at that post, the battles themselves may or may not be archaeologically detectable (although Scott 1989 has demonstrated at Little Big Horn that battles can be detected archaeologically). The defensive structures at Fort Jefferson, their cultural characteristics, and the construction techniques used by the inhabitants of Fort Jefferson may be of greater importance than the battles, because none of Clark's Illinois Battalion "forts" have ever been located or excavated. We simply do not know what military construction techniques were used by Clark's forces in the West at Fort Clark in Kaskaskia, Fort Bowman at Cahokia, Fort Patrick Henry in Vincennes or Fort Nelson in Louisville. Several of those fortifications were built by earlier site occupants (French) using their culturally-dictated construction techniques, some of which may or may not have been altered by Clark's Virginian forces. Moreover, most, if not all, of the above mentioned Illinois Battalion posts have been altered or destroyed. The significance of Fort Jefferson therefore becomes greater because it may be the ONLY remaining military structure occupied by Clark's forces that is still preserved within the archaeological record.

Also important are the military accoutrements and armaments that may remain, as well as their use, quantity, and point of origin: Spain or France. The outfitting of the Illinois Battalion, soldiery and fortification alike, is not as well documented as it could be. To what degree did the French, Spanish, or other allied groups supply the Illinois Battalion (Carstens 1990; James 1929)? There is ample evidence in John Dodge's and Martin Carney's "quartermaster books," that supplies (guns, munitions, ceramics, bottles, tools, etc.) came from both France (via Vincennes and Kaskaskia) and Spain (via Havanna, New Orleans, and St. Louis) (Carstens 2000). However, only archaeological excavations, together with archival study, will provide a more complete reconstruction of economic and ethnic influence.

SOCIOLOGICAL/ETHNIC CONSIDERATIONS

The sociology of the Fort Jefferson community is as dynamic and as complex as is the relationship between it and the cultural communities of the Illinois Country. The five major cultural groups within the Fort Jefferson region are the French, English, Spanish, Native American (if they can be grouped together as one group?), and Black. Although the importance of Spanish influence is not to be overlooked at Fort Jefferson (the majority of its dry goods, weapons, and liquid refreshments came from Spanish-controlled New Orleans), the complimentary role of a strong French influence from Kaskaskia, Ste. Genevieve, and St. Louis can not be overlooked either. Fort Jefferson was a composite of frontier cultures and ethnicity, with each cultural group vying for control, economic advantage, and living space on the frontier.

Ethnocentrism manifested itself at Fort Jefferson, too. Ethnic slurs and innuendo are present within the Fort Jefferson literature (Draper Manuscripts, n.d., 56J) and strongly reflects various forms of racism, differences maintained among eighteenth century social classes, and nationalism. We would, therefore, expect observable remnants of ethnically-based stratification to be present within the archaeological record through social/spatial patterns of different ethnic communities (Black section of the Clarksville community vs. different White sections, e.g. Irish-American, French, Spanish, etc., all living in microcosms of ethnocentric space). Observable differences between ethnic boundaries should be present also as should the recognition of inter-ethnic unions. Specific ethnic groups should be visible archaeologically through their respective artifact assemblages, artifact types, space utilization, and culturally-distinct architectural techniques. The great numbers of individuals from varied cultural backgrounds in the Illinois settlements and at Fort Jefferson offer the archaeologist an exciting opportunity to study eighteenth century sociological, anthropological, and ethnic phenomena.

ECONOMIC CONSIDERATIONS

Last, but by no means least, the economic sphere offers a dynamic area for the archaeologist. Without a doubt, economic considerations will be at the forefront of any archaeological studies of Fort Jefferson. Having the quartermaster books of the fort's two quartermasters (Martin Carney and John Dodge) is extremely helpful for the archaeologist who wishes to model data before going into the field (Carstens 2000). When frontier settlements have direct ties to international urban markets, e.g, New Orleans, or Havana, understanding the complexities of that economic system, and formulating plans to recognize it within the archaeological record becomes especially challenging. In addition to New Orleans as an economic source and outlet, the people of Fort Jefferson interacted economically with the Illinois settlements, both as an economic drain upon the Illinois Country and as a reciprocal market. Ripe with documentation pertaining to subsistence practices, the distribution of dry goods, and a myriad of technological acquisitions and disbursements, the archival records of Fort Jefferson will add considerably to the development of testable economic models for the archaeologist (Carstens 2000).

CONCLUSION

In summary, it should be noted that the actual site of Fort Jefferson has yet to be discovered (Carstens 1989). Although intermittent field testing has taken place since 1981, that testing was neither systematic or intensive. Although we have not isolated the location of the site, our test excavations and magnetometer studies (Foradas and Curran 1989; Foradas, Curran, and Carstens 1990) have demonstrated definitely where the site's structures are not located. We now feel that the site probably is more deeply buried under alluvial deposits, maybe up to 20 feet (6.4 m) deep, than previously anticipated (Carstens 1991b; Stein, Carstens and Wesler 1983). Many years of archival work about Fort Jefferson are now behind us, and we are happy to report that the systematic and intensive field testing phase of the study is about to begin. With continued perseverance, George Rogers Clark's Fort Jefferson will be located soon --we hope--and it will then become possible to interpret more fully, its archaeological remains in light of broader historical and anthropological contexts.

REFERENCES CITED

Alvord, Clarence Walworth
1909 *Kaskaskia Records, 1778-1790.* Illinois State Historical Library, Springfield, Illinois.

Carstens, Kenneth C.

1986a At the Confluence of the Ohio and Mississippi Rivers: Virginia's Claim to the West. Paper presented at the Second Annual Ohio Valley History Conference, Murray State University, Murray, Kentucky.

1986b The William Clark Map of Fort Jefferson: An Exercise in 18th Century Scaling. Paper presented at the Fifth Annual George Rogers Clark Trans-Appalachian Frontier History Conference, Vincennes.

1986c British Allies and American Enemies: The Chickasaws of the Mississippi River Valley. Paper read at the Fifth Annual Ohio Valley History Conference. Murray State University, Murray, Kentucky.

1986d Issues at Fort Jefferson, 1780-1781: The Quartermaster Books of John Dodge and Martin Carney. In *Selected Papers from the 1987 and 1988 George Rogers Clark Trans-Appalachian Frontier History Conference,* edited by Robert J. Holden, pp. 55-76. Eastern National Park and Monument Association, Vincennes.

1991a Praise the Lord and Pass the Ammunition: Munition Supplies at George Rogers Clark's Fort Jefferson, 1780-1781. In *Selected Papers From the 1989 and 1990 George Rogers Clark Trans-Appalachian Frontier History Conferences*, edited by Robert J. Holden, pp. 20-33. Eastern National Park and Monument Association, Vincennes.

1991b Current Field Strategies and Hypothesis Testing: The Fort Jefferson Project Continues. In *Studies in Kentucky Archaeology*, edited by Charles D. Hockensmith, pp. 165-174. Kentucky Heritage Council, Frankfort.

1993 The William Clark Maps of Fort Jefferson: An Exercise in 18th Century Scaling. *Filson Club History Quarterly* 67 (1):23-43.

1995 The Role of Women in Kentucky's Western Colonial Frontier. *Historical Archaeology in Kentucky*, edited by Kim McBride, Stephen McBride, and David Pollack, pp.157-167. Kentucky Heritage Council, Frankfort.

1997 George Rogers Clark's Fort Jefferson, 1780-1781. *Filson Club History Quarterly* 71(3):259-284.

1999 *The Personnel of George Rogers Clark's Fort Jefferson and the Civilian Community of Clarksville [Kentucky], 1780-1781.* Heritage Books, Inc., Bowie, Maryland.

2000 *The Calendar and Quartermaster Books of General George Rogers Clark's Fort Jefferson (Kentucky), 1780-1781*. Heritage Books, Inc., Bowie, Maryland.

n.d. The Structural Composition of George Rogers Clark's Fort Jefferson. Manuscript in possession of author, Murray, Kentucky.

Collins, Richard H.
1874 *History of Kentucky*, Vol. 1. Reprinted by the Kentucky Historical Society (1966), Frankfort.

Draper, Lyman C.
n.d. *Draper Manuscripts*: Microfilm Copies of the George Rogers Clark Papers, Series J and M. Wisconsin Historical Society, Madison.

English, William Hayden
1896 *Conquest of the Country Northwest of the River Ohio, 1778-1783 and the Life of General George Rogers Clark*, Vols. I & II. Bowen-Merrill Company, Indianapolis.

Foradas, James and Paul S. M. Curran
1986 Archaeomagnetic Reconnaissance of a Suspected Site of Fort Jefferson, A Revolutionary War Fort in Western Kentucky: A Preliminary Report. Department of Anthropology, Ohio State University, Columbus.

Foradas, James, Paul S. M. Curran, and Kenneth C. Carstens
1986 Archaeomagnetic Reconnaissance of a Suspected Site of Fort Jefferson, A Revolutionary War Fort in Western Kentucky: Final Report. Unpublished Ms. Copy in possession of Kenneth Carstens, Murray, Kentucky.

Harding, Margery H.
1981 *George Rogers Clark and His Men, 1778-1784*. Kentucky Historical Society, Frankfort.

Hening, William Waller
1823 *The Statutes at Large: Being A Collection of all of the Laws of Virginia*. Vol. I, New York. Reprinted 1969, Jamestown Foundation.

Henry, Patrick (Governor)
1777 Letter to Governor Bernado Galvez. *Archivo General de Indias Seville, Estante 87, Cajon 1, legajo 6.*

James, James Alton
1929 Oliver Pollock, Financier of the Revolution in the West. *Mississippi Valley Historical Review*, XVI:1:67-80.

James, James Alton (editor)
1972 *George Rogers Clark Papers, 1771-1784,* Vols. I and II AMS Press, New York.

Kinnarid, Lawrence (editor)
1949 Spain in the Mississippi Valley, 1765-1794. *Annual Report of the American Historical Association for the Year 1945*, Vol. II. Washington.

McDermott, John Francis
1980 The Battle of St. Louis: 26 May 1780. *Missouri Historical Society Bulletin* 16 (3):132-151.

Meeker, Mary Jan
1976 Original Vouchers in the George Rogers Clark Bicentennial Exhibition. *Indiana History Bulletin* 53(6):87-93.

O'Donnell, James H.
1972 *Southern Indians in the American Revolution.* The University of Tennessee Press, Knoxville.

Scott, Douglas D.
1989 *Archaeological Perspectives on the Battle of the Little Bighorn.* University of Oklahoma Press, Norman.

Seineke, Kathrine Wagner
1980 *The George Rogers Clark Adventure in the Illinois*. Polyanthos Press, Inc., New Orleans.

Stein, Julie, Kenneth Carstens, and Kit Wesler
1983 In Search of Fort Jefferson through Historic records and Geoarchaeological Studies. *Southeastern Archaeology* 12 (2):132-144.

Swem, E. G.
1927 The Lost Vouchers of George Rogers Clarke. *Virginia Journal of Education* 22 (424).

Virginia State Library (V.S.A.)
1780-1781 Unpublished Papers of George Rogers Clark. Virginia State Library, Archives Division, Richmond.

Waller, George M.
1976 *The American Revolution in the West*. Nelson-Hall, Chicago.

Wright, J. Leitch, Jr.
1975 *Britain and the American Frontier, 1783-1815*. The University of Georgia Press, Athens.

WHAT'S FOR DINNER?
LATE EIGHTEENTH CENTURY SUBSISTENCE STRATEGIES AT GEORGE ROGERS CLARK'S FORT JEFFERSON AND THE CIVILIAN COMMUNITY OF CLARKSVILLE, 1780-1781

By

Kenneth C. Carstens
Anthropology Program
Murray State University
Murray, Kentucky

ABSTRACT

Unlike many sites that lack historical documentation to supplement the archaeological record, archives associated with George Rogers Clark's Fort Jefferson contain thousands of economic vouchers and other documents that allow archaeologists the opportunity to reconstruct what the documented late eighteenth century subsistence patterns on the western Kentucky/Virginia frontier were like. The documentation presented here is presented in the form of a site catchment model and is then compared to other Midwestern sites of the eighteenth century.

INTRODUCTION

This paper examines subsistence activities at Fort Jefferson, an American eighteenth century fort and its civilian settlement of Clarksville on the extreme western edge of the Virginian frontier. The site of this outpost is believed to be 5 miles (8.05 km) below the mouth of the Ohio River near its confluence with Mayfield Creek, a small, but extremely deep tributary of the Mississippi River. Construction of this fort and the settlement of Clarksville began April 19, 1780 (George Rogers Clark's letter to John Dodge, dated April 20, 1780, in James, ed., 1972:417-418). Occupation of the post lasted until June 8, 1781 (John Montgomery letter to Governor Thomas Nelson, August 10, 1781, in James 1972:585-586). The chief reason why the fort and community were abandoned, according to Lt. Col. John Montgomery, was the lack of food (James 1972: 585-586). From his position at the Falls of the Ohio, Lt. Col. Montgomery wrote Virginia Governor Thomas Nelson on August 10, 1781. Montgomery (James 1972: 585-586) stated:

> I arrived at Fort Jefferson the 1st of May last (1781), where I found the Troops in a very low and Starving Condition, nor was any goods or other Property wherewith to purchase. From the Illinois nothing could be expected, the Credit of the State being long since lost there, & no supplies coming from this place, occasioned an Evacuation of that Post, which for want of Provisions, took place on the 8th June last.

Despite the brief existence of this post (13 months and 20 days), invaluable information about the late eighteenth century frontier is contained within the Fort Jefferson papers recently edited by Carstens (1999, 2000), within the Clark papers edited by James Alton James (James 1972), and within the Fort Jefferson court records preserved in the Draper Manuscripts (Lyman

Draper n.d.; Carstens 2000). These sources contain a record of activities including vital information about the fort's economic and subsistence systems, as administered by the fort's quartermaster, John Dodge, and the fort's two commissaries Martin Carney and John Donne (Carstens 2000).

Information will be presented in this paper about Fort Jefferson's subsistence practices and a comparison will be made to the potential availability of natural resources near the fort in the form of a site catchment model (Carstens and Potter 1986). This post's subsistence system will be studied in light of other eighteenth century Midwestern frontier settlements in order to delineate better the Fort Jefferson food procurement system.

BACKGROUND

A minuscule amount of published data exists that describes late eighteenth century culinary practices in use throughout the western Virginia frontier (principally Kentucky, but also the Ohio Valley and general Midwest). Several eighteenth century sites in the Midwest have received archaeological and archival investigations. Among those are Elizabeth Scott's (1985) analysis of subsistence patterns at eighteenth century French, then British held, Fort Michilimackinac. Charles Orser's (1976) work at Fort DeChartres II and Bonnie Gums (1988) study at the French village of Cahokia, both in west central Illinois. Nancy O'Malley's (1989) work at Fort Boonesborough in east central Kentucky. And lastly, Vergil Nobel's (1983), Judy Tordoff's (1983) and Terrance Martin's (1986) work at the French outpost, Fort Ouiatenon, in north central Indiana.

Between 1981 and 1996, locating contextual evidence of Fort Jefferson failed. Therefore, the subsistence model described here is based upon eighteenth century historical data only, and from biomass statistics from the site's immediate five-kilometer radius, and from an interpretation of other excavated Midwestern excavated century sites.

ARCHAEOLOGICAL RECORD

Elizabeth Scott (1985) recognizes that at Fort Michilimackinac there are two different patterns of food procurement which characterize the two major cultures present at the fort: French (1715-1761) and British (1761-1781). The French period is subdivided into a French mission period (1715-1730), and into two subsequent units called, first French (1730-1744), and second French (1744-1761). All four periods (mission, first French, second French, and British) are recognized stratigraphically and contextually in the archaeological record at Fort Michilimackinac. Comparable raw data for the two cultures comes from sheet middens (layered garbage), not features (subsurface pits). According to Scott (1985:191), "the overwhelming majority of meat contributed to both French and British diets is from mammals, with the fish contribution a distant second." Scott notes a sampling bias, however, against birds and fish which are under-represented for the French deposits where many more bird and fish remains were recovered than in the British levels. These remains, however, were not identified as to species. Her data further demonstrates that domestic animals where eaten more frequently by the Michilimackinac British (69.8% domestic to 30.2% wild) than by the French (54.8% domestic to 45.2% wild) who relied upon a greater amount of wild animals to supplement their diet (Scott 1985:191). Chief among the animals exploited by both French and British settlers were cow (*Bos taurus*), pig (*Sus scrofa*), white-tailed deer (*Odocoileus virginianus*), river otter (*Lutra canadensis*), mink (*Mustela* cf. *vison*), ferret/mink/weasel (*Mustelidae*), black bear (*Ursus americanus*), wolf/dog (*Canis sp.*), porcupine (*Erethizon* *dorsatum*), and beaver (*Castor canadensis*). Birds included Canada goose (*Branta canadensis*), various ducks (*Anatinae*), hawk (*Accipitrinae*), domestic chicken (*Gallus gallus*), ruffed grouse (*Bonasa umbellus*), turkey (*Meleagris gallopavo*), and passenger pigeon (*Ectopistes migratorius*). Fish included lake sturgeon (*Acipenser fulvescens*), lake whitefish (*Coregonus clupeaformis*), lake trout (*Salvelinus namaycush*), pike/pickerel/muskellunge (*Esox sp.*), walleye/sauger (*Stizostedion sp.*), and freshwater drum (*Aplodinotus grunniens*) (Scott 1985:189-190). Scott's (1985:167) analysis further notes that the French raised corn while the British grew squash.

At the French village of Cahokia (1699-1790), Bonnie Gums (1988) observes that the French civilians sought both domestic and wild animals for subsistence. However, chief among the large mammals was white-tailed deer, comprising 45.9% of the identified specimens and 41.5% of the total biomass (Gums 1988:224-234); cattle/bison embraced only 10% of the sample identified. Other mammals exploited included black bear, beaver, pig, and dog/wolf. In addition, the French hunted birds, including Canada goose, wild turkey, and sandhill crane. Gums notes an under representation of waterfowl in her sample (e.g., only three Trumpeter swams, [*Cygnus buccinator*]). Cahokia's geographical position near a wetland area and in the middle of the Mississippi flyway predicts a greater potential for waterfowl exploitation, but such was not represented in the archeological record. Other species exploited for food at Cahokia included the snapping turtle (*Chrysemys sp.*), catfish (*Ictalurus sp.*), buffalo fish (*Ictiobus sp.*), and sucker (*Catostomidae sp.*) (Gums 1988:228-229; Table 11). Botanical remains of three domestic species were found: corn, wheat, and apple, while wild plant remains were represented by hickory (*Carya sp.*) and walnut (*Juglans*). Gums (1988:230) stated that the French diet reveals a distinct preference for wild animal resources especially white-tailed deer, while some domesticated animals (cattle, pig, and chicken) constitute less than 14% of the sample. Gums (1988:233-234) further states:

> ...the early French subsistence pattern incorporated bison, black bear, beaver, large birds, aquatic turtles, and fish...The pattern that emerges is one in which French families [living] outside major French settlements (e.g., Kaskaskia or Fort de Chartres) were more self-sufficient regarding the acquisition of provisions. Even when domestic animals were maintained, the rich wildlife habitats...were seemingly perceived as too bountiful to ignore. Cattle, pigs, and chickens served as supplements to a local Native American diet which had been adopted by the French.

Charles Orser's (1976) excavations at Fort de Chartres II, found faunal remains in Feature 40 (a large black stain near the east barracks of the fort). Associated with the animal bones were English Whieldon-type earthenware ceramics manufactured between the period of 1750-1775. Elizabeth A. Cardinal (1976) analyzed the faunal remains. In her report, Cardinal (1976:164-165; Table 10) states that "cow appears to have been the most important source of food at [Fort de Chartres II]..., supplemented with deer, birds, and fish."

In Terrance Martin's (1986:341-346) analysis of the 1717-1761 French trading post, Fort Ouiatenon, in north central Indiana, he concluded that:

> 1. Wild animal species were prevalent in the subsistence economy...[and that] white-tailed deer was by far the most significant [wild]...species [and that] waterfowl (including swan, geese, and ducks), wild turkey, and raccoon were also important food animals.

2. Domesticated animals, which include cattle, pig, horse, and chicken, together comprised only a supplement to the subsistence economy.

In Kentucky, Nancy O'Malley (1989) located the remains of Fort Boonesborough. Although this post is 300 miles (483 km) east of Fort Jefferson (on the northern banks of the Kentucky River in Kentucky's central Blue Grass region), it is, nonetheless, socially, culturally, and politically similar to Fort Jefferson, because of its Virginian roots. Terrance Martin (1976:123-126) analyzed the excavated faunal remains from O'Malley's Fort Boonesborough excavations. Martin's study revealed that both wild and domesticated animals were hunted, especially the black bear, pig, white-tailed deer, bison/cattle, turkey, and channel catfish. Of these animals, the most popular was deer, followed by bison/cattle. Large birds, such as turkey, represented the third most popular species exploited by the inhabitants of Boonesborough.

FORT JEFFERSON

The habitat surrounding the Fort Jefferson area is both diverse and rich in plant and animal life. Inhabitants of the post had access to four major biological zones all within an easy five-kilometer walk of the fort: riverine resources for rank 4 and rank 5 streams (Mayfield Creek and the Mississippi River, respectively), rich bottomlands and islands in the Mississippi, forest hill slopes, and upland forests and prairies (Figure 1). As listed in Table 1 these biomes could support a wide array of animals and plants which could be exploited easily by the eighteenth century hunter, gatherer, and fisherman. Chief among animals to be exploited would be the white-tailed deer, black bear, elk, raccoon, passenger pigeon, wild turkey, beaver, opossum, various terrapins, rabbits, snapping turtles, river otter, prairie chicken, geese, ducks, and buffalo. From the forest could be collected walnut, pignut, and other naturally occurring forest fruits and vegetables. This eighteenth century frontier provided a cornucopia of foods.

Based on the listing of animal species in Table 1, a site catchment of more than 20 billion calories of food energy were available annually to the residents of Fort Jefferson within a five-kilometer radius of the post. Even without fishing, almost 94 million calories could be obtained from the natural environment around the fort without depleting the animal populations. If the average eighteenth century adult male requires 2,358 calories per day (Sally DuFord, Registered Dietitian and MSU Associate Professor, personal communication, July 1995), and the average adult female[1] requires 1,858 calories per day (Sally DuFord, personal communication, July 1995), and if on the average there were 110 men and 20 women at the post throughout the fort's existence, then 296,540 calories would have been necessary to feed the post daily. Based on the calories available in the 5 km natural environment surrounding the fort (Table 1), the Fort Jefferson population could sustain itself for nearly a year (316 days) and meet calorie requirements relying only on animals hunted and not fished.

Unfortunately, the Fort Jefferson research project has no excavated faunal remains with which to compare archaeological records with the aforementioned forts and outposts or to test against the site catchment model because the fort and its archaeological deposits have yet to be discovered. However, more than 5,000 Fort Jefferson documents have been found and have been studied recently (Carstens 1990, 1991a-b, 1993, 1994a-b, 1999, 2000). These records provide insight to the daily activities at this frontier post. It is from these papers that the following data are based.

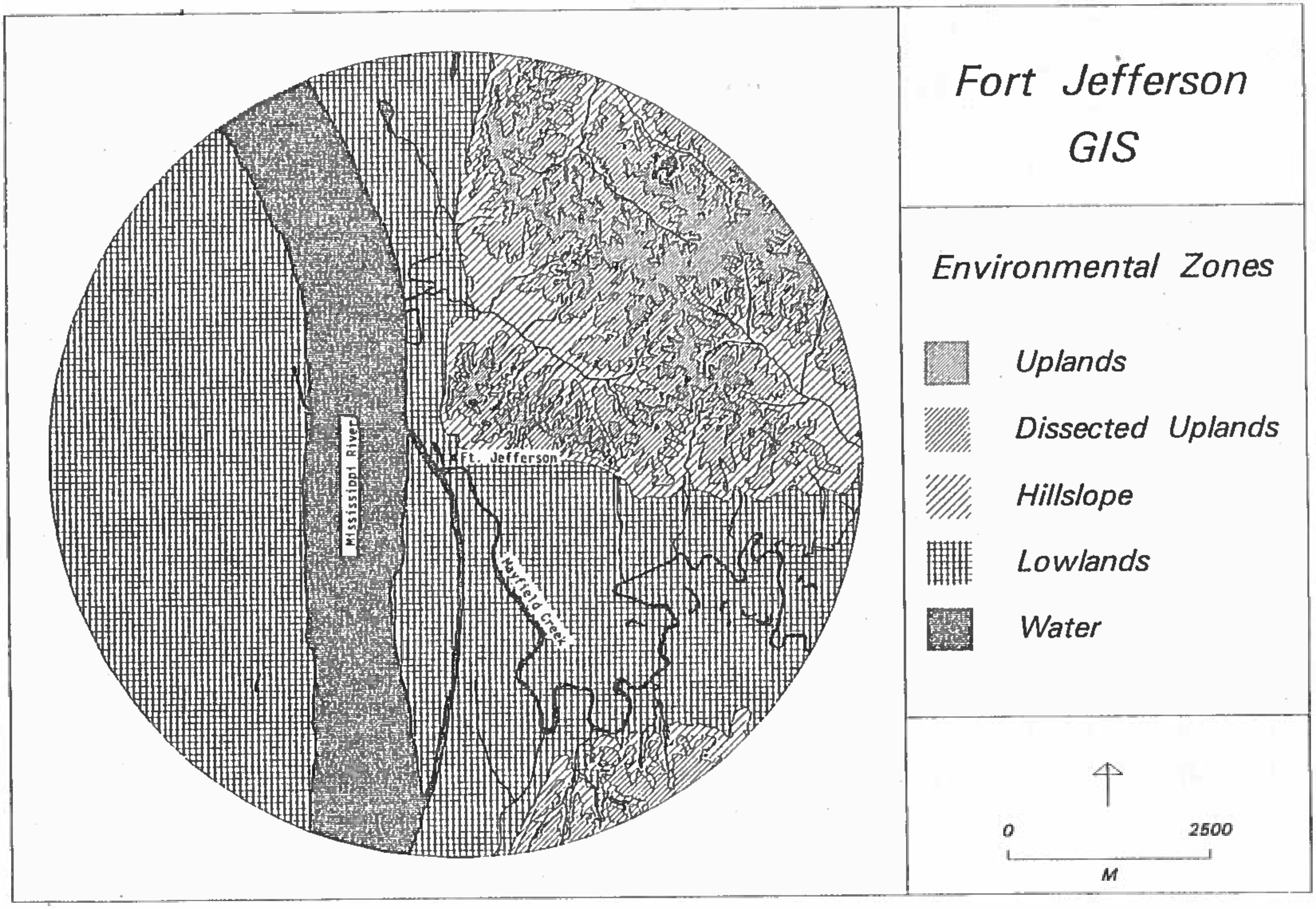


Figure 1. GIS Site Catchment Area Around Fort Jefferson.

Table 1. Estimated Biomass within 5 km of the Fort Jefferson Area (after T. Martin 1986: 347-439).

Animal	Predicted No. Species	Potential Pounds Meat Available	Approximate Calories Per Pound	Potential Calories Available
Bison	9	6,408	572	3,665,376
Elk	4	1,300	572	743,600
Deer	427	32,597	572	18,645,484
Black Bear	3.66	655	1306	855,430
Raccoon	456	4,163	1306	5,436,878
Mustelids	11	132	1306	172,392
Opossums	307	1075	1306	1,403,950
Beaver	219	7,690	1306	10,043,140
Muskrat	154	561	1306	732,666
Gray Squirrel	2189	2191	572	1,253,252
Cottontail Rabbit	1331	1797	989	1,777,233
Terrapin sp.	9696	2851	572	1,630,772
Snapping Turtle	4678	36,024	572	20,605,728
All Fish	141 pounds per acre	278,858	720	2×10^{10}
Passenger Pigeon	25,731	2149	400	859,600
Prairie Chicken	45	9.32	400	3728
Wild Turkey	212	1545	1308	2,020,860
1% All Ducks	13,304	18,626	1300	24,213,800
1% All Geese	125,000	5688	2015	11,461,320
TOTALS		404,319.32		20.1×10^9

The Fort Jefferson dietary record can be divided into five classes of food: meat, vegetables, condiments, beverages, and other (e.g., breads, or references to food procuring activities, e.g., "five men out hunting animals" or "harrowing the fields"). In this paper, only the first four classes will be discussed.

Meat. At least six types of meat were recorded as being consumed by the inhabitants of Fort Jefferson between April 19, 1780, and June 8, 1781. These meats include domestic beef (cow), buffalo, deer, bear, pig, and sheep. Other types of meat, e.g., fish, waterfowl, or small mammals, are not quantified in the Fort Jefferson papers. (That is not to say such animals were not consumed. They probably were. For example, there were issues of fishing seines to the soldiers in March and April, 1781, as well as fishing line, but no record of types or numbers of fish caught were reported.) Of the recorded meats, domestic beef and buffalo constitute the majority recorded, representing 49.8 and 41.7 percent of the total 16,064 pounds of meat (Table 2).

Vegetables. The only vegetables described in the Fort Jefferson papers are corn, "cornmeal," turnips, and a reference to private gardens with squash. However, only the corn and cornmeal were quantified because the commissary agents at the post issued them. Slightly more than 1,431 bushels of corn were issued to the military and civilian inhabitants at Fort Jefferson. An additional 300

Table 2. Recorded Consumption of Meat at Fort Jefferson, 1780-1781.

Meat Consumed	Amount in Pounds	Percent
Domestic Beef	8006	49.8
Buffalo	6695	41.7
Deer	745	4.6
Pig	342	2.1
Bear	246	1.5
Sheep	30	0.02
Totals	16,064	99.72

bushels of cornmeal also were issued. Clarksville civilians planted and raised more than 45 acres of corn, which, had the corn reached maturity, would have yielded another 1,115 bushels (September 2, 1780 report, William Clark and Leonard Helm to Captain Robert George, Draper Manuscripts, 1M8). Unfortunately, the Chickasaw attack of August 28-30, 1780 destroyed the corn crop. What amount of corn was recovered from those burned fields is not known, but some salvaging by the Fort Jefferson militia did occur (Carstens 2000).

Condiments. Condiments of sugar and salt were furnished for many different purposes to the population at Fort Jefferson. More than 3,012 pounds of sugar and 20.56 pounds of salt were imparted. Condiments had many uses. As an example of non-food use, more than 153 pounds of sugar were issued to sick persons as a homeopathic medicine to combat malaria during the month of September (the daily dose was two pounds of sugar per adult per day and one pound per child per day) (Carstens 2000).

Beverages. Beverages as food sources, as well as intoxicants and stimulates, were given. At least four milk cows were present at the post between September and November, 1780. But milk was not the mainstay of the post. Nor was coffee, although more than 418 gallons of coffee were issued. Soldiers and civilians, alike, were allotted alcoholic beverages including, in descending order: tafia (watered-down rum) 1660.76 gallons, an unspecified liquor 254.22 gallons, rum (not watered-down) 150.49 gallons, whiskey 3.41 gallons, and wine, 3 gallons. In total, more than 2,071 gallons of alcoholic beverages were issued at Fort Jefferson (Table 3).

The Fort Jefferson records exhibit that meat, corn, and alcoholic drink had the greatest impact on the inhabitants of Fort Jefferson. Table 4 exhibits the monthly distribution for those three items.

Disbursements of meat and alcoholic drink reflect similar bimodal patterns of distribution (Figure 2), although the reasons for those patterns are different. The distribution of meat, which was done so sporadically throughout the fort's 14 months, peaked during September and October, 1780, and again in March, 1781. The issuance of alcoholic drink peaked during September and October, 1780, and again in January and February, 1781.

Table 3. Beverages Issued at Fort Jefferson, 1780-1781.

Beverage	Amount Gallons	Percent/Total	No. Issues
Coffee	418	16.79	57
Tafia	1660.76	66.70	590
Unsp. Liquor	254.22	10.21	49
Rum	150.49	6.04	7
Whiskey	3.41	0.14	1
Wine	3.00	0.12	1
Totals	2489.88	100.00	705

At the end of August (specifically the 27th-30th), 1780, Chickasaw Indians attacked Fort Jefferson, burning the corn crop and killing much of the fort's livestock. The greatest amount of meat distributed to the fort's inhabitants occurred in the months immediately following that incident. Also, as a result of that attack, settlers would not leave their homes to hunt for themselves. Instead they chose to live from the meat taken off the carcasses of the domestic beef. In addition, there was the buffalo, deer, and bear meat which the friendly Kaskaskia Indians brought to the garrison in November, 1780. These measures helped the settlers prepare for the winter.

The larder would not be filled again until March, 1781, when additional beef, buffalo, and pork were received from the surrounding regions. Fishing also was important in March and April of 1781. A small quantity of domestic meat (beef and pork) was issued again in June, just prior to the evacuation of the post. Such action possibly was taken to ready the inhabitants for their move to Fort Nelson in Louisville.

The distribution of alcoholic drink peaked in October, 1780, and January, 1781. These dates coincide with the arrival of two cargo boats (bateaux) from New Orleans, captained by Philip Barbour, who arrived the first time near the end of September and the second time just after the new year. Libations ensued and continued until all spirits had been fully consumed two months later. Coffee had been drunk in September, prior to the arrival of Captain Barbour's first cargo. Corn was disbursed principally between August and December, 1780, following the major battle. But this autumn date also coincides with the normal availability of freshly harvested corn from other sources (such as, the Illinois country, central Kentucky settlements, and New Orleans). It may not be coincidental that large quantities of corn were issued during the fall arrival of Captain Barbour's New Orleans shipments. Otherwise, corn was only present at the origin of the post in April, 1780, when a shipment of 250 bushels of cornmeal accompanied Clark's Illinois Battalion from the Falls of the Ohio.

Calculating amounts of meat, corn, condiments, tobacco, and alcohol dispensed to each individual is highly probabilistic, but it has its purpose. If, as Lieutenant Colonel Montgomery stated, the fort's inhabitants were near starvation in May, 1781, which caused the evacuation order for this frontier outpost, then examining the amounts of known food quantities becomes important

Table 4. Schedule of Disbursement for Meat, Corn, and Drink at Fort Jefferson, 1780-1781.

Month (1780-1781)	Meat (Pounds)	Corn (Bushels)	Alcoholic Bev. (Gallons)
April, 1780	---	250 cornmeal	---
May	70	---	0.63
June	50	2.5	38
July	10	---	33.75
August	88	102 bushels & 50 bushels cornmeal	---
September	1005	666.05	205.25
October	4667	269	265.38
November	6407	126.75	2.00
December	---	245	52.44
January, 1781	30	---	608.39
February	---	---	557.01
March	3058	19	111.77
April	30	---	74.32
May	623	0.75	122.94
June	---	---	---
Totals	16,064 lbs.	1731.05 bu.	2071.88 gal.

to understanding the daily subsistence patterns. In order to calculate daily food allotments, it is necessary to have a firm population estimate. Unfortunately, the exact size of the garrison and civilian population is not known on a daily basis. The Fort Jefferson record reflects that only an approximate 200 persons (civilian and military) initiated the founding of the fort in April, 1780, but by June, 1780, the numbers had swelled to 565 persons (all named military, civilian, and Kaskaskia Indians) (Carstens 1999). By August, 1780, only about 200 inhabitants again were present (many civilians and soldiers had deserted the post; other military had gone with Clark on his Shawnee campaign into Ohio); by January, 1781, the fort's numbers had lessened to 150. (These numbers are based upon an inventory of civilians still present, and upon quantified disbursements of tafia rations to members of the Illinois Regiment.) Based on the foregoing, it comfortably can be stated that the combined average population of Fort Jefferson and the civilian community of Clarksville was 150 persons, 130 being adults.

Based on the preceding information and the realization that the post and community were quartered for 416 days, it becomes possible to examine approximate food allotments on a "per-person-per-day" basis at Fort Jefferson (Table 5).

Table 5. Projected Disbursements Per Person Per Day Based on a Population Estimate of 150 Persons for 416 days at Fort Jefferson, 1780-1781.

Issue	Total Issue	Per Person	Ration/Day
All Meat	16,064 lbs.	107.09 lbs	0.257 lbs./day
Corn	1411.3 bushels	9.4 bushels	.023 bu./day
Corn Meal	300 bushels	2.0 bushels	4 oz./day
Sugar	3012.5 lbs.	20.08 lbs.	2.77 lbs./day
Tobacco	2108 lbs.	14.05 lbs.	0.53 oz./day
Alcohol	2071.88 gals.	13.81 gals.	0.033 gal./day

The data in Table 5 exhibit that the inhabitants of Fort Jefferson daily received an average of 1/4 pound of meat, 1.5 pints of unprocessed corn, four ounces of cornmeal, almost three pounds of sugar, and about one gill of alcoholic drink. Caloric food value for this "daily" meal is more than 7,700 calories, but it is extremely low in fiber, folacin, and vitamin C which also are needed for survival (Sally Duford, personal communication, July 1995).

It can be concluded that the Fort Jefferson diet was excessively lean. Their diet must have been supplemented with other foods (wild?) in order for the population to have survived. But the biases of written records do not record those other foods. Only the archeological record may contain that information.

The food resources, which were present, were not equally distributed throughout the year, nor was the quality of those foods received necessarily dependable. Take, for example, the following letter from Capt. Robert George, the commandant of Fort Jefferson. In his writing of February 15, 1781, to Col. George Slaughter in Louisville, George stated (James 1972:506-507):

> ...out of your great abundance I shall expect to receive frequent and large Supplies--more especially in the Commissary way. The Small Supplies you have sent us, have been of infinite Service, & if you frequently repeat them they will be of singular advantage as we look to you for it, but the supplies I beg may be of a better Quality than what is yet come to hand. The Beef is really of the poorest kind--ill-cured, and not half salted--the Barrels being bad, the pickle became wasted, if ever any had been put in, and tho' the Meat does not absolutely stink, it wants little of it.

Sustenance at Fort Jefferson appears to have been either feast or famine, primarily because of Indian depredations in August, 1780. Although it is also apparent that Clark, did not heed Governor Thomas Jefferson's statement that the post's population would have to be self-reliant (Thomas Jefferson to G. Clark, January 29, 1780; James 1972: 389):

> ...the less you depend for supplies from this Quarter, the less will you be disappointed by those impediments distance & a precarious foreign Commerce...

The populace of Fort Jefferson was not self-reliant. The problem became worse when too few edible resources were delivered from Virginia stores to Fort Jefferson. Meager offerings did little more than sustain a people who would not hunt regularly, would not collect, or would not exploit the richness of their local environment for themselves for fear of Indian depredations. Such occurrences would lead to the abandonment of Fort Jefferson due to poor leadership and to poor economic planning.

How does the Fort Jefferson subsistence pattern compare to other eighteenth century forts and settlements on the frontier? Both Martin (1986: 306-311) and Tordoff (1983:140), in their discussions of the comparability of faunal assemblages between Midwestern sites, suggest that in addition to observable differences in diet preferences between cultures (e.g., a French or a British frontier diet), a difference may be accentuated by a post's economic position. That is, a greater similarity exists between large, geopolitical hubs of different cultures (or what Tordoff [1983:14] calls regional distribution centers), than among smaller, local distribution centers. Forts Michilimackinac and de Chartres II are regional distribution centers. At these two important sites, diets consisted mainly of cow, but the similarity between French and British ends there. Primary supplements to the French diet focused on wild game from the local environment. The British augmented their diet with greater quantities of lesser-sized domesticated animals (e.g., pig and chicken) and less of wild game species; just the opposite of the French custom.

The small French village Cahokia, the French trading post of Fort Ouiatenon, and the American settlement of Fort Boonesborough, all displayed dietary patterns expected for smaller, local distribution centers, where emphasis is placed upon wild resources supplemented with a handful of domesticated ones. From that vantage then, even an ethnically British-related site such as Boonesborough reflects an exploitation pattern geared not to the urban centers, but to the local environment. Such would be expected for Fort Jefferson, too, because of its cultural and geographical similarities to Boonesboro, but for a plethora of reasons, Fort Jefferson does not fit the mold.

Instead, the dietary pattern of Fort Jefferson mirrored the large regional distribution centers and not a local allocation center (See Table 2). Was Fort Jefferson a regional distribution center? One could make arguments in support of that position (Carstens 2000; Cumings 1988). The Fort Jefferson outpost did serve Virginia as a major dissemination site for the middle Mississippi and lower Ohio River valleys (Carstens 2000). Then, again, it may be argued that the Fort Jefferson subsistence and economic pattern does not follow the dietary pattern of other regional centers because its analysis is based upon the archival record alone, not an archaeological record like other Midwestern sites to which it is compared in this study.

Yet another difference may be explained by Thomas Jefferson's January 29, 1780, directive to Clark, wherein the post was directed to be self-sufficient. Unfortunately, the people of the post were not self-sufficient due to the constant threat of Chickasaw attack. If settlers and soldiers left the fort, they never came back, either by chance or by choice. Indeed, during the month of September, 1780, more than half of the 44 families at Fort Jefferson left for other settlements because they feared additional Indian depredations as well as the prospect of a difficult winter without their corn crop or animal stock (Carstens 1994, 1999, 2000). Shipments of supplies from New Orleans, Kaskaskia, Vincennes, and Louisville to Fort Jefferson simply were too few and were too infrequent between deliveries. When shipments arrived, they consisted of dry goods, military accoutrements, spoiled foods, and alcoholic beverages (Carstens 2000). Dealing with a terrible credit rating throughout the Illinois country, facing 1000% inflation in the cost of goods, and a depreciating Virginian currency, Fort Jefferson was doomed to economic failure (James, ed., 1972: cliv, 173, 379, 388, 444, 561; Carstens 1994). Thus, on June 8, 1781, Lt. Col. John Montgomery, in noting that no new supplies or assistance were imminent and that there existed few prospects for a positive future at Fort Jefferson, Lt. Col. Montgomery decided to evacuate Virginia's claim to her westernmost lands.

REFERENCES CITED

Cardinal, Elizabeth A.

1976 Appendix B.: Faunal Remains from Fort de Chartres. In *The 1975 Season of Archaeological Investigations at Fort de Chartres, Randolph County, Illinois*, by Charles E. Orser, Jr., pp. 164-167. University Museum, Southern Illinois University, Carbondale.

Carstens, Kenneth C.

1990 Issues at Fort Jefferson, 1780-1781: The Quartermaster Books of John Dodge and Martin Carney. In *Selected Papers from the 1987 and 1988 George Rogers Clark Trans-Appalachian Frontier History Conferences*, edited by Robert J. Holden, pp. 21-34. Eastern National Park & Monument Association and Vincennes University.

1991a Praise the Lord and Pass the Ammunition: Munition Supplies at George Rogers Clark's Fort Jefferson, 1780-1781. In, *Selected Papers from the 1989-1990 George Rogers Clark Trans-Appalachian Frontier History Conferences*, edited by Robert J. Holden, pp. 20-33. Eastern National Park & Monument Association, Vincennes, Indiana.

1991b The Structural Composition of George Rogers Clark's Fort Jefferson, 1780-1781: An Assessment. Paper presented at the 1991 Society for Historic and Underwater Archaeology, Richmond, Virginia.

1993 The 1780 William Clark Map. *The Filson Club History Quarterly* 67 (1): 23-43.

1994 Fort Jefferson, 1780-1781: A Summary of Its History. In *Selected Papers from the 1991 and 1992 George Rogers Clark Trans-Appalachian Frontier History Conference*, edited by Robert J. Holden, pp. 43-60. Eastern National Park & Monument Association, Vincennes, Indiana.

1997 George Rogers Clark's Fort Jefferson, 1780-1781. *The Filson Club History Quarterly* 71 (3):259-284.

1999 *The Personnel of George Rogers Clark's Fort Jefferson and the Civilian Community of Clarksville [Kentucky], 1780-1781*, Heritage Books, Inc., Bowie, Maryland.

2000 *The Calendar and Quartermaster Books of General George Rogers Clark's Fort Jefferson (Kentucky), 1780-1781*. Heritage Books, Inc., Bowie, Maryland.

Cumins, Light T.
1988 Oliver Pollock and George Rogers Clark's Service of Supply: A Case Study in Financial Disaster. In *Selected Papers of the 1985 and 1986 George Rogers Clark Trans-Appalachian Frontier History Conference*, edited by Robert J. Holden, pp. 1-16. Eastern National Park and Monument association, Vincennes, Indiana.

Draper, Lyman C.
n.d. *The Draper Manuscripts*, especially Series J. Wisconsin Historical Society, Madison.

Duford, Sally
1995 Personal Communications with Kenneth C. Carstens concerning diet. Department of Home Economics, Murray State University, Murray, Kentucky.

Gums, Bonnie L.
1988 *Archaeology at French Colonial Cahokia*. Studies in Illinois Archaeology No. 3. Illinois Historic Preservation Agency, Springfield.

James, James Alton (editor)
1972 *George Rogers Clark Papers, 1771-1784*, Vols. I and II. AM Press, New York (Originally Published in 1912 by the Illinois State Historical Library).

Martin, Terrance J.
1989 Preliminary Report on Animal Remains from Block C of the Fort Area at Fort Boonesborough State Park, Kentucky. In *Searching for Boonesborough* by Nancy O'Malley, pp. 119-124. *Archaeological Report 193*. Program for Cultural Resource Assessment, University of Kentucky, Lexington, Kentucky.

Noble, Vergil E.
1983 *Functional Classification and Inter-Site Analysis in Historical Archaeology: A Case Study from Fort Ouiatenon*. Ph.D. dissertation, Michigan State University, University Microfilms, Ann Arbor.

O'Malley, Nancy
1989 *Searching for Boonesborough. Archaeological Report 193.* Program for Cultural Resource Assessment, University of Kentucky, Lexington, Kentucky.

Orser, Charles E., Jr.
1976 *The 1975 Season of Archaeological Investigations at Fort de Chartres, Randolph County, Illinois*. University Museum, Southern Illinois University, Carbondale.

Potter, William L. and Kenneth C. Carstens
1986 Floral Reconstruction of the Fort Jefferson Area. Paper presented at the 1986 Southeastern Archeological Conference, Nashville.

Scott, Elizabeth M.
1983 *French Subsistence at Fort Michilimackinac, 1715-1781: The Clergy and the Traders*. Archaeological Completion Report Series, Number 9, Mackinac Island State Park Commission, Mackinac Island, Michigan.

Tordoff, Judith D.
1983 *An Archaeological Perspective on the Organization of the Fur Trade in Eighteenth Century New France*. Ph.D. dissertation, Michigan State University. University Microfilms, Ann Arbor.

WARRANTS, SURVEYS, AND PATENTS AT FORT JEFFERSON, KENTUCKY

By

Andrew C. Kellie,

Kenneth Carstens,

Brandon J. Kellie[1]

ABSTRACT

This research involved the review and examination of record and physical evidence of land ownership pertaining to the location of Fort Jefferson, a Revolutionary War fortification situated in Ballard County, Kentucky. Records used included Virginia Military Surveys, a Virginia Treasury Survey, the rectangular survey of the Jackson Purchase, and field notes, plats, and deeds of record in Ballard and Carlisle counties as well as the National Archives. Additionally, physical lines as marked on the ground or as appear on aerial photos and U.S. Geological Survey topographic quadrangle maps were used to define the land settlement pattern in the area of interest.

INTRODUCTION

Based solely on record evidence, the general location of Fort Jefferson is east of the Mississippi River at the mouth of Mayfield Creek in Ballard County, Kentucky. Recovery of physical evidence on the ground has enabled a deed compilation registered to existing USGS topographic maps. This shows the fort to be located south of the south line of the Meyers Treasury Survey, within the Todd Military Survey, and south of the north line of Section 3, Township 5 North, Range 4 West of the Kentucky Meridian. The fort was adjacent to (and probably east of) the former Mobile & Ohio railroad grade at the point of tangency of the curve immediately south of the Meyers line, possibly in the light toned area visible on historic aerial photographs. With this phase of the research complete, preliminary archaeological surveys can be planned to narrow still further the location of the fort.

BACKGROUND

The land system of a region constitutes the patents, deeds, and surveys that define the location of real property. Indeed, current property boundaries are based on the original surveys that first marked the lines on the ground. Evidence of boundary location includes not only the

---

[1] Andrew C. Kellie is an Associate Professor of Engineering in the Department of Engineering Technology, Murray State University; his son, Brandon J. Kellie is a student in the Biology Department at the University of Louisville; Kenneth C. Carstens is a Professor of Archaeology and Anthropology at Murray State University.

physical marks left by past owners and surveyors, but also the written records of ownership, maps, and plats. In the Jackson Purchase area of western Kentucky (that part of Kentucky west of the Tennessee River), the land system is a composite of parcels based on both the metes and bounds and rectangular survey systems. Thus, it reflects both the townships and ranges established by the original survey of the Purchase as well as surveys based on Virginia military and treasury warrants that pre-date the rectangular survey. Both types of surveys reflect the history of the Jackson Purchase area.

The earliest boundary surveys in the Jackson Purchase are associated with the construction of Fort Jefferson. In 1780, Virginia forces under the command of George Rogers Clark constructed this fort south of the confluence of the Ohio and Mississippi Rivers in what is now Ballard County, Kentucky. The purpose of Fort Jefferson was to assert Virginia's sovereignty to land extending to the east bank of the Mississippi River and to bolster United States claims to the Northwest Territory. Fort Jefferson also was to provide protection for an adjacent civilian community, named Clarksville, which was intended to adjoin the fort. The fort and the adjoining community are shown in Figure 1.

As early as 1777, Virginia Governor Patrick Henry proposed to Spanish Governor Bernardo Galvez that the Virginians be allowed to construct a fort and settlement near the confluence of the Ohio and Mississippi Rivers to justify Virginia's chartered claim to that land, but also to thwart any possible movement by the British against either Spanish or American interest in that area (Henry 1777). It would not be until January 29, 1780, that Virginia Governor Thomas Jefferson selected George Rogers Clark to enact the proposal first made by Henry (Jefferson 1780). On April 19, 1780, the first soldiers and civilian inhabitants arrived at the confluence and selected an area north of Mayfield Creek (then called Liberty Creek) on the east side of the Mississippi River to construct the fort and settlement. This area was approximately 5 miles below the confluence of the Ohio and Mississippi Rivers. In all, more than 550 persons would, for the next 13 months and 20 days, live at Fort Jefferson and the civilian community, Clarksville (Carstens 1999). Unfortunately, with the destruction of corn crops and livestock at the hands of the Chickasaw Indians in July and August, 1780, and the lack of incoming food supplies from outside sources, Fort Jefferson would be short-lived, being abandoned at the request of Lt. Col. John Montgomery on June 8, 1781 (Carstens 2000; Montgomery 1781). In spite of the short duration, Fort Jefferson was a significant outpost for the Virginians. Soldiers from it helped thwart the British-led Indian assault on St. Louis and Cahokia in May, 1780, and in August, 1780, many of its soldiers participated in Clark's attack on the Ohio Shawnee villages at Old Picqua and Chillicothe. Moreover, Fort Jefferson was the only fortification built in Kentucky expressly at the request and support of the Virginia government. Today, locating the exact position of the site of Fort Jefferson is important because it has the potential of being one of the few remaining American Revolutionary War period sites left intact in the Midwest by the Virginians. Fort Clark at Kaskaskia Island was washed away by the Mississippi River, Fort Bowman was destroyed by urban development in Cahokia, Fort Patrick Henry in Vincennes was destroyed by the Rotunda built to honor the memory of George Rogers Clark and the men and women who fought with him, Fort Nelson in Louisville was destroyed by urban expansion, and Fort Harrodsburg has been covered over by an asphalt church parking lot. Should the archaeological site of Fort Jefferson be discovered (Carstens n.d.), its research significance would be multiplied significantly when added to the plethora of published documentation about the fort and community (Carstens 1999, 2000).

The exact location of Fort Jefferson is uncertain today, but the general location of the fort is evidenced by the land system. It is the intent of this research to investigate early land ownership patterns in the area of the fort. Specifically, the work has the following objectives:

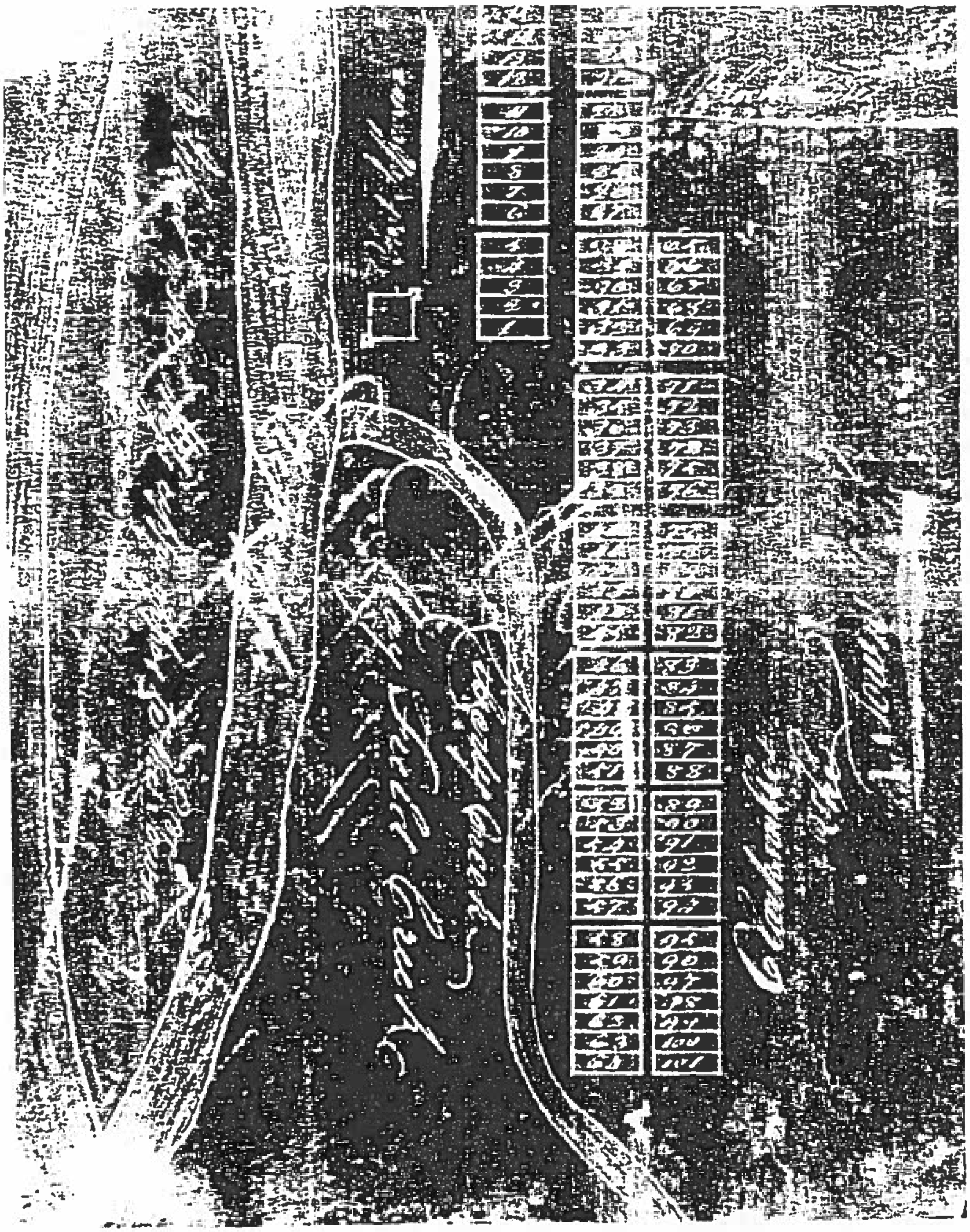


Figure 1. Fort Jefferson and the Civilian Community of Clarksville, 1780. (Draper Manuscripts, 1M8-11, Wisconsin Historical Society, Madison.)

1) Review records of early surveys in the western part of the Jackson Purchase.

2) Identify the lines of the rectangular survey system (if any) in the Fort Jefferson area.

3) Compile Virginia military and treasury surveys that relate to the location of Fort Jefferson.

4) Relate the lines of the above surveys to the ground based on existing U.S. Geological Survey topographic maps.

EARLY SURVEYS IN WESTERN KENTUCKY

Perhaps the earliest survey involving the confluence of the Ohio and Mississippi Rivers was an observation for latitude performed during the French expedition by Marquette and Joliet in 1673. Marquette's journal gives the latitude at that location as 36 degrees (JR59, 1673). However, by the time of the Revolutionary War, a precise determination of the latitude of the confluence was of material interest to Virginia, which claimed to the east bank of the Mississippi River by virtue of the Carolina Charter of 1665. This charter placed the southern boundary of Virginia at 36 degrees 30 minutes north latitude (Thorpe 1909). Consequently, in January 1780 Virginia Governor Thomas Jefferson requested Dr. Thomas Walker and Daniel Smith to determine this location on the ground (Jefferson Papers). In his journal entry for May 1780, Smith notes the following:

> Wednesday 10th. Observed. Thursday 11th. Agreed with Yesterdays observ. We were 3'19" in Virginia—from this point of the Island we ran east to the main land where I marked a buck eye elm & Sugar tree then South 3 m. 265 po. Then west 106 po. To riv. 96 po. of which we mark'd. new land is forming here, nothing to mark but cotton trees (Smith 1915).

The observations by Walker and Smith were instrumental in ensuring that fortifications erected by George Rogers Clark at Fort Jefferson indeed were within the charter boundaries of Virginia and are the first precise surveying observation made in what is now western Kentucky. The only map drawn of Fort Jefferson, made while the fort was occupied, was made in 1780 by William Clark (this William is the cousin of George Rogers Clark and not George's younger brother by the same name). The first map of Fort Jefferson drawn after the fort was abandoned was made in 1795 by William Clark, George's younger brother. This map shows the fort as being on the north bank of a creek on the east side of the Mississippi at the first island south of the confluence of the Ohio and Mississippi. A portion of the 1795 Clark map is shown in Figure 2.

Following the Revolutionary War, the United States recognized title to land between the Tennessee and Mississippi Rivers in western Kentucky as being in the Chickasaw Nation. This land was purchased for the United States in 1818 by a delegation headed by Andrew Jackson and Isaac Shelby and it was subsequently conveyed to Kentucky and Tennessee. The Kentucky portion of the Jackson Purchase is shown on a map published in 1818 by Luke Munsell. This shows the Jackson Purchase as "Land to which the Indian Title is (lately) Extinguished but has not yet been Surveyed." Interestingly, it also shows within the Jackson Purchase two grants: a grant labeled "G. R. Clarke's 37,000 Acres" and "Mayo's 17,000 acres." A portion of the Munsell map is shown in Figure 3.

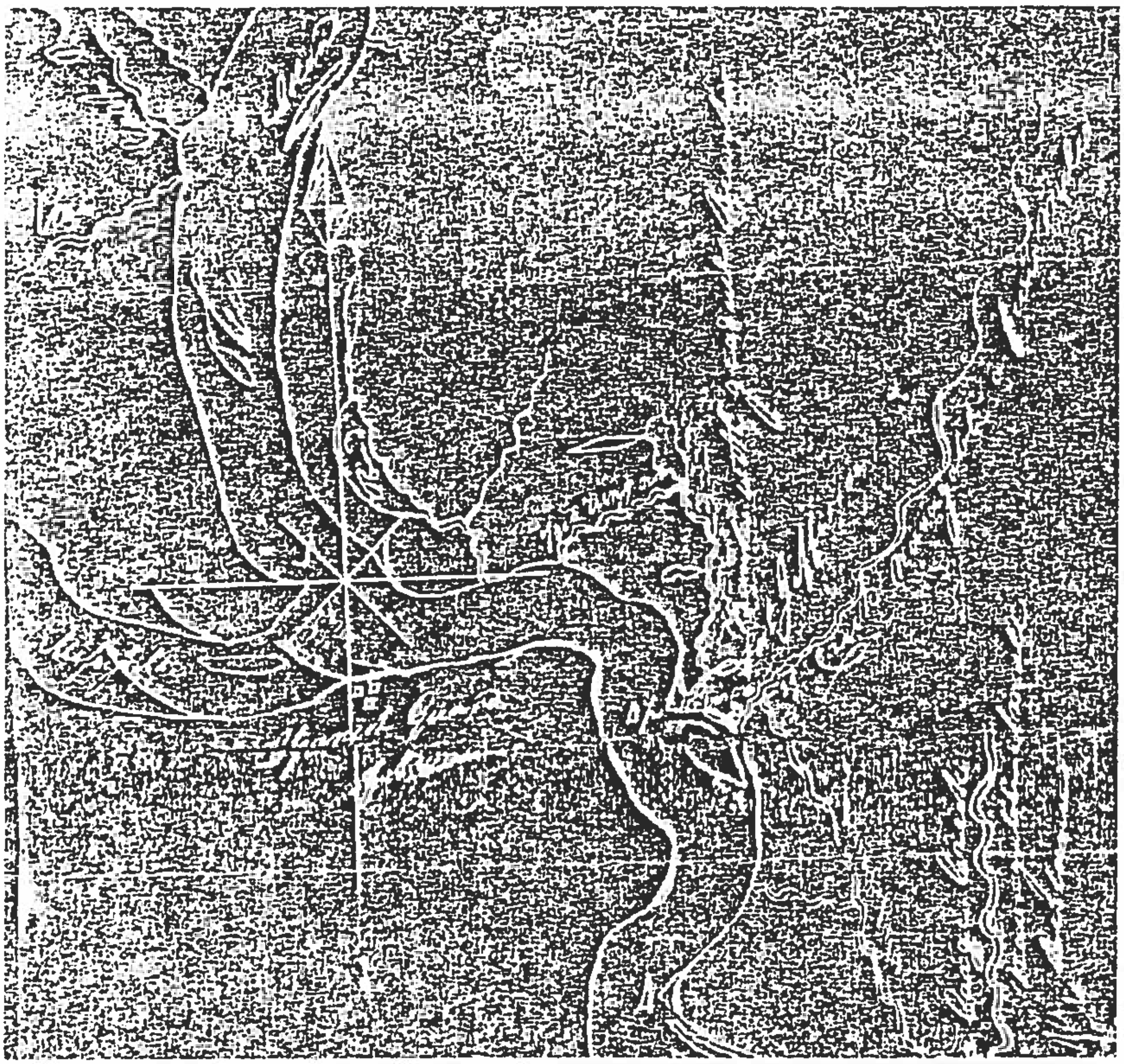


Figure 2. William Clark Map of Fort Jefferson, 1795. (Library of Congress, Lewis & Clark Collection "b").

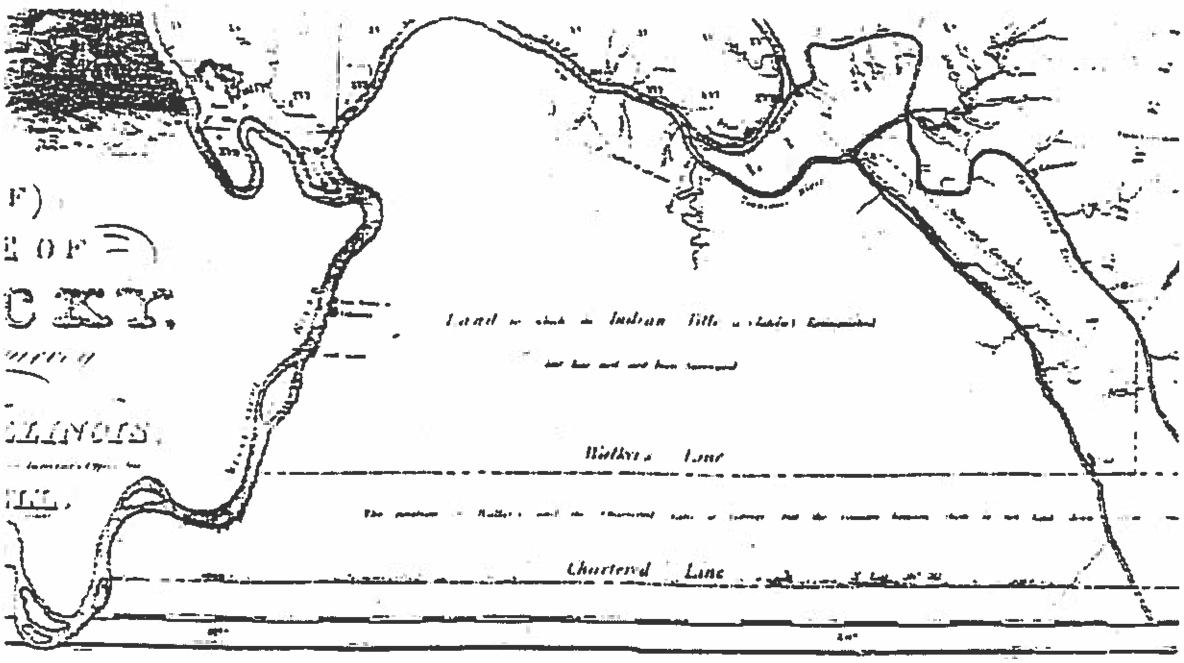


Figure 3. A Portion of "A Map of the State of Kentucky" by Luke Munsell Published at Frankfort, Kentucky, 1818 (Murray State University Map Collection).

RECTANGULAR SURVEY

In 1819, the Act of February 8th authorized the governor of Kentucky to appoint two commissioners to survey the Kentucky-Tennessee boundary west of the Tennessee River (Acts of Kentucky 1820a). Commissioners appointed were Robert Alexander and Luke Munsell. These men subsequently ran the line between Kentucky and Tennessee in 36 degrees 30 minutes north latitude.

By the Act of February 14, 1820, the Kentucky General Assembly provided for the surveying of the lands within the Jackson Purchase (Acts of Kentucky 1820b). The sectionalized land system was to be used. This employed townships six miles "square," each containing 36 sections. William T. Henderson was the surveyor appointed to oversee this work. Henderson used the Kentucky-Tennessee boundary as surveyed by Munsell and Alexander as his baseline. He established a meridian six miles east of the Tennessee River, and conducted the subdivision based on these lines (Henderson 1820).

Military claims within the Jackson Purchase were addressed by the Act of December 26, 1820 (Acts of Kentucky 1821). This act required the surveyor appointed for these claims to survey all entries made prior to May 1792 and to show where these claims "interfere with the townships and sections of the land as laid off by William T. Henderson."

Henderson returned field notes and a plat showing both the sectionalized land system and treasury warrant claims and military claims within the Purchase. Two things from Henderson's work are of particular interest. First, Henderson shows grants along the Ohio River and along the Mississippi River southerly to the vicinity of Mayfield Creek. Second, Henderson shows the location of Fort Jefferson by a symbol located in the north one-half of section 3, township 5, range 4 west. Section 3 is shown on the Henderson map as a fractional section located to the west of what appears to be Island No. 1. Further, the symbol representing Fort Jefferson is shown to the south of a dashed line which, according to the legend on the Henderson map, indicates the location of a survey based on a (Virginia) treasury warrant. The map also shows Mayfield Creek running southeast to northwest across the south one-half of section 3. This section of the Henderson map is shown in Figure 4.

During the survey of Township 5, Range 4 West, Henderson's survey crew meandered the bank of the Mississippi River. The field notes for this part of the work as returned by Henderson read:

> T5 R4W. Beginning at S.E. corner at a white oak. West 4 miles 278 poles to 2 cottonwoods and 5 maples on Mississippi. Up the River N4W 228 P. N 41E 120 P. N48E 225 P. N 48 E 97 P. N37E 240P. N22E 246 P. N24E 225 P. N12E 200 P. N 1609 P. N3E 129 P. N7W 157 P. N17W 104 P to mouth of Mayfield Creek. N 45W 93 P. to 4 cottonwoods between T5 & 6 R 4W... (Henderson 1822).

These notes are important because the meander lines and the call for Mayfield Creek enable the north line of Township 5 to be located with reference to other lines that also cite the mouth of Mayfield Creek.

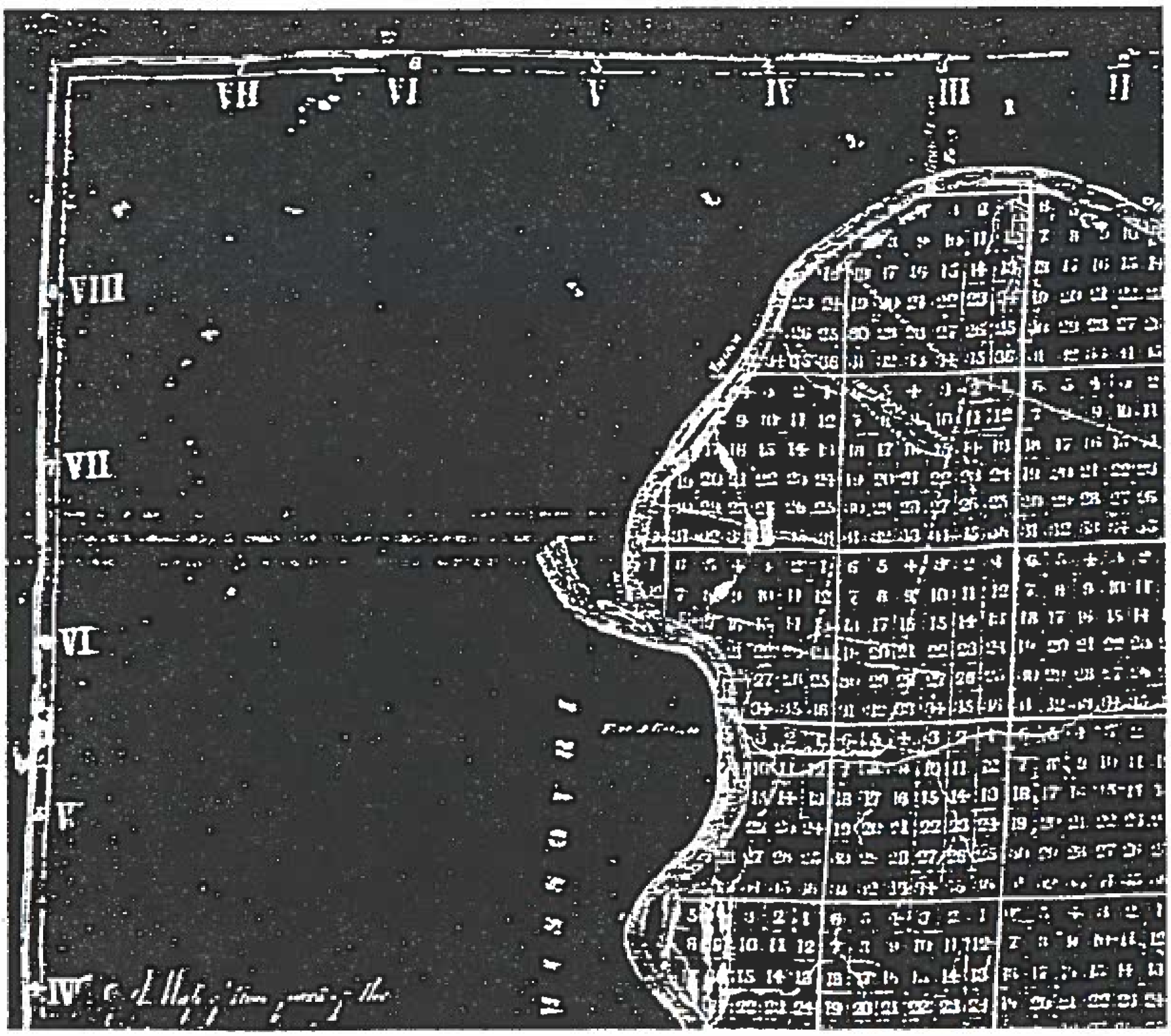


Figure 4. A Portion of "A Map of that Part of the State of Kentucky Lying West of the Tennessee River Surveyed Agreeably to the Act of the Legislature Passed on the 15 of February 1820" by William Henderson (University of Kentucky Map Collection).

VIRGINIA MILITARY AND TREASURY SURVEYS

Land grants from Virginia for land in the Fort Jefferson area were based on both military and treasury warrants. Below, we examine in detail surveys for Robert Todd, William Clark, John Nelson, and James Merewether that were based on Virginia military warrants. In addition, the Jacob Meyers (Myers) survey—also in the Fort Jefferson area—was based on a Virginia treasury warrant. Warrant, entry, and survey documentation given below refers to the Kentucky Office of the Secretary of State. A deed compilation showing the relative location of these parcels as well is provided in Figure 5.

Todd. Robert Todd received Virginia Military Warrant No. 2580 on February 21, 1784 for 4,000 acres of land for his service of three years as captain in the Virginia State Line. His entry is dated August 2, 1784. The survey was recorded on May 5, 1821 and the grant to Todd was made on December 3, 1824. The entry described land to be surveyed as:

> Beginning at the mouth of Mayfield Creek on the lower side and running up the said creek with the meanders thereof 640 poles when reduced to a straight line, thence at right angles from the end of said reduced line and up the Mississippi River for quantity *including Fort Jefferson and the village* (West of the Tennessee River Military Survey (WTR Mil. Surv.) #30 Bk 1 Pg 28).

The survey by Deputy Surveyor Samuel McKee is shown in Figure 6. This shows the parcel to be bounded on the west by the meanders of Mayfield Creek, on the south by the William Clark survey of 666 2/3 acres, and on the east and north by bearing and distances only. The southwest corner of Todd is described as being "three ash trees and a walnut corner to William Clarks survey of 666 2/3 acres," and the south line of Todd is described as running with Clark's line. The southwest corner of Todd is the same corner called for in the William Clark survey and the same trees are identified. Interestingly, no mention is made of either Fort Jefferson or "the village" in the survey description to Todd. The grant to Todd contains 1,000 acres of the 4,000 acres authorized under Virginia Military Warrant No. 2530 (WTR Mil. Surv. 30, Bk 1 Pg 28).

Clark. The William Clark survey adjoins the Todd survey on the south. William Clark received Virginia Military Warrant No. 2681 for 2,666 2/3 acres on March 3, 1784 for his service of three years as a lieutenant in the Virginia State Line. His entry is dated August 3, 1784. The survey was recorded on May 3, 1821, and the grant to Clark was made on May 6, 1825. The survey describes his parcel as:

> Beginning at three ash trees and a walnut on the west bank of Mayfield Creek Robert Todd's upper corner running thence with Robert Todd's upper line... (WTR Mil. Surv. #72 Bk 1 Pg 70).

This description of the corner agrees with that in Todd's survey. The call for Todd's line is interesting, however, because the Todd survey is dated two days later than that of Clark. Surveyor McKee was apparently being very careful to ensure that persons referring to the Clark and Todd surveys understood that the two had a common line. This is important to this research because plotting of the Todd Survey on a U.S.G.S. topographic quadrangle is based on the location of the Clark survey. Examination of the survey shows that the parcel described in Book 1 Page 70 contains 666 2/3 acres of the 2,666 2/3 acres authorized under Military Warrant 2681 (WTR Mil. Surv. #72 Bk 1 Pg 70).

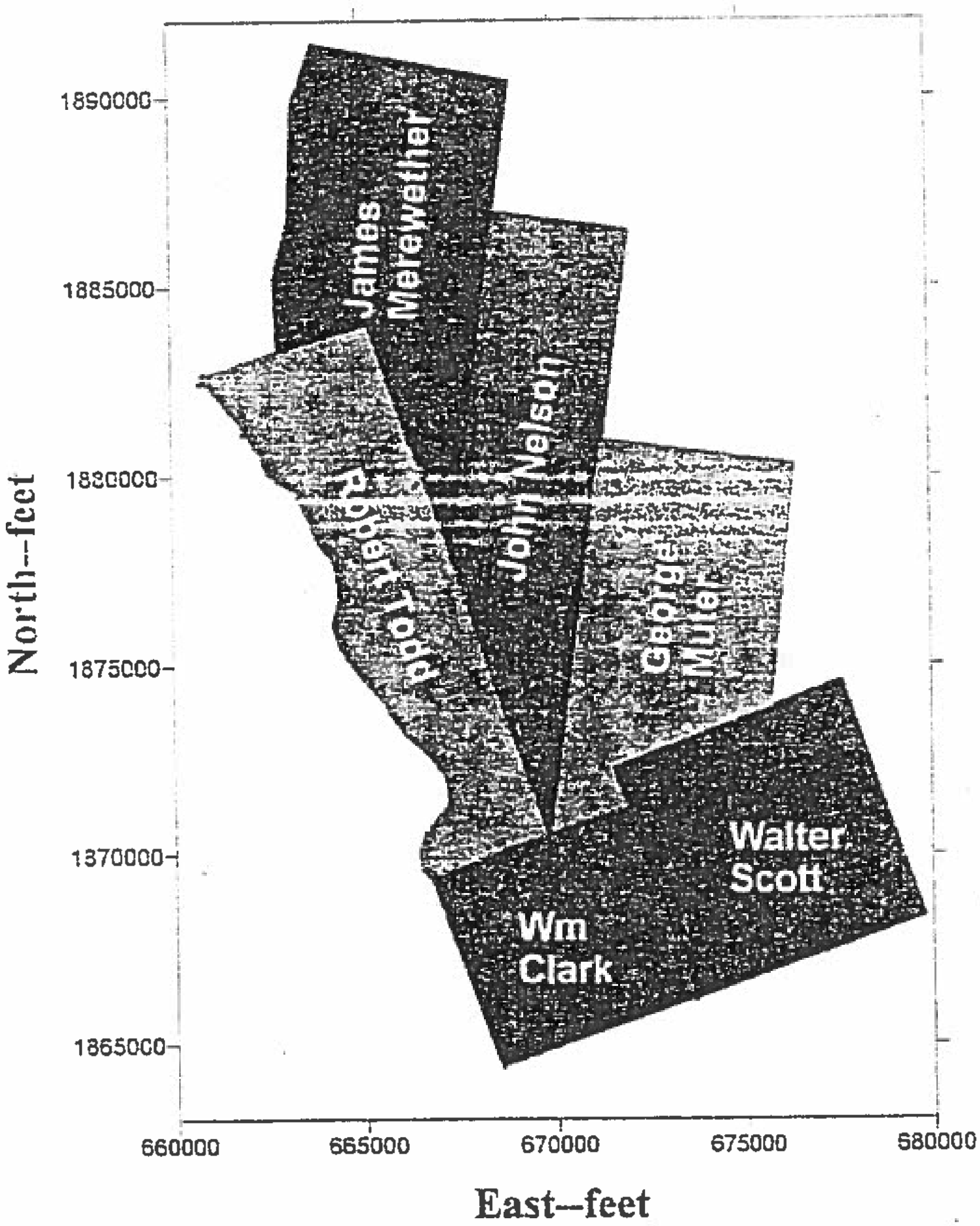


Figure 5. Deed Compilation of Virginia Military Surveys in the Vicinity of Fort Jefferson, Kentucky.

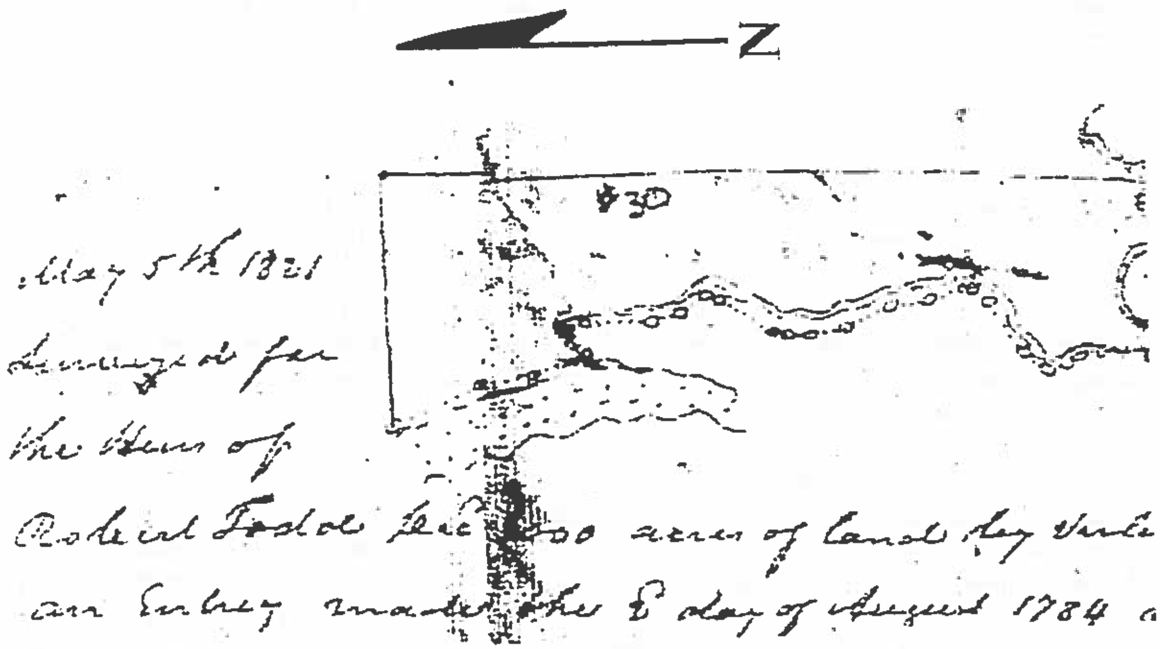


Figure 6. Todd Survey by Deputy Surveyor Samuel McKee, 1821 (WTR Mil. Surv. #30 Bk 1, p. 28).

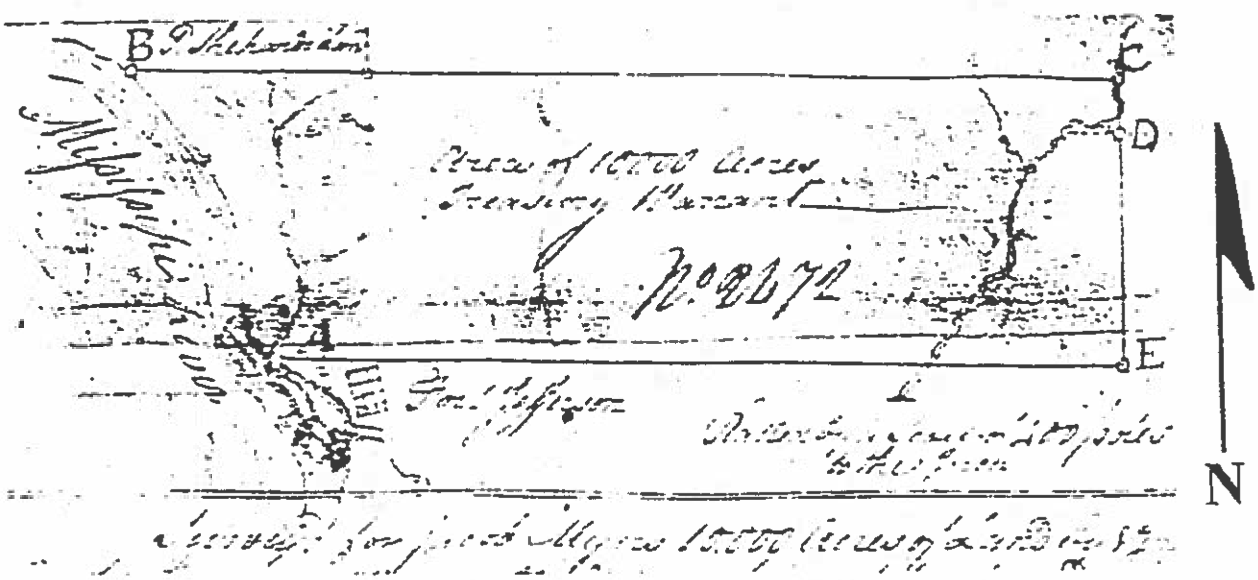


Figure 7. Myers (Meyers) Treasury Survey, 1784 (Old Kentucky #8935, Grant Book 2, p. 18).

Merewether (also Meriweather). The James Merewether survey adjoins Todd on the north and east. James Merewether obtained Virginia Military Warrant No. 2468 for 2,666 2/3 acres on February 11, 1784 for his service of three years as lieutenant in the Virginia State Line. His entry is dated August 26, 1784. The survey was recorded on May 5, 1821, and the grant to Merewether was made on January 15, 1824. The survey describes the south line of the Merewether survey as:

> Beginning at the upper line of Robert Todd survey which *includes Fort Jefferson and the village at the edge of the lands overflowed by the Mississippi* a cottonwood, beech, and ash on a bank (WTR Mil. Surv. # 21 Bk 1 Pg 12).

This point of beginning is not the northwest corner of Todd (two cottonwood trees and a willow) as described in his survey, (WTR Mil. Surv. #30 Bk 2 Pg 28) nor does McKee call for the northwest corner of Todd. Rather, it appears that McKee is simply describing the point of beginning of the Merewether survey as being on the "upper line" of Todd.

The southeast corner of Merewether survey is described as a "red oak, hickory, and gum on Robert Todd's backline." The west line of Merewether then runs "with his [Todd's] line N 21° West 382 poles to a poplar, red oak, and gum said Todd's corner." This description agrees with that in the Todd survey except that in Todd the trees are more specifically described as being on a ridge. The south line of Merewether is then described as running "thence with his [Todd's] upper line S 69° West 140 poles to the beginning." From this description, it is apparent that Merewether and Todd share common boundaries and corners. Further, examination of the grant to Merewether shows it to contain 1,000 acres of the 2,666 2/3 acres authorized by Virginia Military Warrant No. 2468 (WTR Mil. Surv. # 21 Bk 1 Pg 12).

Nelson. The Nelson survey adjoins Todd on the east. John Nelson received Virginia Military Warrant No. 1790 for 5,333 2/3 acres on September 25, 1783 for his service of 3 years as a major in the Virginia State Cavalry. His entry is dated August 12, 1784. The survey of this tract was recorded on May 6, 1821, and the grant to Nelson is dated March 2, 1825. Nelson's survey describes the land conveyed as:

> Beginning at a red oak, hickory, and gum James Merewethers corner on Robert Todd's upper line of his survey *including Fort Jefferson*, thence with Todds line South 21° East 480 poles to four hickories and an ash, with oak and black oak on the west bank of Mayfield Creek corner to said Robert Todd and William Clark line...(WTR Mil. Surv. # 106, Bk 1, Pg 44).

Hence, the southwest corner of Nelson is the same as the southeast corner of Merewether. The south line of Nelson follows the east line of Todd, and the southeast corner of Nelson is located at the southeast corner of Todd on the north line of Clark. The grant to Nelson is for 1,000 acres of the 5,333 2/3 acres authorized by Virginia Military Warrant No. 1790 (WTR Mil. Surv. # 106, Bk 1, Pg 44).

Meyers. The south line of Jacob Meyers survey overlaps the north portions of the Todd, Nelson, and Merewether surveys. Jacob Meyers obtained Virginia Treasury Warrant No. 7069 on October 10, 1781 for 10,000 acres for a payment of £16,000. His entry is dated November 20, 1781. The survey was dated June 12, 1784, and the grant to Meyers was made on December 2, 1796 (Old Kentucky # 8935, Grant Book 2, Pg 18). The survey described the land involved as:

Beginning at the mouth of a creek at the head of the first island in the Mississippi below the mouth of the Ohio, thence up the meanders of the river at high water mark 800 poles, thence to run back parallel with Brigadier General Clarkes entry made on behalf of the State of Virginia of 101,920 acres for quantity" (Lincoln Entries, Book 1 Pg 173).

As shown in Figure 7, the map accompanying the survey shows the south line of Meyer's grant to be located to the north of symbol labeled "Fort Jefferson". Further, the grant to Meyers describes the point of beginning of the survey is described as:

Beginning at a willow and two cotton trees...on the bank of the Mississippi at the mouth of the creek emptying into the Mississippi at the head of the first island below the mouth of the Ohio and about 200 poles above Fort Jefferson...(Old Kentucky # 8935, Grant Book 2, Pg 18).

Examination of the maps and grants above make it apparent that there is overlap between the military and treasury surveys. Both are overlapped by the rectangular survey of Henderson.

SURVEYS SUBSEQUENT TO VIRGINIA MILITARY SURVEYS

Young, Poussin, and Tuttle Map, 1821. This map is Mississippi River chart No. 10. It was prepared as part of a reconnaissance of the Ohio and Mississippi Rivers in 1821 by the Corps of Topographic Engineers. This shows Fort Jefferson to be south of Moffield (sic) River.

Terrill Map, 1830. The Terrill Map appears to be a compilation of land grants and surveys in extreme western Kentucky. Terrill shows Fort Jefferson by symbol to be located north of Mayfield Creek and south of the Myers (later Benjamin Logan) line.

Forsythe Map, 1855. A portion of this map, which was prepared by William Forsythe, is shown in Figure 8. Apparently, the location of the Myers survey was the subject of litigation before the Ballard Circuit Court in 1844. Forsythe shows the south boundary of Meyers to overlap the Todd survey. Neither the Merewether nor the Nelson surveys (which would also be overlapped by the Meyers line) are shown on the plat. Forsythe's bearings show the north and south lines of Meyers to bear S 82 degrees E and the east line to bear N 8 degrees E.

Dupoyster Map. This map, dated 1878, was prepared by Fleet C. Mercer. A portion of this map is shown in Figure 9. It is labeled as "Exhibit A to indenture between Elizabeth B. McComb and others and William Butler Duncan dated May 31, 1883" and "Exhibit A to deed from Joseph C. Dupoyster & his wife Rebecca S. to Henry S. McComb dated May 4th, 1875." The land involved appears to be all or part of the Todd Survey. The north line of Dupoyster (labeled S 83 degrees E) appears to be the south line of Meyers. The east line (labeled N 21 degrees W) appears to be the east line of Todd. The south line, which is shown in dispute, bears N 69 degrees E and corners at the intersection of Black Slough with Mayfield Creek.

The location of the "L. & C.R.R." also is shown on the Depoyster map. The railroad bears N 44 degrees 45 minutes W from its intersection with the east line of Depoyster to the point of tangency of a horizontal curve north of the depot and hotel. West of the horizontal curve, the map is labeled "Deep Overflow."

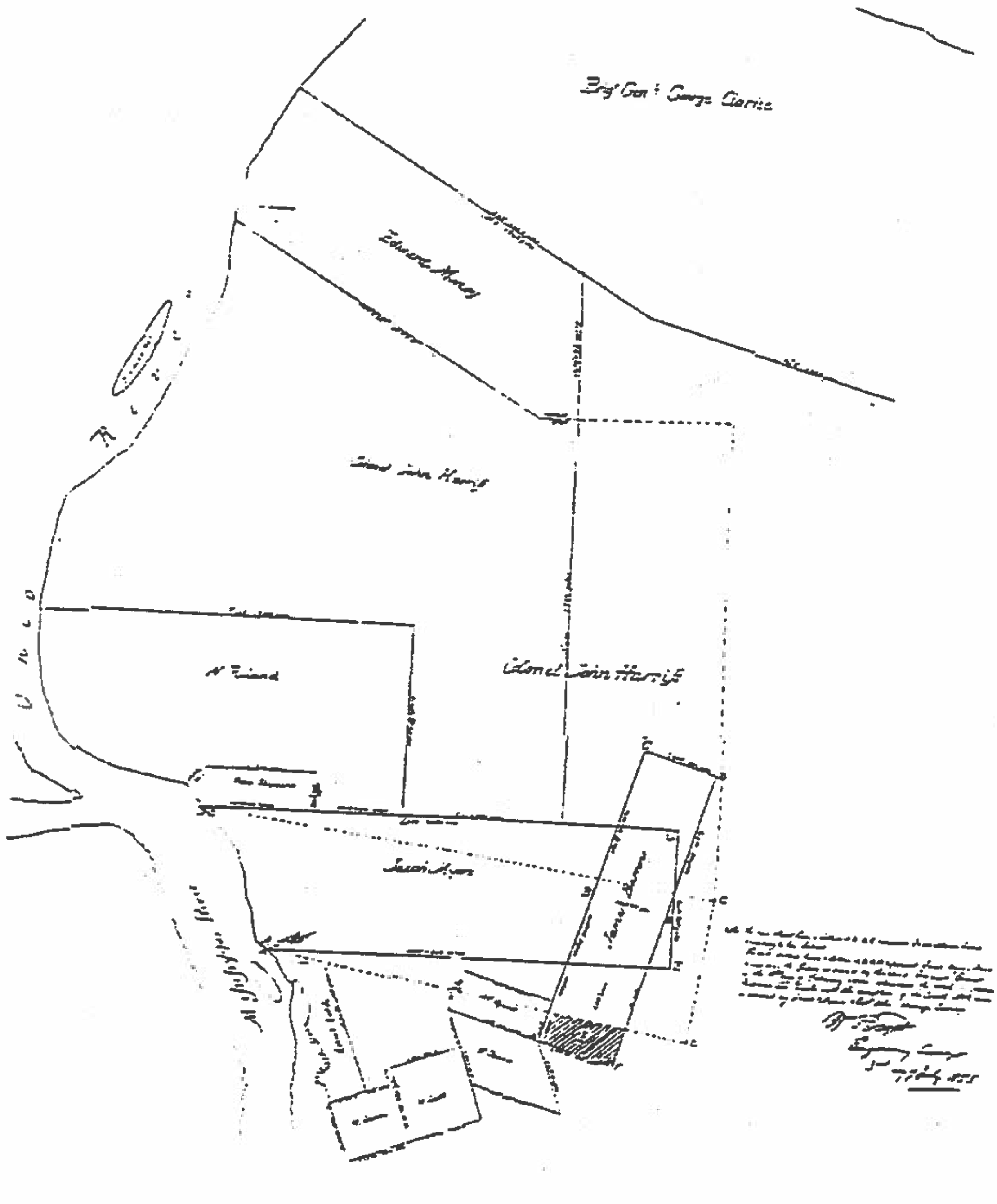


Figure 8. Portion of the Forsythe Map, 1855. Apparently the result of litigation, this map appears to explain the trend of metes and bounds property lines in the vicinity of Fort Jefferson. Note the overlap between the survey for Jacob Myers and that for Robert Todd (Library of Congress, Map Division, Nov. 25, 1912).

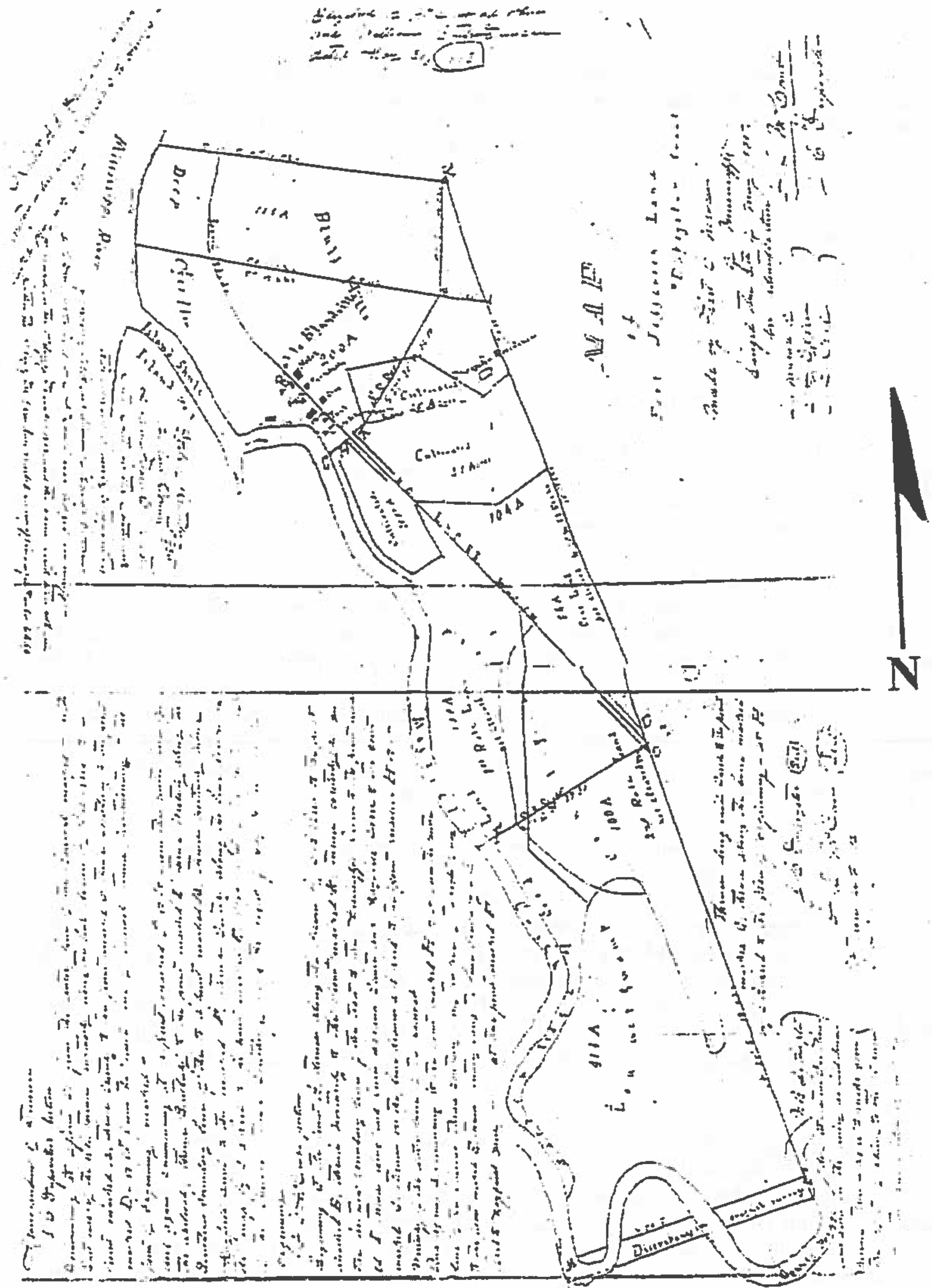


Figure 9. Depoyster Map by Fleet C. Mercer, 1878. Land shown appears to be part of the Todd Military Survey. Note the location of the railroad.

Stovall-Draper Maps. These maps are shown in Figures 10 and 11 and are contained in the Draper Collection of the University of Wisconsin (Draper Manuscripts Reel 28, series J, volume 24, Page 91 & Draper Manuscripts Reel 28, Series J, volume 27, Page 22). The maps show Fort Jefferson to be located north of Mayfield Creek, east of the chute of Island No. 1, and at the point of tangency of the horizontal curve on the railroad. There is also a note between the railroad grade and the north bank of Mayfield Creek: "where the cannons found."

Mobile & Ohio R.R. Co. Map. This map, dated August, 1922, was issued by the Office of the Chief Engineer of the Mobile & Ohio R.R. Co. and was accepted for record in the Ballard County courthouse on May 2, 1923. The map shows the point of tangency of the horizontal curve, the "Old Depot," and additional buildings. A portion of this map is shown in Figure 12.

EXISTING LAND OCCUPATION PATTERNS

Land occupation patterns represent the attempt by land owners to use and mark the boundaries of their land. Such patterns are most evident when the land is viewed from the air. The patterns also are visible on topographic maps as roads, fence lines, and changes in land use. Collectively, such lines are termed lines of occupation.

When the lines of occupation are plotted on a map, a pattern often becomes evident. In this research, lines of occupation shown on the Wickliffe and Blandville (1983 and 1977 editions, respectively) U.S. Geological Survey 7.5 minute quadrangles were digitized together with principal roads and drainages. This work disclosed two distinct patterns. In the eastern half of the Blandville quadrangle lines of occupation trend north-south, east-west in a marked grid system. This apparently reflects the rectangular Henderson survey. This north-south, east-west pattern is missing on the western part of the quad. There is, however, an apparent trend--S 80 degrees E/ N 10 degrees E—to the lines of occupation. This orientation matches closely the lines of the Meyers survey as shown on the Forsythe plat described above.

Because the location of Fort Jefferson relies on historical data, earlier government surveys showing Fort Jefferson area also were examined. Corps of Engineers maps dated 1882 and 1890 show Port (sic) Jefferson north of Mayfield Creek. The railroad grade is shown extending northward from that point along the west side of the bluff to Wickliffe. In 1945, the Army Map Service mapped the east bank of the Mississippi as it existed in 1765. This shows the bank to have been coincident with the chute for Island No.1 and places the mouth of Mayfield Creek at approximately its present position. The 1951 Wickliffe U.S.G.S. quadrangle shows M&O Railroad to have been abandoned and shows the grade to terminate south of the bluff. In summary, none of the government maps consulted showed a definitive location for the missing fort.

In order to correctly place the Virginia military and treasury grants on the Wickliffe 7.5 minute topographical quadrangle map, it was necessary to relate the grants to ground features shown on the quad sheet. In this research, attempts to relate current and past ownerships of the land surrounding Fort Jefferson were hampered by destruction of land records in a courthouse fire in Ballard County in the late 1800's. However, deed research at the Carlisle County, Kentucky courthouse showed the Winford County Road in Carlisle County to be the east line of the William Clark grant. A road intersection fixed as well the southeast corner of the grant. The site was visited on the ground and could be identified on the Wickliffe quadrangle. Consequently, a plot of the Todd and adjoining grants was rotated to match existing lines of the Clark survey. (See Rowland to Compton, Book 114 Page 128; Watson to Rowland, Book 65 Page 458; Hatley to

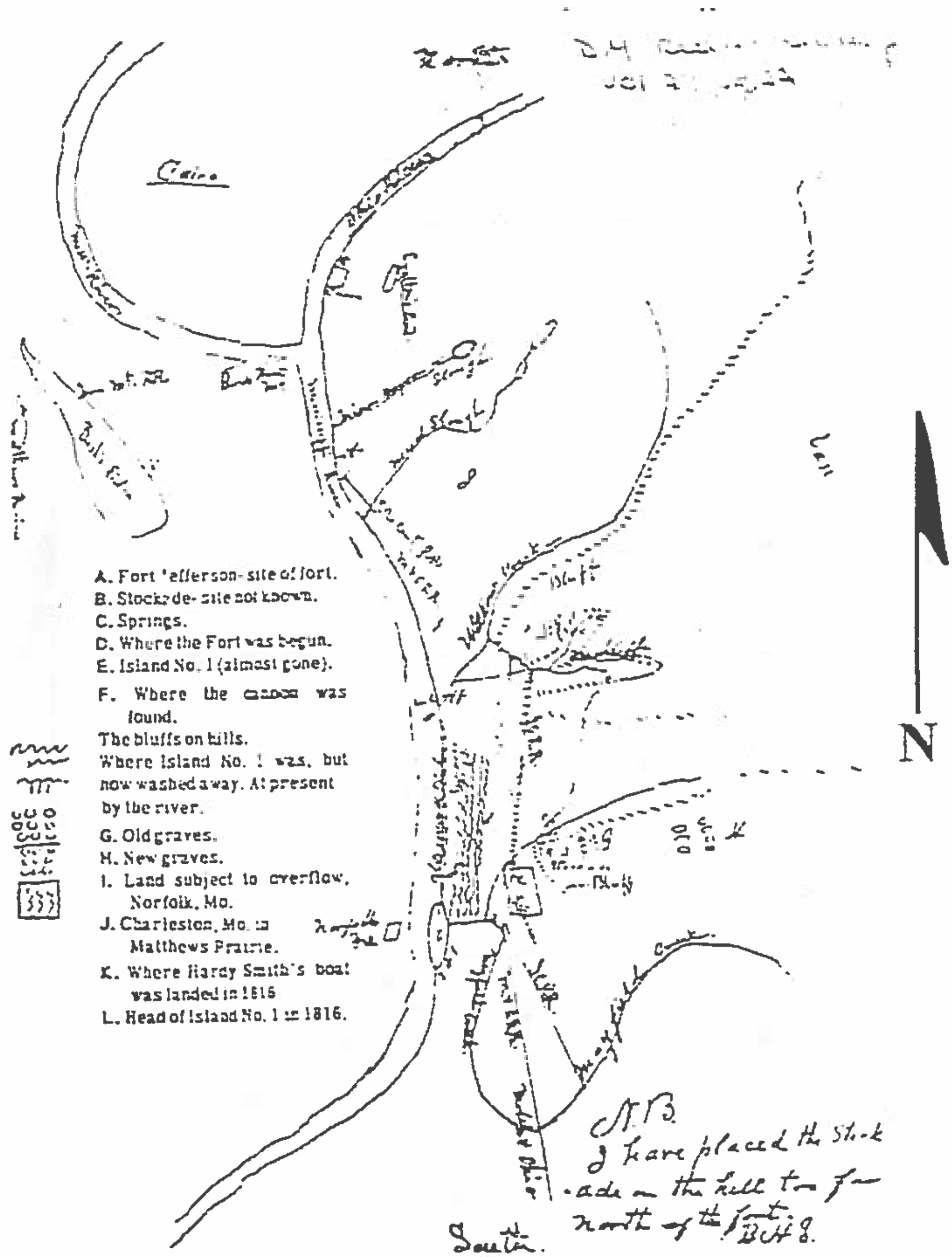


Figure 10. Stovall Map Showing Fort Jefferson at Foot of Bluff and East of the Railroad (Draper Manuscripts Reel 28, series J, volume 24, p. 91; see also volume 27, p. 22).

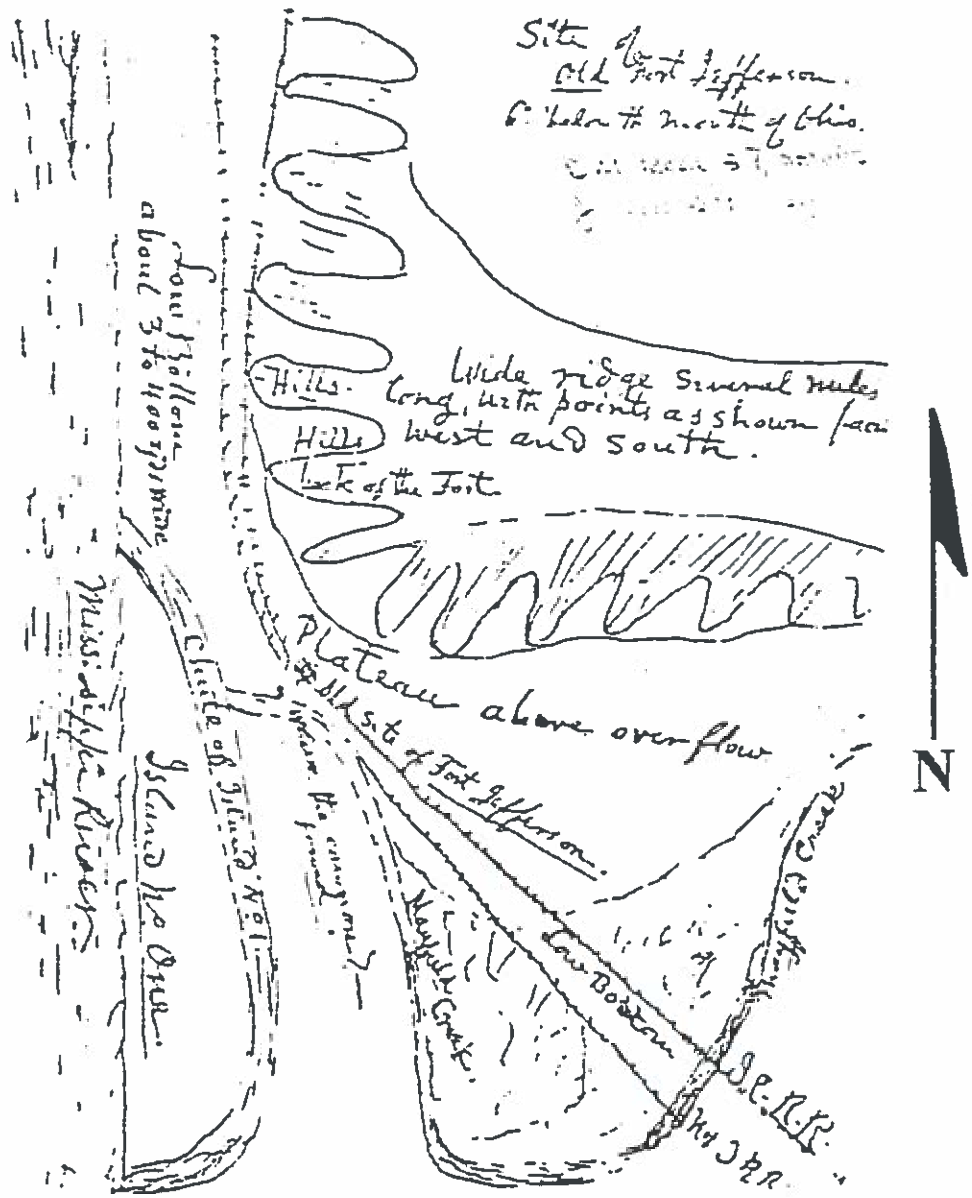


Figure 11. Draper Map (Draper Manuscripts Reel 28, series J, volume 24, p. 91; see also volume 27, p. 22).

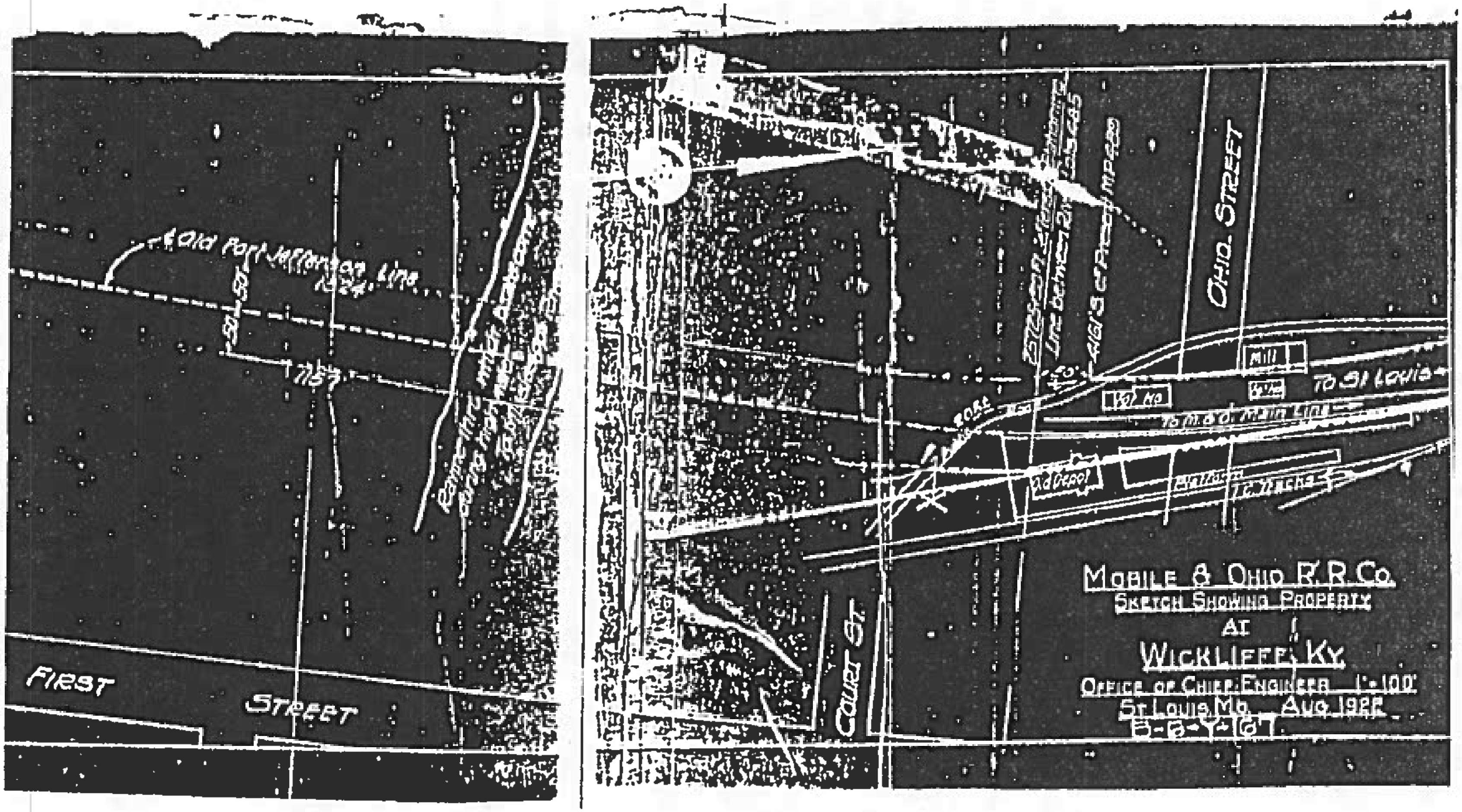


Figure 12. Mobile and Ohio Railroad at Fort Jefferson, 1922 (Ballard County, KY).

Watson, Book 63 Page 447; and Botkin to Sampson, Book 13, Page 327.) The results of this work are shown in Figures 13 and 14.

In addition to the topographic quads, existing aerial photography was examined in an attempt to reconcile the various record evidence listed above. Included was photography taken by various agencies in 1937, 1943, 1950, 1959, 1964, 1972, and 1981. While this photography showed land use changes, the only indications of the possible location of Fort Jefferson were discolored soils to the east of the M&O Railroad grade that might possibly indicate previous disturbance.

CONCLUSIONS

The surveys, land records, and physical lines of occupation when taken together provide a general location for Fort Jefferson. Based on the Todd entry, the Meyers survey, the Henderson survey, and the Forsythe survey, Fort Jefferson is located south of the south line of Meyers. Based on the Depoyster and Stoval maps and on the right-of-way plat of the Mobile and Ohio Railroad, Fort Jefferson is located in the vicinity of the former M&O railroad grade at the point of tangency of the curve immediately south of the Myers line. Based on the topographic description contained in the Merewether survey, Fort Jefferson must be south of the bluff at the south line of section 5 T5N R4W of the Henderson survey and the south line of Meyers. The east-west location of the fort is less certain, but must be east of the "edge of the overflowed lands" as described in Merewether. The edge of the overflow as of the 1780 is difficult to determine, but must be close to the location of the M&O Railroad grade. This is because railroad grade location would have maximized the flat grades adjacent to the river, but been located far enough to the east to prevent repeated inundation. Finally, photographic evidence shows a light-toned area east of the former railroad grade at the base of the bluff. Whether this results from recent disturbance or from compaction of the land incidental to construction and use of fort is uncertain without excavation.

Further work is suggested by this research. First, additional deed research of current land ownerships and surveys of record should be undertaken to enable location on the ground of the south line of Meyers. Second, field investigation to locate the former M&O Railroad grade is indicated. Third, archaeological reconnaissance should be undertaken to locate artifacts and other physical evidence bearing on the location of Fort Jefferson.

REFERENCES CITED

Acts of Kentucky

1820a An Act to ratify and confirm the adjustment of the boundary line between this state and the state of Tennessee, according to the articles of stipulation entered into by the Commissioners appointed by both states. In *Acts Passed at the First Session of the Twenty-Eighth General Assembly for the Commonwealth of Kentucky*, pp. 922-927. Kendall and Russells, Frankfort.

1820b A Resolution providing for an adjustment of the Boundary Line between this state and the state of Tennessee, and giving instructions to our Commissioners for that purpose. In *Acts Passed at the First Session of the Twenty-Eighth General Assembly for the Commonwealth of Kentucky*, pp. 990-991. Kendall and Russells, Frankfort.

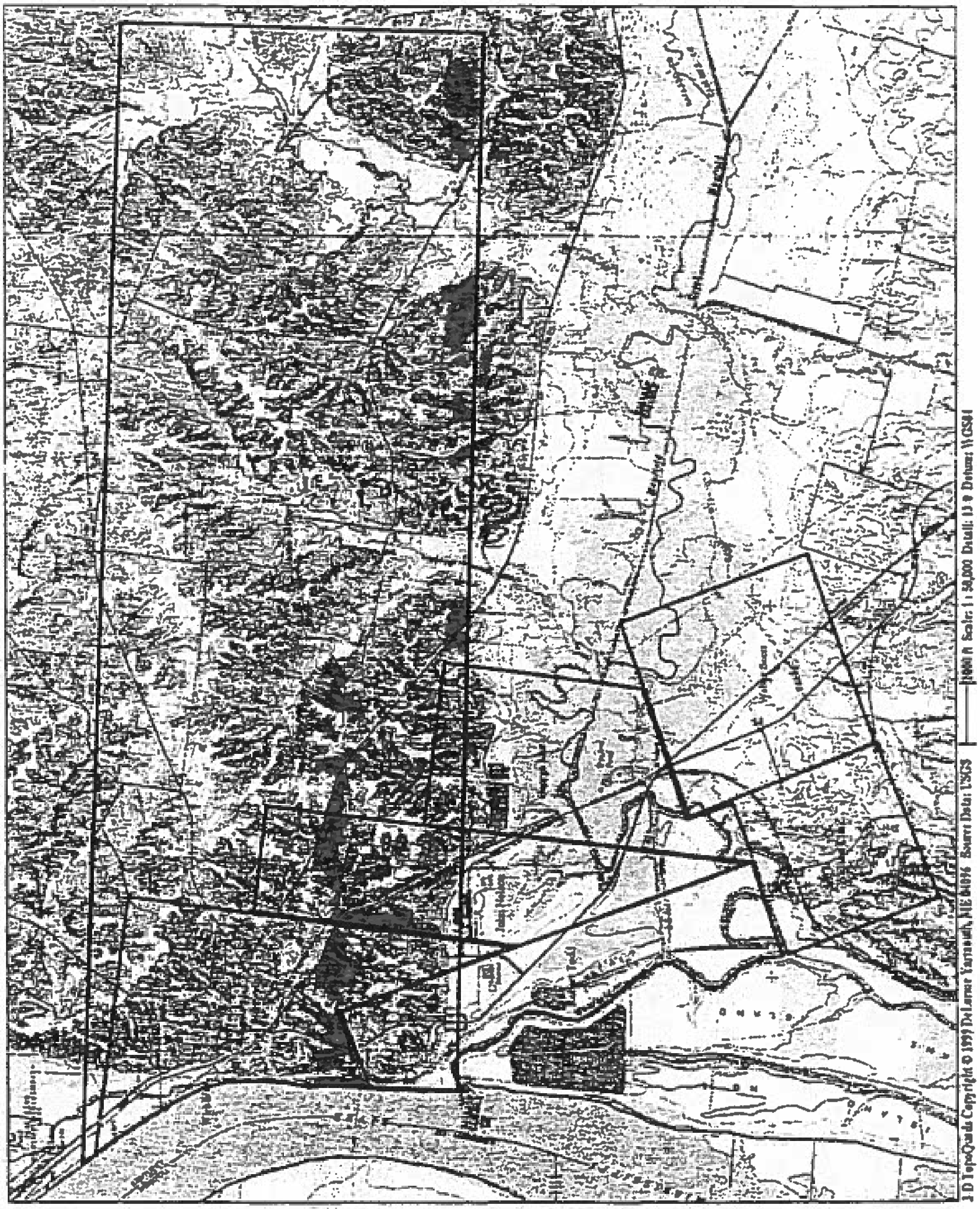


Figure 13. Deed Compilation Registered on Delorme 3D Quad for Kentucky Showing Both Virginia Military and Treasury Surveys in Vicinity of Fort Jefferson as Registered to Ground. North is to the left.

Figure 14. Enlargement of Deed Compilation Showing Todd, Nelson, and Merewether Military Surveys. North at the top of the page.

1821 An Act to amend "an act for surveying the Military Claims west of the Tennessee River," approved Dec. 26, 1820. In *Acts Passed at the First Session of the Twenty-Ninth General Assembly for the Commonwealth of Kentucky*, pp. 384-385. Kendall and Russells, Frankfort.

Carstens, Kenneth C.

n.d. The Structural Composition of George Rogers Clark's Fort Jefferson, 1780-1781. Manuscript in the possession of the author, Murray, Kentucky.

1999 *The Personnel of George Rogers Clark's Fort Jefferson and the Civilian Community of Clarksville [Kentucky], 1780-1781.* Heritage Books, Inc., Bowie, Maryland.

2000 *The Calendar and Quartermaster Books of General George Rogers Clark's Fort Jefferson, Kentucky, 1780-1781.* Heritage Books, Bowie, Maryland.

Clark, George R.

1780 Letter to John Dodge, April 19, 1780. In *The George Rogers Clark Papers*, edited by James Alton James, Vol. I, pp. 417-418 (1972). AMS Press, New York.

Clark, William

1780 The William Clark Map of Fort Jefferson and Clarksville. In *Draper Manuscripts*, 1M 8-11, Wisconsin Historical Society, Madison.

Henderson, William T.

1820 *A Map showing part of the State of Kentucky lying west of the Tennessee River surveyed agreeably to an act of the Legislature passed on the 14th of February 1820.* University of Kentucky Library, Lexington, Kentucky.

Henry, Patrick

1777 Letter to Governor Galvez. Archivo General de Indies Seville, Estante 87, Cajon 1, Legajo 6, Spain.

Jefferson, Thomas

1777 Letter to George Rogers Clark, January 29, 1780. In *The George Rogers Clark Papers*, edited by James Alton James, Vol. I, pp. 386-391, AMS Press, New York (1972 reprint).

Montgomery, John

1781 Letter to Thomas Nelson, August 10, 1781. In *The George Rogers Clark Papers*, edited by James Alton James, Vol. I, pp. 585-586, AMS Press, New York (1972 reprint).

Munsell, Luke

1818 *A Map of the State of Kentucky from Actual Survey.* Murray State University Map Collection, Pogue Library, Murray, Kentucky.

Smith, Daniel

1779 Journal of General Daniel Smith, one of the Commissioners to Extend the Boundary Line between the Commonwealths of Virginia and North Carolina, August, 1779 to July, 1780. *Tennessee Historical Magazine*, No. 1, March, 1915: 40-65.

Thorpe, Francis N.
1909 *Federal and State Constitutions, Colonial Charters, and Other Organic Acts*. Vol V, pp. 2743-53. Government Printing Office, Washington, D.C.

Thwaites, Reuben G.
1966 *The Jesuit Relations and Allied Documents*. Vol 59. University Microfilms, Inc., Ann Arbor.

West of the Tennessee River Military Survey
n.d. Land Surveys, West of the Tennessee River. Maps on File, Secretary of State's Office, Frankfort, Kentucky.

AN OVERVIEW OF KENTUCKY'S HISTORIC LIME INDUSTRY

By

Charles D. Hockensmith
Kentucky Heritage Council
Frankfort, Kentucky

ABSTRACT

Lime was an important product in the building trade, a necessary ingredient for agricultural production, and an essential element in a number of products. Suitable limestones across Kentucky were burned in kilns to produce lime. Lime was produced at two levels, in small kilns for agricultural use by farmers and in larger kilns for commercial production. Available records indicate that lime initially was made in Kentucky during the late 18th century. During the 19th century and the first half of the 20th century, Kentucky had a small lime industry that received little attention from geologists or historians. By the 1970s, Kentucky's lime industry was revived and today the state is one of the largest lime producers in the United States. This paper presents results of archival research about the Kentucky lime industry. Drawing upon a variety of sources, information is compiled for those counties that produced lime.

INTRODUCTION

Kentucky presently is one of the leading lime producing states in the nation. Currently, Kentucky has the second and fourth largest lime plants in the United States (Miller 2001a, 2001b). However, prior to the 1970s, lime manufacturing was not a major industry in the state. Lime was usually produced at a local level as needed for the building trade and for spreading on agricultural fields. Some of the lime was undoubtedly used by various industries, especially in urban areas. Over the course of several years, the author has been collecting information about the lime industry. During background research about the lime industry in Livingston County (Hockensmith 1996, 1999), additional information came to light. It was felt that an overview of the industry would be a useful companion paper for the author's "Historic Lime Production in the Lower Cumberland River Valley, Livingston County, Kentucky" (in this volume). Additional research was undertaken to make this overview more comprehensive. This information, gleaned from many sources, will be of utility to archaeologists and to other scholars studying Kentucky's industrial past. As additional lime kilns are recorded in Kentucky, this overview will provide archaeologists with a general context about the lime industry. While this overview is considered relatively comprehensive, it is not exhaustive.

To assemble this overview of the lime industry, many sources were searched. The U.S. Manufacturing Census schedules for Kentucky (on microfilm) were checked for 1820, 1850, 1860, 1870, and 1880. An effort was made to check the published versions of U.S. Population Census schedules (1850, 1860, 1870, 1880, and 1900) for those counties that had known lime producers. Also, many original hand written U.S. Population Census schedules on microfilm were checked for counties where lime was produced or thought to have been produced. Unfortunately, time was not available to check every roll of microfilm that might contain some information. Kentucky State Gazetteers and Business Directories for 1859-1869, 1870-1871, 1873-1874, 1876-1877, 1879-1880, 1881-1882, 1883-1884, 1887-1888, and 1896 were checked for lime listings (Polk 1887, 1895; Polk and Danser 1876, 1879, 1881, 1883). Other sources consulted included articles of incorporation, biographical sketches, city directories, city histories, county atlases, county histories, geological reports, industrial directories, reports to the Kentucky Legislature, and statewide Kentucky histories. The Kentucky Department of Mines and Minerals Annual Reports were checked for the years 1884 to 1934 (reports for 1909, 1910, 1918, 1919, 1920, 1922, 1927, 1930, 1931 were missing). Unfortunately, these reports contained no references to the lime industry but primarily focused on the coal industry.

A final attempt to find lime makers was made by checking additional counties shown on Garland Dever's (1996) map entitled *Principal Outcrop of Limestone and Dolomite Resources in Kentucky*. This map included many counties that were not previously checked but had the necessary stone outcrops for producing lime. Because of time restrictions, it was not possible to check all the census schedules for these counties. Instead, only those U.S. Population Census schedules that had been transcribed for 1850, 1860, 1870, and 1880 were examined. These counties include Adair 1850 (Flowers and Watson 1986), 1860 (Watson 1988); Barren 1850 (Froggett 1984); Bell 1870 (Nolan and Nolan n.d.); Boyle 1850 (St. Asah's Chapter 1988); Bracken 1850 (Crume n.d.a); Bullitt 1850 (Wright 1981), 1860 (Wright and Dodson n.d.), 1880 (Darnell 1992); Caldwell 1850 (Jones n.d.a), 1860 (Bryant 1977), 1880 (Monks 1978); Calloway 1850 (Jones n.d.b), 1860 (Simmons n.d.); Carter 1850 (Brown 1982); Clark 1850 (Couey 1975), 1860 (Norris 1981); Crittenden 1850 (Hammers 1976), 1860 (Hearell 1994), 1870 (Crittenden County Genealogical Society); Edmonson 1850 (Hammer 1978a), 1860 (Rajewich n.d.); Garrard 1850 (Cornelius n.d.), 1870 (Kurtz n.d.), 1880 (Kurtz 1989); Grayson 1860 (Dennis 1986), 1880 (Dennis 1990); Green 1850 (Lind 1975), 1860 (Lind 1975); Harlan 1880 (Fee 1987); Harrison 1850 (Schunk 1986a); Henry 1850 (Miller 1998); Jessamine 1850 (Vockery 1990), 1860 (Vockery 1994); LaRue 1850 (Jones 1982), 1860 (Howell and Helton 1993), 1880 (Benningfield 1984); Lee 1870 (Workman 1984); Letcher 1870 (Workman 1984); Logan 1850 (West-Central Kentucky Family Research Association 1978), 1870 (Vanderpool n.d.); Madison 1850 (Hubble 1976), 1860 (Hubble 1985), 1870 (Vockery and Vockery 1994); Mercer 1850 (Sanders 1983), 1860 (Sanders 1988), 1870 (Webb 1993), 1880 (Webb 1994); Metcalfe 1860 (Edwards 2000); Monroe 1850 (Anonymous n.d.a), 1870 (Anonymous n.d.b); Morgan 1850 (Crume n.d.b), 1860 (Lewis n.d.); Nicholas 1850 (Lawson 1983); Ohio 1850 (Lawson 1984), 1860 (O'Brien 1981); Oldham 1850 (Schunk 1986b); Owen 1850 (Schunk 1986c), 1870 (Gipson n.d.); Pendleton 1850 (Schunk 1986d; Pike 1850 (Honaken 1978), 1860 (Honaken 1974), 1880 (Robinson and Robinson 1981); Rowan 1860 (Curtis and Read 1976), 1880 (Reynolds 1976); Simpson 1850 (Steers 1984), 1860 (Willhite n.d.a), 1870 (Willhite n.d.b), 1880 (Willhite n.d.c); Taylor 1850 (Benningfield 1983), 1860 (Sullivan and McKinley 1988), 1870 (Wilson 1992), 1880 (Wilson 1994); Todd 1850 (Jones n.d.d), 1860 (Willhite n.d.e), 1870 (Willhite n.d.f); Trimble 1850 (Thompson 1985a), 1860 (Thompson 1985b), 1870 (Thompson 1988), 1880 (Thompson and Jennings n.d.); Washington 1880 (Sanders 1990); and Wayne 1880 (Whitis 1990). No lime makers were listed in the schedules for those years and counties consulted. This information can be interpreted either that these counties had no lime production during the years checked or that lime was only produced on a small scale. If lime was produced on a small scale, it is not surprising that no one was listed as a lime maker. For example, farmers may have made lime for agricultural purposes and quarries may have produced lime as a minor side product. It is also possible that the U. S. Population Census schedules not checked on microfilm may have listed some lime makers.

Since lime, cement, and plaster are often listed together these products will be briefly discussed (see Eckel 1928). Lime is made by burning limestone to remove the carbon dioxide. This process produces a white powder that is classified on the basis of the amount of magnesia present (Department of Commerce and Labor 1911:6). Hydraulic lime is a special type of lime that will set up underwater. This type of lime was used in the construction of the locks and dams on the Kentucky and Licking rivers. To qualify as hydraulic lime, two conditions must be met: "(1) its clinker must contain enough free lime to slake with water, and (2) the resulting powder must be capable of setting or hardening under water" (Eckel 1922:176). Agricultural lime can be lime or ground limestone. Prior to the first World War, most agricultural lime was hydrated lime, but currently most agricultural lime is ground limestone. Cement can be made from natural or artificial ingredients. Natural cement is made by burning and grinding a special limestone that contains the necessary chemical properties. A major natural cement industry once existed in Jefferson County and across the Ohio River in Clark County, Indiana (Hockensmith and Coy 1999). Portland cement is an artificial mixture that replaced natural cement by the late 19th century. Plaster is a mixture of lime, sand, and water used for coating walls and ceilings. Hair or other fibrous materials were often added to increase the tensile strength of the mixture.

This overview compiles into one paper a great deal of information about Kentucky's lime industry that was extracted from many scattered sources. After a general discussion of the lime industry in Kentucky, a subsequent section briefly discusses the modern agricultural lime industry. The main section of this paper is an overview of Kentucky's lime industry that is presented chronologically by county. Some counties have very scant information about lime while other counties have much more information available. The paper concludes with a brief discussion followed by summary remarks about the lime industry.

KENTUCKY'S LIME INDUSTRY

Kentucky's current lime industry is well documented but the archival record of the lime industry prior to 1970 is very scant. Fortunately, scattered references to lime producers do occur in directories, census schedules, and other documents. It should be noted that most of the earlier directories group lime, plaster, and cement together. Some directories list lime manufacturers separately while others directories combine both manufacturers and distributors into one list. Consequently, some of the companies and individuals listed in this paper may be lime distributors only while others may have produced cement or plaster. Further, most of the dates provided for individuals and companies listed are strictly those mentioned in documents consulted. Consequently, the date ranges mentioned in this paper do not reflect the actual years that companies or individuals produced lime but only those years that they were mentioned in documents.

Lime production began in Kentucky sometime after the first pioneers arrived. Green (1983:233) referenced a February 18, 1799 ad in the *Kentucky Gazette* for lime being for sale at Patterson's quarry near Lexington. Another ad appearing in the May 10, 1808 edition of the *Kentucky Gazette* mentioned that "...a quantity of very good LIME" could be purchased at the mill on the estate of Thomas Royle (Kentucky Gazette 1808:4). Between 1800 and 1830, Russellville in Logan County, had two lime kilns (Coffman 1931:25). A court case in Meade County mentioned a lime kiln in that county during 1826 (Meade County 1826).

In 1837, hydraulic limestone was discovered along the Kentucky River. M. R. Stealey (1837:102) noted that limestone suitable for manufacturing hydraulic lime was discovered on the Kentucky River during that season. George Stealey (1837:175-176) prepared a document entitled "Report of Examinations Made for Hydraulic Lime on the Kentucky River." He described locations suitable for manufacturing hydraulic lime below the mouth of Calloways' Creek (five miles below Irvine), at Cupboards Rocks (near Irvine), at the mouth of Drowning Creek, the mouth of the Red River, a location one to two miles up Red River from its mouth (G. Stealey 1837:175-176). The report also took into consideration over burden, thickness of limestone, available water power, and fuel (G. Stealey 1837:175-176). George Stealey (1837:176) reported that:

> The stratum extends from Irvine to Muddy creek can be observed to occupy most of the beds of the small streams and valleys in a large portion of the counties of Estill, Madison and Clarke. It possesses all the necessary qualities to make hydraulic lime, equal, if not superior, to any before discovered in the State.

An excellent description of one of George Stealey's (1837:176) potential locations for making hydraulic lime is the site at the mouth of the Red River. Stealey described the site and his strategy in the following quote:

> In a high bluff, on the north side of the mouth of Red river, the same stratum of rock presents itself for 200 yards immediately at and below Messrs. Thomas & Martin's mill dam, here its base is 16 feet above low water level of the Kentucky river; this bluff is favorable for opening a quarry, either at or below the dam. The present dam is 6 feet high of crib work filled with stone, the mill contains two saws and one pair of stones; at low stage of water there cannot be more than one of these worked at the same time, this results not so much from a scarcity of water as from a misapplication of it as a power; by raising the dam 6 feet higher, and making it water tight, there would be a sufficient quantity of water to drive a mill for manufacturing hydraulic lime, and as much of the machinery of Messrs. Thomas & Martin' mill, as there is driven at present, far the greater part of the year. From one to two miles up Red River from its mouth, there is 250 acres of woodland belonging to Messrs. Thomas & Martin, this tract, and the liberty of excavating the rock, would be given to the State, the proprietors not requiring any compensation for either; the principal part of the wood could be boated on the pool of the dam, if made higher.

During an 1838 geological reconnaissance of Kentucky, W. W. Mather (1988:282) observed that:

> This limestone, which I have called the cavernous limestone, occupies an area of some 5,000 to 8,000 square miles in Kentucky. In most places it makes lime of a superior quality, and it will be used in future to a much greater extent than it has been, not only for mortar, but for supplying lime to the soil, as a mineral manure.

By the 1840s, there are several references to hydraulic lime which was used in the construction of the locks and dams on the Kentucky and Licking rivers. One of these documents mentions the erection of a lime mill on the Licking River by Resident Engineer N. B. Buford (Auditor of Public Accounts 1840:228). The Board of Internal Improvement for the same year (1840:249) mentions a "Hydraulic Lime Manufactory at Louisville" and a "Hydraulic Lime Manufactory on Licking." The same report (Board of Internal Improvement 1840:249) states that:

> The hydraulic lime used in the locks, has been partly manufactured at the lime mill, belonging to the State, in Louisville, and partly at horsemills put up at the locks. 5095 barrels of the Louisville lime has been delivered at an average cost, including transportation, of about $ 2.50 per barrel, or about 75 cents per bushel. The lime manufactured at the locks will cost, including the expense of the mills, and all transportation connected with its delivery, about 37 cents per bushel. The cost, exclusive of the expense of building the mills, is about 25 cents per bushel. The

quantity manufactured up to the 17th of November, was about 3,900 bushels.

Three horse mills have been built- one at lock No. 2, one at No. 3, and one at No. 4. These will make enough lime for the five locks.

The Auditor of Public Accounts Annual Report for 1842 mentions bonds for hydraulic lime furnished for locks on the Licking and Kentucky rivers (Auditor of Public Accounts 1843:187-202). On November 5, 1841 thirty year bonds were issued for $2,000 for a lime establishment by N. B. Buford (Auditor of Public Accounts 1843:187). An entry for the Licking River Navigation project on January 3, 1842 indicated that resident Engineer N. B. Buford received $375 for his 4th quarter salary and another $625 was spent on the lime establishment (Auditor of Public Accounts 1843:191). On February 25,1842, John Hulme was paid $3,000 for hydraulic lime furnished on the Kentucky River locks (Auditor of Public Accounts 1843:192). An additional $1,000 was paid to J. S. Bush (Superintendent of Lime Establishment) for hydraulic lime on the Kentucky River Navigation project (Auditor of Public Accounts 1843:194). Three entries were made for the Licking River Navigation project. On June 14, 1842, J. S. Bush (Superintendent) was paid $250 for his services between February 1 to May 1, 1842 and $750 was spent on the lime establishment. The last listing was to J. S. Bush (Lime Establishment) for $1,000 on June 28, 1842 (Auditor of Public Accounts 1843:202).

Limited information is available about Kentucky's lime industry between 1850 and 1939. Lime producers were listed for Fayette, Kenton, and Trigg counties in the 1850 Manufacturing Census. *George W. Hawes' Kentucky State Gazetteer and Business Directory for 1859 and 1860* did not list any lime or cement manufacturers (Hawes 1859). Likewise, no lime makers were listed in the 1860 Manufacturing Census. The Population Census schedules for 1860 reveal the presence of lime makers living in Christian, Greenup, Kenton, Livingston, and Meade counties. By 1870, the Manufacturing Census listed lime makers in Greenup and Hardin counties. Other counties reporting lime between 1870 and 1873 include Jefferson, Kenton, Lyon, Meade, and Warren. Between 1876 and 1883, lime makers and distributors were listed in 23 counties. In the period between 1887 and 1890, only five counties were listed in connection with lime: Anderson, Mason, Menifee, Nelson, and Woodford. During 1896, lime was listed for Bourbon, Hart, Jefferson, Lyon, and Rockcastle counties.

For the period between 1900 and 1939, lime production was mentioned at various times for Breckinridge, Greenup, Jefferson, Lyon, Meade, Muhlenberg, Powell, Pulaski, Rockcastle, Scott, and Warren counties. In the *Mineral Resources of the United States, 1911*, lime was reported as being produced in Breckinridge, Meade, Rockcastle, Scott, and Warren counties (Miller 2001c). In 1920, 1,757 tons of lime was produced in Kentucky with a value of $18,063 (Crouse 1925:159). During the mid-1920s, the University of Kentucky College of Agriculture published two reports encouraging the use of lime and included lime kiln plans for farmers (Roberts 1924; Welch and Kelly 1924). Jillson (1930:156) reported that Kentucky produced 6,862 tons of lime during 1927 valued at $47,620. Bowles (1939:412) mentioned a major lime plant in Kentucky at Pine Hill, Rockcastle County and a smaller plant that operated in Campbellsville, Taylor County a few years earlier.

There was little activity in Kentucky's lime industry for nearly thirty years. Between 1940 and 1960, the *Mineral Resources of the United States* listed no lime production in Kentucky (Miller 2001c). In 1960, the Air Reduction Chemical and Carbide Company of Calvert City in Marshall County produced captive quicklime for the manufacture of calcium carbide (Patterson and Schreck 1961:7). This inactive period is also mentioned by Ault, Rooney, and Palmer (1974:32) who noted that "Kentucky has been a small producer in the past; production in the state ended completely from about 1936 until 1970, when the Black River Mining Co. began producing lime at a new plant at Carntown" [a small community on the Ohio River in Pendleton County]. Miller (2001c) noted that the

Black River Mining Company began construction of a lime plant in Pendleton County in 1968 which went on-line in 1973. In 1974, Dravo Lime Company began a lime plant in Mason County which went into operation in late 1976 (Miller 2001c). Dravo purchased Black River in 1986 and has been operating both plants to the present. Kentucky has shifted from a minor lime producer in the past to a significant producer today. Commenting on the lime industry for 2000, Miller (2001b:46.1) observed that "the two leading producing States were Missouri and Kentucky, which accounted for 21 % of production."

KENTUCKY'S MODERN AGRICULTURAL LIME INDUSTRY

The modern lime industry in Kentucky is very different from Kentucky's earlier lime industry. Early lime makers used vertical kilns to burn limestone into lime. Most of the current lime produced in Kentucky is made by grinding limestone. Thus, agricultural lime has not undergone any chemical alteration. Exceptions to this modern trend was the burned lime produced by the Black River Mining Company (later Black River Lime Company) and the Dravo Lime Company. Currently, the Dravo Lime Company operates lime plants in Pendleton County (formerly Black River Lime Company) and in Mason County. These companies are discussed in the main section of this paper. Also not included in this section is carbide lime which was produced by Airco Alloys and Carbides (1969-1985) and The Carbon/Graphite Group (1990-1996) in Jefferson County. Boynton (1980:192) noted that "carbide lime is a waste lime hydrate by-product of the generation of acetylene from calcium carbide and may occur as a wet sludge or dry powder of widely varying degrees of purity and particle size."

Burned limestone was used for agricultural liming throughout the nineteenth century and the early years of the twentieth century (Boynton 1980: 435-436). Between 1915 and 1933, county agents began promoting the benefits of agricultural liming (Boynton 1980:436). The shift to ground limestone was discussed by Boynton (1980:436):

> Many of these leading agriculturalists concluded that their promotion of liming would be more fruitful with the farmers if they stressed the use of limestone over lime. They reasoned that ground burnt quicklime was two to three times more costly than ground limestone, that hydrated lime was even more costly than quicklime, and that on an equivalent basis limestone could be applied by farmers at a total cost of one-half that of burned lime, even allowing for the fact that 1.75 times more limestone would have to be applied than lime for the same equivalent neutralizing value. In other words, their liming recommendations were geared to the farmers' pocketbook.

The rapid growth in the use of the agricultural lime by American farmers was due largely to the U.S. Government's role. Boynton (1980:128) stated that:

> Its rapid ascendancy in 1939 and the 1940s is attributed to the U.S. Department of Agriculture and its soil conservation program, which stimulated much greater use through liberal federal subsidies (i.e, cost sharing of liming with farmers). On an average, nearly half the cost of liming, including spreading, was borne by the American Stabilization Conservation Service and its precursory administrations in the Department of Agriculture.

The shift to ground limestone in Kentucky was remembered by Roy Gaddie, who worked at a quarry in Upton in the 1930s:

> In those days [the 30's] you couldn't give fine dust away-the dust that went through about a No. 8 screen. It was farm lime, but they didn't know it at the time; it was just something they couldn't use, except to choke the stone in a water-bound base.
>
> Well, at about 1936 or '37 the government started buying lime for the farmers. Up until then, we didn't have enough room to store it. In fact, up in Tyrone they put this lime dust in the river to get rid of it, until the government finally stopped them. Every quarry had a mountain of it.
>
> We were trying to get 15 cents a ton for this lime-whatever we could get. If somebody would haul it off, that'd be okay. It went from 15 cents when the government started buying it to $1.50 to $2 a ton, in about 18 months. That's what made us. A whole lot of it was due to the fact that the government was buying this lime (Dalton 1994:38).

During the research for this paper, a great deal of information was obtained about the modern agricultural lime industry in Kentucky. Since this "lime" was ground limestone rather than burned limestone, a decision was made to remove this information from the current overview. It is hoped that the information compiled about the modern agricultural lime industry in Kentucky can be published in a future paper (Hockensmith n.d.a).

OVERVIEW OF KENTUCKY'S LIME INDUSTRY BY COUNTY

A great deal of information was encountered during the course of this research. This information ranges from data about specific companies, to brief references, to lime production in certain counties. The following pages present this information alphabetically by county.

ANDERSON COUNTY

Wheat and Skeldon of Tyrone were listed as a lime manufacturers during 1887 and 1888 (Polk 1887:844). The 1850 (Lawson 1987) and 1880 U. S. Population Census schedules for Anderson County (United States Federal Census 1880b) did not produce any additional references to lime makers.

BOONE COUNTY

In Petersburg, Kentucky, W. H. Chapin was listed under lime, plaster, and cement between 1876 and 1881 (Polk and Danser 1876:652; Polk and Danser 1879:654; Polk and Danser 1881:735). It is not known whether Chapin was a lime maker or just sold lime. No lime makers were listed in the transcribed 1850 Population Census (Lawson 1986a) or in the1870 and 1880 Population Census schedules for Boone County on microfilm (United States Federal Census 1870c, 1880c). Likewise, no lime makers were listed for Boone County in the 1883 atlas (Lake 1883).

BOURBON COUNTY

Jacob Schwartz of Paris was a lime manufacturer that operated between 1881 and 1896. During 1881 he is listed by Polk and Danser (1881:735) and again in 1887 (Polk 1887:844). The *Kentucky State Gazetteer and Business Directory for 1896* also listed Jacob Schwartz (Polk 1895:1128). No lime makers were listed in the transcribed 1850 Population Census (Hubble 1986) or in the 1880 Population Census schedule for Bourbon County (United States Federal Census 1880d).

BRECKINRIDGE COUNTY

The 1850, 1860 and 1870 Population Census schedules for Breckinridge County did not list any lime makers. Likewise, no lime makers were listed in the 1880 Population Census schedules for Breckinridge County (Cook and Cook 1984). The 1911 edition of *Mineral Resources of the United States* mentioned lime production in Breckinridge County (Miller 2001c). In the 1913 edition of the "Mineral Resources of the United States," Burchard (1914:1153) reported that high-calcium lime was produced in Breckinridge and other counties. No additional details are available for Breckinridge County.

CAMPBELL COUNTY

No lime makers were listed in the 1880 Population Census schedules for Campbell County (United States Federal Census 1880e). L. D. Ermert of Newport was listed in the *Kentucky State Gazetteer and Business Directory for 1881-1882* under lime, plaster, and cement (Polk and Danser 1881:735). The 1880-1881 city directory for Newport (Williams & Co. 1880:263) listed the following individuals under "Lime, Cement & c." Louis D. Ermert (southwest corner of Ringgold and Overton), Conrad Hahn (corner Front and Taylor's Creek, Bridge and 30 York), Andrew M. Rardin (west side Monmouth between Williamson and Liberty), John Schaich (80 John), Henry Schriver (220 Monmouth), and Charles Spinks (95 Jefferson). It is not known whether these men were lime makers or if they sold lime and other products.

The 1883 atlas that included Campbell County listed H. A. Schriver of Newport (Lake & Co. 1883) as a "...Carpenter, Jointer and Builder. Manufacturer [of] Doors, Sash and Venitian Shutters. Also Dealer in Sand, Lime, Cement, Plaster's Hair, and Chain Pumps...". The other men listed in the 1880-1881 Newport City directory did not advertise in the atlas.

Across the Ohio River from Covington and Newport, Kentucky, lime kilns were operating in Cincinnati, Ohio. The 1880-1881 Cincinnati Business Directory (Williams & Co. 1880:402) had two listings under lime kilns: Brockmann & Lambert (Hopple Street, north of Fairmount) and E. Howe & Son and W. Kohlhas (Browne north of McMillian).

CARROLL COUNTY

William L. Smith of Carrollton was listed under the heading of lime, plaster, and cement for 1876-1877 (Polk and Danser 1876:652). It is not known whether Smith made lime or was just a distributor.

CASEY COUNTY

No lime makers were listed in the 1860 (Austin 1990) or the 1870 (Black 1994) Population Census schedules for Casey County. Thomas Richardson was listed as a lime manufacturer living in Poplar Hill during 1879 and 1881 (Polk and Danser 1879:654; Polk and Danser 1881:735). In the 1880 Population Census schedules for Casey County (United States Federal Census 1880f), Thomas Richardson was listed as a 27 old Farmer from Kentucky (Sanders n.d.:220). No lime makers were listed in the 1850 Population Census schedule (Thomas 1979) or in the 1880 Population Census.

CHRISTIAN COUNTY

The 1860 Population Census for Christian County listed George Long as a "lime burner" (Hopkins County Genealogical Society 1978:178). The 48 year old Long was born in Kentucky (Hopkins County Genealogical Society 1978:178). The 1870 (Willis 1996) and the 1880 Population Census (Cain 1981) schedules for Christian County did not list any lime makers.

Andrew Hall of Hopkinsville was listed as a lime manufacturer in 1883 (Polk and Danser 1883:880). The 1880 Population Census for Christian County listed two men with this name. The first person is 27 year old Andrew Hall, born in Kentucky, who was a stone mason (Cain 1981:46). The second person is 40 year old A. N. Hall, born in Virginia, employed as a farmer (Cain 1981:361). It is not known which of these men was the lime maker. The 1900 Population Census for Christian County did not list any lime makers (Willhite 1996).

DAVIESS COUNTY

J. T. Harrison of Owensboro was listed in the *Kentucky State Gazetteer and Business Directory* between 1876 and 1881 (Polk and Danser 1876:652; Polk and Danser 1879:654; Polk and Danser 1881:735). It is assumed that J. T. Harrison was a business man that sold lime since he owned the Planters' Tobacco Warehouse in Owensboro (Potter 1974:113).

FAYETTE COUNTY

Lime making was an early industry in Fayette County. The April 11, 1799 issue of *The Kentucky Gazette* carried the following ad for J. R. Shaw:

> The subscriber hereby informs the public that he will keep constantly on hand, excellent lime, at his lime house, about half a mile from Lexington, at col. Pattersons quarry at 10d half penny per bushel, giving ten bushels for every hundred sold, he will have two or three thousand bushels ready by the last of April; he now has on hand five hundred bushels of excellent lime, for which he will take 9d per bushel giving the above allowance-No lime will be delivered without an order.
>
> He also informs the public that he will carry on the well digging business, as usual, his prices are 2/ and 6d per foot, through earth, if a cavity or as far as a cavity extends in a rock, 9/ per foot, 15/ per foot for the first three feet after, and 18/ per foot as far as the well is continued, 2/ per foot for walling, boarding, laborers, powder, smiths work & c. Found by the owner of the well.

J. R. SHAW
Pattersons quarry near Lexington,}
February 18th, 1799

Staples (1996:134) stated that John Robert Shaw, the well digger, was born in Bristol, England, served in the English Army, joined the American Army, and settled in Lexington after he was discharged. In Lexington, Shaw married and became employed as a well digger, inn keeper, and operator of a stone quarry (Staples 1996:134-135). The year after Shaw's ad, Staples (1996:165) cited an October 21, 1800 entry in the *Kentucky Gazette* that mentioned that lime delivered in New Orleans was sold for 50 cents per bushel.

The 1850 Manufacturing Census for Fayette County listed R. Tinspatrick's (?) stone quarry as a producer of lime as well as stone and stone curbing (United States Federal Census 1850a). He manufactured 5,000 bushels of lime valued at $500 in addition to 700 perch of stone ($837) and 3,000 feet of stone curbing ($350).

The 1864-1865 Lexington City Directory (Williams & Co. 1864:111, 116) listed B. H. Hall (south side of Short between Mulberry and Walnut) under both lime and plaster. The city directory for 1873-1874 (Sheppard 1873:236) listed John C. Young (11 Vine) under lime, cement and plaster. An ad in the same directory (Sheppard 1873:222) noted that Young was a contractor and builder who also dealt in cement, plaster, sand, hair, lathes, terra cotta, and chimney tops. *Prather's Lexington City Directory, For 1875 and 1876* (Prather 1875:273) listed four "Lime Yards:" George Clark (rear of 73 Walnut), C. C. Shiddell & Co. (136 Constitution), W. R. Snyder (127 East Main), and John C. Young (10 west Vine). W. R. Snyder was listed in *Kentucky State Gazetteer and Business Directory* for 1876 under the heading of lime, plaster, and cement (Polk and Danser 1876:652). G. B. Wilgus was listed under lime, plaster, and cement in 1879 *Kentucky State Gazetteer and Business Directory* (Polk and Danser 1879:654). The author's research about the Lexington brick industry indicates that both Young and Wilgus were brick makers and contractors who sold building supplies. In the 1879-1880 Lexington City Directory (Emerson & Co. 1878), W. R. Snyder (127 East Main) and G. B. Wilgus (North Mulberry) were listed under lime, cement, and plaster. The 1881-1882 Lexington City Directory (Williams & Co. 1881:216) listed four individuals under lime, plaster, and cement: Jas. M. Elliott, Jr. (31 North Limestone), W. R. Snyder (127 East Main), G. D. Wilgus (80 North Limestone), and John H. Young agent (11 West Vine). Wilgus is last listed in 1893 (Prather 1893:306) while Snyder is last listed in 1885-1886 (Sholes & Co. 1885:60). Between 1885 and 1928 (last year checked), many new dealers were listed under lime and cement. Probably the most prominent of the group was desCognets and Hagyard (1885-1886) (Sholes & Co. 1885:60) and their successor Louis desCognets and Company (75-77 North Limestone), 1887-1928 (Norwood 1887:51; Polk 1928:819).

FLEMING COUNTY

The *Kentucky State Gazetteer and Business Directory for 1881-1882* listed N. S. Dudley of Flemingsburg under lime, plaster, and cement (Polk and Danser 1881:734). It is not known whether Dudley was a lime manufacturer or just sold building supplies. However, the 1850 (Cowan and Courtney 1986) and 1880 Population Census of Fleming County (United States Federal Census 1880g) did not list any individuals involved in lime making. Further, the *Atlas of Bath & Fleming Co.'s, Kentucky* (Lake & Co. 1884) did not list any lime makers.

FRANKLIN COUNTY

Geologist A. M. Miller (1914:55) mentioned a soil sample analyzed by Robert Peter in 1857 from a former lime kiln burnt about 30 years before (ca. 1827) located about two miles from Frankfort in Franklin County. Miller (1914:55) stated that "this is probably the old J. Clarke place on the east side of the first road turning off the Louisville pike-this road was formerly the road to Lawrenceburg."

George B. Macklin is listed under lime, plaster, and cement in the *Kentucky State Gazetteer and Business Directory for 1876-1877* (Polk and Danser 1876:652). Macklin was a prominent Frankfort businessman who sold coal and other materials. The 1882 atlas for Franklin County (Lake & Co. 1882a) listed George B. Macklin as a "Com. Merchant and Dealer in all kinds of Coal, Grain, Cement, Hay, Lime and Shingles."

No lime makers were listed in the 1884-1885 Frankfort City Directory (Emerson 1884) or in the 1891-1892 Frankfort City Directory (Dryden 1891). Between 1908 (The Inter-State Directory Company 1908:233) and 1921 (Caron Directory Company 1921:314), the Frankfort city directories listed several individuals and companies that sold lime. These appear to be middle men who just distributed lime made elsewhere.

GREENUP COUNTY

Lime was produced in Greenup County between ca. 1860 and ca. 1900. No lime makers were noted in the 1850 Population Census Schedules for Greenup County (Jackson 1988; United States Federal Census 1850d). Henry Fapairs (?) was listed as a lime burner in the 1860 Population Census schedules for Greenup County (United States Federal Census 1860a). He was a 32 year old Kentuckian with $1,500 of real property and $300 worth of personal property.

The 1870 Census of Manufacturing listed William Tong as a manufacturer of lime in Greenup County (United States Federal Census 1870a). Tong had $12,000 of capital invested in his business which yielded him $12,240 of income. Eight months of work with seven male employees were required for Tong to produce his 14,400 barrels of lime. His cost included $2,240 for labor, $3,600 for limestone (2,880 perches), $675 for coal (8,437 bushels), and $2,880 for 12,440 barrels. The 1870 Population Census Schedules for Greenup County listed William Tong as a 70 year old man born in Ohio. He had $10,000 of real property and $900 of personal property (United States Federal Census 1870e). Biggs and Mackoy (1951:280) stated that William W. Tong was born in 1797 moved from Adams County, Ohio to Mason County, Kentucky in 1842. Further, Biggs and Mackoy (1951:280) reported the following about Tong:

> Sometime in the 1840s he came to Greenup County and located near the present site of Limeville. He built a lime kiln and the business was called the Greenup Lime Works. He also had a blacksmith shop where the schoolhouse was built later, and in this schoolhouse the post office is now located.

John S. Duvall was another lime manufacturer listed in the 1870 Census of Manufacturing (United States Federal Census 1870a). He had $4,000 invested in his operation and employed seven men. Making lime (12,000 barrels) during eight months of the year yielded him $13,500 of income. Expenses for Duvall's business included $2,000 for labor, $3,375 for limestone (2,400 perches), $1,080 for coal (12,000 bushels), and $2,400 for 12,000 barrels. In the 1870 Population Census, Duvall was listed as a 37 year old Kentuckian. He had $1,500 of personal property (United States

Federal Census 1870e).

The 1870 Population Census Schedules for Greenup County listed 15 people associated with the lime industry in the county (United States Federal Census 1870e). Only William Tong and John S. Duvall occupations were listed as "manufacturing lime". Apparently, the remaining 13 men were their employees since they were all listed as "laborer at lime kiln". If Tong (probably too old to work) is excluded from the active work force, the 14 other men mentioned in the 1870 Census of Manufacturing are accounted for. The men working at the lime kilns are listed in Table 1. They are all white males ranging in age from 17 to 50 years. Only two of the men are native Kentuckians. Four are from Ohio, three from West Virginia, two from New York, one from "East Virginia", one from Pennsylvania, and one from Ireland. With the exception of Reding Bertram (Precinct No. 1), all the lime makers were residing in Precinct No. 2.

A lime quarry was operated in Greenup County by Josiah G. Merrill. The 1870 Census of Manufacturing indicates that Merrill had $6,000 invested in his quarrying operation (United States Federal Census 1870a). Expenses to operate the quarry included $50 for powder (250 pounds), $25 for steel (50 pounds), and $30 for fuses (3,000 feet). The powder and fuses would have been used in blasting the limestone free in the quarry. The steel was probably made into drills and stone working hammers by a blacksmith. Working nine months a year, Merrill employed four men at a yearly cost of $1,000. His quarry produced 2,000 tons of limestone valued at $2,800 per year. He may have supplied some of the limestone to the lime makers.

The *Kentucky State Gazetteers* listed two lime makers operating during 1879 in Greenup County. Henry Tong and T. W. Radcliff are listed as a lime manufacturers at Duvall's Landing (Polk and Danser 1879:654). Elsewhere in the same directory, Henry Tong is listed as a lime burner at Duvall's Landing while T. W. Radcliff is listed as a lime manufacturer (Polk and Danser 1879:40).

The 1880 Population Census Schedules for Greenup County list five white males in Precinct No. 6 whose occupations are listed as "laborer in Lime Works" (United States Federal Census 1880h). These men are listed in Table 2.

In 1881, three men are listed as being associated with the Greenup Lime Works: C. Cartwright, J. T. Molder, and W. R. Tong (Polk and Danser 1881:734-735). The Williams Brothers were lime makers the same year at Russell (Polk and Danser 1881:734). By 1887, four men are associated with the lime industry in Greenup County. Cartwright & Tony [Tong?] and J. H. Merrill were connected with the Greenup Lime Works (Polk 1887:844). B. F. Bennett was a lime producer at Greenup (Polk 1887:844). J. H. Merrill appears to be John Hayward Merrill, son of Josiah Merrill, Jr. (Biggs and Mackey 1951:222). The Cartwright of Cartwright & Tong is Cyrus Cartwright, born in Hanging Rock (Lawrence County), Ohio in 1844 (Biggs and Mackoy 1951:140). Biggs and Mackoy (1951:140) stated that:

> After William W. Tong's death in 1879, Mr. Cartwright operated the Lime Works for several years and then he open a general store near his home at what is now known as Tongs Post Office. He carried on this merchandise business until his death in 1915.

> Biggs and Mackoy (1951:107) further stated that:

> Limeville is still known by its original name, although the post office has been known as Tongs for many years. In the 1870's Limeville was a very busy place and

Table 1. Individuals Involved in the Lime Industry in Greenup County During 1870. From the Population Schedules from the Ninth Census of the United States.

Name	Age	Place of Birth
Delaney, William H.	22	Kentucky
Wonfield, John	33	West Virginia
Hillhouse, Sammuel	21	Ohio
Zaruck (?), John	26	New York
Tong, William	70	Ohio
Gordon, William R.	22	East Virginia
Duvall, John S.	37	Kentucky
Tingler, Solomon	49	West Virginia
Holmes, Alexander	41	Pennsylvania
Bertram, Reding	42	Kentucky
Burdum (?), Semis C.	19	Ohio
Burdum (?), Franklin C.	17	Ohio
Haystett, Robert	18	West Virginia
Canada, Michael	50	Ireland
Canada, Michael	17	New York

had the only post office between Greenup and Portsmouth. The mail was delivered by boat or brought from Wheelersburg, Ohio.

Limeville was so named because of the quantity of lime burned and shipped up and down the river from Pittsburgh to Cincinnati.

The land on which Limeville is located was bought from the Gray family in 1849 by

William Tong, who built and operated the first lime kiln. In 1870 John H. Merrill took over the lime business. He also kept a general store...

Table 2. Individuals Involved in the Lime Industry in Greenup County During 1880. From the Population Schedules from the Tenth Census of the United States.

Name	Age	Place of Birth
Coleman, Eli	66	Massachusetts
Davidson, Charles	18	Ohio
Neighbors, Franklin	31	Pennsylvania
Neighbors, Jacob	19	Ohio
Price, Benjamin	57	Kentucky

Biggs and Mackoy (1951:55) stated that "At Limeville there were lime kilns and a thriving business was carried on by the Tong family and later by the Merrills. Lime was shipped by boat to both Cincinnati and Pittsburgh...". The "General Highway Map, Greenup County, Kentucky" shows Limeville (Tongs P. O.) as being located on the Ohio River between South Shore and Greenup (Kentucky Transportation Cabinet 1992).

Kentucky directories and gazetteers mention two other place names in Greenup County that may be earlier names for Limeville. Hawes (1859:160) mentioned Lime Works as "a post office of Greenup county, in the north-east corner of the State." The community of Lime Forks was mentioned by Hodgman (1865:18) six years later as "a post office of Greenup county, situated in the north-eastern part of the State." In 1873, Lime Forks was still listed as a community in Greenup County (Ohio Valley Publishing Company 1873:41).

Geologist A. R. Crandall (1877, 1884) briefly mentioned lime kilns in his discussion of the geology of Greenup County. Crandall (1884:6) stated that:

> A thin layer of limestone is found on Smith's Branch. The hills back of the lime-kilns show the only considerable development of this formation near the Ohio. Here the deposits reaches a thickness of 35 feet at one point; but rapidly falls away in thickness, so that outside of an area of a few square miles, only a thin cherty rock occurs to represent this formation...

Crandall (1884:7) further stated that:

> The sub-carboniferous limestone, when present in considerable thickness, is usually made up of rocks varying in character from a pure white or grayish limestone to that

> which is sandy or ferruginous or cherty. The former rock makes an excellent quicklime, as shown by the demand for the products of the lime-kilns on the Ohio, in Greenup county.

Plate 4 of Crandall's report included a stratigraphic drawing illustrating the rock formations at the "Lime Kilns Above Mouth of Tygert's Cr., Greenup Co." This plate is cited in reference to the following text (Crandall 1884:29):

> The exceptional dip mentioned in this region deserves a passing notice. In general the rocks of a given geological level rise towards the south, as noticed before, but the elevation of the Waverly rocks, as shown in the hills back of Springville, present a marked exception to the general rule, and this exception continues eastward to the river hills above the lime-kilns. The top of the Waverly at the lime-kilns is fully 100 feet higher than at Bennett's Mills.

The 1900 Population Census Schedules for Greenup County listed six white males as "Quarryman-lime" (United States Federal Census 1900). These include 36 year old Frank Blair from Kentucky, 35 year old George Monk from Ohio, 57 year old Elijah Smith from Kentucky, 36 year old William Robinson from Virginia, 47 year old Vincent Lambert from Kentucky, and 42 year old Charley Muttles from Kentucky. It is uncertain whether these men quarried stone for lime kilns or were quarrymen that worked in limestone.

HANCOCK

Crider's (1913:298) report on the "Economic Geology of Tell City and Owensboro Quadrangles" provided the following statement on the manufacture of lime:

> The Lead Creek limestone at one or two localities has been used for the manufacture of lime. Where it is found in large boulders with little or no overburden it could still be used for that purpose.

HARDIN COUNTY

The 1870 Census of Manufacturing listed Henry P. Hoffman as operating a lime kiln in the Big Springs and Howe Valley area of Hardin County (United States Federal Census 1870b). Hoffman had $300 capital invested in his business which yielded him $800 in income. Eight months of work with four male employees were required for Hoffman to produce his 320 barrels of lime. His cost included $300 for labor, $30 for limestone (40 pts.), $ 40 for fuel, and $90 for the 320 barrels. The 1850 Population Census for Hardin County did not include any lime makers (United States Federal Census 1850e). Likewise, the 1870 Census did not list any lime makers (Deardorff 1983).

HART COUNTY

The 1850 (Crabb 1979), 1870 (Hawley 1996a), and 1880 (Hawley 1996b) Population Census schedules did not list any lime makers. The *Kentucky State Gazetteer and Business Directory for 1896* listed Payton & Brother of Munfordville as lime manufacturers (Polk 1895:1128). No additional information was found for Payton & Brother.

HICKMAN COUNTY

Kentucky State Gazetteer and Business Directory for 1876-1877 listed Halliday & Co. of Columbus under the heading of lime, plaster, and cement (Polk and Danser 1876:652). It is likely that Halliday & Co. was only a dealer in lime. The 1870 Population Census for Hickman County listed Edwin G. Haliday as a 34 year old white male born in Ohio (Goodgion and Goodgion 1976:77). Further, Haliday's occupation was listed as a merchant with $19,000 worth of property.

JEFFERSON COUNTY

Several individuals and companies were listed at various times under the heading of lime, cement, and plaster for Jefferson County. Those mentioned repeatedly are discussed separately. The remaining individuals and companies are grouped together chronologically.

J. B. Speed & Company

The J. B. Speed & Company was incorporated on June 2, 1908 (Secretary of State 1908). The major shareholders included James B. Speed (150 shares), William S. Speed (147 shares), and Henry S. Gray (3 shares). The corporation had $30,000 of capital stock divided into 300 shares valued at $100 each. Article three of the corporation stated that "the nature of the business to be transacted, and condicted [sic], and the object and purposes to be performed by said corporation are to buy, sell, trade and deal in salt, sand, lime, plaster, cement and other building materials; to own, operate, and conduct a barge line; ..." (Secretary of State 1908). The articles were amended on May 26, 1914 to increase the company's stock from $30,000 to $60,000 (Secretary of State 1914). On December 13, 1915, William S. Speed, F. M. Sackett, and Henry S. Gray further amended the company's charter to raise the capital stock from $60,000 to $100,000 (Secretary of State 1915, 1916). The new stock was divided into 1,000 shares worth $100 each.

It appears that J. B. Speed & Company shifted most of their operations to southern Indiana at an early date. In 1871, J. B. Speed & Company open a lime plant at Utica, Indiana which operated until 1907 (Ault, Lawrence, and Palmer 1974:31). Blatchley (1904:222) stated that "J. Speed, Esq., has erected at Utica two of Page's patent kilns, each producing 120 barrels of lime per day." J. B. Speed & Company also produced lime at Milltown, Indiana between 1887 and 1915 (Ault, Lawrence, and Palmer 1974:24).

Louisville Cement Company

The Louisville Cement Company was incorporated in 1869. The Kentucky Secretary of State's office has an extensive file on this company. The articles of incorporation were amended many times between 1910 and 1951 to increase the amount of the capital stock. In 1910, the company was under the control of James B. Speed, John H. Caperton, and W. S. Speed (Secretary of State 1910). During 1954, the Louisville Cement Company and the Louisville Cement Corporation (an Indiana Corporation) merged (Secretary of State 1954). The company made additional amendments between 1955 and 1964. On April 1985, Coplay Acquisitions Subsidiary was merged into the Louisville Cement Company (Secretary of State 1985a). The Louisville Cement Company was merged into the Coplay Cement Company during May 31, 1985 (Secretary of State 1985b). On February 14, 1998, the Coplay Cement Company became ESSROC Materials, Inc. (Secretary of State 1998). Kramer (2001:538) recently published a summary of the Louisville Cement Company.

The 1880 Census of Manufacturing for Jefferson County provided some information on the Louisville Cement Company (United States Federal Census 1880a). The company had $100,000 of capital invested and operated 11 months per year. Eighty men were employed by the company with up 95 men at busy times. Wages ranged from $1.10 per day for ordinary labor to $1.30 for skilled labor for the 10 hour work day. The company used $5,800 of materials and produced $7,800 worth of cement.

Blatchley (1904:222) noted that "The Louisville Cement and Lime Company, and the Utica Lime Company, and Mr. J. Robinson burn 125,000 barrels of lime per year, employing in the business a large number of hands."

During the late nineteenth century the company operated a lime kiln at Florida Heights in northeastern Jefferson County. Starks (1923:65) provided the following comments about the Louisville Cement Company's involvement in lime making:

> While engaged in the manufacture of hydraulic cement, the Company took up the collateral line of the manufacture of lime, beginning in a small way at Utica, Indiana and Florida Heights, Kentucky, both points located about six or eight miles above the city of Louisville on the Ohio River. In 1885 the discovery of a very high quality of lime stone in Crawford County, Indiana, led the Company to abandon its original lime works, and concentrate its energies on the manufacture of lime at Milltown, where their present plant is equipped with the latest type of improved gas burning kilns, producing the highest quality of high calcium lime for chemical and industrial uses.

Florida Heights (a former railroad station depot) is located at present day Glenview on the Ohio River northeast of Louisville. The 1879 *Atlas of Jefferson and Oldham Counties, Kentucky* (Beers and Lanagan 1879a:37) shows the location of the above lime kiln. The lime kiln was located on the west side of Lime Kiln Road where it intersected with the former Harrods Creek Railroad line. Big Goose Creek flows into the Ohio River about 300 m northwest of the kiln location. Ballard School is currently located within the old quarry associated with the lime kiln (Fred E. Coy, Jr., personal communication 1999).

In addition to their lime operations at Utica, Indiana and Florida Heights, Kentucky, the Louisville Cement Company had other operations. During 1913, the Louisville Cement Company acquired the Eichel Lime & Stone Company operation at Milltown, Indiana (Ault, Lawrence, and Palmer 1974:25). In 1915, the Louisville Cement Company acquired the J. B. Speed & Company facility at Milltown, Indiana (Ault, Lawrence, and Palmer 1974:24). Azbe (1946:10-11) provided an excellent description of the Milltown plant after a visit in 1923. The Louisville Cement Company ceased operation at Milltown in 1953 (Ault, Lawrence, and Palmer 1974:26).

Union Cement and Lime Company

The Union Cement and Lime Company was listed in a number of directories. The 1873 Louisville City Directory listed the company at 169 Main Street (Caron 1873:625). It was also listed in the *Kentucky State Gazetteer and Business Directories* for 1876-1877 (Polk and Danser 1876:652) and 1883-1884 (Polk and Danser 1883:880). Siebenthal (1900:376) indicated that the Union Cement and Lime Company (owned by D. Belknap & Company) operated the Black Diamond mill and the Falls City mill in Indiana and the Black Diamond River mill in Louisville

The 1880 Census of Manufacturing for Jefferson County provided some information on the Union Cement and Lime Company (United States Federal Census 1880a). The company had $275,000 of capital invested and operated ten months per year. Sixty-seven men were employed by the company with wages ranging from $1.20 per day for ordinary labor to $2.00 for skilled labor for the 10 hour work day. The company used $5,300 of materials and produced $6,700 worth of cement.

Articles of incorporation for the Union Cement and Lime Company were filed with the Secretary of State on December 26, 1896 (Secretary of State 1896). This document mentioned that the company was originally incorporated on November 25, 1872. The 1896 incorporators included R. A. Robinson, William A. Robinson, J. W. E. Bayly, and J. T. Cooper whom each owned five shares (Secretary of State 1896). The capital stock of the company was valued at $450,000 divided into 4,500 shares worth $100 each. Article three noted that "the nature of the business of said Company shall be the manufacture and dealing in hydraulic cement, lime and barrels, and all other articles usually manufactured and dealt in, in connection with cement and lime; also the quarrying, mining and dealing in building and other stone..." (Secretary of State 1896). "A Statement of Dissolution" is also on file with the Secretary of State recording that the company was dissolved on March 13, 1918.

Biographical sketches were located for two of the Union Cement and Lime Company incorporators: R. A. Robinson and William A. Robinson. Richard Alexander Robinson was born on October 23, 1817 near Winchester in Frederick County, Virginia (Johnson 1912:1266; Johnston 1896:368). R. A. Robinson came to Louisville in 1837 and was involved in different business ventures (Johnson 1912:1266; Johnston 1896:368-370). Johnston (1896:370) stated that:

> Many years earlier, he established another of the important industries of Louisville, the Union Lime and Cement Company, which has a capital of $450,000. He was made President of this company at its organization and has ever since held the position, being the largest stockholder in both of these corporations.

Johnson (1912:1267) noted that R. A. Robinson died on December 9, 1897. William Alexander Robinson was one of R. A. Robinson's sons. He was born on June 26, 1843 in Louisville and died on May 9, 1917 (Johnson 1912:319). William A. Robinson had varied business interests during his life time. Johnson (1912:319) noted that "Mr. Robinson also filled the office of president of the Union Cement & Lime Company during a period of five years."

Blatchley (1904:248-249) provided information on the Union Cement and Lime Company in his discussion of the lime industry in Indiana:

> The Union Cement and Lime Co.-The first lime was burned from Bedford oolitic stone at the Salem quarries about 1884. In 1898 the property passed into the control of the Union Cement and Lime Company, whose main offices are at Louisville, Kentucky. This company at present controls 50 acres of stone land in the immediate vicinity of the plant. The latter is located on a spur of the Monon Railway, a dummy engine, owned by the company, doing the switching.
>
> Five continuous process kilns are used in burning the lime, three of which were in operation in October, 1903. Four of the kilns are stone; the other of steel. The dimensions of the stone kilns are, base, 22 feet square; top, 18 feet square; height, 38 feet above the drawpit. The stone kilns have a capacity of 250 bushels each and the steel kilns 175 bushels, per day. Wood, oil and coal have all been used as fuel, the use of the first two having been abandoned on account of increase in cost. The coal

> used in 1903 was nut and slack from Wolfman's mine near Huntingburg, Dubois County, and cost $1.40 per ton, delivered at the plant. The firing is done in furnaces located at the base of the kilns, above the drawpit. Blowers are used in all furnaces to increase the draught.

Blatchley (1904:250) also provided details about the Union Cement and Lime Company's firing process, lime quality, and its uses:

> The kilns are filled by day and topped up for night burning. Bins at the top hold stone enough for two or three days' burning when severe weather is experienced. The plant is operated all the year, except for two or three weeks in midwinter. But little trouble is experienced with "cores."
>
> The lime is drawn every eight hours, the output for the three kilns in operation at the time of my visit being 750 bushels daily. It is at first rather dark in color, but becomes pure white when slacked. It is a "hot" lime which slacks quickly and is evidently very pure in composition. It is used mainly for mortar and plaster, though large quantities are sold to tanneries and paper mills. It is shipped wholly in bulk, and goes mainly to Louisville, from which point it is distributed by the company. At Salem, where there is no competition, it is retailed at 20 cents per bushel. The cost of production is estimated at about 9 ½ cents on board cars. ...Twenty men are employed in and about the plant, their wages ranging from $1.25 for quarrymen to $1.60 per day for foremen and chief burners.

The Utica Lime Company

The Utica Lime Company operated in Louisville for over 30 years. J. T. Cooper was listed as the company's president (Edwards 1870:456). It is listed for the following years: 1870 (Edwards 1870:456; Hodgman 1870:359), 1871 (Caron 1871:551), 1873 (Ohio Valley Publishing Company 1873:232), 1874 (Caron 1874:645), 1876-1877 (Polk and Danser 1876:652), 1878 (Caron 1878:714), 1879-1880 (Polk and Danser 1879:654), 1881 (Caron 1881:845; Polk 1881:735), 1882 (Caron 1882:859), 1887-1888 (Polk 1887:844), 1895 (Caron 1895:1553), and 1901 (Caron 1901:1744).

The Utica Lime Company began a lime operation in Utica, Indiana in 1870 (Ault, Rooney, and Palmer 1974:31). Blatchley (1904:222) stated that "The Utica Lime Company use a mixture of wood and coal, and have two kilns, each producing 90 barrels of well burned lime per day."

National Carbide Company/Airco Alloys & Carbide

The National Carbide Company (a Division of Air Reduction Company, Inc.) was listed in the 1957-1958 Kentucky Industrial Directory (Kentucky Department of Economic Development 1957:352) as a producer of hydrated lime. Located at Bells Lane in Louisville, the company had 464 employees. By 1969, the company's name had changed to Airco Alloys & Carbide (still a Division of Air Reduction Company) and employed 381 individuals (450 men and 7 women) at their facilities (Kentucky Department of Commerce 1969:213). In 1975, Airco Alloys & Carbide was listed as a producer of carbide lime and had 254 employees including 250 males and 4 females (Kentucky Department of Commerce 1975:254). The *1980 Kentucky Directory of Manufactures* (Kentucky Department of Commerce 1980:238) indicated that the carbide lime producer's work force had grown to 277 persons (247 men and 30 women). Five years later, Airco Carbide was employing 250 men and 30 women (Department of Economic Development 1985:197). Sometime between 1985 and

1990, the company's name was changed to The Carbon/Graphite Group, Inc. at 4400 Bells Lane (Kentucky Department of Commerce 1990:204). The company was still producing carbide lime with 200 employees. During 1992 and 1996, the company's employment remained at 200 individuals (Kentucky Department of Commerce 1992:212 and 1996:284). The Carbon/Graphite Group was not listed under lime for 1998 or 2000 (Harris InfoSource 1998 and 2000).

Boynton (1980:398) provided the following comments concerning Air Reduction Company's (the parent company of the National Carbide Company) process to recover lime:

> Air reduction Co., has developed a process to recover lime for recycling. When acetylene is generated from calcium carbide, a waste calcium hydroxide (hydrated lime) is obtained...The waste hydrated lime is then dried, pelletized, and charged into kilns where the chemically combined water is expelled, forming quicklime for reuse in the carbide process.

Other Lime Companies

Some companies appear to have been short lived lime companies. These include Goose Creek Lime and Cement Company (Caron 1878:714; Caron 1879:776), The Rudd Lime Company- C. P. Rudd, agent- (Caron 1879:776), Salem Steam Lime and Stone Works (Polk and Danser 1881:735; Polk and Danser 1883:880); Salem Lime and Stone Works (Polk and Danser 1883:880). Unfortunately, no articles of incorporation were on file with the Secretary of State for these companies.

Blatchley (1904:248) provided the following information on the Salem Stone & Lime Company:

> Salem, the county seat of Washington County, is a town of 2,000 population, located on the C., I. & L. (Monon) Railway, 41 miles northwest of Louisville. The quarries of Bedford oölitic limestone near which the limekilns are situated, are in the northwest quarter of section 19 (2 N., 4 E.) one mile west and a little south of the courthouse. They were first operated under the name of the "Salem Stone & Lime Co.," and then for a time under that of "The Salem-Bedford Stone Company." In 1896 Mr. Hopkins wrote of them as follows...There is a large stone mill and a number of limekilns at the quarry, but the mill is now idle...A unique feature of this quarry is the absence of the large dump piles of waste stone, the universal accompaniment of the quarries elsewhere. The explanation of this is found in the limekilns at the quarry, where all the waste stone is burned to quicklime and marketed in that form. The only stone that is being quarried at present (July, 1986) is the broken stone for lime burning.

Lime, Plaster Or Cement Distributors

Several companies and individuals were listed under lime, plaster, and cement in various directories. In chronological order, these include John Duffy & Company (Hodgman 1870:359), J. D. Bondurant (Ohio Valley Publishing Company 1873:232), W. W. Waring & Company (Ohio Valley Publishing Company 1873:232), Merwin Wiard & Company (Ohio Valley Publishing Company 1873:232), J. Nelson Harris (Polk 1876:652), C. I. Caufield (Caron 1878:714; Caron 1879:776; Polk and Danser 1879:654), Philip Speed (Polk and Danser 1879:654), and William B. Blunck (Polk and Danser 1881:735), and Salem-Bedford Stone (Caron 1895:1553).

Callahan & Son appear to have been lime dealers (Polk and Danser 1881:735). Callahan & Sons were incorporated on August 28, 1897 (Secretary of State 1897). The principle men of the company included James Callahan, James E. Callahan, and R. L. Callahan of Louisville. The Callahans appear to be merchants or brokers dealing in a number of commodities. Article three of the corporation stated that "the general nature of the business to be carried on by said corporation is to be the buying and selling of grain, hay, flour, feed and such commodities as are usually dealt with in connection therewith, and the operation of warehouses and elevators for storing and handling such commodities for account of said corporation and other dealing with it" (Secretary of State 1897).

Natural Cement Manufacturers

A number of the companies and individuals listed under lime, cement, and plaster are obviously natural cement manufacturers or distributors. J. B. Speed & Company (Caron 1874:645; Polk and Danser 1876:652; Caron 1878:714; Caron 1879:776; Caron 1880:784; Caron 1881:845; Caron 1882:869; Polk 1881:735; Caron 1895:1553) was a major natural cement manufacturer. Speed owned the Louisville Cement Company (Polk 1887:844; Siebenthal 1900:376). Rhorer & Speed (Hodgman 1870:359; Ohio Valley Publishing Company 1873:232) appears to be a natural cement partnership. The Ohio Valley Cement Company (Polk and Danser 1881:735) was a natural cement manufacturer that operated between ca. 1881 and 1898 (Siebenthal 1900:379). The Union Cement Association (Hodgman 1870:359; Ohio Valley Publishing Company 1873:232) was an organization (existing before 1873 until 1892) to control the production of natural cement (Siebenthal 1900:376). The Union Cement Association was replaced by the Western Cement Association which controlled the production and prices of natural cement between 1892 and 1898 (Committee on Industrial and Commercial Improvement 1887:95; Polk and Danser 1879:654; Siebenthal 1900:376).

KENTON COUNTY

The 1850 Manufacturing Census for Kenton County listed seven lime burners (United States Federal Census 1850b). These included John Scott, Allison Nunmcy (or Nanmcy), Benjamin Bryant, George Martin, Owen Banie, Elsey Moore, and Aron Tandy. Table 3 provides information on these lime producers. There are some similarities and differences between the lime burners. One thing they all had in common was that they paid $1 per cord of wood used to burn the lime. Their consumption of wood ranged from 60 to 100 cords annually. Surprisingly, the number of bushels of lime produced per cord of wood varied. In one case, Elsey Moore produced twice as many bushels of lime as did Allison Numncy with the same amount of wood. The lime operations were all about the same size since they employed two hands. Elsey Moore was the only producer that had three work hands. Monthly wages per person ranged between $5.50 and $9.00. In terms of annual production of lime, the range was from a low of 4,000 bushels to the high of 12,000 bushels. There was also a range in lime prices by the bushel. Four lime burners sold their lime for 8 cents per bushel with two selling lime at 6.75 and 7 cents per bushel respectively. If the figures for Allison Numncy are correct, his lime was selling for 14.5 cents per bushel. It is not known whether are the figures were recorded correctly or if Numncy was producing a better quality of lime.

Only one of the seven lime burners listed in the 1850 Manufacturing Census was listed in the 1850 Population Census as a lime burner. John Scott was listed as a 23 year old lime burner with an unknown birth place (Wieck 1987). John S. Scott who lived between 1824 and 1884 was buried in the Linden Grove Cemetery in Covington (Sexton and Meyers 1996:63). The 1850 census indicates that Benjamin Bryant was a 33 year old laborer born in Virginia (Wieck 1987). Likewise, Elsey Moore was listed as 27 year old laborer born in Virginia (Wieck 1987). George Martin was a 48 year old laborer born in Germany (Wieck 1987). Owen Banie, Allison Nunney, and Aron Tandy were not listed in the 1850 population census for Kenton County. They may have lived in an adjacent Kentucky county or in southern Ohio.

Table 3. Lime Burners Listed in the 1850 Manufacturing Census for Kenton County, Kentucky.

Name	Cords of Wood	Value of Wood	Number of Hands	Monthly Wages	Bushels of Lime	Value of Lime
John Scott	100	$100	2	$11	12,000	$810
Allison Nunmcy	80	$80	2	$17	4,000	$580
Benjamin Bryant	60	$60	2	$15	7,000	$560
George Martin	100	$100	2	$18	8,000	$640
Owen Banie	80	$80	2	$15	6,500	$520
Elsey Moore	80	$80	3	$17	8,000	$640
Aron Tandy	80	$80	2	$18	8,000	$560

The 1860, 1870, and 1880 Population Census schedules mentioned a few men that were connected to the lime industry in Kenton County. John Kearney and Clements Resenbeck were listed for the 1860 Population Census. John Kearney, a 48 year old man born in Ireland, was a lime and cement dealer (Wieck 1983). Clements Resenbeck, a 34 year old man born in Oldenburg, Germany, was a lime burner (Wieck 1983). For 1870, A. D. Easton and Eli T. Rusk were included. A. D. Easton was a 24 year old lime and sand merchant born in Ohio (Wieck 1986). Eli T. Rusk, a 57 year old man from Kentucky, was also listed as lime and sand merchant (Wieck 1986). The 1880 Population Census listed Clem Resenbeck and Frank Wolking. Clem Resenbeck, was listed as a 53 year lime burner born in Kentucky (Wieck 1996). Frank Wolking, a 26 year old man born in Ohio, was listed as working in a lime mill (Wieck 1996). Wolking who lived between 1853 and 1933 was buried in the Mother of God Cemetery in Newport (Meyer 1968:60).

The *Kentucky State Gazetteer and Business Directory for 1879-1880* mentioned Stevens & Ware of Covington under lime, plaster, and cement (Polk and Danser 1879:654). The 1880-1881 City Directory for Covington (Williams & Co. 1880:158) listed Edward Spinks (423 Greenup) and the Wolking Brothers (126 West 6th) under "lime, Cement & c."

LIVINGSTON COUNTY

The 1860 Population Census of Livingston County listed 36 year old John Richardson as a lime Merchant (Drennan 1987:92). In the 1850 Census, John Richardson was listed as a farmer (Drennan 1980:102). No other individuals associated with the lime industry were found in the 1870 or 1880 Population Census schedules (United States Federal Census 1870f, 1880i) or in any of the Manufacturing Census schedules. Consequently, the operators of the Lower Rudd Lime Kiln (15Lv226) (Hockensmith 1996) and the Upper Rudd Lime Kiln (15Lv227) (Hockensmith 1999) at Lemon Landing remain a mystery. These round kilns were discovered eroding out of the bank of the Cumberland River upstream from Smithland (Hockensmith 1996, 1999).

LOGAN COUNTY

Between 1800 and 1830, Russellville in Logan County was an important manufacturing town (Coffman 1931:25). Among the many businesses operating in Russellville were two lime kilns (Coffman 1931:25). No additional archival mention of the lime industry in Logan County has been discovered. The archaeological remains of the Shrull Lime Kiln (15Lo210) were documented by the author on April 18, 2002. This substantial rectangular kiln was constructed of quarried limestone slabs and was associated with an early quarry southwest of Russellville (Hockensmith n.d.b).

LYON COUNTY

The 1870 U. S. Population Census for Lyon County listed Lewis A. Vogle, District No. # 3 at Eddyville, as being employed in lime manufacturing (United States Federal Census 1870g). The 35 year old Vogel was born in Brussels. He had $2,000 of real estate and $2,000 of personal property. L. A. Vogle was next mentioned in connection with the Star Lime Works in the 1876 state directory (Polk and Danser 1876:652). The *Kentucky State Gazetteer and Business Directory for 1879-1880* listed L. A. Vogle (Star Lime Works) as a lime manufacturer (Polk and Danser 1879:654). Vogle also ran the general store at the Star Lime Works community (Polk and Danser 1879:482). L. A. Vogle of Star Lime Works was mentioned again in the 1881-1882 directory (Polk and Danser 1881:735). During 1883, Vogle was listed as a running a general store, a lime manufacturer, farmer, and fruit grower (Polk and Danser 1883:625).

A biographical sketch was published for Louis A. Vogle in 1885 (Battle, Perrin, and Kniffen 1885:867). Vogle was born on March 31, 1836 in Brussels, Belgium and came to America in 1852 (Battle, Perrin, and Kniffen 1885:867). After serving in the Civil War, Vogle "...went to Paducah and was there three years. Then he bought his present farm [200 acres], located on the Tennessee River, at the Star Lime Works" (Battle, Perrin, and Kniffen 1885:867). He "...has in operation extensive lime works, known as Star Lime Works and is carrying on a large country mercantile business at the same place" (Battle, Perrin, and Kniffen 1885:867).

Joseph Chaudet of Star Lime Works was also listed under lime, plaster, and cement for 1881-1882 (Polk and Danser 1881:735). During 1883, Chaudet was also listed as a lime manufacturer for 1883 and 1884 (Polk and Danser 1883:625).

The *Kentucky State Gazetteer and Business Directory, 1896* listed R. B. Collie of Star Lime Works under lime (Polk 1895:793). The Star Lime Works was described as "a landing on the Tennessee river, in Lyon County, 10 miles southwest of Eddyville, the county seat. Population, 40"

(Polk 1895:793). Walker (1994:40) in his discussion of Lyon County Post Offices stated "Star Lime Works, established April 19, 1872; closed November 15, 1943; Louis Vogle was the postmaster."

Richardson (1923:230; 1924:169) indicated that lime was produced at the H. B. Lyon Quarry in Lyon County:

> This quarry is 3 miles southeast of the courthouse. The stone was burned for lime for constructional and agricultural purposes.

The 1860 Population Census (Jones 1980) and the 1900 Population Census (Blue, Sellers, and Willis 1998) for Lyon County did not list any lime makers. The 1880 Population Census records on microfilm likewise did not contain any lime makers (United States Federal Census 1880j).

MCCRACKEN COUNTY

R. G. Terrell and L. A. Vogle of Paducah were both listed under lime, plaster, and cement for 1881-1882 (Polk and Danser 1881:735). Terrell was also listed for 1887-1888 as a lime manufacturer (Polk 1887:844). Vogle moved to Lyon County after three years in Paducah. For more information on Vogle see the discussion on the Star Lime Works in Lyon County. No lime producers were listed in the Population Census records for 1860, 1870, and 1880 (United States Federal Census 1860b, 1870h, 1880k).

MARSHALL COUNTY

The 1883-1884 *Kentucky State Gazetteer and Business Directory* listed E. J. Hobbs of Birmingham as a lime manufacturer (Polk and Danser 1883:880). The 1850, 1860, 1870, and 1880 Population Census records for Marshall County did not list any lime makers (United States Federal Census 1850f, 1860c, 1870i, 1880l).

In 1960, the Air Reduction Chemical and Carbide Company of Calvert City in Marshall County, produced captive lime for the manufacture of calcium carbide (Patterson and Schreck 1961:7). Patterson and Schreck (1961:7) provided the following information:

> Air Reduction Chemical & Carbide Co., a division of Air Reduction Co., Inc., began operating a rotary kiln at Calvert City, Ky., in 1960 to produce captive quicklime for calcium carbide manufacture. Waste sludge from former calcium carbide production was the kiln feed. Hydrated lime, a byproduct of calcium carbide operations, was offered in an exclusive spray-dried form that was economical to ship and handle. This lime hydrate was recommended as a neutralizing agent for acids and acidic waste, as a causticizing agent for aluminum and paper manufacture, as a flux in sintering iron ore, as a construction material, and for sewage treatment.

The size of this operation was reflected in the number of employees. The Kentucky Industrial Directories revealed that 381 individuals (375 men and 6 women) were employed by the company in 1969 and 93 individuals (92 men and 1 woman) in 1975 (Kentucky Department of Commerce 1969:213 and 1975:254).

MASON COUNTY

Sphar & Cooper at Chester were listed a lime manufacturers the 1887-1888 *Kentucky State Gazetteer and Business Directory* (Polk and Danser 1887:844). The earlier 1883-1884 directory mentioned that Sphar and Cooper were brick and lime manufacturers (Polk and Danser 1883:147-148). A. C. Sphar was the owner of the A. C. Sphar Brick Company and the Maysville Brick Company (Hockensmith and Stottman 1996, 1997). It appears that Sphar and Cooper formed a partnership for a few years. Chester is located on the Ohio River two miles east of Maysville (Polk and Danser 1883:147-148). Further, the 1876 atlas of Mason County did not list any lime makers (Lake, Griffing & Stevenson 1876).

During the mid-1970s, the Dravo Lime Company opened a lime plant in Mason County near Maysville on the Ohio River. About 1973, the Dravo Corporation organized the Dravo Lime Company with the plan to construct a 3,000 ton-per-day lime plant near Maysville, Kentucky (Reed 1973:1). In 1974, Dravo Lime Company began construction on a lime plant in Mason County which went into operation in late 1976 (Pressler 1976:4; Robertson 1976). .A company brochure provides the following information (Dravo Lime Company n.d. a:3):

> Maysville is a combination limestone mine and lime production facility. The mine, one of the largest in North America, supplies the plant with more than 2.7 million tons of limestone annually. When calcined, this limestone yields more than a million tons per year of Thiosorbic7 lime.
>
> The Maysville calcining plant features rotary kilns with polgon-shaped refractory preheaters, among the largest kilns in the U.S., crushers, conveyors and a barge, truck and rail loading system. A central control panel operates the conveyors, calcining systems and crushers.

Just prior to the Dravo Lime Company beginning operation, Robertson (1976) published an article about the plant which was accompanied by construction photographs. Robertson (1976) noted that:

> ...the facility is designed to produce a special lime used in scrubbing sulfur dioxide from power plant stack gases. It will produce approximately 3,000 tons of lime a day from three 1,000-tpd preheater-kiln combinations.
>
> In addition to the three 17 x 203-ft kilns, other unusual features of the Maysville facility include a limestone mine designed to produce 10,000 tpd; three lime storage silos, each with a capacity of 15,000 tons, and a 2,200 ft long dock which will handle tows of up to 15 barges. The dock facility will also handle incoming coal used to fuel the kilns, as well as the barge shipments of lime being shipped to electric generation plants in western Pennsylvania and Ohio by barges of the Union Mechling Corp., a Dravo subsidiary.

Concerning the rotary kilns, a brochure describes them as (Dravo Lime Company n.d. c:2):

> ...the plant's three KVS rotary kilns. Measuring 17 ft. X 203 ft., the 1,000-TPD kilns are coal fired and equipped with preheaters for efficient lime production.

Another company brochure noted that (Dravo Lime Company n.d. b:3):

> When it came on lime in the mid-1970s, Dravo Lime's Maysville operation was the largest and most efficient lime plant ever built as a greenfield project in the U.S. Rigorous testing ensured that Maysville shipments met the quality specifications required for successful scrubber operation at customer power plants.

Concerning the Maysville plant's products, a company brochure stated that (Dravo Lime Company n.d. c:2):

> Designed and built entirely by various Dravo Corporation units, the Maysville complex was developed specifically for the production of Thiosorbic7 Lime, a material used as a scrubbing agent in Dravo Lime's proprietary Thiosorbic7 process for removing sulfur dioxide from stack gasses at coal-fired power plants.
>
> Accounting for more than 90 percent of the lime used in the U.S. for SO_2 control applications, Dravo's Thiosorbic7 lime delivers unsurpassed levels of removal efficiency and system availability at high sulfur installations.

The Kentucky Directories of Manufacturers provide information on the number of employees working at the Dravo plant. In 1975, the Dravo lime and calcinating plant employed 250 people (Kentucky Department of Commerce 1975:254). During 1980, the work force was reported as 150 individuals consisting of 144 men and 6 women (Kentucky Department of Commerce 1980:238). By 1985, the staff of Dravo had grown to 260 persons including 246 males and 14 females (Kentucky Department of Commerce 1985:197). The 1990 figures indicate that the company's work force had dropped to 215 individuals (Kentucky Department of Commerce 1990:204). In 1996, Dravo was still employing 215 individuals (Kentucky Department of Commerce 1996:284).

The 1997 Annual Report of the Dravo Corporation provided the following information about the Maysville operation (Dravo Corporation 1997:3):

> The Maysville plant is a four kiln, 1,400,000 tons-per-year facility located along the Ohio River and produces a material marketed under the trade name Thiosorbic7 lime. Thiosorbic7 lime has a chemistry ideally suited for removing sulfur dioxide from power plant stack gases. Most of Maysville's output is committed under long-term contracts with utility companies in the Ohio Valley region. All contracts contain provisions for price escalation. Owned reserves at the Maysville site are recovered from a mine 950 feet underground and are considered adequate to sustain the four kiln operation in excess of eighty years.

The Dravo Lime Company was sold in October of 1998 to Carmeuse North America (Love 2001a). The Dravo name is still used for the Kentucky plants but they area a subsidiary of the private Belgian company Carmeuse (Love 2001b). For a detailed technical discussion of the Dravo Lime Company's limestone mine and lime plant, see Raymer and Smith (n.d.).

MEADE COUNTY

Meade County was one of the major lime producing areas of Kentucky according to archival records. The earliest record currently known is an 1826 law suit between Solomon Brandenburg and

William Stewart that mentioned a lime kiln (Meade County 1826). The 1850 Population Census of Meade County did not list any lime makers (Sims 1984). However, the *Second Report of the Geological Survey of Kentucky, Made During the Years 1856 and 1957* (Owen 1857:91) referred to a geological section that was "...two miles above North Hampton, near lime kiln". A check of available early Meade County maps did not reveal the location of North Hampton. The sequence of geological sections described by Owen (1857:89-91) suggest that North Hampton was on the Ohio River somewhere between Concordia and Brandenburg. The 1860 Population Census of Meade County listed six individuals that were involved in the lime industry (Table 4). These included Alex C. Hamilton, a 26 year old lime burner born in Kentucky (Boucher 1978:90), Calvin L. Pleasant, a 30 year old lime burner, born in North Carolina (Boucher 1978:101), Wiley M. Pleasant, a 38 year old lime burner, born in North Carolina (Boucher 1978:101), Moreman Pleasant, a 29 year old lime burner, born in Indiana (Boucher 1978:105), Alexander Bartles, a 32 year old lime burner and boater, born in East Tennessee (Boucher 1978:106), and William Humphries, a 40 year old lime burner, born in Kentucky (Boucher 1978:109). The Pleasants appear to be brothers and the sons of 63 year old Clarrisa Pleasant from North Carolina. The two older Pleasant men, Wiley and Calvin, married women from Indiana and their older children were born in Indiana. The above information combined the fact that Moreman was born in Indiana and Clarrissa's youngest son William was born in Indiana, suggest that the Pleasant family left North Carolina and settled in Indiana about 1831 and moved to Kentucky sometime before 1853.

The 1870 Population Census of Meade County indicated that the lime industry was still active in Meade County (Table 5). Wiley M. Pleasant, 47 years old, was still listed as a lime burner (Miller and Newton 1991:22). The other 1860 lime makers were no longer listed but five new men were involved in the industry. The new men included Oren Betrick, a 36 year old lime burner, born in Pennsylvania (Miller and Newton 1991:22), Henry Johnson, a 39 year old lime burner, born in Kentucky (Miller and Newton 1991:22), Henry Owens, a 24 year old lime burner, born in Kentucky (Miller and Newton 1991:22), Harrison Cowley, a 30 year old lime burner, born in Kentucky (Miller and Newton 1991:22), and John Thompson, a 38 year old lime burner, born in Kentucky (Miller and Newton 1991:22). In terms of race, Betrick, Pleasant, and Thompson were White while Cowley was Black and Owens was a Mulatto. During 1876 and 1877, J. B. Curry (superintendent) was listed under lime, plaster, and cement at Rock Haven (Polk and Danser 1876:652). The *Kentucky State Gazetteer and Business Directory for 1879-1880* listed Hayden Thompson of Richardson's Landing as a lime manufacturer (Polk and Danser 1879:654). In addition to Hayden Thompson (lime burner) other men associated with the lime industry in Richardson's Landing included Johnson Bennett (lime, etc.), Peter Bennett (justice of peace and lime dealer), T. T. Daily (justice of peace and lime dealer), and J. W. Thompson (lime, etc.) (Polk and Danser 1879:448-449). Richardson's Landing (also known as King's Landing) was described as a settlement of 300 people on the Ohio River, 48 miles from Louisville (Polk and Danser 1879:448). Brown and Coleman (1992:176) noted that "Richardson Landing was a Post Office in Meade County, Kentucky and was located on Richardson Landing Road, where the mail was delivered daily by boat. The location was just above the old upper quarry which is up the river toward Brandenberg from Oolite." They further noted that "the Post Office was still called Richardson Landing until May 31, 1932" (Brown and Coleman 1992:176).

The 1880 Population Census of Meade County did not list any lime burners (Newton and Miller 1995). In 1881 and 1882, Johnson Bennett, Hayden Thompson, and J. W. Thompson of Richardson's Landing were listed under lime, plaster, and cement (Polk and Danser 1881:735). The *Kentucky State Gazetteer and Business Directory for 1883 and 1884* listed Johnson Bennett, Peter Bennett, Hayden Thompson, and J. W. Thompson (all from Richardson's Landing) (Polk and Danser 1883:880) as lime makers. Lime manufacturers for Richardson's Landing for 1887 and 1888 included

Table 4. Lime Burners Listed in Meade County During 1860. From the Population Schedules from the Eighth Census of the United States.

Name	Age	Place of Birth
Hamilton, Alex C.	26	Kentucky
Pleasant, Wiley M.	38	North Carolina
Pleasant, Calvin L.	30	North Carolina
Pleasant, Moreman	29	Indiana
Bartles, Alexander	32	East Tennessee
Humphries, William	40	Kentucky

Table 5. Lime Burners Listed in Meade County During 1870. From the Population Schedules from the Ninth Census of the United States.

Name	Age	Place of Birth
Betrick, Oren	36	Pennsylvania
Johnson, Henry	39	Kentucky
Owens, Henry	24	Kentucky
Pleasant, Wiley M.	47	North Carolina
Cowley, Harrison	30	Kentucky
Thompson, John	38	Kentucky

John Belkemper, Johnson Bennett, Peter Bennett, J. B. Lain, Hayden Thompson, and J. W. Thompson (Polk 1887:844). The *Kentucky State Gazetteer and Business Directory* for 1896 (Polk 1895:1128) listed J. Bennett at Battletown while the entry under Richardson's Landing listed John H. Bennett (lime), J. E. Brown (lime), G. W. Daily (lime), L. T. Daily (General Store and lime), J. W. Thompson (lime) (Polk 1895:737). At least three of these men were buried in Meade County: Peter Bennett, born May 6, 1816 and died March 7, 1896 (Thompson 1973:78), L. T. Daily, born 1863 and died 1947

(Thompson 1973:14), and J. W. Thompson, born October 12, 1851 and died March 19, 1938 (Thompson 1973:19). The other lime makers may have moved further west for new opportunities.

The next available information on lime was in 1906. Young & Company (1906:801) listed M. J. Bennett of Battletown under Lime and Cement. The 1911 "Mineral Resources of the United States" mentioned that lime was produced in Meade County (Miller 2001c). In the 1913 edition of the "Mineral Resources of the United States," Burchard (1914:1153) reported that both high-calcium lime and magnesian lime were produced in Meade County. No additional information was encountered for 20th century lime making in Meade County, Kentucky.

It is not surprising that Meade County played an important role in Kentucky's lime production. This area has high quality limestones that are conductive to lime making. Also, lime was produced across the Ohio River in southern Indiana. Ault, Rooney and Palmer (1974:24) provided the following information on the area across from Meade County, Kentucky:

> The first lime was produced in commercial amounts, however, was probably from small kilns near Mauckport along the Ohio River. Collett (1879, p. 402) wrote that lime was burned near Mauckport in the Stockslager quarry about 1840 to about 1878. Prior to the Civil War, lime was produced from many hillside kilns along the banks of the Blue River and on the Ohio River where "oolitic" stone outcrops could be found (Collett, 1879, p. 414). Much of the "Blue River Lime" from the small kilns was shipped on flat boats to southern planters and merchants, but part of the output was used locally for mortar, plaster, and whitewash. The Civil War stopped trade to the South and most of the kilns were abandoned. After the war the kilns were never used again.

It is assumed that the Kentucky kilns operating during the same period shipped their lime to the same southern markets. Undoubtedly, the Civil War had some effect on the Kentucky lime industry but the industry revived and continued in Meade County until at least the mid-1890s.

A brief newspaper clipping from the February 2, 1939 issue of the *Meade County Messenger* provided the following news item:

> Lime Kiln Found Under Public Road
>
> Luther Allen, Wolf Creek, recently found a lime kiln under the public road at a knob near Wolf creek in which four hundred barrels of lime had been burned. It was thought that the kiln had been burned more than a hundred years ago, because the road has been in its present location beyond the memory of all persons living in that vicinity.
>
> Mr. Allen is removing the lime and will rebuild the road. Wolf Creek was named Limeopolis until about 80 years ago, and each year, many flatboat loads of lime were shipped to New Orleans and other points in the South.

In his discussion on economic geology for the "Geologic Map of the New Amsterdam and Mauckport Quadrangles," Amos (1972) stated that:

> During the later half of the 1800's, beds of oolitic limestone between about 20 and 60 feet below the top of the Ste. Genevieve Limestone were mined at several locations in

the northwest quarter of the mapped area and the limestone was burned to produce lime.

During March of 2003, the author and Richard Brown of Louisville began a research project focusing on the lime industry in Meade County, Kentucky. To date, this research has documented a rectangular kiln adjacent to the Ohio River just west of Brandenburg (Hockensmith and Brown 2004) and 13 lime kilns in the Cedar Branch Hollow drainage. Seven additional kilns have been observed in the Cedar Branch Hollow drainage and will be documented in the future. Also, three other kilns are now known to the author in northern Meade County. Most of the new kilns are pit kilns of varying degrees of complexity. The goal of the project is to document the archaeological remains and archival history of the lime industry in Meade County, Kentucky.

At least one company was exploiting limestone in Meade County to produce natural cement. The Rock Haven Cement Company (Polk and Danser 1876:652) was producing natural cement. Rock Haven was a small community near the Ohio River in northeastern Meade County, Kentucky. During an archaeological survey of Otter Creek Park, Otto and Gilbert (1981:80) provided the following information on the company:

> The ruins of the Rockhaven Cement Mill — built in 1875—are located on privately owned land near the present-day L. H. and St. Louis railroad line. The Rockhaven Mill once shipped thousands of barrels of cement throughout the Ohio River valley. Limestone for cement making was quarried from the cliff face behind the mill, while extensive hardwood forests provided an abundance of firewood. A competing cement mill — located further down river — caused the Rockhaven mill to shut down sometime before 1890, when railway construction destroyed much of the site.

MENIFEE COUNTY

Limited information is available about the lime industry in Menifee County. The March 4, 1885 issue of the *Hazel Green Herald* contained the following news item:

> Correspondence-Menifee County-Cornwell
>
> The lime kiln at this place will resume operations again in a few days, and times have already begun to brighten, and we predict a livelier and more prosperous spring and summer than has been witnessed for several years.
>
> SHORT FELLOW

The *Kentucky State Gazetteer and Business Directory for 1887-1888* listed Chiles, Thompson & Co. of Cornwell as lime manufacturers (Polk 1887:844). The community of Cornwell was located 6 miles north of Frenchburg on the L. C. & L Railroad and had a population of 150 (Polk and Danser 1879:112). It is likely that this operation was connected with that Bean Chiles and Company in adjacent Montgomery County. The 1880 Population Census schedules for Menifee County did not list any lime makers (United States Federal Census 1880m).

MONTGOMERY COUNTY

One individual and two companies were mentioned in association with lime between 1876 and 1884. W. B. Smallwood of Levee was listed under lime, plaster, and cement during 1876 and 1877 (Polk 1876:652). Beers and Lanagan's (1879b) "Map of Montgomery County, Kentucky" shows a lime kiln north of the Levee Post Office which may be Smallwood's kiln. Robert Peter (1876:141; 1884:141) discussed a sample of quick lime from the Star Lime Company at or near Mt. Sterling. The Bean Chiles and Company of Mt. Sterling was listed in the *Kentucky State Gazetteer and Business Directory* for 1881-1882 and 1883-1884 (Polk and Danser 1881:735; Polk and Danser 1883:880). Finally, Linney (1884:57) noted that "lime has been burned from rocks of this series [Upper Hudson River Beds] at Mt. Sterling and on the pike near Levee. They make a good article of quicklime, but are not the whitest." The 1850 (Lawson 1986b), 1870, and 1880 Population Census schedules for Montgomery county did not contain any lime manufacturers (United States Federal Census 1870j, 1880n).

MUHLENBERG COUNTY

Lime was produced at the Mack Ferguson Quarry in Muhlenberg County. Richardson (1923:252; 1924:183-184) stated that:

> This quarry is situated 2 mile west of South Carrollton. The quarry is in limestone. The stone was quarried for road construction and burned into lime for both building and agricultural purposes.

Inspection of the 1850 (Hammers 1969) and 1860 (Hammers 1978b) Population Census schedules for Muhlenberg County did not reveal any lime makers. Apparently, the lime industry developed in Muhlenberg County sometime after 1860.

NELSON COUNTY

J. E. Evan of Samuels' Depot was listed as a lime manufacturer for 1887-1888 (Polk 1887:844). The 1850 (Keeling and Smith 2000), 1860 (Nelson County Genealogical Society 1992), 1870 (McManaway 1985), 1880 (Clements et al. 1999), and 1900 (Nelson County Genealogical Society 2000) Population Census schedules for Nelson County did not list any lime makers. Further, no lime makers were listed in the atlas for Nelson and Spencer Counties (Lake & Co.1882b).

PENDLETON COUNTY

The Black River Mining Company near Butler, Kentucky was established sometime in the 1960s by a Mr. Coffman (George Love, personal communication 2001a). Located adjacent to the Ohio River, the plant was a pebble lime calcinating facility. Allsman (1968:1) stated that "Black River Mining Co., owned by Armco Steel Corp., Southwestern Portland Cement Co., and Marble Cliff Quarries, began construction of burnt lime producing facilities at Carntown, Ky., to serve BOF steelmaking plants at Ashland and Middletown, Ky." Reed (1971:4) indicated that Black River Mining Company had started a new quicklime plant at Carntown, Kentucky. Two years later, Reed (1973:1) stated that "Black River Mining Co. was doubling its plant at Carntown, Ky. to a total capacity of 700,000 tons per year by late 1975." During 1976, "...Black River which is now listed as a joint venture of Armco Steel Corp. and Jones & Laughlin Steel Corp., placed its third kiln in operation thus completing the capacity expansion begun in 1973." Further, in 1979, Black River Mining began construction of a 30-ton-per-hour hydrated lime adjunct to its quicklime plant and a pulverized quicklime facility in Butler, Kentucky (Pressler 1979:4). In the available directories, 1980 was the first listing under lime encountered (Kentucky Department of Commerce 1980). The 1985 directory showed that the named had been changed to the Black River Lime Company which was producing quicklime products (Kentucky Department of Commerce 1985). The company was purchased by the Dravo Lime Company in 1986 (George Love, personal communication 2001a; Miller 2001c). Dravo Lime Company sold the Black River operation along with the Mason County operation to Carmeuse North America in October of 1998 (Love 2001b). The directories between 1990 and 2000 indicate that this plant produced chemical and metallurgical quicklime products (Kentucky Department of Commerce 1990, 1992, 1996; Harris InfoSource 1998, 2000).

A Dravo Lime Company brochure provides the following information about the Black River plant (Dravo Lime Company n.d. c:2-3):

> DLC/BLACK RIVER operates a 660,000-TPY facility near Butler, Kentucky, a location approximately 25 miles southeast of Cincinnati.
>
> Mining a high-calcium formation 630 feet beneath the plant site, Black River provides limestone to three coal-fired rotary kilns with a total production capacity of 2,000 TPD.
>
> Pebble quicklime from Black River is used for a variety of industrial applications, including steel, pulp and paper, and chemical plants, as well as wastewater treatment and combustion gas desulfurization. Pulverized limestone is available for molten metal desulfurization and related applications. The plant's 30-TPH hydrator produces bagged and bulk material suitable for soil stabilization, water and sewage treatment, acid neutralization, and a variety of other industrial applications.
>
> Capable of shipping by barge, rail, and truck, Black River supplies much of the material distributed through Dravo Lime's terminal facility near Baton Rouge, Louisiana.

The Kentucky Directories of Manufacturers provide information on the number of employees working at the Black River plant. In 1980, the Black River Mining Company's work force was reported as 180 individuals consisting of 172 men and 8 women (Kentucky Department of Commerce 1980:238). By 1985, the staff of Black River Lime Company was listed as 169 persons including 160 males and 9 females (Kentucky Department of Commerce 1985:197). The 1990 figures indicate that the company's work force had increased to 190 persons (Kentucky Department of Commerce 1990:204). The 1992 work force decreased to 160 individuals (Kentucky Department of Commerce 1992:212). In 1996 the employees had increased to 250 individuals (Kentucky Department of Commerce 1996:284).

The 1997 Annual Report of the Dravo Corporation provided the following information about the Black River operation (Dravo Corporation 1997:3):

> Dravo Lime's Black River facility produces Thiosorbic7 quicklime, high calcium pebble and pulverized quicklime, and bulk and bagged hydrated lime. Located along the Ohio River at Butler, Kentucky, Black River has an annual quicklime capacity of 1,400,000 tons-per-year. Of that total, forty percent is committed to utility companies and steel and paper customers under long-term contracts with price escalation provisions. Limestone reserves at Black River are recovered from a 600-feet-deep

underground mine. At Black River's current capacity, reserves are considered adequate to sustain production levels for more than seventy years.

POWELL COUNTY

A lime kiln was operated briefly by Richard Noel in the vicinity of Clay City. In the April 21, 1904 edition of *The Clay City Times*, the following news item appeared: "Richard Noel has started a new industry for Powell county that of burning lime. He has burned several kilns of first-class lime, and markets his product in Clay City." The November 23, 1905 issue of *The Clay City Times* contained an ad for R. S. Noel's Black Creek Lime Works near Clay City in Powell County, Kentucky. This ad offered unslakened lime for sale at the kilns for 65 cents per barrel or delivered at Clay City at 75 cents per barrel. Noel is not listed in the 1900 Population Census for Powell County (Morton n.d.). Apparently, Noel lived in Powell County only briefly or lived in an adjacent county.

Another mention of lime was reported in the March 8, 1934 edition of *The Clay City Times*. This news item states that:

> Hardin Kennon has hauled several loads of burnt lime from his kiln on Upper Hardwick's Creek. This lime which will sweeten up soured land is available by some labor to all farmers in Powell county.

The 1860 and 1880 Population Census schedules for Powell County listed no lime makers (United States Federal Census 1860d, 1880o).

PULASKI COUNTY

George Webb of Somerset was listed under lime, plaster, and cement for 1879 and 1880 (Polk and Danser 1879:654). Richardson (1923:93, 1924:78) provided the following information on lime produced at the Beecher Smith Quarry in Pulaski County:

> This quarry is located some 2 miles due east of Somerset. The stone is white or grayish white in color and has been used in building purposes, and also burned into white lime for both constructional and agricultural use.

The 1850, 1860, 1870, and 1900 (Pulaski County Historical Society 1987) Population Census schedules did not mention lime makers (United States Federal Census 1850g, 1860e, 1870k).

ROCKCASTLE COUNTY

Lime making had a long history in Rockcastle County. Our earliest reference appeared in a geological report for surveys conducted between 1854 and 1859 (Owen 1861). According to Owen (1861:482):

> The cavernous member of this limestone occurs about 100 feet below the top of the formation...There is a higher level, 50 or 60 feet above this, where springs are common, issuing from a fine grained, white lime rock, much esteemed in this and the adjoining counties for burning. The Main street of Mount Vernon, (1,156 feet above

tide, opposite the courthouse,) is upon this stratum, locally known as the Marble limestone.

At least five lime manufacturers operated in Rockcastle County between the late 19th century and early part of the 20th century. The *Kentucky State Gazetteer and Business Directory for 1896* (Polk 1895:1128) listed White & Krenger of Mt. Vernon as a lime manufacturer. The 1900 Rockcastle County Population Census did not list any lime makers (Bonham and Heylmann 1993). The 1911 "Mineral Resources of the United States" mentioned that lime was produced in Rockcastle County (Miller 2001c). The 1912 geological report on Rockcastle County listed three quarries that produced lime: the Kruger quarry owned by the Mt. Vernon Lime Company at Mt. Vernon; the Dudley quarry owned by the Winchester Granite Brick Company at Dudley; and the Sparks quarry owned by the W. J. Sparks Company at Burr (Fohs 1912:81). The account written by Fohs (1912) is the most detailed and comprehensive published on any Kentucky lime kiln. Fohs (1912:81-83) provided the following detailed description of lime kilns in Rockcastle County:

LIME-KILNS

There were three kilns, the Dudley, Kruger, and Sparks which produced about 5000 tons of lime in 1910 in the county.

The abundance of good limestones for lime burning especially for high-calcium, makes it desirable that this industry shall be extended as far as possible. Heretofore there has been little magnesian lime produced but there are several beds which are suitable for this purpose (see table of uses under Limes.) A hydrating plant is also very desirable.

The rock for lime burning is usually hand-sorted and broken, nothing being put in the kiln larger than 10 inches or smaller than 3 inches, 6-inch cubes being the best size to use. After breaking to this size it is loaded into cars or wheel-barrows and loaded into the top of the kiln.

The Dudley and Kruger kilns are of sheet-iron, lined with fire-brick, and the Sparks kiln of limestone lined with firebrick. The first two kilns have a capacity of 75 bbls. and the Sparks kiln, 100 bbls. per 24 hours. Aside from the man employed to load the lime into the kiln, two men are required to fire the kiln, and one to draw lime and load barrels.

A description of the Dudley kiln and its practice is given which gives a good idea of the others:

The kiln shaft is 18 feet high and 6 feet in diameter inside of the brick. It is a steel shell lined with a single course each of sand-lime and firebrick. The pedestal is 6 feet high and built of sand lime brick which stand the heat splendidly, the firebox only being firebrick lined. The pedestal contains the fire chamber with the two doors on the two opposite sides of the kiln, while lower on a third side are the two doors for drawing the lime. There is a drawing room built of sand lime brick attached, 30 feet long, 18 feet wide and 8 feet high and 10 feet to apex of the roof.

The limestone is charged at 6:30 A.M. and 5 P.M. The day man draws 4 ½ feet of lime at 3:30 P. M. and the night man draws about 6 feet at the same time in the morning. The kiln with natural draft is fired continuously on both sides; Straight Creek nut coal costing $2.30 per ton being used. The average draw per 24 hours is 75 bbls or 7 ½ tons.

The lime usually sells at $3.00, rarely as low as $2.80 per ton in bulk at the kiln; the freight rate to Paris Ky., being $1.20; to Lexington, $1.30; to Cincinnati, $1.40. Barrelling cost extra $2.75 to $3.00 per ton (the barrel stock cost 17 to 20 cents, making 5 cents, loading 2 cents per barrel).

> The cost of production is given at from \$2.00 to \$2.50 per ton. The cost for fuel seem to be the chief item and judging from statements given by the operators this varies widely according to the fuel used, the cost per ton of lime produced being as follows: Cord-wood, \$1.07, charcoal, 97c, straight Creek coal 47c. Wood and charcoal produce the best quality of lime but with a properly built kiln with artificial draft, the coal will produce a good and economical lime. The wood cost \$2.00 per cord, charcoal \$1.75 per cord, and coal \$2.35 per ton. The remainder of the cost of lime per ton includes quarrying and stone about 60c, labor for loading, burning, and drawing, and the usual fixed charges such as superintendence, repairs, and interest on investment.

In the 1913 edition of the *Mineral Resources of the United States*, Burchard (1914:1153) reported that high-calcium lime was produced in Rockcastle and other Kentucky counties. The Rockcastle Lime and Cement Plant at Pine Hill was briefly described by Richardson (1923:96):

> This quarry and \$200,000 plant is situated at Pine Hill, 5 2 miles southwest of Mt. Vernon. The limestones are gray in color, fine grained, some of them crystalline, and could be used for building purposes. The bottom portion of the limestone carries 94.28 per cent calcium carbonate and 2.00 per cent silica. The central portion carries 93.21 per cent calcium carbonate and 2.85 per cent silica. The upper portion carries 93.48 per cent calcium carbonate and 2.40 per cent silica. The rock is therefore a siliceous limestone.

Richardson (1923:95-96) also mentioned the Fred Kreuger Quarry as a lime producer:

> This quarry is within the city limits. It is in the white, oolitic, crystalline limestone which at this quarry runs about 99 per cent calcium carbonate. While the white blocks would make an excellent building stone, yet the entire product is put into lime for agricultural purposes.

In the 1924 edition of the *Mineral Resources of the United States*, two lime companies were listed as operating in Kentucky, both in Rockcastle County (Miller 2001c). These include the Mount Vernon Lime Company at Mount Vernon and the Rockcastle Cement and Lime Company at Pine Hill (Miller 2001c).

Two years later, the Rockcastle Lime and Cement Plant at Pine Hill, was the only lime producer listed for Rockcastle County in the "Directory of Kentucky Mineral Operators" for 1926 (Burroughs 1930:91, 165). Seiller (1929:350) noted that "hydrated and other grades of lime was manufactured in a plant at Pine Hill." Miller (2001c) noted that in 1929 that only the Rockcastle Cement and Lime Company was still in business. Also, Seiller (1929:351) stated that the Rockcastle Cement and Lime Company at Pine Hill had 25 White male employees. McFarlan (1943:415) stated that the lime plant at Pine Hill was the only such operation reported in Kentucky during 1937. In a discussion concerning Kentucky, Bowles (1939:412) noted that "the largest, most continuously operated lime plant in Kentucky is at Pine Hill, Rockcastle county. Its products are used in the chemical, metallurgical, and building industries, and for agriculture."

On March 18, 1999, the author and John T. Carter visited the ruins of the Rockcastle Lime and Cement Plant at near Pine Hill. The ruins are situated in Lime Plant Hollow at Pine Hill which is ca. 3.5 to 4 miles east-southeast of Mount Vernon off State Highway U.S. 25. Mr. Lambert (personal communication 1999) said that the plant must have been established in the 1890s based on his review of the deeds for the property. He said that between 28 and 30 tracts made up the company's holdings at Pine Hill. Hilton's (1992:18) research confirmed that a large rock quarry was opened in Pine Hill during the mid 1890s and he noted that:

> The quarry furnished ballast rock for railroad grade stabilization and crushed stone used in highway and street surfacing. Lime kilns were soon added to the quarry facilities to provide agricultural lime for use by farmers throughout Kentucky and other states. A railroad spur line was constructed from near the site of the abandoned Pine Hill School for a distance of about 1 mile to serve the rock quarry.

Lambert (1992:19) stated that the last owners of the lime plant was the Pine Hill Lime and Stone Company. The last officers or supervisors of the lime plant were brothers B. H. Egan and Howard Egan (Hilton 1992:18; Lambert 1992:19). Sometime between 1939 and 1940 labor disputes arose at the plant which result in its closure shortly afterwards (Hilton 1992:18; Lambert 1992:19). Mr. Lambert shared that he toured the lime plant one afternoon during World War II when it was still operating (personal communication 1999).

Attorney James W. Lambert of Mount Vernon and his brother-in-law Earl Turner purchased 2,000 acres of the former Rockcastle Cement and Lime Company's property in May of 1942 (Lambert 1992:19). Initially, the lime company retained 10 acres containing the company buildings so that they could salvage the metal (James W. Lambert, personal communication 1999). He was able to later acquired the 10 acres with the buildings. Mr. Lambert said that there were five lime kilns operating at the plant (personal communication 1999). The kilns were round structures about 20 to 25 feet (6 to 7.5 m) in diameter and 35 to 40 feet (10.5 to 12 m) tall. They were located in the flat area adjacent to the northern side of the foundations. The kilns were placed next to the base of the hill so that they could be charged from the top. Coal was used as the fuel. The kilns were lined with fire bricks and had a metal portion made of 2 inch (1.3 cm) thick iron. Mr. Hilton (personal communication 1999) also stated that there were five brick lined lime kilns about 15 to 18 feet (4.5 to 5.4 m) in diameter. Before Mr. Lambert got the tract with the buildings, the lime kilns were blown up with dynamite (personal communication 1999). The metal was recycled as part of the World War II scrap iron effort. Many of the fire bricks were broken when the kilns were blown up. Mr. Lambert sold the fire bricks from the kilns.

The surviving concrete foundations are the location of a large (two to three stories high) structure that housed the equipment. These remains are still in a good state of preservation. Large iron bolts are embedded in the top of the foundations where equipment was secured. The company produced lime, cement, crushed stone, fertilizer, and other products. After abandonment, Mr. Lambert (personal communication 1999) said that people stripped the wiring from the building and started vandalizing the property. Most of the metal was removed for the war effort. An visual inspection of the ruins by the author revealed the presence of some sheet metal fragments, fire bricks, and fire brick fragments. None of the fire bricks examined contained brand names. These brick fragments were identified as modern wire-cut stiff-mud specimens.

Mr. Evans Hilton (personal communication 1999) had a number of memories about the lime plant when he lived in Pine Hill as a 15-16 year old boy. Mr. Hilton (personal communication 1999) stated that the main building at the plant was 50 to 75 feet (15 to 22.5 m) tall. The building had a post framework and covered with sheet metal. The main plant building rotted down over a lengthy period of time and was still standing during the 1950s and 1960s (Hilton, personal communication 1999). The company office, which burned 15 to 20 years ago, was a very nice frame structure with five or six rooms (Hilton, personal communication 1999). The approximately 40 people worked at the lime company including a foreman, superintendent, time keeper, powder man (for blasting), crusher man, and laborers for loading rock (Hilton, personal communication 1999). During the Great depression, supervisors were paid $2-3 per day while other workers were paid $1 per day (Hilton, personal communication 1999). The coal used to fire the lime kilns was furnished by Charles McHargue from mines located about 1 mile (1.6 km) to the north of the lime plant (Hilton, personal communication 1999). Eight to ten men were involved in mining the coal and transporting it in wagons (1 ton per load) to the kilns.

The limestone quarry is a large pit with a large horizontal shaft extending into the north wall. Mr. Lambert (personal communication 1999) said that the hill was hollowed out from the removal of limestone. He went into the quarry about 40 years ago but would not go again because of the potential of roof collapse. He said that trucks approached the quarry from the top of the hill and drove into the horizontal shaft. The quarry appears very different today than it did when the cement and lime company was in operation. Mr. Lambert (personal communication 1999) said that about 1950 the quarry was deepened by modern quarrying for local road improvement projects and for stone to be used a the London-Corbin Airport. Portable stone crushers were set up across the road from the quarry. Hilton (1992:18) has also commented on this period of the quarry's history:

> The closing of the lime plant in 1940 marked the end of the industrial era for Pine Hill as the coal and lumber industry had terminated its operation about 40 years earlier. There was, however, one more brief period of activity for the stone quarry. In 1948, highway U.S. 25 was relocated and re-constructed from just south of Pine Hill to London. Turner and Lambert leased the rock quarry to Lambert Brothers Construction Company of Tennessee, where stone was obtained for paving the new road. The Lambert Construction Company installed a modern, up-to-date rock plant and produced some 300,000 tons of stone for paving the new road which was completed by about 1953. The quarry has been closed since then.

Across the road (to the south) from the company's processing buildings, the company office was located. A mobile home is currently sitting at the location of the former office. In the bottom land area east of the office, Mr. Lambert (personal communication 1999) said that stone was stock piled in large piles. A rail road spur extended into this area where the stone was loaded onto cars. A large stone abutment is located near the current county road that was connected with the railroad. The railroad bed is still clearly visible as an elevated bench on the north side of the county road. This spur line extended out to U.S. 25 where it merged with the L & N Railroad just beyond U.S. 25.

SCOTT COUNTY

The 1870 and 1880 Population Census schedules were consulted for Scott County but no lime makers were listed (United States Federal Census 1870l, 1880p). The 1911 "Mineral Resources of the United States" mentioned that lime was produced in Scott County (Miller 2001c). In the 1913 edition of the *Mineral Resources of the United States*, Burchard (1914:1153) reported that high-calcium lime was produced in Scott, and several other counties in Kentucky. Ten years later, Richardson (1923:191, 1924:136) noted that lime was produced at the Albert Vaughn Quarry in Scott County [following quote in both publications]:

> This quarry is situated about 50 rods south of the Slaughter House quarry [one mile southeast of Georgetown] and is about equal to it in size [200 by 50 feet]. An

analysis of this stone was reported to give 99.5 per cent carbonate of lime. If the report is correct, this is one of the purest limestones known. An old lime kiln was found here, and the stone formerly was burned for lime for both building and agricultural purposes.

SHELBY COUNTY

Two men were listed under lime, plaster, and cement in the *Kentucky State Gazetteer and Business Directory for 1876-1877* (Polk and Danser 1876). These include J. K. Schooler of Shelbyville and W. A. Tate of Christiansburg (Polk and Danser 1876:652). J. P. Allen, Jr. of Shelbyville was listed as a lime manufacturer for 1883 and 1884 (Polk and Danser 1883:880). John P. Allen was born in Shelby County in 1850 and "for many years he has been engaged in the selling of lime, salt, coal and other products, in which he has been very successful" (Perrin, Battle, and Kniffin 1887b:753). No lime makers were found in the 1850, 1860, 1870, and 1880 Population Census schedules for Shelby County (United States Federal Census 1850h, 1860f, 1870m, 1880q).

TRIGG COUNTY

The 1850 Manufacturing Census for Trigg County listed William Clemmets as a producer of lime (United States Federal Census 1850c). This operation employed three work hands which were paid a total of $30 per month. His expenses included the purchased 650 barrels at a cost of $95. Clemmets sold 650 barrels of lime for a total of $650. He had $300 of capital invested in the lime business. The 1860 Population Census list W. C. Clemments as a 53 year old farmer born in Virginia (Simmons 1983:10). The 1850, 1860 (Simmons 1983), 1870, and 1880 Population Census schedules did not mention any lime makers (United States Federal Census 1850i, 1870n, 1880r).

UNION COUNTY

Logan Cameron of Uniontown was listed under lime, plaster, and cement for 1876 and 1877 (Polk and Danser 1876:652). No lime makers were listed in U. S. Population Census schedules for 1870 and 1880 (United States Federal Census 1870o, 1880s). Further, the 1880 atlas for Henderson and Union counties did not list any lime makers (Lake & Co. 1880).

WARREN COUNTY

The 1870 Black Population Census of Warren County listed African America Frank Erwin (born in 1842) as a lime burner (Gorin 1997:41; United States Federal Census 1870p). The 28 year old Erwin was born in Kentucky. George Lehman of Bowling Green was listed as a lime manufacturer during 1879-1880 and 1887-1888 (Polk and Danser 1879:654; Polk 1887:844). No other lime makers were observed in the 1880 Population Census schedules (United States Federal Census 1880t). A biographical sketch for a George Lehmann noted that he was born in the city of Selce in the province of Alsace (now Germany) on August 1, 1812 (Perrin, Battle, and Kniffin 1887a:905-906). Lehmann came to America when he was 16 years old and engaged in the confectionary business in New York, New Orleans, Cincinnati, Louisville, and eventually to Bowling Green where he stayed 44 years (Perrin, Battle, and Kniffin 1887a:906). His biographical sketch did not mention his lime making but that he was a wealthy man who no doubt had many business ventures.

The 1911 "Mineral Resources of the United States" mentioned that lime was produced in Warren County (Miller 2001c). The last mention of the lime industry in Warren County was in the 1913 edition of the "Mineral Resources of the United States," Burchard (1914:1153) reported that high-calcium lime and magnesian lime were both produced in Warren County, Kentucky.

Burgher (1916) described a lime burning experiment conducted on the farm of Ben Cherry of Bowling Green. Christ Hofecker, a Pennsylvania German, with lime burning experience was secured to oversee the work. The kiln was 30 feet long by 16 feet wide. Layers of wood poles, corn stalks, and coal were used as fuel with alternating layers of limestone. Two weeks were required to burn the kiln. The estimated yield was 2,400 bushels or nearly 87 tons of lime. The total cost of $57.10 included 452 bushels of coal ($36.24), four loads of wood ($2.50), and labor ($18.10).

WOODFORD COUNTY

E. N. Berryman & Son and P. A. Hill of Cicero were listed as lime manufacturers for 1883-1884 and 1887-1888 (Polk and Danser 1883:880; Polk 1887:844). The section in the directory on Cicero mentioned that P. A. Hill and W. A. Redman were manufacturers of Utica lime while E. N. Berryman & Son dealt in coal, lime, and salt (Polk and Danser 1883:149). W. A. Redman of Cicero was mentioned as a lime manufacturer for 1887-1888 (Polk 1887:844). Davis (1989:19) noted that Cicero is the name of a village six miles from Versailles on the Kentucky River. The village has also been named Woodford City and Clifton (its current name) (Davis 1989:19). In addition to other businesses, two lime kilns were located at Cicero (Davis 1989:20).

No lime makers were listed in the 1850, 1860 (Wilson 2001), 1870, and 1880 Population Census schedules (United States Federal Census 1850j, 1870q, 1880u).

LIME INDUSTRY DISCUSSION

The lime industry in Kentucky has a long but poorly known history. It is assumed that lime was made soon after Euro-Americans first settled in Kentucky. Very limited information is available on the Kentucky lime industry for the late 18th century and early 19th century. The earliest document discovered during this research indicates that lime was made in Lexington during the late 1790s. It is probable that lime was produced in other locations in the Commonwealth during the late 18th century. By 1838, lime was being produced in unspecified areas of Kentucky for mortar and for improving the soil (Mather 1988:282). Limestone suitable for making hydraulic lime was discovered in 1837 and was being used in the construction of locks on the Kentucky and Licking rivers during the 1840s. Additional archival research will be required to gain a better understanding of this period.

Our knowledge of the lime industry in the Commonwealth begins to increase in 1850 when more information becomes available. This is the point in time when the Manufacturing Census records are more complete and the Population Census schedules first record occupations. The 1850 Manufacturing Census for Kentucky listed nine lime burners residing in Fayette, Kenton, and Trigg counties. These records reveal both similarities and differences between these lime burners. The Kenton County manufacturers all paid $1 per cord of wood used to burn the lime while no information was given for Fayette or Trigg counties. Consumption of wood ranged from 60 to 100 cords annually. Surprisingly, the number of bushels of lime produced per cord of wood varied. The lime operations were all small with most lime makers employing two men and a couple lime makers employed three hands. Monthly wages per person ranged between $5.50 and $10.00. In terms of annual production of lime, the range was from a low of 4,000 bushels to the high of 12,000 bushels. There was also a range in lime prices by the bushel. Four lime burners sold their lime for 8 cents per bushel while two men sold lime at 6.75 and 7 cents per bushel respectively. In Trigg County lime was sold at $1 per barrel. Lazell (1915:81) noted that "a bushel of lime is from 75 to 80 pounds, depending upon the law in the state in which the lime is purchased. A bushel contains from 1 to 1.3 cubic feet. Concerning barrels, Lazell (1915:81) indicated that "a 200 pound barrel of lime contains 185 pounds net of lump lime, or 3.1 cubic feet. A 300 pound barrel of lime contains 280 pounds of lime or 4.7 cubic feet."

During the 1860s, the Population Census indicates that lime was made in Christian, Greenup, Kenton, Livingston, and Meade counties. Since the 1860 Manufacturing Census does not include lime makers, no details about the industry are available for this period. We just know who was making lime and the counties where lime was being made.

The Kentucky Manufacturing Census for 1870 listed only three lime burners who resided in Greenup and Hardin counties. These businesses varied from a low of $300 of capital invested to $12,000 capital invested. The larger manufacturer had seven employees while the other two had four employees each. Yearly wages varied from $300 to $2,240 during the eight month work season. From $30 to $3,600 was spent on limestone by the lime makers. The two largest lime manufacturers burned coal at a cost of $675 to $1,080 while the smaller operation spent $40 on unspecified fuel. A major expense was the purchase of barrels for transporting the lime, from $90 to $2,880. The Greenup County lime makers paid between 20 and 23.15 cents per barrel while the Hardin County lime maker paid 28.12 cents per barrel. There are some similarities and differences between the lime burners. In terms of annual production, the Greenup County lime makers produced between 12,000 and 14,400 barrels of lime while the Hardin County lime maker only produced 320 barrels of lime. There was also a great range in lime prices by the barrel. The Greenup County lime makers sold their lime from 85 cents to $1.125 per barrel while the Hardin County lime maker sold his lime at $2.50 per barrel. Apparently, the limited supply of lime in Hardin County greatly increased the price per barrel while it was produced in greater quantities in Greenup County and thus was much cheaper per barrel. Other counties reporting lime production between 1870 and 1873 include Jefferson, Kenton, Lyon, Meade, and Warren.

Between 1876 and 1883, lime makers and distributors were listed in 23 Kentucky counties. In the period between 1887 and 1890, only five counties were listed in connection with the lime industry: Anderson, Mason, Menifee, Nelson, and Woodford. During 1896, lime was available in Bourbon, Hart, Jefferson, Lyon, and Rockcastle counties. For the period between 1900 and 1923, lime was made in Breckinridge, Greenup, Jefferson, Lyon, Muhlenberg, Powell, Pulaski, Scott, and Warren counties. By 1937, the plant at Pine Hill was the only lime producer reported in Kentucky. In 1939, Bowles (1939:412) noted the largest lime plant in Kentucky was at Pine Hill in Rockcastle County. He also noted that another smaller lime plant had operated in Campbellsville, Taylor County, a few years earlier (Bowles 1939:412).

It is suspected that the lime industry in Kentucky has a much greater distribution than the archival record suggest. During the preparation of this paper, lime kilns were documented by the author in Logan County (15Lo210) (Hockensmith n.d.b) and in Green County (15Gn41) (Hockensmith 2004). No information was found on the lime industry in Green County and only one reference for Logan County. Likewise, oral history indicates that lime was burned in primitive kilns in Washington County (Anderson 2001). Field's (1991:127) *A Guide to Kentucky Place Names* mentions locations with lime related names. Place names in counties with a known lime industry include names such as Lime Branch of Whetstone Branch (eastern Greenup County), Lime Kiln Ridge (northeast Jefferson County), Limeville (northern Greenup County), and Limeville Branch (northern

Greenup County) (Field 1991:127). Counties that do not have a recorded lime industry have place names such as Lime Kiln Fork of Elsam Fork (northern Jackson County), Lime Kiln Hill (southern Metcalfe County), Lime Kiln Ridge (northern Jackson County), and Limekiln Hollow (central Rowan County). The place names and archaeological remains indicate that the Kentucky lime industry is more wide spread that previously thought. In fact, the author feels that most if not all counties containing accessible limestone outcrops had some level of lime making after Euro-Americans settled the state. These lime making activities probably ranged from farmers burning lime for agricultural purposes in many areas to commercial lime operations in a few areas.

Early lime making in Kentucky can be viewed at two levels, commercial and personal. The commercial lime industry appears to have been centered in Greenup, Jefferson, Lyon, and Meade counties historically. During the early 20th century the lime industry shifted to Rockcastle County. The personal level would consist of small kilns built by farmers producing lime for the own use. These small kilns were probably temporary structures that occurred throughout the state in areas containing limestone deposits. Only the commercial lime industry was significant enough to receive much attention in the state records.

CONCLUSIONS

Using available information on lime makers from U. S. Population Census schedules, some general comments can be made. These comments are restricted to age, place of birth, and race. Of these, race is the most difficult to comment on since some census transcribers did not include this information. The 1850 Population Census schedules examined included only four individuals in the lime industry that resided in Kenton County. These men ranged in age from 23 years to 48 years. Two men were born in Virginia, one in Germany, and one man did not have his birth place recorded. Race was not included in the published version suggesting that they were probably White. For 1860, the Population Census schedules included 10 lime makers living in Christian, Greenup, Kenton, and Meade counties. These men ranged in age from 26 years to 48 years, with most men (n=7) in their 20s and 30s. Places of birth for the 1860 lime makers included Kentucky (n=4), North Carolina (n=2), Indiana (n=1), East Tennessee (n=1), Germany (n=1), and Ireland (n=1). The available race information suggests that most, if not all, were White. In 1870, the Population Census schedules included information for 25 men involved in the lime industry. They were living in Greenup, Kenton, Lyon, Meade, and Warren counties. Their ages ranged from 17 years to 70 years, with 20 men falling between 17 years and 42 years of age. Places of birth for the 1870 lime makers included Kentucky (n=9), Ohio (n=5), West Virginia (n=3), East Virginia (n=1), New York (n=2), Pennsylvania (n=2), North Carolina (n=1), Belgium (n=1), and Ireland (n=1). Most of the men appear to be White with one Black man, and one Mulatto man listed. During 1880, seven men were listed for the lime industry in the Population Census schedules for Greenup and Kenton counties. These men ranged in age from 18 years to 66 years, with four men under 32 years and three men over 53 years. Places of birth included Ohio (n=3), Kentucky (n=2), Massachusetts (n=1), and Pennsylvania (n=1). Available information suggests that these men were probably White.

Some very broad statements can be extracted about the lime makers from the U. S. Population Census schedules. First, the ages of workers change through time. During the 1850s and 1860s, lime makers ranged in age from their 20s up to 48 years. By 1870 and 1880, the work force in the lime industry had changed to include both teenagers and older individuals (66 to 70 years). However, the vast majority of these men were in their 20s, 30s, and 40s. The older individuals may be the owners of the lime works.

General statements can also be made about the place of birth for the lime workers. The lime makers of 1850 came from Virginia and Germany. By 1860, Kentucky born men were more numerous but men born in North Carolina, Indiana, and Tennessee were also represented. Foreign born workers during 1860 included one man from Germany and one man from Ireland. In 1870, a labor force with more diverse origins included men from Kentucky, six other states, Belgium, and Ireland. The 1880 lime makers included men from Kentucky and three other states.

Using distribution maps, some general observations can be made concerning the location of the lime industry in Kentucky between 1850 and 1923. The "Land Region Map" in the *Atlas of Kentucky* (Karan and Mather 1977:9) was used as the reference for the geographic regions in the Commonwealth. In 1850, the lime industry was primarily located in the Bluegrass Region with one lime producing county in the western portion of the Pennyroyal Region. By 1860, lime producing counties were mostly located along the Ohio River in the Pennyroyal, Bluegrass, and Mountains (northern edge) regions. A single lime producing county was located in the southwestern portion of the Pennyroyal Region in 1860. Between 1870 and 1873, the lime industry was still very concentrated along the Ohio River in the Pennyroyal, Bluegrass, and Mountains (northern edge) regions. Three inland counties producing lime during this period were located in Pennyroyal and the Western Coal Field (eastern edge). In the period between 1876 and 1883, there was an even greater density of lime producers along the Ohio River. Other counties (away from the Ohio River) making lime during this period were located in the Pennyroyal, Bluegrass, Mountains (northern edge), and Jackson Purchase. Between 1887 and 1890, the lime industry had a much reduced distribution. This may be due in part to the lack of Census data for 1890 which necessitated a reliance on directories for information. All the known counties associated with the lime industry were in the Bluegrass Region or adjacent western edge of the Mountains Region. During 1896, the lime industry was still very small but more scattered including counties in the Bluegrass and Pennyroyal regions. Between 1900 and 1923, lime was produced in a greater number of counties and was present in the Bluegrass, Pennyroyal, Western Coal Field, and Mountains (northern edge) regions.

The commercial lime producing areas appear to be closely connected to cheap transportation. Most major lime producing counties were located along rivers where lime could have been cheaply moved to available markets on boats. Along the Ohio River, lime was produced in Meade, Jefferson, Boone, Kenton, Campbell, and Greenup counties. Other examples include Livingston County on the Cumberland River, Lyon County on the Tennessee River, and Woodford County on the Kentucky River. Lime producing areas located away from rivers undoubtedly used local highways and railroads when present. Some sense of lime markets can be determined from accounts shared about Utica by which was just upstream from Louisville by Baird (1909:401; cited in Ault, Rooney, and Palmer 1974:31):

> The economic success of the industry in the late 1800's at Utica was directly tied to the Ohio River. Some of the first lime was shipped in flour barrels on flatboats to complete other loads to markets as far south as New Orleans. After 1870, when lime was produced in larger quantities, lime was shipped throughout the waterways of the Midwest, south to New Orleans on the Mississippi River to Louisiana and Texas and east to the west coast of Florida .

The Census records suggested that the early lime makers were temporarily involved in the industry. This assumption is support by the fact that most of the men mentioned in the 1850 and 1860 Census schedules as lime makers were not mentioned in subsequent Census records. Further, cemetery records in Kenton and Meade counties, for example, suggest that most lime workers were not buried in these counties. Since most of the men involved in the early lime industry were not mentioned in subsequent Census records and did not die in these counties, it appears that they were only temporarily employees in the lime industry. During the 1850s and 1860s it was not uncommon for men to settle in Kentucky for a few years and then to move further west as the population expanded. Thus, it is very likely that most early lime makers were short term residents of Kentucky.

In the future, as additional information accumulates, we will be able to gain a better understanding of Kentucky's lime industry. Several avenues of future research are apparent. One important task is locating the ruins of the surviving lime kilns. The greatest probability would be in rural areas where lime kilns have not been destroyed by modern development. The counties that appear to have the most potential for containing commercial kilns would be Greenup, Lyon, and Meade although many other counties may contain kiln ruins. It is anticipated that many small kilns built by farmers will be found throughout the state in areas containing limestone. Once lime kilns are located, additional information may be extracted from deeds and other county records. A potential source of information for lime makers is newspapers. In those counties with a known lime industry, it may be productive to search early newspapers for ads or brief stories about the industry.

Major archival sources that still need to be searched are the U.S. Population Census schedules for Fayette and Jefferson counties during 1860, 1870, and 1880. These microfilmed documents are so extensive that researchers have not attempted to transcribed them. While searching these records would require many tedious hours of viewing the microfilm, it is likely that the names of many lime makers (especially employees) would come to light.

Future archaeological studies can provide information on lime kiln construction. Currently, too little information is available to say much about lime kilns sizes and styles across the Commonwealth. Once this information is collected, we will be able to look for regional patterns in construction materials, kiln styles, kiln settings, etc. This will allow researchers to see how kilns evolved in different areas of the state. It is sincerely hoped that future researchers will accept the challenge to increase our understanding of Kentucky's lime industry.

ACKNOWLEDGMENTS

Several individuals were very helpful in providing information on the lime industry or providing access to archival resources. Special thanks is due to Dr. Garland R. Dever, Jr. with the Kentucky Geological Survey in Lexington for suggesting literature sources and his past assistance with my research on the lime industry. Garland also read a draft of this paper and provided many helpful suggestions. Mr. M. Michael Miller, lime specialist, with the U.S. Geological Survey discussed the lime industry with me and graciously reviewed the U.S.G.S. records and prepared a brief overview of the lime industry in Kentucky during the 20th century. Further, Mr. Miller provided many helpful comments on a draft of this paper and graciously furnished copies of references on the modern lime industry in Kentucky. Mr. James W. Lambert (retired attorney living in Mt. Vernon) and Evans V. Hilton (retired highway engineer living in Frankfort) who both grew up in Pine Hill in Rockcastle County answered the author's questions about the Rockcastle Lime and Cement plant. Mr. Lambert (property owner) accompanied the author to the ruins of the Rockcastle Lime and Cement plant. Archaeologist John T. Carter also graciously accompanied the author to the plant. Mr. Larry G. Meadows, Red River Historical Society at Clay City, Kentucky, shared newspaper clippings and other information on the lime industry in Menifee, Montgomery, and Powell counties. William J. Tallent with the New River Lime Company of Covington loaned the author an excellent publication on the manufacture of lime. Mr. George Love, geologist with Dravo Lime Company in Maysville, shared information about his company and suggested some helpful contacts. Ms. Arline Seegar, Director of the National Lime Association, was very helpful. Dr. Fred E. Coy, Jr. tracked down the location of Florida Heights near Louisville and the location of the lime kiln. Ms. Nancy O'Malley with the William S. Webb Museum of Anthropology shared information about lime kilns that she obtained from the Internet. Mr. Ron D. Bryant (Rare Book Curator), Kentucky Historical Society Library, provided access to the Rare Book Room for directories and provided assistance in other ways. Ms. Lynne Hollingsworth (Manuscript Curator) and Ms. Mary E. Winter (Maps and Photographs Curator), with Kentucky Historical Society, provided access to early maps, county atlases, and other resources. Librarian Ms. Pam Lyons, Kentucky Department of Libraries and Archives, was extremely helpful in obtaining some publications about the lime industry through interlibrary loan. Ms. Linda Anderson, retired Kentucky Historical Society librarian, shared about lime making in Washington County according to what her grandfather told her. Thomas N. Sanders, Site Protection Program Manager at the Kentucky Heritage Council, allowed the author to work on this paper and provided encouragement. Ms. Tina Bates, Corporate Records Examiner for the Office of the Secretary of State, checked their files for various lime and cement companies and provided copies of available records. Mr. William C. Richardson, State Publications Program Coordinator at the Kentucky Department of Libraries and Archives, provided access to the Kentucky Department of Mines and Minerals Annual Reports. Mr. Rick Brown, WAVE 3 TV in Louisville, shared archival information and assisted the author with the documentation of lime kilns in Meade County. My coeditor, Dr. Kenneth C. Carstens of Murray State University, made many helpful comments that improved the quality of this paper. The assistance of each of the above individuals is greatly appreciated.

REFERENCES CITED

Allsman, Paul L.

1968 Lime. Preprint from *Bureau of Mines Minerals Yearbook, 1968.* United States Department of the Interior, Washington, D.C.

Amos, D. H.

1972 Geologic Map of the New Amsterdam Quadrangle, Kentucky-Indiana, and Part of the Mauckport Quadrangle, Kentucky. U.S. Geologic Survey Quadrangle Map GQ-990. U.S. Geological Survey, Reston, Virginia.

Anderson, Linda

2001 Personal communication concerning her grandfather Jebez Frank Anderson (born 1865) making lime in Washington County, Kentucky. July 5, 2001.

Anonymous

n.d.a 1850 Monroe County, Kentucky Census. Ms. On file at the Kentucky Historical Society Library, Frankfort.

n.d.b 1870 Monroe County, Kentucky Census. Ms. On file at the Kentucky Historical Society Library, Frankfort.

Auditor of Public Accounts

1840 Annual Report of the Auditor of Public Accounts, for the Year Ending October 10, 1840. In *Reports Communicated to Both Branches of the Legislature of Kentucky at the December Session, 1840.* A. G. Hodges, Frankfort.

1843 Annual Report of the Auditor of Public Accounts, for the Year Ending October 10, 1842. In *Reports Communicated to Both Branches of the Legislature of Kentucky at the December Session, 1842*. A. G. Hodges, Frankfort.

Ault, Curtis H., Lawrence F. Rooney, and Margaret V. Palmer
1974 *The Lime Industry of Indiana*. Department of Natural Resources, Geological Survey Bulletin 42-J, Bloomington.

Austin, Bert A.
1990 *1860 Census Casey County, Kentucky*. Casey County Public Library, Liberty, Kentucky.

Azbe, Victor J.
1946 Louisville Cement Company's Lime Plant One of the Most Efficient. In *Theory and Practice of Lime Manufacture: A Collection of Articles by Victor J. Azbe*, pp. 10-11. Azbe Engineering Corporation, Clayton, Missouri.

Baird, L. C.
1909 *History of Clark County, Indiana*. B. F. Bowen and Company, Indianapolis, Indiana.

Battle, J. H., W. H. Perrin, and G. C. Kniffin
1885 *Kentucky: A History of the State*. 2nd edition. F. A. Battery Publishing Company, Louisville.

Beers, D. G. and J. Lanagan
1879a *Atlas of Jefferson and Oldham Counties, Kentucky*. Compiled and published by Beers and Lanagan, Philadelphia.

1879b *Map of Montgomery County, Kentucky*. Beers and Lanagan, Philadelphia.

Benningfield, Edward
1983 *The 1850 Census of Taylor County, Kentucky*. Taylor County Historical Society.

1984 *Larue County, Kentucky 1880 Census*. McDowell Publications, Utica, Kentucky.

Biggs, Nina Mitchell and Mabel Lee Mackoy
1951 *History of Greenup County, Kentucky*. The Franklin Press, Louisville.

Black, Patty
1994 *Casey County, Kentucky 1870 Census and Mortality Schedules*. Privately printed, Hustonville, Kentucky.

Blatchley, W. S.
1904 The Lime Industry in Indiana. In the *Indiana Department of Geology and Natural Resources Twenty-Eighth Annual Report*, pp. 211-257, Bloomington.

Blue, James, Betty Sellers, and Laura Willis
1998 *Lyon County, KY. Census of 1900*. Simmons Historical Publications, Melber, Kentucky.

Board of Internal Improvement
1840 Annual Report of the Board of Internal Improvement of the State of Kentucky. In *Reports Communicated to Both Branches of the Legislature of Kentucky at the December Session, 1840.* A. G. Hodges, Frankfort.

Bonham, Jeanne Snodgrass and Patricia Heylmann
1993 *Rockcastle County, Kentucky: 1900 Federal Census.* High Grass Publications, Greenwood, Tennessee.

Boucher, Mrs. Avery
1978 *1860 Census, Meade County, Kentucky.* Ancestral Trails Historical Society, Vine Grove, Kentucky. Printed by McDowell Publications, Hartford, Kentucky.

Boynton, Robert S.
1980 *Chemistry and Technology of Lime and Limestone.* John Wiley & Sons, New York. 2nd edition.

Bowles, Oliver
1939 *The Stone Industries.* McGraw-Hill Book Company, New York. Second edition.

Brown, Fred, Jr.
1982 *Times Out Of Mind: 1850 Carter County, Ky Census.* Privately printed, Clearfield, Kentucky.

Brown, Laura Young and Marie Coleman
1992 *The History of Meade County, Kentucky 1824-1991.* McDowell Publications, Utica, Kentucky. Second edition.

Bryant, Kathleen Tayloe
1977 *1860 Federal Census, Caldwell County, Kentucky.* The Hopkins County Genealogical Society, Madisonville, Kentucky.

Burchard, Ernest F.
1914 Sources of Lime. In *Mineral Resources of the United States, Calendar Year 1913, Part II-Nonmetals*, pp.1511-1555. Government Printing Office, Washington, D.C.

Burgher, J. E., Jr. (publisher)
1916 Economical Plan for Burning Limestone: Simple Experiment Conducted on One Farm has Good Results. *Better Farms and Roads* 1 (28), July, Clay City, Kentucky.

Burroughs, Wilbur G.
1930 *Directory of Kentucky Mineral Operators.* The Kentucky Geological Survey, Series 6, Volume 32, Frankfort.

Cain, Shirley West
1981 *1880 Federal Census of Christian County, Ky.* Published by the Christian County Genealogical Society, Hopkinsville.

Caron, C. K.
1871 *Caron's Annual Directory of the City of Louisville, for 1871.* Bradley and Gilbert,

Louisville.

1873 *Caron's Annual Directory of the City of Louisville, for 1873.* Bradley and Gilbert, Louisville.

1874 *Caron's Annual Directory of the City of Louisville, for 1874.* Bradley and Gilbert, Louisville.

1878 *Caron's Annual Directory of the City of Louisville, for 1878.* Bradley and Gilbert, Louisville.

1879 *Caron's Annual Directory of the City of Louisville, for 1879.* Bradley and Gilbert, Louisville.

1880 *Caron's Annual Directory of the City of Louisville, for 1880.* Bradley and Gilbert, Louisville.

1881 *Caron's Annual Directory of the City of Louisville, for 1881.* Bradley and Gilbert, Louisville.

1882 *Caron's Annual Directory of the City of Louisville, for 1882.* Bradley and Gilbert, Louisville.

1895 *Caron's Annual Directory of the City of Louisville, for 1895.* Bradley and Gilbert, Louisville.

1901 *Caron's Annual Directory of the City of Louisville, for 1901.* Bradley and Gilbert, Louisville.

Caron Directory Company
1921 *Caron's Directory of the City of Frankfort for 1921-1922-1923.* Volume 5. Caron Directory Company, Louisville.

Clements, Attie, Marie Greenwell, Lucy Geohegan, Lillian Ockerman, and Margaret Schroder
1999 *Nelson County, Kentucky 1880 Federal Census.* Nelson County Genealogical Society, Bardstown, Kentucky.

Coffman, Edward
1931 *The Story of Russellville: A Short History of the Town of Russellville, Logan County, Ky.* The News-Democrat Print, Russellville, Kentucky.

Collett, John
1879 *Geological Report on Harrison and Crawford Counties, Indiana, 1878.* Indiana Geological Survey Annual Reports 8, 9, and 10, pp. 29-522, Bloomington.

Committee on Industrial and Commercial Improvements
1887 *The City of Louisville and a Glimpse of Kentucky.* Committee on Industrial and Commercial Improvements of the Louisville Board of Trade. Courier-Journal Job Printing, Louisville.

Cook, Michael Lewis and Bettie Anne Cummings Cook
1984 *1880 Federal Census, Breckinridge County, Kentucky*. Breckinridge County Kentucky Records, Volume 5. Kentucky Records Series. Cook Publications, Evansville, Indiana.

Cornelius, Wilma J.
n.d. *Garrard County, Kentucky Census of 1850*. Privately printed, Lancaster, Kentucky.

Couey, Ann Poindexter
1975 *Clark County, Kentucky 1850 Census and Mortality Schedules 1852-1861*. Privately printed, Winchester, Kentucky.

Cowan, Jane and Bill Courtney
1986 *Fleming County Census 1850. District I & II*. Privately printed, Ewing, Kentucky.

Coy, Fred, E., Jr.
1999 Personal Communication concerning a lime kiln quarry in Jefferson County, Kentucky. Louisville, Kentucky.

Crabb, Katharine Sturgeon
1979 *1850 Census of Hart County, Kentucky*. Ancestral Trails Historical Society, Vine Grove. McDowell Publications, Owensboro, Kentucky.

Crandall, A. R.
1877 *Report on the Geology of Greenup, Carter, and Boyd Counties, and a Part of Lawrence*. Geological Survey of Kentucky, New Series, Volume 2, pp. 1-77, Frankfort.

1884 *Report on the Geology of Greenup, Carter, and Boyd Counties, and a Part of Lawrence*. Geological Survey of Kentucky, Eastern Coal Field, Volume C, pp. 1-77, Frankfort.

Crider, A. F.
1913 *Economic Geology of Tell City and Owensboro Quadrangles*. Geological Survey of Kentucky, Fourth Series, Volume 1, Part 1, pp. 263-316, Frankfort.

Crittenden County Genealogical Society
1994 *The Crittenden County, Kentucky 1870 Federal Census*. Crittenden County Genealogical Society, Marion, Kentucky.

Crouse, Charles S.
1925 The Intrastate Industrial Utilization of the Mineral Resources of Kentucky. In *Oil Shales of Kentucky and Other Papers* by Richard Thiessen, David White, and Charles S. Crouse, pp.145-192, Kentucky Geological Survey, Series 6, Volume 21, Frankfort.

Crume, Mrs. Barney D.
n.d.a Bracken County, Kentucky 1850 Federal Census. Lubbock, Texas. Manuscript on file at the Kentucky Historical Society Library, Frankfort.

n.d.b Morgan County, Kentucky 1850 Federal Census. Privately printed Lubbock, Texas.

Curtis, Mary G. and Alethea B. Read
1976 The 1860 Census of Rowan County, Kentucky. Cleek/Print, Sanata Rosa, California.

Dalton, Katherine
1994 *Written in Stone: The Crushed Stone Industry in Kentucky*. The Kentucky Crushed Stone Association, Inc., Frankfort.

Darnell, Betty Rolwing
1992 *Bullitt County, Kentucky 1880 Census*. Privately printed by authors, Mt. Washington, Kentucky.

Davis, Lucile Shryock
1989 Clifton. In *Woodford County, Kentucky: The First Two Hundred Years, 1789-1989*, edited by Dabney Garrett Munson and Margaret Ware Parrish, pp. 19-22. Lexington, Kentucky (no publisher given).

Deardorff, Jennie
1983 *1870 Census of Hardin County, Kentucky*. Ancestral Trails Historical Society, Vine Grove. McDowell Publications, Utica, Kentucky.

Dennis, Lennie C.
1986 *Grayson County 1860 Census*. Kinko's Copies, Bowling Green, Kentucky.

1990 *Grayson County, Kentucky 1880 Federal Census*. Privately printed, Madisonville, Kentucky.

Dever, Garland R., Jr.
1996 Map: *Principal Outcrop of Limestone and Dolomite Resources in Kentucky*. Kentucky Geological Survey, University of Kentucky, Lexington.

Department of Commerce and Labor
1911 *Lime: Its Properties and Uses*. Circular of the Bureau of Standards, No. 30. Department of Commerce. Government Printing Office, Washington, D.C.

Dravo Corporation
1997 Annual Report of Dravo Corporation Pursuant to section 13 or 15 (d) of the Securities Exchange Act of 1934 for the fiscal year ended December 31, 1997. Commission file number 25-0447860.

Dravo Lime Company
n.d. a Dravo Lime: Capabilities Beyond Stone. Undated Dravo Lime Company brochure, Pittsburgh, Pennsylvania.

n.d. b Dravo Lime Company. Undated Dravo Lime Company brochure, Pittsburgh, Pennsylvania.

n.d. c Dravo Lime: Capabilities and Products With an Accent on Quality. Undated Dravo Lime Company brochure, Pittsburgh, Pennsylvania.

Drennan, Juanita Walker

1980 *1850 Census of Livingston County, Kentucky.* Privately printed, Smithland, Kentucky.

1987 *1860 Census of Livingston County, Kentucky.* Privately printed, Ledbetter, Kentucky.

Dryden, Jno. B.

1891 *Jno. B. Dryden's Frankfort Directory, 1891-92.* George A. Lewis Book and Job Printer, Frankfort.

Eckel, Edwin C.

1922 *Cements, Limes and Plasters: Their Materials, Manufacture and Properties.* John Wiley & Sons, London. (2nd edition).

1928 *Cements, Limes and Plasters: Their Materials, Manufacture and Properties.* John Wiley & Sons, London (3rd edition).

Edwards, Dennis L.

2000 *1860 Metcalfe County Census.* Metcalfe County Historical Society, Edmonson, Kentucky.

Edwards, Richard (editor)

1870 *Edwards Sixth Annual Directory of the City of Louisville for 1870.* Southern Publishing Company, Louisville.

Emerson, Chas. & Co.

1878 *Chas. Emerson & Co.'s Lexington (Ky.) Directory, 1879-80.* Transylvania Printing and Publishing Company, Lexington.

Emerson, Charles

1884 *Chas. Emerson's Frankfort Directory, 1884-85.* George A. Lewis Book and Job Printer, Frankfort.

Fee, Hally

1987 *1880 Census of Harlan County.* Footprints Publications & Research, Harlan, Kentucky.

Field, Thomas P.

1991 *A Guide to Kentucky Place Names.* Revised edition. Kentucky Geological Survey, Series 11, Special Publication 15, Lexington.

Flowers, Mrs. Randy H. and Michael C. Watson

1986 *1850 Census of Adair County, Kentucky.* Adair County Genealogical Society. Printed by South Central Printing, Columbia, Kentucky.

Fohs, F. Julius

1912 *The Geology and Economic Resources of Rockcastle County.* Kentucky Geological Survey, Series 3, County Report Number 4, Frankfort.

Froggett, Judy
1984 *United States Census, Barren County, Kentucky 1850.* Green County Public Library, Greensburg, Kentucky.

Gipson, Winfred
n.d. 1870 Federal Census for Owen County, KY For Precincts Monterey, Caney, Dallasburg, New Liberty, Town of New Liberty and Portion of Gratz. Ms. On file at the Kentucky Historical Society Library, Frankfort.

Goodgion, Roland E. and Ernestine Goodgion
1976 *1870 Census Hickman County, Kentucky.* Printed by Creative Printers, Inc., Murray, Kentucky.

Gorin, Michelle Bartley
1997 *1870 Warren County, Kentucky Black Census.* Gorin Genealogical Publishing, Glasgow, Kentucky.

Green, Karen Mauer
1983 *The Kentucky Gazette 1787-1800: Genealogical and Historical Abstracts.* Gateway Press, Baltimore.

Hammers, Mrs. Marion G.
1969 *1850 Census of Muhlenberg County, Kentucky.* Privately printed, Madisonville, Kentucky.

1976 *1850 Census of Crittenden County, Kentucky.* Hopkins County Genealogical Society, Madisonville, Kentucky.

1978a *Edmonson County, Kentucky 1850 Census.* West-Central Kentucky Family Research Association, Owensboro. McDowell Publications, Hartford, Kentucky.

1978b *1860 Census, Muhlenberg County, Kentucky.* Muhlenberg County Genealogical Society, Central City, Kentucky.

Harris InfoSource
1998 *Kentucky Directory of Manufacturers* 98. Harris InfoSource, Twinsburg, Ohio in cooperation with the Kentucky Cabinet for Economic Development and the Kentucky Chamber of Commerce.

2000 *Kentucky Directory of Manufacturers* 2000. Harris InfoSource, Twinsburg, Ohio in cooperation with the Kentucky Cabinet for Economic Development and the Kentucky Chamber of Commerce.

Hawes, George W.
1859 *George W. Hawes' Kentucky State Gazetteer and Business Directory for 1859 and 1860.* No. 1. G. W. Hawes, Louisville.

Hawley, Carlos
1996a *Hart County, Kentucky 1870 Census.* Hart County Historical Society, Munfordville.

1996b *Hart County, Kentucky 1880 Census*. Hart County Historical Society, Munfordville.

Hazel Green Herald

1885 Correspondence concerning lime kiln at Cornwell in Menifee County, Kentucky. *Hazel Green Herald* 1 (1), March 4, 1885 issue.

Hearell, Beverly

1993 *Crittenden County, Kentucky 1860 Federal Census*. Crittenden County Genealogical Society, Marion, Kentucky.

Hilton, Evans V.

1992 Pine Hill. In *Rockcastle County, Kentucky and its People* by the Rockcastle County History Book Committee, pp. 18-19. Walsworth Publishing, Waynesville, North Carolina.

1999 Telephone interview with Evans V. Hilton by Charles D. Hockensmith concerning the lime plant at Pine Hill in Rockcastle County, Kentucky. March 19th.

Hockensmith, Charles D.

1996 Archaeological Investigations at the Rudd Lime Kiln, Livingston County, Kentucky. *Ohio Valley Historical Archaeology* 11:115-124.

1999 The Upper Rudd Lime Kiln: An Industrial Archaeological Site Near Lemen Landing, Livingston County, Kentucky. *Ohio Valley Historical Archaeology* 14:95-104.

2004 Archaeological Investigations at the Cowherd Lime Kiln, Near Bengal, Green County, Kentucky. *Ohio Valley Historical Archaeology* 19 [In Press].

n.d.a An Overview of Kentucky's Modern Agricultural Lime Industry. Draft manuscript on file at the Kentucky Heritage Council, Frankfort.

n.d.b Archaeological Investigations at the Shrull Lime Kiln Near Russellville, Logan County, Kentucky. Draft manuscript on file at the Kentucky Heritage Council, Frankfort.

Hockensmith, Charles D. and Richard M. Brown

2004 Archaeological Investigations at the Pace Lime Kiln, Near Brandenburg, Meade County, Kentucky. *Currents of Change*, Journal of the Falls of the Ohio Archaeological Society 2 (1):1-12, Clarksville, Indiana. [In Press]

Hockensmith, Charles D. and Fred E. Coy, Jr.

1999 Archaeological Investigations of the Natural Cement Kilns at the Queen City Mill, Clark County, Indiana. *Ohio Valley Historical Archaeology* 14:105-122.

Hockensmith, Charles D. and M. Jay Stottman

1996 The Maysville Brick Company, Mason County, Kentucky. *Journal of the International Brick Collectors Association* 14 (1): 3-16.

1997 Investigations at the Maysville Brick Company: An Example of Industrial Archaeology in Kentucky. *Ohio Valley Historical Archaeology* 12:89-111.

Hodgman, George H.

1865 *Hodgman & Co.'s Kentucky State Directory Travelers and Shippers' Guide for 1865-1866*. G. H. Hodgman, Louisville.

1870 *Kentucky State Directory Travelers and Shippers' Guide for 1870-1871*. John P. Morton, Louisville.

Honaken, Dewey R.

1974 *1860 Census of Pike County, Kentucky*. Privately printed, Pikeville, Kentucky.

1978 *1850 Census of Pike County, Kentucky*. Privately printed, Pikeville, Kentucky.

Hopkins County Genealogical Society

1978 *Federal Census of Christian County, Kentucky 1860*. Published by the Hopkins County Genealogical Society, Madisonville, Kentucky.

Howell, Joyce and Shirley Helton

1993 *The Annotated 1860 LaRue County Census*. Ancestral Trails Historical Society, Vine Grove. McDowell Publications, Utica, Kentucky.

Hubble, Anna Joy Munday

1976 *Madison County, Kentucky 1850 Census*. Privately printed.

1985 *Madison County, Kentucky 1860 Census*. Privately printed.

1986 *Bourbon County, Kentucky 1850 Census*. Privately printed, Whitefish, Montana.

Jackson, Evelyn Scyphers

1988 *1850 Census of Greenup County, Kentucky*. Eastern Kentucky Genealogical Society, Ashland.

Jillson, Willard Rouse

1930 Administrative Report for the (Sixth) Kentucky Geological Survey, Year 1928 and 1929. In *Geological Survey Affairs* by Willard Rouse Jillson, pp.101-220. Kentucky Geological Survey, Series 6, Volume 35, Frankfort.

Johnson, E. Polk

1912 *A History of Kentucky and Kentuckians*. Volume III. The Lewis Publishing Company, Chicago.

Johnston, J. Stoddard

1896 *Memorial History of Louisville from its First Settlement to the Year 1896*. Volume I. American Biographical Publishing Company, Chicago and New York.

Jones, Mary J.

1982 *Larue County Kentucky 1850 Census*. Ancestral Trails Historical Society, Vine Grove. McDowell Publications, Owensboro, Kentucky.

Jones, Thomas H.

1979 *Lyon County Kentucky 1860 Federal Census*. Cook-McDowell Publications, Owensboro.

n.d.a *Caldwell County Kentucky 1850 Federal Census*. Privately printed, Edwardsville, Illinois.

n.d.b *Calloway County Kentucky 1850 Federal Census*. Privately printed, Edwardsville, Illinois.

n.d.c *Todd County Kentucky 1850 Federal Census*. Privately printed, Edwardsville, Illinois.

Karan, P. P. and Cotton Mather (editors)
1977 *Atlas of Kentucky*. The University Press of Kentucky, Lexington.

Keeling, Celia and Ellen Smith
2000 *Nelson County, Kentucky 1850 Federal Census*. Nelson County Genealogical Society, Bardstown, Kentucky.

Kentucky Department of Commerce
1966 *1966 Kentucky Directory of Manufacturers*. Kentucky Department of Commerce, Frankfort.

1969 *1969 Kentucky Directory of Manufacturers*. Kentucky Department of Commerce, Frankfort.

1975 *1975 Kentucky Directory of Manufacturers*. Kentucky Department of Commerce, Frankfort.

1980 *1980 Kentucky Directory of Manufacturers*. Kentucky Department of Commerce, Frankfort.

1985 *1985 Kentucky Directory of Manufacturers*. Kentucky Department of Commerce, Frankfort.

1990 *1990 Kentucky Directory of Manufacturers*. Kentucky Department of Commerce, Frankfort.

1992 *1992 Kentucky Directory of Manufacturers*. Kentucky Department of Commerce, Frankfort.

1996 *1996 Kentucky Directory of Manufacturers*. Kentucky Department of Commerce, Frankfort.

Kentucky Department of Economic Development
1957 *Kentucky Industrial Directory 1957-58*. Kentucky Department of Economic Development in cooperation with the Kentucky Chamber of Commerce, Frankfort.

Kentucky Transportation Cabinet
1992 General Highway Map, Greenup County, Kentucky. Kentucky Transportation Cabinet, Frankfort.

Kramer, Carl E.
2001 Louisville Cement Company. In *The Encyclopedia of Louisville*, edited by John E. Kleber, p. 538. The University Press of Kentucky, Lexington.

Kurtz, J. M.
1989 *1880 Census of Garrard County, Kentucky*. Privately printed, Lancaster, Kentucky.

n.d. *Garrard County, Kentucky Census of 1870*. Privately printed, Lancaster, Kentucky.

Lake, D. J. & Co.
1880 *An Illustrated Historical Atlas of Henderson and Union Counties, Kentucky*. D. J. Lake & Co., Philadelphia.

1882a *An Atlas of Franklin County, Kentucky*. D. J. Lake & Co., Philadelphia.

1882b *An Atlas of Nelson & Spencer Cos., Kentucky*. D. J. Lake & Co., Philadelphia.

1883 *An Atlas of Boone, Kenton, and Campbell Counties, Kentucky*. D. J. Lake & Co., Philadelphia.

1884 *Atlas of Bath & Fleming Cos., Kentucky*. D. J. Lake & Co., Philadelphia.

Lake, Griffing & Stevenson
1876 *An Illustrated Atlas of Mason County, Kentucky*. Lake, Griffing & Stevenson, Philadelphia.

Lambert, James W.
1992 Pine Hill # 2. In *Rockcastle County, Kentucky and its People* by the Rockcastle County History Book Committee, p. 19. Walsworth Publishing, Waynesville, North Carolina.

1999 In person interview with James W. Lambert by Charles D. Hockensmith concerning the lime plant at Pine Hill in Rockcastle County, Kentucky. March 18th at Mount Vernon and Pine Hill.

Lawson, Rowena
1983 *Nicholas County, Kentucky 1850 Census*. Heritage Books, Inc., Bowie, Maryland.

1984 *Ohio County, Kentucky 1850 Census*. Heritage Books, Inc., Bowie, Maryland.

1986a *Boone County, Kentucky 1850 Census*. Heritage Books, Inc., Bowie, Maryland.

1986b *Montgomery County, Kentucky 1850 Census*. Heritage Books, Inc., Bowie, Maryland.

1987 *Anderson County, Kentucky 1830-1850 Censuses*. Heritage Books, Inc., Bowie, Maryland.

Lazell, E. W.
1915 *Hydrated Lime: History, Manufacture and Uses in Plaster-Mortar-Concrete.*

Jackson-Remlinger Ptg. Company, Pittsburgh.

Lewis, Rexford Gardner
n.d. *Morgan County, Kentucky 1860 Census, 1870 Census, 1880 Census. Thomas Lewis of Morgan County, Kentucky and Related Families*. Privately printed, Buffalo Grove, Illinois.

Lind, Ruth Marcum
1975 United States Census, Green County, Kentucky 1850-1860. Privately printed, Dinuba, California.

Linney, William M.
1884 *Report on the Geology of Montgomery County*. Kentucky Geological Survey, Series 2, Frankfort, Kentucky.

Love, George E. W.
2001 Telephone interview with George E. W. Love, geologist with Dravo Lime Company, Maysville, Kentucky by Charles D. Hockensmith concerning the Dravo lime plants in Mason and Pendleton Counties, Kentucky. September 21, 2001.

2001 Letter to Charles D. Hockensmith concerning the Dravo lime plants. Dravo Lime Company, Maysville. September 27, 2001.

McFarlan, Arthur C.
1943 *Geology of Kentucky*. The University of Kentucky, Lexington.

McManaway, Robert D.
1985 *Nelson County, Kentucky 1870 Census*. McDowell Publications, Utica, Kentucky.

Mather, W. W.
1988 *Report on the Geological Reconnaissance of Kentucky, Made in 1838*. Kentucky Geological Survey, Series XI, Reprint 25, Lexington. Reprinted from the Journal of the Commonwealth of Kentucky, 1839.

Meade County
1826 Law Suit: Solomon Brandenburg versus William Stewart that mentioned a lime kiln. In a book of Meade County court cases in Brandenburg dating between April 1824 and March 1842. In the collection of the Southern Baptist Theological Seminary, Louisville, Kentucky.

Meade County Messenger
1939 Lime Kiln Found Under Public Road. *Meade County Messenger* February 2, 1939, Brandenburg, Kentucky.

Meyers, Shelby L., Sr.
1968 *Mother of God Cemetery*. Volumes I and II. Privately printed, Newport, Kentucky.

Miller, A. M.
1914 *Geology of Franklin County*. Kentucky Geological Survey, Fourth Series, Volume 2, Part 3, Frankfort.

Miller, Marguerite
1998 *1850 Census of Henry County, Kentucky*. Privately printed, Smithfield, Kentucky.

Miller, M. Michael
2001a *2000 Directory of Lime Plants in the United States*. U.S. Geological Survey, Reston, Virginia.

2001b Lime. *Mineral Industry Surveys, 2000 Annual Review*, pp. 46.1-46.7. U.S. Geological Survey, Reston, Virginia.

2001c Faxed letter to Charles Hockensmith summarizing the lime industry in Kentucky during the 20th century. Lime Specialist, U. S. Geological Survey, Reston, Virginia.

Miller, Wathena Kennedy and Jane Meador Newton
1991 *Meade County Kentucky 1870 Census*. Ancestral Trails Historical Society, Vine Grove, Kentucky.

Monks, Sue
1980 *1880 Caldwell County, Kentucky Federal Census*. The Caldwell County, Kentucky Historical Society, Princeton, Kentucky.

Morton, Douglas
n.d. *1900 Census Powell County, Kentucky*. Privately printed, Stanton, Kentucky.

Nelson County Genealogical Society
1992 *Nelson County, Kentucky 1860 Federal Census*. Nelson County Genealogical Society, Bardstown, Kentucky.

2000 *Nelson County, Kentucky 1900 Federal Census*. Nelson County Genealogical Society, Bardstown, Kentucky.

Newton, Jane Meador and Wathena Kennedy Miller
1995 *Meade County Kentucky 1880 Census*. Ancestral Trails Historical Society, Vine Grove, Kentucky.

Nolan, Gertrude and Janette Nolan
n.d. *The 1870 Bell County Census*. American Publishing Company, Lexington.

Norris, William V.
1981 *1860 U.S. Census Clark County, Kentucky*. Privately printed, Jacksonville, Florida.

Norwood, Connelly & Co.
1887 *City Directory of Lexington, Kentucky 1887*. Connelly Norwood & Co., Chattanooga, Tennessee.

O'Brien, Bobbie H.
1981 *Ohio County, Kentucky 1860 Census: An Indepth Study of the Census and Marriage Records of Ohio County*. Cook and McDowell Publications, Owensboro.

Ohio Valley Publishing Company
1873 *Kentucky State Directory and Shipper's Guide for 1873-4*. Ohio Valley Publishing Company, Louisville.

Otto, John S. and Geryl D. Gilbert
1981 Appendix B: Phase I Survey of Historic Sites in Otter Creek Park, Meade County, Kentucky. In "A Survey of Archaeological Sites in Otter Creek Park, Meade County, Kentucky" by John R. Hale, pp. 80-86. Towards a Research and Management Design: Cultural Resources Studies in the Falls Region of Kentucky, Volume II. University of Louisville Archaeological Survey, Louisville.

Owen, David Dale
1857 *Second Report of the Geological Survey in Kentucky Made During the Years 1856 and 1857*. A. G. Hodges, Frankfort.

1861 *Fourth Report of the Geological Survey in Kentucky Made During the Years 1858 and 1859*. Printed at the Yeoman Office, Frankfort.

Patterson, C. Meade and Victoria R. Schreck
1961 Lime. Preprint from *Bureau of Mines Minerals Yearbook, 1961*. United States Department of the Interior, Washington, D.C.

Perrin, W. H., J. H. Battle, and G. C. Kniffin
1887a *Kentucky: A History of the State*. 3rd edition. F. A. Battery Publishing Company, Louisville.

1887b *Kentucky: A History of the State*. 6th edition. F. A. Battery Publishing Company, Louisville.

Peter, Robert
1876 *Chemical Report on the Soils, Marls, Clays, Ore, Coals, Iron Furnace Products, Mineral Waters, &c. &c.* Geological Survey of Kentucky, Frankfort.

1884 *Chemical Analyses. A: First, Second, and Third Chemical Reports, and Chemical Analyses of the Hemp and Buckwheat Plants*. Geological Survey of Kentucky, Frankfort.

Polk Company, R. L.
1887 *Kentucky State Gazetteer and Business Directory, For 1887-88*. R. L. Polk Company, Detroit.

1895 *Kentucky State Gazetteer and Business Directory, For 1896*. R. L. Polk Company, Detroit.

1928 *Polk's Lexington (Kentucky) City Directory 1928*. Volume 14. R. L. Polk & Co., Columbus, Ohio.

Polk, R. L. Company and A. C. Danser
1876 *Kentucky State Gazetteer and Business Directory, For 1876-77*. R. L. Polk Company and A. C. Danser, Detroit and Louisville.

1879 *Kentucky State Gazetteer and Business Directory, For 1879-80.* R. L. Polk Company and A. C. Danser, Detroit and Louisville.

1881 *Kentucky State Gazetteer and Business Directory, For 1881-82.* R. L. Polk Company and A. C. Danser, Detroit and Louisville.

1883 *Kentucky State Gazetteer and Business Directory, For 1883-4.* R. L. Polk Company and A. C. Danser, Detroit and Louisville.

Potter, Hugh O.
1974 *A History of Owensboro and Daviess County, Kentucky.* Daviess County Historical Society. Printed by Herff Jones-Paragon Publishing, Montgomery, Alabama.

Prather, Jas. H.
1875 *Prather's Lexington City Directory, For 1875 and 1876.* Transylvania Printing and Publishing, Lexington.

1893 *City Directory of Lexington, KY. June 1893. Volume 4.* Transylvania Printing Company, Lexington.

Pressler, J. W.
1976 Lime. Preprint from *Bureau of Mines Minerals Yearbook, 1978-79.* United States Department of the Interior, Washington, D.C.

1979 Lime. Preprint from *Bureau of Mines Minerals Yearbook, 1976.* United States Department of the Interior, Washington, D.C.

Pulaski County Historical Society
1987 *1900 Census, Pulaski County, Kentucky.* Published by the Pulaski County Historical Society, Somerset.

Rajewich, Kathleen
n.d. *1860 Edmonson County Census.* Privately printed. [No city or date given].

Raymer, John and Wilbert M. Smith
n.d. Development of the Maysville, Kentucky Limestone Mine of Dravo Lime Company. Paper presented at the National Lime Association Annual Meeting about 1981.

Reed, Avery H.
1971 Lime. Preprint from *Bureau of Mines Minerals Yearbook, 1971.* United States Department of the Interior, Washington, D.C.

1973 Lime. Preprint from *Bureau of Mines Minerals Yearbook, 1973.* United States Department of the Interior, Washington, D.C.

Reynolds, Alice P.
1976 *1880 Census of Rowan County.* Privately printed, Morehead, Kentucky.

Richardson, Charles H.

1923 *The Building Stones of Kentucky.* The Kentucky Geological Survey, Series 6, Volume 11, Frankfort.

1924 *The Road Materials of Kentucky.* The Kentucky Geological Survey, Series 6, Volume 22, Frankfort.

Roberts, George

1924 Making Limestone More Available for Farmers. In *Circular No.* 174, pp. 3-9. University of Kentucky, College of Agriculture, Extension Division, Lexington.

Robertson, Joseph L.

1976 New Dravo Lime Plant is Geared to Growing Scrubber Needs. *Rock Products*, June, reprint.

Robinson, Lewis and Teresa Robinson

1981 *1880 Federal Census of Pike County, Kentucky.* Privately printed, Pikeville, Kentucky.

Sanders, Faye Sea

1982a *1850 Federal Census, Washington County, Kentucky.* Privately printed, Louisville, Kentucky.

1982b *1860 Federal Census, Washington County, Kentucky.* Privately printed, Louisville, Kentucky.

1983 *1850 Federal Census, Mercer County, Kentucky.* Privately printed, Louisville, Kentucky.

1987 *1870 Federal Census, Washington County, Kentucky.* Privately printed, Louisville, Kentucky.

1988 *1860 Federal Census, Mercer County, Kentucky.* Privately printed, Louisville, Kentucky.

1990 *1880 Federal Census, Washington County, Kentucky.* Privately printed, Louisville, Kentucky.

Sanders, Carol

n.d. *1880 Casey County, Kentucky Census.* Privately printed, Blue Ash, Ohio.

Schunk, John F.

1986a *1850 U. S. Census Harrison County, Kentucky.* S-K Publication.

1986b *1850 U. S. Census, Oldham County, Kentucky.* S-K Publication.

1986c *1850 U. S. Census, Owen County, Kentucky.* S-K Publication.

1986d *1850 U. S. Census, Pendleton County, Kentucky.* S-K Publication.

Secretary of State

1896 Articles of Incorporation for the Union Cement and Lime Company of Louisville, Kentucky. Original on file at the Office of the Secretary of State, Corporate Records Division, Frankfort, Kentucky.

1897 Articles of Incorporation for Callahan & Sons of Louisville, Kentucky. Original on file at the Office of the Secretary of State, Corporate Records Division, Frankfort, Kentucky.

1908 Articles of Incorporation for J. B. Speed & Company of Louisville, Kentucky. Original on file at the Office of the Secretary of State, Corporate Records Division, Frankfort, Kentucky.

1910 Amendment to Articles of Incorporation for the Louisville Cement Company of Louisville, Kentucky. Original on file at the Office of the Secretary of State, Corporate Records Division, Frankfort, Kentucky.

1914 Amendment to Articles of Incorporation for J. B. Speed & Company of Louisville, Kentucky. Original on file at the Office of the Secretary of State, Corporate Records Division, Frankfort, Kentucky.

1915 Amendment to Articles of Incorporation for J. B. Speed & Company of Louisville, Kentucky. Original on file at the Office of the Secretary of State, Corporate Records Division, Frankfort, Kentucky.

1916 Amendment to Articles of Incorporation for J. B. Speed & Company of Louisville, Kentucky. Original on file at the Office of the Secretary of State, Corporate Records Division, Frankfort, Kentucky.

1918 Statement of Dissolution for the Union Cement and Lime Company of Louisville, Kentucky. Original on file at the Office of the Secretary of State, Corporate Records Division, Frankfort, Kentucky.

1954 Agreement of Merger for the Louisville Cement Company of Louisville, Kentucky and the Louisville Cement Corporation of Indiana. Original on file at the Office of the Secretary of State, Corporate Records Division, Frankfort, Kentucky.

1985a Articles of Merger Merging Coplay Acquisitions Subsidiary, Inc. into of Louisville, Kentucky. Original on file at the Office of the Secretary of State, Corporate Records Division, Frankfort, Kentucky.

1985b Articles of Merger of the Louisville Cement Company and Coplay Cement Company. Original on file at the Office of the Secretary of State, Corporate Records Division, Frankfort, Kentucky.

1998 Application for Amended Certificate of Authority changing Coplay Cement Company to ESSROC Materials, Inc. Original on file at the Office of the Secretary of State, Corporate Records Division, Frankfort, Kentucky.

Seiller, Edward F.
1929 *Kentucky Natural Resources, Industrial Statistics, Industrial Directory Description by Counties*. Bureau of Agriculture, Labor and Statistics, Bulletin 34.

Sexton, Allen, Jr. and Shelby L. Meyers, Sr.
1996 *Linden Grove Cemetery of Covington, Kenton County, Kentucky.* Privately printed, Florence, Kentucky.

Sheppard, J. S. & Co.
1873 *Sheppard's Lexington City Directory for 1873 and 1874.* J. S. Sheppard & Co, Cincinnati, Ohio,

Sholes & Co.
1885 *Sholes Directory of the City of Lexington.* Volume 1. Transylvania Printing Company, Lexington.

Siebenthal, C. E.
1900 The Silver Creek Hydraulic Limestone of Southeastern Indiana. *Indiana Department of Geology and Natural Resources, Annual Report 25*, pp. 331-389, Indianapolis.

Simmons, Don
1983 *Trigg County, Ky. Census of 1860.* Simmons Historical Publications, Melber, Kentucky.

n.d. *Calloway County, Ky. Census of 1860.* Simmons Historical Publications, Melber, Kentucky.

Sims, Shelly
1983 *1850 Census, Meade County, Kentucky.* Ancestral Trails Historical Society, Vine Grove, Kentucky.

St. Asaph's Chapter
1986 *Boyle County, Kentucky 1850 Census.* St. Asaph's Chapter, NSDAR. McDowell Publications, Utica, Kentucky.

Staples, Charles R.
1996 *The History of Pioneer Lexington, 1779-1806.* The University Press of Kentucky, Lexington. Reprint of 1939 edition.

Starks, Thomas S. (Supervisor)
1923 *Louisville Fifty Years Ago, 1873-1923: A Souvenir Issued on the Occasion of the Louisville Board of Trade Luncheon on March 9th, in Honor of Firms that have been in Business Fifty Years or More.* C. T. Dearing Printing Company and John T. Morton Company, Louisville.

Stealey, George
1837 Report of Examinations Made for Hydraulic Lime on the Kentucky River. *Journal of the Senate of the Commonwealth of Kentucky.* In "An account of the Finances of the Board of Internal Improvement Up to and Including the 20th November, 1837", pp. 175-176. A. G. Hodges, Frankfort, Kentucky.

Stealey, M. R.
1837 Report of the Resident Engineer on the Kentucky River Navigation. *Journal of the House of Representatives of the Commonwealth of Kentucky*. A. G. Hodges, Frankfort, Kentucky.

Steers, Dorothy Donnell
1984 *Simpson County, Kentucky 1850 Census and Tax List*. Printers, Inc., Franklin, Kentucky.

Sullivan, Gwynette Turner and Aileen Wilson McKinley
1988 *The 1860 Census of Taylor County, Kentucky*. Taylor County Historical Society, Campbellsville, Kentucky.

The Clay City Times
1904 News item concerning Richard Noel's new lime business in Powell County. *The Clay City Times*, April 21, 1904, Clay City, Kentucky.

1905 Ad for R. S. Noel's Black Creek Lime Works in Powell County. *The Clay City Times*, November 23, 1905, Clay City, Kentucky.

1934 News item concerning Hardin Kennon's lime kiln in Powell County. *The Clay City Times*, March 8, 1934, Clay City, Kentucky.

The Inter-State Directory Company
1908 *The Inter-State Directory Company's Directory of Frankfort and Franklin County Gazetteer For the Year 1908*. The Inter-State Directory Company, Marion, Indiana.

The Kentucky Gazette
1799 Ad by J. R. Shaw for Lime in Lexington. *The Kentucky Gazette* 12 (No.635):4.

1808 Ad concerning lime for sale at the estate of Thomas Royle. *Kentucky Gazette*, Tuesday May 10, 1808, page 4, Lexington.

Thomas, Gladys Cothan
1979 *1850 Census of Casey County, Kentucky*. Bicentennial Heritage Corporation, Liberty, Kentucky.

Thompson, Donna Stark
1985a *1850 Census Trimble County, Kentucky With Mortality Schedule*. Privately printed, Frankfort.

1985b *1860 Census Trimble County, Kentucky With Mortality Schedule*. Privately printed, Frankfort.

1988 *1870 Census Trimble County, Kentucky With Mortality Schedule*. Privately printed, Frankfort.

Thompson, Donna and Violet Jennings
n.d. *1880 Census Trimble County, Kentucky*. Trimble County Historical Society, Pendleton, Kentucky.

Thompson, Rita Adkisson
1973 *Meade County, Kentucky Cemeteries, Volume I.* Ancestral Trails Historical Society, Vine Grove, Kentucky.

United States Federal Census
1850a Manufacturing Census Schedules for the Seventh Census of the United States: Fayette County, Kentucky. Microfilm on file at the Kentucky Department of Library and Archives, Frankfort.

1850b Manufacturing Census Schedules for the Seventh Census of the United States: Kenton County, Kentucky. Microfilm on file at the Kentucky Department of Library and Archives, Frankfort.

1850c Manufacturing Census Schedules for the Seventh Census of the United States: Trigg County, Kentucky. Microfilm on file at the Kentucky Department of Library and Archives, Frankfort.

1850d Population Schedules for the Seventh Census of the United States: Greenup County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1850e Population Schedules for the Seventh Census of the United States: Hardin County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1850f Population Schedules for the Seventh Census of the United States: Marshall County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1850g Population Schedules for the Seventh Census of the United States: Pulaski County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1850h Population Schedules for the Seventh Census of the United States: Shelby County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1850i Population Schedules for the Seventh Census of the United States: Trigg County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1850j Population Schedules for the Seventh Census of the United States: Woodford County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1860a Population Schedules for the Eighth Census of the United States: Greenup County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1860b Population Schedules for the Eighth Census of the United States: McCracken County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1860c Population Schedules for the Eighth Census of the United States: Marshall County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1860d Population Schedules for the Eighth Census of the United States: Powell County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1860e Population Schedules for the Eighth Census of the United States: Pulaski County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1860f Population Schedules for the Eighth Census of the United States: Shelby County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870a Manufacturing Census Schedules for the Ninth Census of the United States: Greenup Kentucky. Microfilm on file at the Kentucky Department of Library and Archives, Frankfort.

1870b Manufacturing Census Schedules for the Ninth Census of the United States: Hardin Kentucky. Microfilm on file at the Kentucky Department of Library and Archives, Frankfort.

1870c Population Schedules for the Ninth Census of the United States: Boone County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870d Population Schedules for the Ninth Census of the United States: Breckinridge County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870e Population Schedules for the Ninth Census of the United States: Greenup County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870f Population Schedules for the Ninth Census of the United States: Livingston County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870g Population Schedules for the Ninth Census of the United States: Lyon County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870h Population Schedules for the Ninth Census of the United States: McCracken County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870i Population Schedules for the Ninth Census of the United States: Marshall County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870j Population Schedules for the Ninth Census of the United States: Montgomery County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870k Population Schedules for the Ninth Census of the United States: Pulaski County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870l Population Schedules for the Ninth Census of the United States: Scott County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870m Population Schedules for the Ninth Census of the United States: Shelby County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870n Population Schedules for the Ninth Census of the United States: Trigg County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870o Population Schedules for the Ninth Census of the United States: Union County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870p Population Schedules for the Ninth Census of the United States: Warren County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1870q Population Schedules for the Ninth Census of the United States: Woodford County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880a Manufacturing Census Schedules for the Tenth Census of the United States: Jefferson County, Kentucky. Microfilm on file at the Kentucky Department of Library and Archives, Frankfort.

1880b Population Schedules for the Tenth Census of the United States: Anderson County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880c Population Schedules for the Tenth Census of the United States: Boone County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880d Population Schedules for the Tenth Census of the United States: Bourbon County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880e Population Schedules for the Tenth Census of the United States: Campbell County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880f Population Schedules for the Tenth Census of the United States: Casey County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880g Population Schedules for the Tenth Census of the United States: Fleming County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880h Population Schedules for the Tenth Census of the United States: Greenup County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880i Population Schedules for the Tenth Census of the United States: Livingston County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880j Population Schedules for the Tenth Census of the United States: Lyon County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880k Population Schedules for the Tenth Census of the United States: McCracken County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880l Population Schedules for the Tenth Census of the United States: Marshall County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880m Population Schedules for the Tenth Census of the United States: Menifee County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880n Population Schedules for the Tenth Census of the United States: Montgomery

County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880o Population Schedules for the Tenth Census of the United States: Powell County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880p Population Schedules for the Tenth Census of the United States: Scott County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880q Population Schedules for the Tenth Census of the United States: Shelby County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880r Population Schedules for the Tenth Census of the United States: Trigg County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880s Population Schedules for the Tenth Census of the United States: Union County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880t Population Schedules for the Tenth Census of the United States: Warren County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880u Population Schedules for the Tenth Census of the United States: Woodford County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1900 Population Schedules for the Twelfth Census of the United States: Greenup County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

Vanderpool, Montgomery

n.d. *1870 Logan Co. KY Census*. Privately printed, Russellville, Kentucky.

Vockery, Bill and Kathy Vockery

1990 *1850 Federal Census of Jessamine County*. Privately printed, Richmond, Kentucky.

1994a *1860 Federal Census of Jessamine County*. Privately printed, Richmond, Kentucky.

1994b *1860 Federal Census of Madison County*. Privately printed, Richmond, Kentucky.

Walker, Odell

1994 *Profiles of the Past: A Collection of Writings From Lyon County's Historian*. McClanahan Publishing House, Kuttawa, Kentucky.

Watson, Michael C.

1988 *1860 Census of Adair County, Kentucky*. Adair County Genealogical Society. Printing Creations, Inc., Columbia, Kentucky.

Webb, Donna Jean

1993 *1870 Federal Census Mercer County, Kentucky*. Privately printed, Lexington, Kentucky.

1994 *1880 Federal Census Mercer County, Kentucky*. Privately printed, Lexington, Kentucky.

Welch, Earl G. and James B. Kelly
1924 Plans and Specifications for Building and Burning a Lime-Kiln. In *Circular No.* 174, pp. 10-13. University of Kentucky, College of Agriculture, Extension Division, Lexington.

Wieck, Dorothy L.
1983 *1860 Census Index for Kenton County, Kentucky.* Kenton County Historical Society, Covington.

1986 *1870 Census Index for Kenton County, Kentucky.* Kenton County Historical Society, Covington.

1987 *1850 Census Index for Kenton County, Kentucky.* Kenton County Historical Society, Covington.

1996 *Kenton County, Ky. Census of 1880.* Kenton County Historical Society, Covington.

West-Central Kentucky Family Research Association
1978 *Logan County, Kentucky 1850 Census.* West-Central Kentucky Family Research Association, Owensboro. McDowell Publications, Hartford, Kentucky.

Whitis, Alma Coffey
1990 Wayne County, Kentucky 1880 Census. Privately printed.

Willhite, A. B.
1996 *Christian County Kentucky 1900 Federal Census.* Privately printed, Russellville, Kentucky.

n.d.a *Simpson County Kentucky 1860 Federal Census.* Privately printed, Russellville, Kentucky.

n.d.b *Simpson County Kentucky 1870 Federal Census.* Privately printed, Russellville, Kentucky.

n.d.c *Simpson County Kentucky 1880 Federal Census.* Privately printed, Russellville, Kentucky.

n.d.d *Todd County Kentucky 1850 Federal Census.* Privately printed, Russellville, Kentucky.

n.d.e *Todd County Kentucky 1860 Federal Census.* Privately printed, Russellville, Kentucky.

n.d.f *Todd County Kentucky 1870 Federal Census.* Privately printed, Russellville, Kentucky.

Williams & Co.
1864 *Williams' Lexington City Directory for 1864-5.* Williams & Co., Lexington.

1880 *Williams' Covington and Newport Directory, Including Dayton, Bellevue and*

Ludlow, Ky. Cincinnati Business Directory for 1880-1881. Williams & Co., Cincinnati, Ohio.

1881 *Williams' Lexington City Directory for 1881-82.* Williams & Co., Lexington.

Willis, Laura
1996 *Christian County, Ky, Census of 1870.* Christian County Genealogical Society, Hopkinsville. Simmons Historical Publications, Melber, Kentucky.

Wilson, DeWayne
1992 *1870 Census of Taylor County, Kentucky.* Privately printed, Campbellsville, Kentucky.

1994 *1880 Census of Taylor County, Kentucky.* Privately printed, Campbellsville, Kentucky.

Wilson, Dona Adams
2001 *Woodford County, Kentucky 1860 Census.* Woodford County Historical Society, Versailles, Kentucky. Printed by Lynn Blue Print, Lexington, Kentucky.

Workman, Velma Ballard
1984 *Lee & Letcher County, KY 1870 Census Record.* Published by G & H Enterprise, Minden City, Michigan.

Wright, Joan J.
1981 *Bullitt County, Kentucky 1850 Census.* Ancestral Trails Historical Society, Vine Grove. Printed by McDowell Publishing Company, Owensboro.

Wright, Joan J. and Patricia Dodson
n.d. *Bullitt County, Kentucky 1860 Census.* The Pioneer News, Shepherdsville, Kentucky.

Young & Company
1906 *Business Professional Directory of the Cities and Towns of Kentucky.* Young & Company, Atlanta.

HISTORIC LIME PRODUCTION IN THE LOWER CUMBERLAND RIVER VALLEY, LIVINGSTON COUNTY, KENTUCKY

By

Charles D. Hockensmith
Kentucky Heritage Council
Frankfort, Kentucky

ABSTRACT

In this paper two historic lime kilns located near Lemen Landing in Livingston County, Kentucky are described. The kilns are thought to date between the mid and late 19th century. Both kilns are vertical shaft kilns designed for intermittent use. Brief overviews of the manufacture of lime and the uses of lime are provided. Further, a summary of known Kentucky lime kilns is included. Pertinent archaeological and historical literature about lime kiln research is reviewed to provide a broader context. The archaeological remains associated with the Lower Rudd Lime Kiln and the Upper Rudd Lime Kiln are described. After brief comparisons of the Rudd kilns to other lime kilns, a few summary remarks are presented.

INTRODUCTION

The Rudd Lime Kilns are located on the south bank of the Cumberland River near Lemen Landing northwest of Vicksburg in Livingston County, Kentucky. Geologist Boyce Moodie of Paducah, Kentucky discovered the Lower Rudd Lime Kiln (15Lv226) during a fishing trip in 1993. On May 6, 1993, the author accompanied Mr. Moodie to the site. Since the base of the kiln was under water at the time of their visit, a second trip was made by the author on July 9, 1993 to complete the fieldwork. Five years later, Mr. Moodie discovered a second lime kiln in the same vicinity that was designated the Upper Rudd Lime Kiln (15Lv227). The author documented the Upper Rudd Lime Kiln on October 29, 1998. During this trip, the Lower Rudd Lime Kiln was revisited. During the field work, both kilns were measured, drawn in plan view, drawn in profile, and were documented with photographs.

Unlike habitation sites, historic mineral extractive and processing sites, such as lime kilns, are not randomly scattered across the countryside. By necessity, these site types are located at, or very near, the mineral resource being exploited. Minerals are often restricted to faults or geological deposits with very limited surface exposures. Also, these processing sites have to be close to an economical mode of transportation to be feasible to ship the product to available markets. Consequently, researchers must consider these factors when locating or interpreting mineral extractive and processing sites.

The locations of the Upper and Lower Rudd Lime Kilns are closely linked to the outcropping of a high calcium limestone and to the Cumberland River. Geologist Boyce Moodie (personal communication, 1998) observed that the hill at Lemen Landing is the only place where high calcium limestone outcrops immediately adjacent to the Cumberland River in the Lower Cumberland River Valley. There are several fault systems in the vicinity of Lemen Landing (Amos 1974). The Latrobe Fault System follows the southern and eastern edge of the St. Geneive Limestone (Amos 1974). This limestone usually occurs much lower in the geological sequence than the other rock types exposed along the Lower Cumberland River. However, the fault system has pushed the St. Geneive Limestone to the surface near Lemen Landing. The Fredonia Limestone Member is exposed on most of the hill containing the lime kilns while a small amount of the Rosiclare Sandstone Member is exposed on the higher elevations of the hill (Amos 1974). The Rosiclare Sandstone provided a source of raw material for lining the kilns. Further, the outcropping of a high calcium limestone at Lemen Landing made this a very desirable location for manufacturing lime since it could be easily shipped by boat on the Cumberland and Ohio rivers.

Kentucky geologists have noted the quality of high calcium limestone in the Lower Cumberland, Tennessee, and Ohio River valleys. Dever (1969:9) studied these limestones "...to point out the occurrence of limestone deposits of sufficiently high chemical purity to meet the specifications for a number of metallurgical, chemical, and special industrial uses." Among other uses, Dever (1969:9) noted that "these pure limestones, generally referred to as high-calcium limestones, may be utilized as raw material for the production of lime...". In his discussion about Livingston County, Dever (1969:73) stated that "several fault blocks [are] located on the south side of the Cumberland River: in the drainage of Sugar Creek and Hickory Creek, on the north side of Dunn, and at the north end of Vick Hill (Burna quadrangle)." The Upper and Lower Rudd Lime Kilns are located at the north end of Vick Hill where this limestone occurs closest to the Cumberland River. Situated in western Kentucky, Livingston County is located in the western Pennyroyal region.

In the first part of this paper, a general context is established for the lime industry. A brief overview is provided about how lime is manufactured and the various uses that have been found for lime. Next, references to lime kilns mentioned in the Kentucky archaeological literature and other reported examples are discussed. A discussion of the archaeological and historical literature about lime kilns in other states follows. The archaeological remains associated with the Lower Rudd Lime Kiln and the Upper Rudd Lime Kiln are described in detail in the subsequent sections. A discussion section briefly compares the Rudd Lime Kilns to other lime kilns. I conclude the paper with some brief summary remarks.

THE MANUFACTURE OF LIME

Much has been written about the manufacture of lime in the United States. Available literature includes federal publications (Burchard 1914; Department of Commerce and Labor 1911; Emley 1914), books (Azbe 1946; Burnell 1870; Eckel 1928; Gillmore 1874; Jones 1942; Searle 1935), volumes published by individual state geological surveys (Ault, Rooney, and Palmer 1974; Blatchley 1904; Buehler 1907; Jacobs 1918; Matthews and Grasty 1910; Orton and Peppel 1906; Ries 1903), and various other studies (Briggs 1969; Grindle 1971; Long 1966; Robinson 1976; Wall 1969; West 1991; Williams 1952). A comprehensive literature overview is far beyond the space restrictions of this paper. Instead, a generalized overview of how limestone is quarried, prepared, and transported to the kiln is presented. Next, quotes are extracted from accounts that describe the design and function of lime kilns. This overview provides descriptions of early lime kilns including ground-hog kilns, pot kilns, vertical or shaft kilns, and flare kilns. These are all simple lime kilns that are similar to the Rudd Lime Kilns.

The initial step of lime manufacture was quarrying the limestone. After the overburden was removed, holes were drilled and the limestone was blasted into large pieces (Emley 1914:1559-1562; Emley and Porter 1927:14-16; Orton and Peppel 1906:263). The larger blocks of limestone were blasted into smaller fragments, sorted, loaded, and transported to the kiln (Emley and Porter 1927:16-19). The limestone was transported by wheelbarrow, horse and cart or by tram cars to the kiln (Emley 1914:1562-1563; Emley and Porter 1927:18; Orton and Peppel 1906:264-265). Once at the lime kiln, the limestone had to be dumped or charged into the top of the kiln. Different types of kilns, transportation systems, and dumping strategies were used depending on local conditions and the amount of lime required. The method of charging was also dependent on whether a kiln was an intermittent or continuous type. Eckel (1928:100) stated that "intermittent kilns are those in which each burning of a charge constitutes a separate operation. The kiln is charged, burned, cooled, and the charge is drawn; then the kiln is again charged, and so on." On the other hand, in a continuous kiln, limestone and fuel are added as needed while the lime is drawn from the bottom (Eckel 1928:102). The continuous kiln permits constant operation for an extended period of time.

Indiana State Geologist W. S. Blatchley (1904:225-226) provided a description of a "ground-hog" (Figure 1) or early vertical shaft kiln in his study entitled *The Lime Industry in Indiana*:

> The kilns used at local points for burning lime for neighborhood use are or were intermittent kilns of stone. In them the fire was allowed to go out after each burning, to be started again after the kiln was recharged with stone. These cheaper, temporary or "ground-hog" kilns were rudely constructed of stone, and were located on the side of a hill, so that the top was easily accessible for charging the kiln with stone, and the bottom for supplying fuel and drawing out the lime. In charging, the largest pieces of limestone were first selected and formed into a rough, dome-like arch with large open joints springing from the bottom of the kiln to a height of five or six feet. Above this arch the kiln was filled with fragments of limestone from the top, the larger pieces being used in the lower layers, these being topped off with those that were smaller. A fire of wood was then started under the dome, the heat being raised gradually to the required degree in order to prevent a sudden expansion and consequent rupture of the stone forming the dome. Should this happen, a downfall of the entire mass above would take place, thus putting out the fire and causing a total loss of the contents of the kiln. After a bright heat was once reached through the mass of stone, it was maintained for three or four days to the end of the burning. This was indicated by a large shrinkage in the volume of the contents, choking up of the spaces between the fragments and the ease with which an iron rod could be forced down from the top. The fire was then allowed to die out and the lime was gradually removed from the bottom. It was in this manner that all the lime used in Indiana for many years was burned, and in some localities these temporary intermittent kilns are still in operation. The process of burning is simple and cheap, the only expense being for blasting the stone and preparing the fuel. Possibly but one or two kilns were necessary to supply a neighborhood for a year. These were burned in a week or two when required, the kiln remaining idle for the remainder of the time.

In 1911, the Department of Commerce and Labor (1911:5) noted that there were three types of lime kilns in operation. They include:

> ...the pot kiln, the patent kiln, and the rotary kiln. All consist essentially of shafts lined with fire brick. The stone is fed in at the top and the lime drawn out at the bottom. In the pot kiln fuel is fed in with the stone in alternate layers; the patent kiln

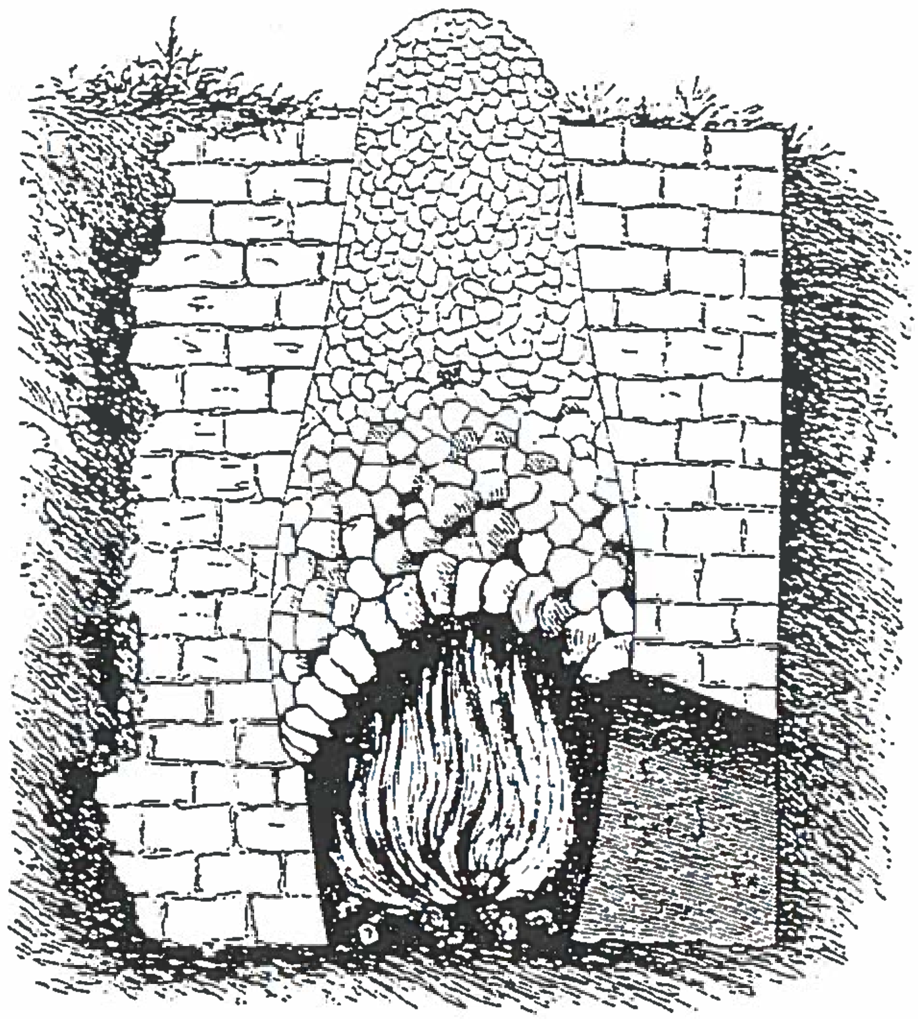


Figure 1. An old fashioned "ground-hog" or temporary lime kiln (From Blatchley 1904:225, Figure 1). Reproduced courtesy of the Indiana Geological Survey, Bloomington.

is provided with external fire boxes, so that only the gases of combustion come into contact with the stone; the rotary kiln is of the ordinary type used in the cement industry. Of the three, the patent kiln is much the best for the production of lime, because where fuel is in actual contact with the stone the ashes of the fuel will contaminate the lime produced. This objection does not, of course, apply to rotary kilns fired with gas.

Lazell (1915:24) provided a brief description of intermittent "pot kilns" as follows:

> Intermittent kilns, usually called "pot kilns," are those in which each burning of a charge constitutes a separate operation. The kiln is charged, burned, cooled, and then drawn. After completing the cycle, the kiln is recharged for another burning. Such a kiln often consist of a crude shaft excavated in the side of a hill; the interior of the shaft being lined with larger stones of the same material as those to be burned. At the bottom of the shaft, there is a horizontal passage to the outside. At the place where the horizontal passage meets the vertical shaft, an arch of limestone is made, and on top of this, more limestone is placed until the shaft is completely filed. A fire is then built under the arch, and the burning is continued until the stone is thoroughly calcined.

By 1927, Emley and Porter (1927:21-22) noted that there were two major types of kilns: vertical kilns and rotary kilns. They indicated that the vertical kilns or shaft kilns could be divided into six types according to the outline of the kiln (Emley and Porter 1927:25). Since rotary kilns are the most modern type, they are not discussed in detail. Vertical kilns or shaft kilns were described by Emley and Porter (1927:22-23) as follows:

> In general, a shaft kiln resembles a short wide stack of either square, round, or elliptical cross section. It consists of a casing of steel or stone which is lined with refractory material. The long vertical chamber formed by this lining may be divided into three compartments by imaginary planes. The top compartment, called the hopper, is used for storing and preheating the stone. Its sides slope in so that the stone may slide down into the middle compartment, the shaft. This shaft is the place where the lime is burned. It may be of either square, round, or elliptical cross section independently of the outside of the kiln. Generally, the sides of the shaft are vertical, although in some cases they slope outward. In this latter method of construction it is customary to omit the hopper. At the bottom of the shaft the third compartment or cooler is used for storing the lime after it is burned. The top of the cooler must, of course, have the same cross section as the shaft. The sides are drawn in to form a slide leading to the drawing door. A hole in the side or bottom of the cooler is closed by a door or by sheets of iron which swing on a pivot and are known as shears. The lime is removed through this opening. The fuel used in burning the lime is consumed in the fire boxes usually arranged on two sides of the kiln. They are very similar to the common fire boxes in use under boilers. Each kiln has two or more which are set in openings through the casing and lining into the lower part of the shaft. In this paper the level of the grates in the fire box will be considered the bottom of the shaft, it being assumed that lime is not burned below this point. Whether or not this assumption is valid has not been demonstrated. In either case the draft caused by the combustion of the fuel draws the flame up through the shaft in direct contact with the lime and stone and the gases formed pass out the top of the hopper.

An excellent discussion of lime kilns is found in Searle's (1935:270-394) well illustrated chapter in his book *Limestone & Its Products: Their Nature, Production, and Uses*. Searle (1935:270-273) discussed two types of intermittent kilns (flare kiln and field kiln) and three types of continuous kilns (vertical of shaft kilns, horizontal kilns, and rotary or inclined kilns). The vertical shaft kilns can be divided into two main classes: mixed feed kilns and separate feed kilns (Searle 1935:280-368). Horizontal lime kilns can be divided into two types: ring or Hoffman kilns and tunnel kilns (Searle 1935:368-375). Rotary kilns are comprised of long steel cylinders, nearly horizontal but titled, which slowly turn as the stone is heated (Searle 1935:375-381). Of the kilns described by Searle, the intermittent kiln is most similar to those in Livingston County. The early kilns were described by Searle (1935:271-272) as follows:

> At one time, in many parts of the country each large farm had its own kiln, which was usually a solid stone structure built against a hill so that a cart could fill the stone into the top of the kiln. These kilns were usually 20 ft. deep, round inside, about 6 ft. diameter at the top, widening out for about 6 ft. until 7 ft. diameter and then contracting to about 2 ft. x 18 in. at the bottom where there is an opening in the side about 18 in. square (the "eye" or draw-hole).

The more formal flare kilns were described by Searle (1935:271) as follows:

> In a flare kiln (fig. 58), a rough cylindrical or similar structure is built of stone at the side of a hill or embankment, so as to permit of easy access to the top, whilst an arched opening, about 4 ft. high, in the front of the kiln enables the fire to be replenished and the burned lime to be withdrawn. The height of such a kiln is usually twice its greatest diameter, the opening in the top being one-third the greatest internal diameter of the kiln, and the opening for the fire about one quarter the greatest diameter.

THE USES OF LIME

Limes produced from different limestones have different chemical properties and thus different uses. Before proceeding further, it is appropriate to discuss the general properties of lime. The Department of Commerce and Labor (1911:6) stated that:

> lime is merely limestone from which the carbon dioxide has been removed by heat... The wide variation in the chemical and physical properties of limestones necessitates a similarly great difference in the kinds of lime. Therefore, some system of classification becomes necessary. The National Lime Manufacturers Association has officially adopted a classification based on the content of magnesia ...[high-calcium lime, magnesian lime, dolomitic lime, and super-dolomitic lime]... There are, however, several properties which are common to all limes in a greater or less degree. Thus it may be said that lime is a white or nearly white substance which will slake when water is added to it. When lime slakes, it enters into chemical combination with water. This reaction generates heat, and is accompanied by an increase in volume.

Once the lime is ready for sale, it sold as lump lime or ground lime. The Department of Commerce and Labor (1911:7) noted that:

> Lump lime is shipped in bulk, or in wooden barrels holding from 100 pounds to 300 pounds. Ground lime is lump lime which has been ground and screened generally through 60 mesh. It is shipped in air-tight iron casks holding about 400 pounds.

After the lime has been slaked, it is sold under the name "hydrated lime" which is "...a fine, dry powder, consisting of calcium hydrate and magnesium oxide..." (Department of Commerce and Labor 1911:9). Hydrated lime was sold in bags ranging from 40 to 100 pounds and various grains sizes between 10 and 200 mesh (Department of Commerce and Labor 1911:9). There were several advantages to using hydrated lime including a lack of danger in spoiling during slaking, it kept better, it posed no danger of fire, and was ready to use by just adding water (Department of Commerce and Labor 1911:9).

The various types of limes were used in many industries. Searle (1935:531-532) listed and defined many types of lime for different uses: agricultural lime, air slaked lime, caustic lime, chalk lime (gray and white), chemical lime, clot lime, cob lime, dolomitic lime, fat lime, greystone lime, ground lime, hydrated lime, hydraulic lime, lean lime, lime putty, lump lime, magnesian lime, meagre lime, plaster lime, poor lime, pot lime, quick lime, run of kiln lime, screened lime, selected lime, shell lime, slaked lime, and Vienna lime. In the building trade, lime was in mortar, plaster, Portland cement, natural cement, and as a major ingredient in sand-lime bricks (Department of Commerce and Labor 1911:10-14; Emley 1914). Many industries used lime as an ingredient or an additive to cause chemical reactions in their products. Products and industries using lime include glass, ceramics, water purification, soda ash, caustic soda, bleaching powder, calcium carbide, illuminating gas, ammonia, calcium cyanamide, calcium nitrate, fertilizer, insecticides, sugar, distillation of wood, paper, paints, glycerin, lubricants, candles, and leather tanning (Department of Commerce and Labor 1911:13-20; Emley 1914). Hitchcock et al. (1861:746-747, cited in Rolando 1992:213) listed a number of uses for lime in the 1860s:

> [To] clarify the juice of sugar cane, generate heat and absorb the volatile gases in a compost heap; to purify the coal gas that illuminates our cities, bleach the rags of the papermaker and the cotton and linen fabrics of the manufacturer; to render potash and soda caustic in the soap manufacture, and used in water to restore health to the invalid; to free the hide from hair in the tanner's vat, and when mixed with litharage to dye the gray whiskers of the bachelor; to stop the stench that might arise from the slaughter-house, and to aid the chemist in his researches; and were the soil deprived of it entirely, large tracts of country now supporting luxuriant vegetation would become desolate and barren wastes.

Searle (1935) mentioned some additional uses of lime not mentioned above. These include lime used in the abrasive and polishing industries, in firebricks, road pavements, in chemical industries, in the manufacture of dyes, in the distilling industries, in coke and gas manufacture, in the explosive industries, in the food industries, in fuels, in furnace construction, in glass and gelatin manufacture, leather manufacture, in medicine, in metallurgy, in refining non-edible oils and lubricants, in petroleum refining, in pottery glaze and enamel industries, in the rubber and resin industries, in sanitation, in the textile industries, and in water purification and softening (Searle 1935:533-681). Searle (1935:533-681) provided many specific uses under the industries listed above as well as those covered by other authors.

KENTUCKY LIME KILNS

Lime kilns represent a poorly documented site type in Kentucky. Only a few references to lime kilns exist in the archaeological literature and no kilns have been excavated in the Commonwealth. Site 15Md176, within the former community of Garnettsville at Fort Knox, was interpreted as a lime kiln by Donald B. Ball (1991:168). Ball (1991:168) stated that:

> The large, prominent semi-circular wall near the center of the site most closely resembles the lower masonry levels of a circular "groundhog" limekiln. Indeed, when standing in the interior of this concavity, one may readily observe that the interior of the rough stone walls are not plumb but uniformly angle slightly inward. This angulation appears to be too consistent to have been caused by soil slump alone. Likewise in common with known limekilns, the excavation into the adjacent terrace formation would have produced a perfect work area for off-loading an obviously heavy commodity like large chunks of limestone into a top-loading kiln.

Granger and Bader (1989) observed three lime kilns during an archaeological survey at Carver's Lake on Upper Paradise Bottom in Meade County, Kentucky. They stated that:

> ...in the Carver's Lake portion of Upper Paradise Bottoms some light quarry activity was taking place in the nineteenth century for lime production. Three ruined dry-laid stone circular lime kilns were found on the lower bluff slopes between Project Area A and Project Area B (Granger and Bader 1989:VIII-2).

Since the above lime kilns were outside the project area, the investigators were not allowed to documented them. Donald B. Ball and the author had an on-site meeting for this project with Dr. Joseph Granger in 1989. During the meeting we had an opportunity to view these kilns. Ball (1991:169) mentioned that these kilns were about four miles (6.4 km) down stream from Battletown and were ca. 20 feet (6 m) in height. The author remembers these kilns as substantial silo-shaped stone structures built into the side of a steep slope near the base of a steep hill overlooking the Ohio River floodplain. The tops of the kilns were easily reached from the upper slope while the bases were easily accessible from the lower slope. Small arches were present on the lower sides of these kilns for firing and removing the lime.

Other lime kilns have been mentioned by Donald Ball (1991:169). These include the following:

> At least two limekilns (possibly fired by natural gas around 1900) stand near the former community of Rock Haven (Meade County, Kentucky) near the confluence of Otter Creek and the Ohio River just a few miles north of the site 15Md176 example. ...One additional example (in ruins) is situated about one mile down stream of Mauckport, (Harrison County) Indiana: this site is located across the Ohio River from Meade County. ...

On March 18, 1999, the author and John T. Carter visited the ruins of the Rockcastle Lime and Cement Plant at near Pine Hill. The ruins are situated in Lime Plant Hollow at Pine Hill which is ca. 3.5 to 4 miles east-southeast of Mount Vernon off State Highway U.S. 25. Surviving concrete foundations are associated with a large (two to three stories high) structure that housed the equipment. These remains are still in a good state of preservation. Large iron bolts are embedded in the top of the foundations where equipment was secured. The company produced lime, cement, crushed stone, fertilizer, and other products. A visual inspection of the ruins by the author revealed the presence of some sheet metal fragments, fire bricks, and fire brick fragments. None of the fire bricks examined contained brand names. These brick fragments were identified as modern wire-cut stiff-mud specimens. The archaeological remains have not been documented.

Two additional lime kilns came to the author's attention during November of 2000. The first kiln, the Shrull Lime Kiln (15Lo210) is located on the southwestern edge of Russellville in Logan County, Kentucky (Shrull and McIntosh 2000). This massive rectangular stone structure is within an old abandoned limestone quarry (Hockensmith n.d.). The author documented this site on April 18, 2002 (Hockensmith n.d.). The Shrull Lime Kiln is located at the western end of the quarry and the north side of the kiln is built into a low cliff. A ramp extending to the north provided easy access to the top of the kiln for filling it with limestone. The kiln measures 5.5 x 7.46 m (17 ft 9 inches x 24.5 ft) with a maximum height of 4.34 m (14 feet, 3 inches). The arch is 2.26 m (7.5 feet) high in the front and 2.2 m (7 feet 3.5 inches) wide at the base. The passage from the front of the arch to the rear extends a distance of 2.55 m (8 feet 4.5 inches). The interior of the kiln has round shaft that is lined with sandstone slabs. The interior diameter of this filled in shaft is 3.4 m (11 feet 2 inches). The associated quarry area measures approximately 50 m (164 feet) east-west and 21 m (68 feet 11 inches) north-south. The area east and immediately north of the kiln has been excavated to the same level as the base of the kiln.

The Cowherd Lime Kiln (15Gn41) is located in Green County, southwest of the community of Bengal (Bryan Cowherd, personal communication 2000). This kiln was documented by the author on November 19, 2001 (Hockensmith 2004). The rectangular lime kiln was constructed from quarried limestone slabs and built into the side of a low cliff. The kiln is 3.7 m (12.21 feet) tall and measures 5.8 m (19.14 feet) by 4.9 m (16.17 feet) at the top. A small arch is present on the lower side of the kiln. The kiln has been on Cowherd family property for over 200 years.

In March of 2003, Charles D. Hockensmith and Richard Brown (a Meade County native) initiated a research project focusing on the archaeological study of the lime industry in Meade County, Kentucky. Archival research indicates that Meade County was one of the major lime production areas in Kentucky. The initial field work explored a portion of the Cedar Branch Hollow drainage and looked at one kiln along the Ohio River near Brandenburg. Cedar Branch Hollow is a small tributary of the Ohio River in northwestern Meade County. This drainage is in the same portion of Meade County as the kilns observed by Granger and Bader (1989:VIII-2) 14 years earlier. Three days of fieldwork identified 20 lime kilns in the Cedar Branch Hollow drainage. Once the drainage system is comprehensively surveyed, it is expected that there could be as many as 40 lime kilns along this stream and its tributaries.

All the lime kilns recently observed in the Cedar Branch Hollow drainage are circular in shape. These kilns can be roughly placed into three groups: simple pits, pits with stone walls in the front, and one sandstone silo-shaped kiln. The simple pits are usually excavated into the edge of benches adjacent to streams or located near the edge of low bluffs. An opening or low area in the pit is usually present on the down hill side of the kilns. Limestone and sandstone slabs are commonly present on the slope below the kilns suggesting that the openings were once enclosed with a low stone wall. Sometimes a few stacked stones are visible in the bottoms of these openings. It is thought that these low stone walls had arches built into them for firing and extracting the lime. They range in size from 4 x 4.2 m to 6 x 6.3 m with depths ranging from 0.8 to 2 m. The slopes below the kilns are often littered with burned limestone, ash, charcoal, and slag. The stream beds near the kilns frequently contain large amounts of slag and burned limestone. A few of these kiln pits have been discovered on the floodplain where the excavated soil was piled up to create a berm around the periphery of the pit.

One side of these floodplain kilns is lower and slabs are often present in the bottom of these openings or scattered nearby. Up slope from all the kilns are limestone outcrops of varying heights and lengths.

The second kiln type is more substantial than the simple pits. These pits are typically deeper and have intact curved sandstone walls across their fronts or down hill sides. The tops of buried arches are sometimes visible at the bottom of the interior stone walls in these pits. The interior walls are usually coated with a green glassy glaze. These intact walls and the heavy glazing suggest that these kilns were designed for repeated firings while the simple kilns were for more limited use. Only two of the four kilns of this type have been measured to date. They range in size from 5 x 5.1 m to 6.3 x 6.7 m with depths ranging from 1.4 m to 2 m. These kilns are also associated with larger outcrops of limestone, which are just up slope.

Only one example of the silo-shaped lime kiln has been documented in the Cedar Branch Hollow drainage thus far. This kiln is a substantial sandstone structure, situated on a bench adjacent to the stream, was designed for major lime production. It is 3.2 meters in diameter and is 3.45 meters deep. This kiln undoubtedly had an arch on the lower side but this area (both interior and exterior sides) was covered by rubble. The kiln was completed lined with sandstone slabs. Red clay is visible behind some of the stone walls and may have served as insulation. The interior walls are coated with a thick green glassy glaze suggesting multiple firings of the kiln. A cliff 3-4 meters high is located a short distance up slope from the kiln. Irregular pits and spoil piles are located along the base of the cliff which suggests extensive quarrying of this limestone for commercial lime production.

Charles Hockensmith and Richard Brown (2004) documented the Pace Lime Kiln in March of 2003. The kiln is located just west of Brandenburg on the Ohio River. This rectangular stone structure is located at the base of a high bluff. The kiln measures 6 x 6.4 m and has a maximum wall height of 2 m. A small arch is located on the down hill side of the kiln. The only visible limestone outcrop is located high above the kiln near the top of the bluff. There may have been limestone outcrops that were closer but were covered by soil eroding down the steep slope after the kiln was abandoned.

During the past 25 years, the author has seen several lime kilns and has been told about others that are not recorded. In 1978, the author recorded a possible lime kiln in the Raven Run Nature Sanctuary in southern Fayette County (Hockensmith 1979). This structure is 15 feet (4.5 m) long, 12 feet (3.6 m) wide, and over 11 feet (3.3 m) high (Hockensmith 1979:65). It is crescent shaped with an arched opening at each end. While oral history suggests that this is a lime kiln, the shape is very different from other examples. The author and Dr. R. Berle Clay looked at another lime kiln in northern Fayette County in the 1980s. The kiln is on the south side of Elkhorn Creek and a few hundred meters west of Mt. Horeb Road. It was a small circular silo-shaped structure built into the side of the steep creek bank. A small arched opening was present at the base on the down stream side of the kiln. It is remembered as being approximately 8 feet (2.4 m) high and about 6 feet (1.8 m) in diameter. It was probably a farm kiln for producing agricultural lime. Mr. A. G. McConnell reported another lime kiln to the author by during 1986. This kiln was located on Mr. McConnell's farm about 3.5 miles (5.6 km) west of Danville (Boyle County) and 495 feet (150 meters) north of KY 52 (A. G. McConnell, personal communication 1986). Unfortunately, a field trip was not made to the kiln.

The Black Creek Lime Works kiln is located in northern Powell County about 2.5 miles (4 km) north of Clay City (Larry Meadows, personal communication 1994). The kiln is just east of KY 11 and Black Creek. Constructed from shaped sandstone slabs, the kiln is rectangular in shape and measures approximate 12 by 15 feet (3.6 by 4.5 m) in size (Larry Meadows, personal communication 1998). Oral history indicates that the upper courses of stone from the kiln walls were used in road fill when the nearby White Rock Limestone Quarry opened in 1938. Former property owner, Mrs. Arch

Toler (95 years old in 1994) remembered that the kiln walls were about 8 feet (2.4 m) high (Larry Meadows, personal communication 1994). Ads in *The Clay City Times* (1905) suggests the kiln was operated between about 1904 and 1907 by R. S. Noel. The base of the kiln survives as an archaeological site but has not been documented yet.

Place names also offer clues on the location of other Kentucky lime kilns. In northern Jackson County, there is a Lime Kiln Fork and a Lime Kiln Ridge (Field 1961:144). There is also a Lime Kiln Road in northeastern Jefferson County (Field 1961:144). In southern Metcalfe County, there is a Lime Kiln Hill (Field 1961:144). A Limekiln Hollow is present in central Rowan County (Field 1961:144). Another place name, Limekiln Knob was found on the Lenox U.S.G.S. 7.5 Minute Quadrangle in Morgan County northeast of Lenox (United States Geological Survey 1977). Finally, the Lime Plant Hollow place name appears on the Mount Vernon U.S.G.S. 7.5 Minute Quadrangle in Rockcastle County (United States Geological Survey 1970).

STUDIES OF LIME KILNS IN THE EASTERN U. S.

Very limited attention has been given to lime kilns by American archeologists. A number of kilns have been documented during archaeological surveys. A few lime kilns have been excavated. Historians and other researchers have mentioned other lime kilns. In this brief overview of literature, those studies on lime kilns in the eastern U.S., that the author is currently aware of, are discussed first. The second portion of the overview mentions lime kilns in the western part of the U.S. Each discussion is organized alphabetically by state and chronologically within the state discussions. Undoubtedly, many other lime kilns have been recorded during CRM surveys but such reports are difficult to find in the so called "gray literature." Hopefully, as more research is conducted about lime kilns, researchers will summarize available CRM studies in their overviews.

Burchard (1914:1553-1555) provided a listing of lime producing states for 1913. The eastern states producing lime included: Alabama (Blount, Calhoun, Cobert, Dekalb, Etowah, Jefferson, Madison, and Shelby counties), Connecticut (Fairfield and Litchfield counties), Florida (Marion County), Georgia (Bartow and Walker counties), Illinois (Adams, Carroll, Cook, Kankakee, Madison, Rock Island, Whiteside, Will, and Winnebago counties), Indiana (Bartholomew, Carroll, Crawford, Harrison, Huntington, Jay, Jefferson, Lawrence, Ripley, and Washington counties), Kentucky (Breckinridge, Meade, Rockcastle, Scott, and Warren counties), Maine (Knox County), Maryland (Allegany, Baltimore, Carroll, Frederick, Garrett, Howard, and Washington counties), Massachusetts (Berkshire County), Michigan (Alpens, Arenac, Bay, Charlevoix, Cheboygan, Emmet, Mackinac, Menominee, Schoolcraft, and Wayne counties), Missouri (Calloway, Cape Girardeau, Cole, Cooper, Dade, Franklin, Greene, Jasper, Jefferson, Lawrence, Marion, Miller, Osage, Pettis, Pike, Ralls, St. Clair, St. Genevieve, St. Louis counties), New Jersey (Hunterdon, Somerset, Sussex, and Warren counties), New York (Albany, Clinton, Dutchess, Fulton, Genesee, Herkimer, Jefferson, Lewis, Livingston, Monroe, Niagara, Onondaga, Orange, St. Lawrence, Ulster, Warren, Washington, and Westchester counties), North Carolina (Columbus, Craven, Henderson, Swain, and Yadkin counties), Ohio (Belmont, Clark, Delaware, Erie, Greene, Hardin, Holmes, Marion, Montgomery, Ottawa, Preble, Sandusky, Seneca, Stark, Tuscarawas, Wood, and Wyandot counties), Pennsylvania (Adams, Armstrong, Bedford, Berks, Blair, Bucks, Butler, Center, Chester, Clarion, Clinton, Columbia, Cumberland, Dauphin, Fayette, Franklin, Huntingdon, Jefferson, Juniata, Lancaster, Lawrence, Lebanon, Lehigh, Lycoming, Monroe, Montgomery, Montour, Northampton, Northumberland, Perry, Snyder, Somerset, Union, Westmoreland, and York counties), Rhode Island (Providence County), Tennessee (Carter, Coffee, Cumberland, Davidson, Dickson, Franklin, Houston, Knox, Lawrence, Montgomery, Rhea, Union, and Washington counties), Vermont (Addison, Chittenden, Franklin, Rutland, Windham, and Windsor counties), Virginia (Augusta, Botetourt, Frederick, Giles, Loudoun, Montgomery, Rockbridge, Rockingham, Russell, Shenandoah, Tazewell, Warren, and Washington counties), West Virginia (Berkeley, Greenbrier, Jefferson, Preston, and Wayne counties), and Wisconsin (Buffalo, Calumet, Dodge, Door, Fond du Lac, Kewaunee, Lafayette, Manitowoc, Oconto, Outagamie, Ozaukee, Shawano, Sheboygan, Trempealeau, Vernon, Washington, and Waukesha counties).

Lime kilns have been documented throughout the eastern United States where suitable limestones were available. The kilns will be discussed alphabetically by state. The discussion includes Alabama, Connecticut, Illinois, Indiana, Massachusetts, Michigan, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, and Wisconsin.

ALABAMA

A lime kiln was excavated at Nance's Ferry near Pickensville, Alabama in the Tombigee River Valley (Atkinson and Elliott 1978). The authors (Atkinson and Elliott 1978:20) described the kiln as follows:

> The remains of the lime kiln consist of 2 parallel rectangular brick foundations separated by a 40 cm-wide firing chamber (see Plate 4). Three brick courses were present in each foundation, but a large number of bricks were missing from the upper courses... Each foundation was about 2.60 m in length and 85 cm in width. The entire structure, including the firing chamber, was about 2.60 m in length and 2.10 in width.

After reviewing the literature about lime kilns, Atkinson and Elliott (1978:32) concluded that:

> According to the evidence, it seems obvious that the Nance's Ferry Kiln was a variation of the "intermittent" shaft, or pot type, as described by the aforementioned authors. The major difference in the kilns described by these writers and the one at the Nance's Ferry Site appears to be that the former were built of limestone and the latter of brick. Otherwise, the Nance's Ferry kiln undoubtedly operated in the same manner, in that a domed arch of limestone would have been constructed over the firing chamber and broken down following the "burn" to allow removal of the calcined limestone through the firing chamber in one side of the kiln.

CONNECTICUT

During an inventory of historic engineering and industrial sites in Connecticut, two lime kilns were recorded (Roth, Clouette, and Darnell 1981). The Sharon Valley Lime Kiln (ca. 1880) at Sharon is 15 feet (4.5 m) square and 17 feet (5.1 m) high with timber reinforcement around all four sides (Roth, Clouette and Darnell 1981:107). The Sharon Valley Lime Kiln has arches on two sides (Roth, Clouette, and Darnell 1981:107). This is one of the few remnants of the once important lime industry in northwest Connecticut. The Woodbridge Lime Kiln (ca. 1900) at Woodbridge is a 55 feet by 25 feet (16.5 m by 7.5 m) stone structure (Roth, Clouette, and Darnell 1981:161). The kiln contains two brick lined hearths that are 9.5 feet (2.85 m) high and 15 feet (4.5 m) wide that each that have an arch (Roth, Clouette, and Darnell 1981:162).

ILLINOIS

Limited information is available on the lime industry in Illinois. Mansberger and Stratton (1995:172-186) provided excellent information on the Griggsville Landing Lime Kiln Site in Pike County, Illinois. Constructed in the 1850s, the Griggsville Landing Lime Kiln is a substantial stone structure built into the side of a bluff (Mansberger and Stratton 1995:177). The base is somewhat square while the walls become more circular towards the top. The lime kiln is 19 feet (5.7 m) in diameter with 3 feet (0.9 m) thick walls and rises to over 17 feet (5.1 m) in height (Mansberger and Stratton 1995:177). An arched opening on the lower side of the kiln is 4 feet (1.2 m) wide and currently 3 feet 4 inches (1 m) high (partially filled) (Mansberger and Stratton 1995:177). Surviving examples of other Illinois lime kilns include one at Maeystown in Monroe County (ca. 1852-1870), a kiln at Kankakee River State Park in Kankakee County (ca. 1873), the Polo Kiln in Ogle County (late 19th century), the Chase Kilns near Port Byron in Rock Island County, the Johnson Kiln near Cordova in Rock Island County, and three surviving kilns at the U. S. Gypson Plant at Cordova in Rock Island County (Mansberger and Stratton 1995:232-233). The report by Mansberger and Stratton (1995) also included copies of historic photographs and other documentation.

A second study documented the Keepataw Site in Will County, Illinois which was associated with the Western Stone Company limestone quarrying and processing operation (Poulson 1995:1). The company operated a quarry and two lime kilns between 1889 and 1918 (Poulson 1995:1). The first kiln was constructed from cut limestone blocks and was built into the base of a small hill (Poulson 1995:26-28). This kiln is 4.6 m wide, 4.9 m long and an unrecorded height (Poulson 1995:26). The second kiln is a tapered chimney-like structure (continuous feed type kiln) located on a rise in the middle of a marsh (Poulson 1995:27). Built on a stone foundation, this brick structure is 14 meters tall and appears to have been filled by an inclined rail line (Poulson 1995:27). The base measures 2.35 meters by 2.35 meters (Poulson 1995:27). An arch on the bluff side of the kiln measured 91.44 cm high and 63.5 cm wide at the base (Poulson 1995:29). Another opening on the Des Plaines River side of the kiln is 1.6 m high, 1.22 m wide, and 50.8 cm deep (Poulson 1995:29).

INDIANA

Several lime kilns have been documented in Indiana. Presently, information is available on kilns in Carroll, Clark, Huntington, and Owen counties. Two lime kilns located at Cataract Lake in Owen County, Indiana were investigated by test excavations (Dolan and Pace 1973). These circular shaft kilns were built side by side into a vertical stream bank. The authors (Dolan and Pace 1973:74) described the kilns as follows:

> In preparing for their construction, a vertical cut approximately 20 feet [6 m] wide and 6 feet 5 inches [1.92 m] deep, was removed from the bank. The two kilns were nestled into the vertical wall, and the floor that extended some 15 feet [4.5 m] into the bank. Walls of the kilns were constructed of local clay, and approached 6 inches [15 cm] in thickness around the middle of the 6-foot [1.8 m] high structure. Reinforcing slabs, daubed with clay, were placed around the lower two-thirds of the kilns. From the reinforced wall to the top, 3-4 inch [7.5-10 cm] clay walls sloped inward, leaving a 3-foot [0.9 m] opening, in contrast to the base which measured 5 feet [1.5]. The opening in the top served as the access for loading the kilns, and as a chimney in the firing of the load.

During an archaeological survey of Huntington Lake in Huntington County, Indiana, two lime kilns (12Hu541 and 12Hu687) were recorded (Wepler and Cochran 1983). One of these appeared on an 1879 map of the Rock Creek Township (Wepler and Cochran 1983:166). The authors noted that the kilns were similar to the ground hog kiln illustrated by Blatchley (1904) in his report on the Indiana lime industry (Wepler and Cochran 1983:107).

Between 1857 and 1917, many lime kilns operated north of Delphi in southwest Carroll County, Indiana (McCain 1999). In 1871, 22 lime kilns were operating in northern Delphi. McCain's great grandfather Daniel McCain operated one of the major companies, the Delphi Lime Company. This operation employed between 80 and 100 men and produced 500,000 bushels of lime annually (McCain 1999).

An archaeological survey of the Indiana portion of the Louisville-Southern Indiana Ohio River Bridges Project located 64 sites including several lime kilns at two sites (12CL551 and 12CL561) (Striker, Jackson, and Blanton 2000). Site 12CL551 is a "groundhog" lime kiln located at the base of a hill constructed of cut limestone blocks (Striker, Jackson, and Blanton 2000:113). The overall measurements were not provided for the debris filled kiln but the rounded arch is 1.9 m high and 3.38 m wide (Striker, Jackson, and Blanton 2000:113). Site 12CL561 is a lime kiln complex operated by the Utica Lime Company between 1870 and 1885 (Striker, Jackson, and Blanton 2000:118). Both kilns were built into the side of a hill. The Eastern Kiln is constructed from cut limestone blocks and has two adjacent kilns with one arch each (Striker, Jackson, and Blanton 2000:118). The exposed walls measured 12 m, 14 m, and 10.5 m in length with a height of 12.3 m (Striker, Jackson, and Blanton 2000:120). The western opening in the top of the kiln is 2.5 m in diameter while the eastern opening is 2.9 m in diameter (Striker, Jackson, and Blanton 2000:120). The arches are brick lined. The eastern arch is 3.03 m high, 1.84 m wide and extends 2.7 m into the kiln (Striker, Jackson, and Blanton 2000:119). The western arch is 2.81 m high, 1.88 m wide and extends 2.64 m into the kiln (Striker, Jackson, and Blanton 2000:119).

The Western Kiln at 12CL561 is constructed from concrete and faced with limestone blocks (Striker, Jackson, and Blanton 2000:120). Like the Eastern Kiln, this kiln has two individual kilns within the same overall structure. The exposed walls measure 10 m, 10 m, and 7.5 m in length with a height of 8.5 m (Striker, Jackson, and Blanton 2000:120). The arches are brick lined (with a different pattern from the Eastern Kiln) and nearly identical size measuring 2.6 m high, 1.8 m wide and extending 2.5 to 3 m into the kiln (Striker, Jackson, and Blanton 2000:120). Several other foundations were present at the complex (Striker, Jackson, and Blanton 2000:120).

MAINE

Robinson (1976:111) mentioned that the lime industry at Penobscot Bay in Maine. Further, he noted that (Robinson 1976:111):

> In Maine the kilns stood at the ocean's shore and the lime was loaded aboard coastal schooners, called limers, for fast runs to Boston and other New England ports. Sailing aboard a limer was a heart-in-mouth profession, for there was constant danger of seawater igniting the cargo.

MASSACHUSETTS

A historic engineering and industrial sites inventory of the Lower Merrimack River Valley of Massachusetts resulted in the recording of one lime kiln and associated quarry (Molloy 1976). The Chelmsford Lime Quarries and Kilns at Chelmsford operated between about 1740 and 1830 (Molloy 1976:13). The actual number of kilns (in ruins) were not mentioned but three quarries were preserved (Molloy 1976:13). Robinson (1976:109) quoted Nathaniel Hawthornes's description of an 1850s lime kiln near Adams, Massachusetts.

MICHIGAN

During a historic engineering and industrial sites inventory of the lower peninsula of Michigan, three lime kilns were recorded (Abbott 1976). The Bay Port Quarries Lime kiln at Bay Port operated between about 1888 and 1908 (Abbott 1976:7-9). This stone kiln is a truncated pyramid in shape and measures 15 feet (4.5 m) square at the base, 12 feet (3.6 m) square at the top, and stands about 30 feet (9 m) high (Abbott 1976:7-8). The kiln has three brick lined arches and wooden exterior supports (Abbott 1976:7-8). The Dyer Lime kiln at Bellevue was constructed in 1875 and operated until 1899 (Abbott 1976:15-16). The stone structure is 20 feet (6 m) square at the base, 12 feet (3.6 m) square at the top, and about 15 feet (4.5 m) tall (Abbott 1976:15-16). Brick arches (one per side) are located on all four sides (Abbott 1976:15-16). Finally, the Holden lime Kiln, located southwest of Bellevue, is a round structure built into the side of a hill (Abbott 1976:22). Constructed in 1835, this crude stone kiln was the first in Michigan and was still producing lime in 1878 (Abbott 1976:22). The kiln is 20 feet (6 m) in diameter and 15 feet (4.5 m) high with four stone line arches (Abbott 1976:22).

OHIO

In 1991, David Bush R. Bush, Inc. located a lime kiln during an archaeological survey for the proposed Marblehead Ferry Boat Dock in Ottawa County, Ohio (Bush, Thomas, Martello, and Fissel 1991). The authors stated that the Marblehead Kiln Site (33OT223) is (Bush, Thomas, Martello, and Fissel 1991: Management Summary):

> ...the archaeological remains of a four-bay kiln that operated briefly circa 1900-1910. The structural elements present include the brick floors and the base of the limestone walls between the kiln bays. Calcined lime deposits next to the walls and the limestone block base to a kiln-related but separate structure were exposed. In addition, 2 features associated with the quarry company houses (1910-1970s) were identified.

Elsewhere, the authors (Bush, Thomas, Martello, and Fissel 1991:V-2) noted that:

> The only portion of the kiln that remains is the very base of the limestone walls, the brick floors between the walls and in two areas outside of the kiln indicating contributing structures, and a separate limestone base which supported another related structure. Without any of the superstructure, it is not possible to determine the type of kiln (although it can be inferred from others in the region that it was probably a continuous feed kiln). Whether it was mix-feed or furnace fired is another supposition. The Kelley Island Lime and Transport Company kiln is a more modern kiln and was certainly a furnace type. The Judges Kiln, which dates to the 1880s,

also appears to have been a furnace fire type, but this is not certain. Whether the kilns were fired by wood or coal is not known, nor is the charging method (earthen incline, wooden trestle, or hoist).

Test excavations at the Marblehead Kiln Site produced the following information (Bush, Thomas, Martello, and Fissel 1991:IV-4, IV-7):

> ...Feature 1 consist of 5 sets of limestone block walls (a-e), of which 4 (a-d) are flush with the undisturbed ground surface and 1 (e) is 40 centimeters high. These 5 walls are roughly equidistant (1.5 meters apart) and are close to the same width (1.2-1.8 meters). A test excavation placed on the north side of wall b revealed that limestone blocks are eight to nine courses and extend 1.2 meters beneath ground surface.
>
> Between walls e, d and c are single layer brick floors with stretcher bond (Plate 8). The stretchers' long axes are oriented north-south. Although the east and west edges of the northern brick floor have been disturbed, it is probable that the 2 floors had the same east-west dimensions (4 meters)...

Bush, Thomas, Martello, and Fissel (1991:V-2) mentioned other lime kilns in the vicinity:

> Additionally, there are three kilns in the immediate neighborhood that better represent the lime industry on the Peninsula. All three, the Judges Kiln, the Ohenmacher kilns, and the Kelley Island Lime and Transport Company Kilns are in deteriorated condition but contain much more of their structural integrity than does the Marblehead lime Kiln (33OT223).

In 1986, Ronald Kingsley (1988) conducted rescue excavations at a lime kiln at Geneva State Park. Several years later, Kingsley (1993) prepared an article that described a lime kiln located in the Connecticut Western Reserve in northeastern corner of Ohio. The Chestnut Grove Site (33Ab-157) was discovered eroding out of Lake Erie's northern shoreline within the Geneva State Park in Ashtabula County (Kingsley 1993:72-73). Excavations were conducted to document the kiln before it was destroyed by erosion. The round stone lined lime kiln had an inner diameter of 7 feet (2.1 m), was 6 feet (1.8 m) high, and narrowed to 44 inches (1.1 m) at the base (Kingsley 1993:78). The kiln was built into a hillside. An arched opening, estimated to be 26 inches (65 cm) high and 16 inches (40 cm) wide, was discovered facing Cowles Creek (Kingsley 1993:78). Kingsley (1993:81) noted that "this kiln was one of several which were built along the east side of Cowles Creek circa 1825...".

PENNSYLVANIA

The lime industry in eastern Pennsylvania was described by Williams (1952:73) as follows:

> Lime kilns were of common occurrence throughout the farming areas of Eastern Pennsylvania wherever these areas were within reasonable wagon hauling distances from limestone beds but the Lower Jordan Valley appears to have had more than its share of these kilns because of the presence there of many limestone out-croppings and because of the great demand during a certain period for burned lime to be used for top dressing of agricultural land and for structural demands also.

William's (1952: Plate XIII) map of Lower Jordan Valley in Lehigh County, Pennsylvania provides the general locations of 29 lime kilns and kiln ruins that he had observed. These coal fired kilns date between ca. 1825 and 1900 (Williams 1952:73, 76). Williams (1952:79) noted that:

> In most cases the kilns have been built on a hillside and into the slope so that the front of the kiln has a face that is almost vertical and the top of the kiln is on a level with the ground line at the rear of the kiln. In a few cases, where the slope of the ground was not great a fill was made at the rear of the kiln to provide a ramped driveway for hauling limestone and fuel to the top of the kiln.

The exterior appearance of the Lower Jordan Valley lime kilns was described by Williams (1952:80) as follows:

> The kiln proper is constructed of "flint-stone", sandstone and other field stones- most of them of glacial origin. The outside stones are rough dressed and laid up apparently as dry walls- no mortar was found in the joints. The front openings were tapered inwardly and vary widely in dimensions. The outside opening was about 6'-0" [1.8 m] wide at the base, from 6'-0" to 10'-0" [1.8 to 3 m] high with a stone lintel at the top where the widths vary from about 1'-6" [45 cm] to less than 4'-0" [1.2 m]. The inside opening vary from 20" to 24"[50 to 60 cm] wide at the bottom, 9" to 16" [22.5 to 40 cm] wide at the top, and from 24" to 37" [60 to 92.5 cm] high.
>
> The fronts of the kilns were flat and usually were cambered backwards from bottom to top. The bottom width was about 18'-0" [5.4 m] wide, the top about 17'-0" [5.1 m] wide and the height varied from 11'-0" [3.3 m] to somewhat more than 19'-0" [5.7 m]. The horizontal section of the kiln was approximately square but stone wing walls were sometimes built out from the sides to support the driveway to the top of the kiln.
>
> The circular limestone pot or shaft was lined with firebrick throughout. Both small and large firebrick were used and the spaces between the outside walls of the kilns and the firebrick linings were filled with random size and apparently undressed field stones. The top of the kiln may have been surfaced with clay or earth over the stones to make a driveway.

Williams (1952:79-80) described the interiors of the Lower Jordan Valley lime kilns as follows:

> The limestone pot or shaft is about 10'-0" [3 m] diameter in section, cylindrical to a depth of about 7'-0" [2.1 m] and then contracting as an inverted frustrum of a cone for a depth of less than 5'-0" [1.5 m] more to a diameter of about 5'-0" [1.5 m], then continuing with sloping sides for a further depth of about 4'-0" [1.2 m] to a bottom diameter of about 3'-0" [0.9 m]. Below this trough with a rectangular section about 20" [50 cm] wide and 12" [30 cm] deep with its axis in line with the opening in the front of the kiln. This opening serves a triple purpose; it is the opening through which the fuel is ignited, it admits air for combustion, and it is the opening through which the burned lime is removed.

Berkheiser and Hoff (1983:9) described the Arthur L. Long Lime Kiln in Northumberland County, Pennsylvania between the communities of Mandata and Urban. The lime kiln was thought to have been built around 1850 and was still being used in 1883 by Arthur L. Long as a hobby

(Berkheiser and Hoff 1983:9). The authors noted that "batch kilns were used in Stone Valley from the time of the first permanent settlers to about 1936, when they were gradually replaced with more productive draw kilns" (Berkheiser and Hoff 1983:9). The Arthur L. Long Lime Kiln was built into the side of a hill, has a sandstone lining, and was surrounded by a clay liner (Berkheiser and Hoff 1983:11). A firebox and work chamber are located at the base of the kiln. Using the scaled drawing in the article, the kiln was estimated to be about 15.5 feet (4.65 m) high, 9.5 feet (2.85 m) wide at the top and tapers to 4 feet (1.2 m) at the bottom of the firing chamber (Berkheiser and Hoff 1983:11) In addition to the Long Kiln, Berkheiser and Hoff (1983:9) indicated that "...the remains of a smaller and much older kiln are located on the upper charging level."

Several lime kilns were recorded in Blair County during an inventory of historic engineering and industrial sites in Blair and Cambria counties, Pennsylvania (Fitzsimons 1990). Unfortunately, the report does not provide information on shapes or dimensions for most of the kilns. The Frankstown Kiln located near Frankstown was a stone structure built on a concrete base (Fitzsimons 1990:90). This kiln was built by the American Lime & Stone Company ca. 1900 (Fitzsimons 1990:90). Near Tyrone Forge, the American Lime & Stone Company (ca. 1900) constructed five lime kilns from stone in association with its Brush Mountain quarry (Fitzsimons 1990:91). A bank of eight cast-concrete lime kilns dating to ca. 1900 were recorded on the Bennett farm (Fitzsimons 1990:92-93). These kilns were operated by the Blair Limestone Company and were built in two sections of four kilns each (Fitzsimons 1990:92-93). Each section was 80 feet (24 m)long, 25 feet (7.5 m) wide, and 15 feet (4.5 m) high with an arch for each kiln (Fitzsimons 1990:93). The two sections of kilns were separated by a 10 foot (3 m) passage way and were designed to be fed from the top with a railroad line spur (Fitzsimons 1990:93). An example of an 1890s agricultural lime kiln is the Brua Lime Kiln southwest of Frankstown (Fitzsimons 1990:93). This stone structure was built into the side of a hill, has a round arch and was brick lined on the interior (Fitzsimons 1990:93). At Canoe Creek State Park, a bank of six cast-concrete lime kilns were built by the Canoe Creek Stone Company about 1899 (Fitzsimons 1990:94). The kilns are arranged in a row and measure about 23 by 23 feet (6.9 by 6.9 m) each with 10 or more courses of red brick above the concrete (Fitzsimons 1990:94). An arched opening 10 feet (3 m) high faced a terrace allowing the lime to be loaded into railroad cars (Fitzsimons 1990:94).

RHODE ISLAND

During an inventory of historic engineering and industrial sites in Rhode Island, the Limerock Quarry and Kilns were documented at Lincoln (Kulik and Bonham 1978). Three kilns survive at the site along with the water filled quarry (Kulik and Bonham 1978:100). The lime industry started there about 1650 and continued until the 20th century. One kiln is an older style stone kiln built into an embankment while a shale lime kiln has been modernized with brick, cut stone, and sheet iron (Kulik and Bonham 1978:100). The third kiln is a stone structure with three arched openings (Kulik and Bonham 1978:100). Unfortunately, the report does not discuss the shape or size of the kilns.

SOUTH CAROLINA

Archaeological investigations have been undertaken at one lime kiln in South Carolina. Garrow & Associates conducted excavations at the Jimmie Green Lime Kiln in Berkeley County, South Carolina near Charleston (Wheaton 1986, 1987). The lime kiln was used between 1750 and 1780 (Wheaton 1987:1). This rectangular kiln measured about 23 by 36 feet (6.9 by 10.8 meters) with brick walls 2.5 feet (75 cm) thick (Wheaton 1986:6). Instead of limestone, the Jimmie Green Lime

Kiln burned oyster shells for lime (Wheaton 1986:2).

TENNESSEE

Five rectangular lime kilns have been recorded in northwest Tennessee in Houston County. A map and photographs of these lime kilns are available at Landmark Archaeological and Environmental Services' website "http://www.landmarkarchaeology.com/kilns_houston.html." These include the adjacent Masonic Hall kilns at Erin, the Metcalf kiln at Erin, the Stewart kiln, and the Cook's Hollow kiln. All five kilns are substantial structures constructed from quarried stone slabs. Arches are present on at least one side of each kiln. The lime industry thrived from the post Civil War era to the 1940s in Houston County.

VERMONT

The most comprehensive and detailed study of U.S lime kilns, undertaken to date, was conducted by Victor Rolando (1992) in Vermont. Rolando (1992:205-223) provided an excellent overview of the lime burning process, discusses the various types of lime kilns, and the lime industry in Vermont. Between 1984 and 1992, Rolando (1992:226) documented 71 kiln sites containing 93 fully or partially standing ruins of lime kilns. The kilns are described individually by county within three districts (northern, central, and southern) of Vermont (Rolando 1992:230-270). Rolando (1992:226-227) provided the following summary statements:

> Visible ruins include 71 made of stone, 13 of a combination stone and concrete, and 9 made of concrete. Thirteen stone and/or concrete types displayed remains of their tall iron shells in various stages of deterioration. Forty-three kilns probably operated at one time with iron shells...
>
> Lime kilns ruins were generally found associated with limestone outcrops or quarries. Although the earlier primitive farm-type kilns were usually found well away from the nearest farmhouse, almost all later commercial-type lime kiln ruins were found near roads, highways, and railroads. Farm-type ruins were the smallest type found; commercial-type ranged from much larger round shapes to imposing square structures, some with their rusting iron stack wholly or in part above stone and/or concrete bases. One lime kiln site was found associated with an early-20th-century calcium carbide plant.
>
> Many lime kilns were built of stone from the same quarry where they obtained stone to burn. Although appearing to be a peculiar practice, the insides of these kilns soon glazed over from the heat of burning, which protected the walls from further heat effects. The glaze also sealed the kiln from out side drafts, keeping the heat inside and reducing fuel consumption. At some ruins, the glaze was observed as being all that remained to hold small sections of inside walls intact, long after major sections of the outside walls had collapsed. Concrete kilns and combination stone-and-concrete kilns were usually found associated with firebrick, although two stone-built kiln ruins were also found with fire brick. All combination stone-and-concrete kilns were the base for iron shells.

Lime kiln ruins were generally round or square. Some kiln ruins were built into hillside or slight rise and their front side (that is, the open side) was faced with a small stone wall. This wall was as high as the kiln and extended up to 20 feet [6 m] on either side to act as a retaining wall to support the work area above and around the top of the kiln. A majority of the lime kiln sites found ranged up to seven ruins per site. Fifty of the sites (70 percent) contained one ruin. All were made of stone and were mostly of the early-19th-century "pot kiln" variety.

WISCONSIN

Investigations were undertaken at the Patrick Walsh Site, part of the Greenfield Lime Industry District, in Milwaukee County, Wisconsin by Elizabeth Benchley (1988). The Patrick Walsh Site was part of a limestone quarry and lime production area between the early 1850 to approximately 1900 (Benchley 1988:1). Benchley's (1988:3-4) preliminary conference paper mentioned the Trimborn lime kiln ("a vertical stone front, and a banked earthen back"), "a free standing limestone (dolomite) block kiln next to the quarry...built by Trimborn after 1876", and a "pit kiln...excavated into the ridge...". Benchley was hoping to work with the site developer to avoid the complex or mitigate the kilns by excavation before construction.

MISCELLANEOUS

Several lime kilns have been documented in the Historic American Building Survey/Historic American Engineering Record for the eastern United States. The website listed the following sites: Godey Lime Kilns, Washington, District of Columbia; H. L. Shepard Company Lime Kiln, Knox County, Maine; Swayze Lime Kiln, Warren County, New Jersey; Lime Kiln, Montgomery County, New York; Solvay Process Company, Lime Kiln Building, Onondaga, County, New York; Lime Kilns, Berks County, Pennsylvania; Isaac A. Packer Farm Lime Kiln, Clinton County, Pennsylvania; John Tur Farm Lime Kiln, Monroe County, Pennsylvania; and the Standard Lime & Stone Quarry kilns, Jefferson County, West Virginia.

STUDIES OF LIME KILNS IN THE WESTERN U. S.

Burchard (1914:1553-1555) provided a listing of states producing lime in 1913. The western states producing lime included: Arizona (Coconlino and Yavapal counties), Arkansas (Benton, Izard, and Washington counties), California (Amador, Contra Costa, Eldorado, Kern, Mono, Placer, San Benito, San Bernardino, Santa Cruz, Shasta, Siskiyou, Tuolumne, and Ventura counties), Colorado (Boulder, Chaffee, Douglass, Fremont, and La Plata counties), Idaho (Bannock, Bear Lake, Cassia, Kootenai, Lemhi, Nez Perce, and Oneida counties), Iowa (Cerro Gordo, Clayton, Dubuque, and Jackson counties), Kansas (Elk, Leavenworth, and Shawnee counties), Minnesota (Blue Earth, Goodhue, Mower, and Scott counties), Montana (Deerlodge, Madison, Park, and Powell counties), Nevada (Lyon County), New Mexico (Grant, San Juan, San Miguel, and Santa Fe counties), Oklahoma (Coal and Delaware counties), Oregon (Baker, Jackson, Josephine, and Wallowa counties), South Dakota (Custer, Lawrence, Meade, and Pennington counties), Texas (Comal, Coryell, Dallas, El Paso, Nolan, San Saba, Tarrent, Travis, and Williamson counties), Utah (Cache, Salt Lake, Sanpete, Sevier, Utah, Wasatch, and Weber counties), Washington (Chelan, Ferry, Okanogan, San Juan, Stevens, and Whatcom counties), and Wyoming (Carbon County).

CALIFORNIA

The lime industry in Santa Cruz County, California (central part of the west coast) has received considerable attention. The available reports cover the area between Bonny Doon and Felton and the area between Felton and Santa Cruz. An excellent summary was prepared by Kenneth Jensen (1976) entitled "The Lime Industry in Santa Cruz County." The lime kilns of Pogonip, north of Santa Cruz, were documented by Robert Piwarzyk (1994). Two years later, Piwarzyk (1996) produced a report on the Laguna Lime Kilns northeast of Boony Doon. The Laguna Lime Kilns (ca. 1899-1912) are two roughly square side-by-side stone structures built into a hillside with fire brick linings (Piwarzyk 1996:9, 12). The front wall of both kilns have two arches (3 feet 3inches [0.97 m] wide and 6 feet [1.8 m] high) each (Piwarzyk 1996:9, 12). The interior measurements of the Left Kiln are 18 feet 10 inches (5.65 m) by 13 feet 9 inches (4.12 m) with a height of 15 feet 10 inches (4.75 m) (Piwarzyk 1996:12). The interior measurements of the Right Kiln are 19 feet 3 inches (5.77 m) by 14 feet 6 inches (4.35 m) with a height of 16 feet 10 inches (5.05 m) (Piwarzyk 1996:13). In 1998, Thomas Wheeler (1998) documented the Samuel Adams Lime Kilns, quarry areas, and associated remains at the Gray Whale Ranch between Felton and Santa Cruz. The three adjoining lime kilns, constructed into a hillside, have an overall length of 120 feet (36 m), 35 feet (10.5 m) in width, and are 15 feet 8 inches (4.7 m) high (Wheeler 1998:27). They are constructed of thick (4 to 5 feet; 1.2 to 1.5 m) limestone walls with four arches per kiln (Wheeler 1998:27, 32). The arches are 3 feet (0.9 m) wide, 5 feet (1.5 m) high, and extend 5 feet (.5 m) into the kiln (Wheeler 1998:28). The interior measurements for the rectangular kilns are ca. 28 to 30 feet (8.4 to 9 m) long and 12 to 15 feet (3.6 to 4.5 m) wide (Wheeler 1998:32). Most recently, Piwarzyk and Hoch (2002) produced a manuscript entitled "The History of the Rockland Lime and Lumber Company, 1887 to 1890."

IOWA

Reesink (1979) briefly described the lime industry in east central Iowa near Maquoketa. Two individuals were mentioned as being involved in the lime industry in Jackson County, Iowa (Reesink 1979). About 1871, Alfred Hurst built a pot kiln and began lime production on a small scale producing about 100 barrels of lime per week (Reesink 1979:60). Later, Hurst built four draw kilns that could produce 800 barrels of burned lime daily (Reesink 1979:60-61). The Hurst kilns ceased operation in 1920 (Reesink 1979:60). The second individual in the lime industry in Jackson County was Otis W. Joiner who arrived from New York in the 1870s (Reesink 1979:61). His operation eventually became the Joiner Lime Company which operated until sometime between 1920 and 1930 (Reesink 1979:61).

UTAH

The Mantua Lime Kiln in Box Elder County, Utah was documented as part of a HAER project by archaeologist Michael R. Polk (1991). This kiln was built into the slope of a steep slope near Mantua, Utah in 1892 (Polk 1991:1). Constructed from cut limestone, the rectangular kiln is 21 feet (6.3 m) wide at the base, 17 feet (5.1 m) wide at the top, about 22 feet (6.6 m) high (Polk 1991:12). The interior of the kiln (hopper, shaft, and cooling chamber) is made from common red bricks and fire bricks (Polk 1991:13). An arch, 11 feet (3.3 m) high and 8.5 feet (2.55 m) wide, was built into the front of the kiln. The interior of the kiln was coated with a glassy green slag. The Mantua Lime Kiln operated until sometime between 1905 and 1907 (Polk 1991:1).

MISCELLANEOUS

Several lime kilns have been documented in the Historic American Building Survey/Historic American Engineering Record for the western United States. The website listed the following sites: Lime Kiln, Marin County, California; Four Lime Kilns, Monterey County, California; Sainsevain Property Lime Kilns, San Bernardino County, California; Lime Kiln, Tuolumne County, California; Lime Kiln near Morrison, Jefferson County, Colorado; Casa Vieja Lime Kiln and Arch, Bexar County, Texas; and Red Wire Pasture Lime Kiln, Coleman County, Texas.

THE LOWER RUDD LIME KILN

The Lower Rudd Lime Kiln (15Lv226) is located on the south bank of the Cumberland River at Lemen Landing northwest of Vicksburg in Livingston County, Kentucky (Hockensmith 1996). The kiln was discovered by geologist Boyce Moodie of Paducah during a fishing trip. The river bank in this area was covered with limestone rubble from the abandoned Rudd Quarry which is located about 150 m to the east. Flooding during the spring of 1993 removed some of the stone rubble along the river bank and exposed the kiln. Mr. Moodie notified Kentucky Geological Survey geologist Garland R. Dever, Jr. who in turn called the author. On May 6, 1993, the author accompanied Mr. Moodie to the site. Since the base of the kiln was under water (Figure 2) at the time of their visit, it was not possible to completely document the site. A second trip was made by the author on July 9, 1993 to complete the fieldwork. During the investigations, the kiln was measured, drawn in planview, and drawn in profile. The site was also documented with photographs. Some additional observations were made during a site visit on October 29, 1998.

The exact age of the Lower Rudd Lime Kiln is unknown. The senior property owner, Mr. Jess Rudd, was 82 years old when interviewed by Boyce Moodie during 1993. He grew up on the farm containing the kiln. Even as a small boy, Mr. Rudd did not remember hearing anything about the kiln. An elm tree between three and four feet in diameter grew up inside the kiln after it was abandoned. When the dead tree collapsed into the river, it destroyed most of one the wall. The presence of this large tree suggests that the lime kiln was probably abandoned during the late 19th century.

Prior to the survey, the lower side (north) of the kiln had collapsed into the Cumberland River. The collapse removed the upper half of the kiln on the river side. The surviving portions included the upper walls against the steep river bank and much of the base (Figure 3). The kiln is a circular silo-shaped structure built into the side of the river bank (Figure 4). It has an exterior diameter of 4 meters (13.2 feet) and interior diameter of 3.25 meters (10.73 feet). The broken walls reveal that the main kiln was constructed of clay (Figure 4). The interior lining of the kiln is a grayish brown clay forming a very hard 12 cm (4.75 inches) thick layer. This lining exhibits green glassy glazing from firing of the kiln. The outer wall was constructed of a reddish brown clay, which is much softer and ranges in thickness from 18 to 34 cm (7.13 to 13.5 inches). Mr. Moodie noted that this type of clay does not occur locally and had to be transported from another locality. It may be of a refractory quality to withstand the firing of the kiln. The kiln is 2.78 meters (9.2 feet) high but was probably taller when in use. A bench above the kiln undoubtedly served as a road for hauling limestone from the quarry to the kiln. From the bench, limestone could have been loaded into the kiln either by hand or dumped from a horse drawn cart. The interior of the kiln was filled with fragments of lime stone, brick fragments, and dirt.

At the base of the kiln are the remains of a brick firebox or drawing area (Figures 5 and 6). This feature has three levels. At the bottom is a shallow trough 40 cm (15.75 inches) wide and 10 cm

Figure 2. Photograph of the Lower Rudd Lime Kiln (just right of center) Facing South During High Water on May 6, 1993. The base of the kiln is under water.

Figure 3. Photograph of the Fire Box or Drawing Area at the Base of the Lower Rudd Lime Kiln. The trough is in the bottom center with intact brick work on each side of a large tree root. The photograph is facing south.

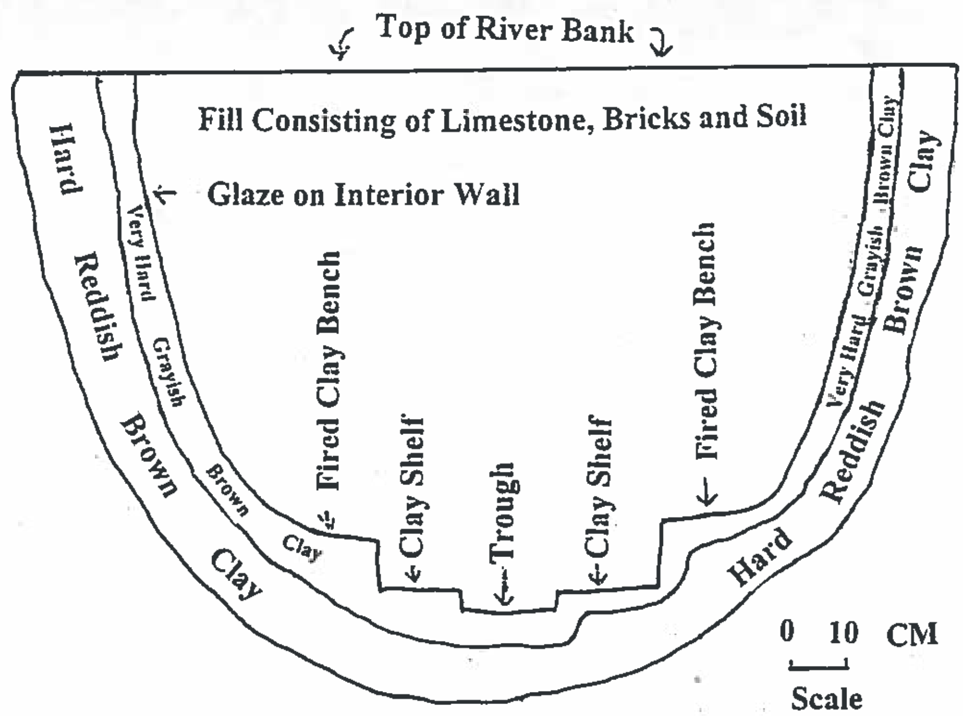


Figure 4. Profile Drawing of the Lower Rudd Lime Kiln Facing South Showing the Main Characteristics.

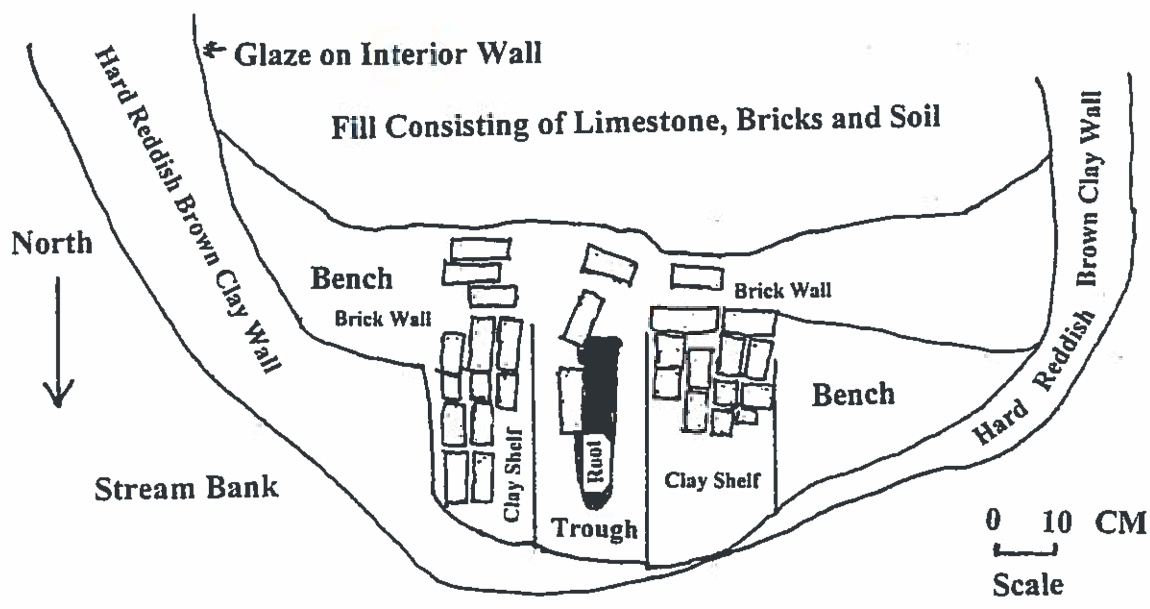


Figure 5. Planview Drawing of the Lower Rudd Lime Kiln Showing the Fire Box Characteristics and Base of Walls. View facing south.

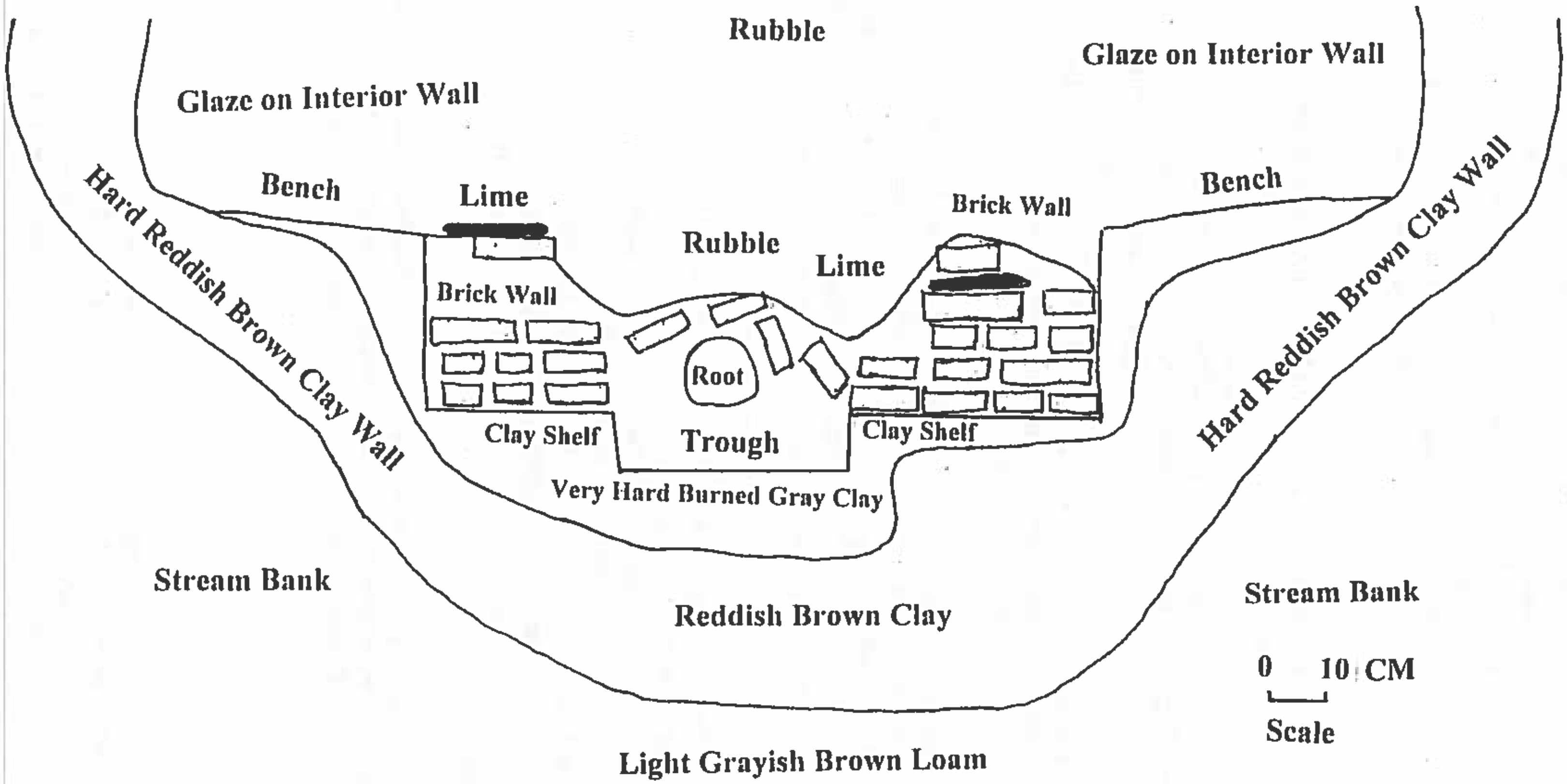


Figure 6. Profile drawing of the base of the Lower Rudd Lime Kiln showing the fire box characteristics and base of the kiln walls.

(ca. 4 inches) deep. This trough is glazed and still contained small amounts of lime. Above the trough are two flat shelves, one on each side (Figure 6). These shelves contain four courses of common building bricks. Some lime is present above the bricks. The eastern shelf is 38 cm (15 inches) wide while the western shelf is 43 cm (17 inches) wide. Immediately above (25 to 28 cm; 9.88 to 11 inches) the two shelves are two additional shelves or benches that form the bottom of the kiln. Part of the brick work from the fire box was still intact. Unfortunately, the nature of any firing arch or drawing door above the described feature will remain speculation since the upper portion of the wall was entirely washed away.

The October 29, 1998 visit to the Lower Rudd Lime Kiln revealed that much of the kiln had been washed away since it was first recorded in 1993. Only the base and south wall remained intact (Figures 7 and 8). The flooding episodes had removed most of the rubble, making the interior details of the base more visible. The trough, 40 cm (15.75 inches) was found to be 1.4 m (4.66 feet) long and 30 cm (11 7/8) deep (Figure 9). Bricks were laid on either side of the trough on the bench above it. The bricks were laid parallel to the long axis of the trough, end to end, and three bricks wide. Toward the rear (south) of the trough, five courses of brick were still intact. On the east side, the intact bricks extended for a distance of 90 cm (3 feet) and on the west side, the bricks extended for 86 cm (2.86 feet). An elevated fired clay bench surrounds the brick walls. The top of the bench was the same height as the five courses of bricks on each side of the trough.

It appears that the kiln may have had an outer sandstone lining. Photographs of the elm tree root system show sandstone slabs encased in the roots. These slabs have been shaped into rectangular blocks. Two possible explanations come to mind for the sandstone slabs. First, the slabs may have supported the grate or have been part of the fire box construction. Second, the slabs may have fallen from the top of the kiln which is now entirely destroyed. The answers these questions may be forth coming once similar kilns are documented in the area.

Historically, the Lower Rudd Lime Kiln was about 60 meters (200 feet) from the Cumberland River (Boyce Moodie personal communication, 1995). After the Barkley Dam was constructed several miles upstream, the river width and depth was changed. Even today the river depth can vary greatly as the volume of water released from the reservoir fluctuates. Boyce Moodie indicates that there is an old sandstone floor or landing between the kiln and the old river bed (personal communication, 1995). This sandstone pavement is only exposed during periods of very low water. The pavement may have served as a road from the lime kiln to the Cumberland River where the lime could be shipped by boat.

It is suspected that there may have been additional lime kilns at the site. Some adjacent kilns may have previously eroded away by the swift waters of the Cumberland River. It is also possible that additional kilns may be still buried under the stone rubble dumped during quarrying activities in the 1930s.

METAL ARTIFACTS

During several visits to the Lower Rudd Lime Kiln, Boyce Moodie (personal communication, 1995) collected a number of metal artifacts associated with the kiln. Additional artifacts were exposed as the river eroded the bank away. The artifacts are in the possession of Mr. Moodie. Verbal descriptions based on Mr. Moodie's observations were previously published (Hockensmith 1996). On October 28, 1998, the author visited Mr. Moodie's home and measured these artifacts and made some sketches. The largest item recovered was a portion of an iron door that was either a drawing door or a

Figure 7. Photograph of the Fire Box Area of the Lower Rudd Lime Kiln on October 29, 1998 After Several Years of Erosion. Photograph is facing south.

Figure 8. Photograph of the Back Wall and the Rear of the Fire Box at the Lower Rudd Lime Kiln on October 29, 1998 After Several Years of Erosion. Photograph is facing southwest.

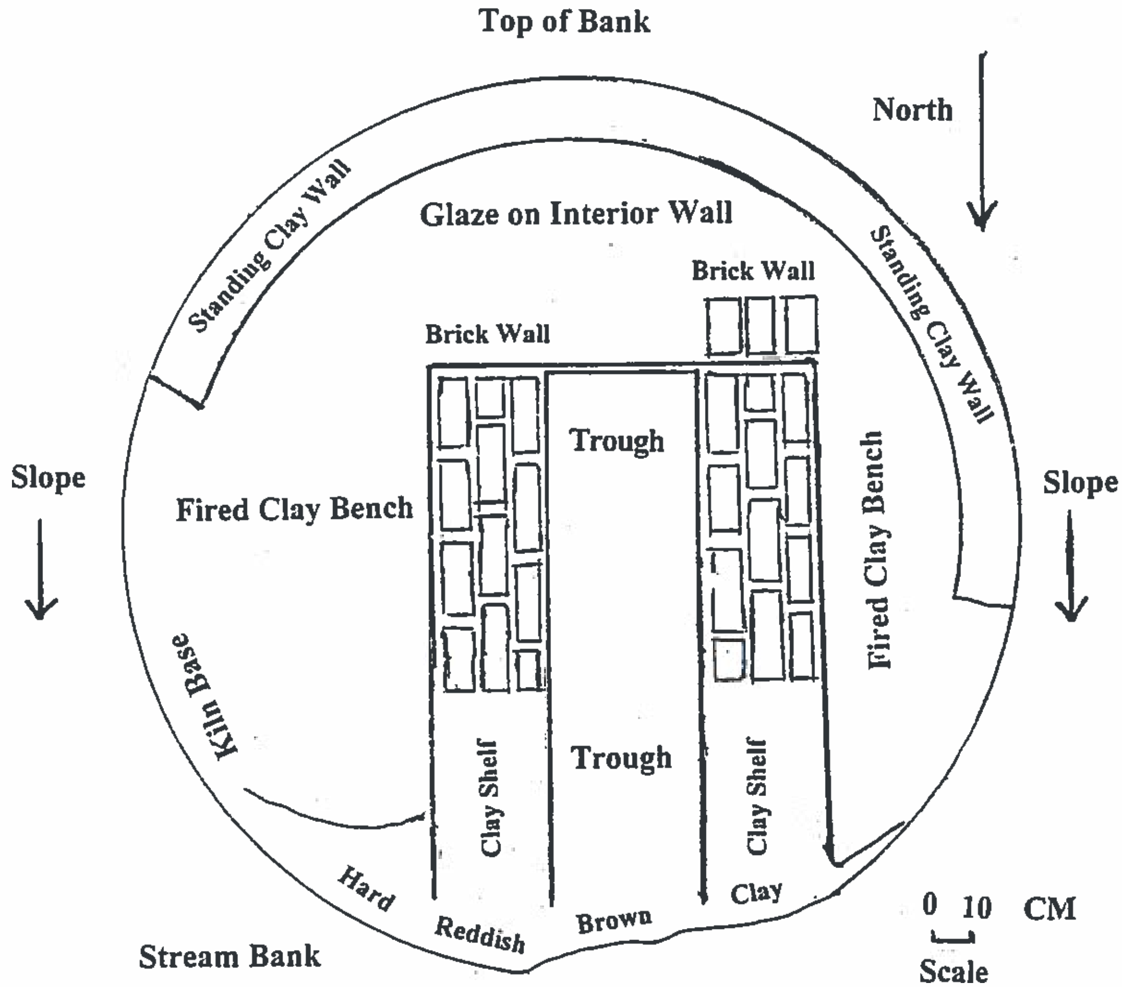


Figure 9. Planview Drawing of the Fire Box and Base of the Lower Rudd Lime Kiln on October 29, 1998. The drawing shows the surviving portions after several years of erosion.

fire box door. The door measures 41 by 51 cm (16.25 by 20 inches) and 2.5 cm (1 inch) thick. The door has a raised "X" brace on one side that 2 cm wide and 3 cm high. Another large piece of metal consist of two parallel iron bars 5 cm (2 inches) apart which are connected at 40 cm (15.75 inches). This artifact may be part of a door track or section of a fire grate. A fragment of an iron grate for the fire box about 25 cm (9.75 inches) long was also recovered. It has two parallel supports 5. 5 cm apart (2.25 inches), 4.5 cm (1.75 inches) high, and 1.5 cm (5/8 inch) thick. The grate fragment has round holes 2 cm (13/16 inch) in diameter that are through the metal. An iron pin 18 cm (7 1/8 inches) long and 1.5 cm (5/8 inch) was tapered at one end was also found at the site. An iron pry bar 78 cm (30.75 inches) long and 2.5 cm (1 inch) thick was found. The end of the pry bar has an angled bit 4 cm (1.5 inches) wide and 1.5 cm (5/8 inch) thick. Additional artifacts remained encased within the root system of a large tree that once grew within the kiln.

BRICKS

A sample of four bricks were collected from the remains of the fire box associated with the Lower Rudd Lime Kiln. One complete brick was collected from the fire box during the first visit in 1993. During the 1998 visit another complete brick was collected from the fire box base while one complete brick and one fragment were collected from the kiln rubble on the beach. These specimens appear to be common building bricks at first glance. However, they are probably early fire bricks made with clay exhibiting refractory qualities. A fragmentary specimen with a recent break reveals a light yellowish brown paste with yellow inclusions. Also, the paste contains some fine hematite particles and small holes.

Three bricks are a light yellowish brown color and one specimen is a light reddish brown. These bricks range from well-fired to over-fired, are dense, well-made, and have a sandy texture. They lack brand names and frogs. The sandy texture is a result of the mold being coated with sand to prevent the bricks from sticking. Linear strike lines extend along the long axis of one surface which indicates they were manufactured by the soft-mud technique. These specimens are 20.8 to 21 cm (8.25 inches) long, 10.3 to 10.6 cm (4 1/16 to 4 3/16 inches) wide, and 5.6 cm (2.25 inches) thick. On one brick, the struck surface has an irregular (5 by 10.5 cm) layer of clay (ca. 5 to 9 mm thick) adhering to it. This layer of clay has a gray glaze covering a portion of its upper surface and was used as a mortar between the bricks. Another specimen has a very fine light yellowish brown mortar 1.1 mm thick. One end of the first brick and the adjacent areas are covered with a gray and yellow glaze. Two other specimens have a light to medium gray glaze that has a dull appearance. Fragments of other bricks from the kiln have glaze on broken surfaces suggesting that the glaze is associated with the firing of the limestone to produce lime.

LIMESTONE SAMPLES

Four rock samples were selected from the interior of the kiln. It was not known whether these samples were associated with the last burning of the kiln or were deposited after the kiln was abandoned. They were mailed to Dr. Garland R. Dever, Jr. with the Kentucky Geological Survey in Lexington. Dr. Dever, Kentucky's limestone expert, provided the following comments (Dever 1993):

> Your samples from the Rudd lime kiln are being returned under separate cover. Three samples are oolitic limestone; one is a siltstone/sandstone.
>
> The oolitic limestone consist of oolites, or ooids, which are sand-sized, coated

particles. The oolites/ooids have nuclei composed of small fossil fragments which are coated with concentric and radial layers of calcium carbonate. In Livingston County, oolitic limestone mainly occurs in the Fredonia Limestone member of the Ste. Genevieve Limestone, and commonly is high-calcium limestone, composed of more than 95% $CaCO_3$, which would be suitable for lime manufacture.

The limestone sample in the plastic bag is slightly finer-grained than samples in the paper sacks. Weathering also has removed the "softer" oolitic coatings and left the more resistant fossil nuclei, giving the rock a "sandy" feel. All three limestone samples are slightly weathered, but none show any evidence of firing.

The fourth sample ranges from a coarse siltstone to a very fine-grained sandstone, with most silt and sand particles apparently being composed of quartz, in a partly calcareous matrix. The rock may be from either the Rosiclare Sandstone Member of the Ste. Genevieve or from the upper part of the Fredonia Member.

The Kentucky Geological Survey analyzed a sample of lime that was collected from the base of the kiln. The sample contained the following major elements 91.67 % calcium carbonate, 5.13 % silicon dioixide, and 1.76 % magnesium carbonate. Minor elements include aluminum oxide, ferric oxide, and sulfur trioxide.

THE UPPER RUDD LIME KILN

The Upper Rudd Lime Kiln (15Lv226) is located on the south bank of the Cumberland River about 300 m (990 feet) upstream from Lemen Landing, northwest of Vicksburg, in Livingston County, Kentucky (Hockensmith 1999). The kiln was brought to the author's attention by geologist Boyce R. Moodie, III of Paducah, Kentucky. During 1998, flood waters eroded the Cumberland River bank near Lemen Landing sufficiently to expose this buried kiln. The Upper Rudd Lime Kiln was upstream from the Rudd Lime Kiln that was documented by the author in 1993 (Hockensmith 1996). To avoid confusion, the previously described Rudd Lime Kiln will be referred to as the Lower Rudd Lime Kiln. On October 29, 1998, the Upper Rudd Lime Kiln was measured and was drawn in both plan view and profile. The site was also documented with black and white photographs as well as with color slides.

The precise age of the Upper Rudd Lime Kiln is unknown. Mr. Jess Rudd, the senior property owner, grew up on the farm containing the two lime kilns. Even though Mr. Rudd was born in 1911, he was unaware of their existence. A large tree had grown inside the kiln and had fallen over. Also, the rotten stump of an even larger tree (87 cm [34.8 inches] in diameter) was located 1.5 m (59.25 inches) east of the kiln top. These trees required many years to mature, die, and decay. The presence of these trees and the lack of Rudd family knowledge about these kilns suggest that they were abandoned sometime during the late 19th century.

The archaeological remains associated with the Upper Rudd Lime Kiln consist of the kiln and a nearby limestone outcrop that was quarried. The only artifacts recovered from the site were bricks. Also, several limestone samples and a small quantity of lime from the interior of the kiln were collected for analysis. A few metal artifacts were observed on the river bank but were not collected.

The Upper Rudd Lime Kiln is located on the south bank of the Cumberland River east (upstream) of Lemen Landing (Figures 10 and 11). This kiln is ca. 248 m (818.4 feet) upstream from the Lower Rudd Kiln documented in 1993 (Hockensmith 1996). Erosion caused by flood waters

Figure 10. Photograph of the Upper Rudd Lime Kiln Facing South Taken on October 29, 1998. Please note the kiln situated at the top of the river bank and the rubble associated with the kiln in the bottom of the photograph.

Figure 11. Photograph of the Upper Rudd Lime Kiln Showing More Details Taken on October 29, 1998. Please note the kiln in the top center and the eroded state of the river bank. The dark areas below and on the right side of the kiln were notches cut in the clay to permit standing on the steep slope. The photograph is facing south.

Figure 12. Close-up Photograph of the Upper Rudd Lime Kiln Showing the Fire Box and Remaining Lime (white area in lower center) Taken on October 29, 1998. Please note the base of the tree that grew into the kiln. The photograph is facing south.

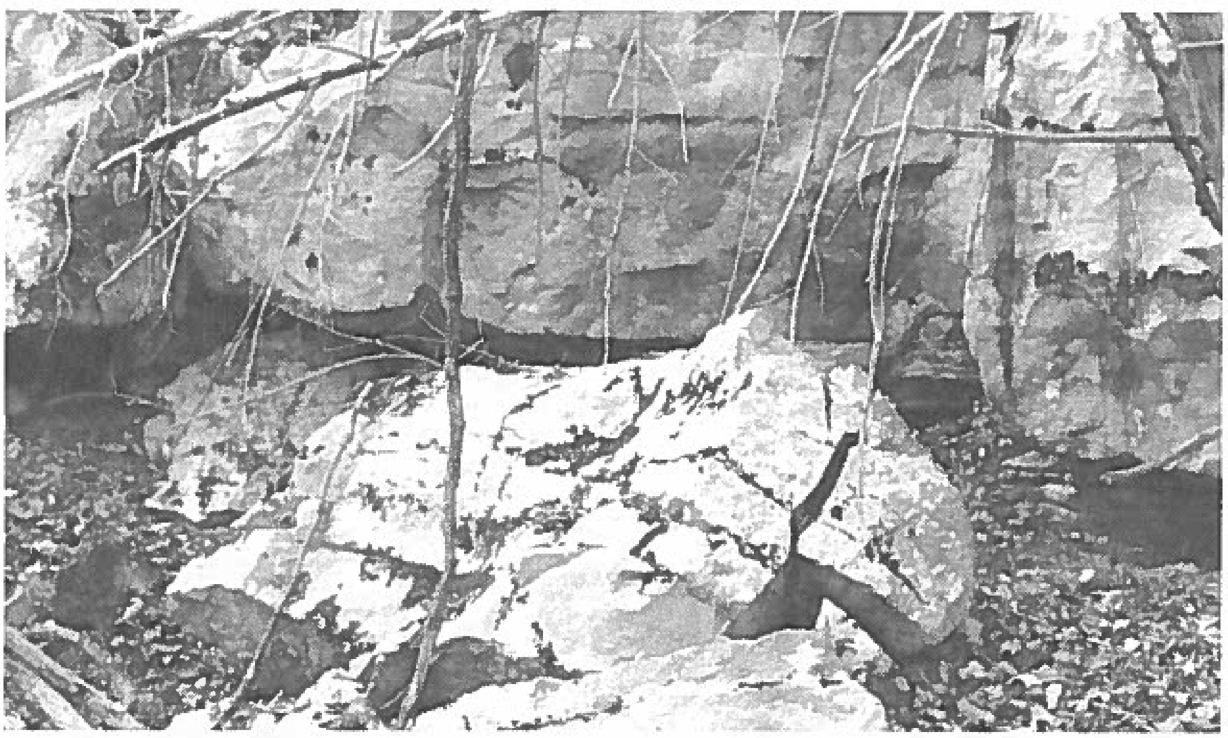


Figure 13. Photograph of the Limestone Working Face at the Upper Rudd Lime Kiln Taken on October 29, 1998 Facing South. This area served as a small quarry where the limestone was extracted for the kiln.

during 1998 exposed the kiln for the first time in recent history. Fortunately, most of the damage to the kiln was restricted to the wall on the river side (north) and to the outer edge of the fire box. The remainder of the lime kiln appears to be relatively intact. Documentation of the kiln was a tremendous challenge since the kiln was exposed on a steep river bank, which was nearly vertical in places. Shallow notches had to be cut into the 7 m (23.1 feet) high bank with a shovel to permit climbing the bank and to create areas for standing while taking measurements. Detailed measurements and observations could not be obtained for the upper portion of the exposed kiln wall since this area could not be safely documented without scaffolding (Figure 12).

The top of the kiln is visible on the surface of a narrow bench (ca. 15 m wide; 49.5 feet north-south) that forms the river bank at that location (Figure 14). A low pile of limestone (10 to 50 cm, 4 to 19.75 inches high) measuring 2 m (6.6 feet) east-west and 4 m (13.2 feet) north-south was located immediately west of the kiln top. This may be the remnant of the last stone stock-piled to burn in the kiln. An old road bed (ca. 3 m or 9.9 feet wide) depression extends along the bench from near the kiln eastward for about 37 m (122.1 feet) to the edge of a cleared field. The field contains the remains of an abandoned farmstead. About 9 m (29.7 feet) south of the kiln, a limestone outcrop is present at the base of the slope. Approximately 16 m (52.8 feet) further south, quarried limestone boulders (Figure 13) are situated on a man made bench, which is 6 m (19.8 feet) wide (north-south) and about 7 m (23.1 feet) vertically higher than the top of the kiln. Four meters (13.2 feet) south of the bench is a quarried limestone face (1.7 m or 5.6 feet high) about 4 m (13.2 feet) wide, and about 20 m (66 feet) long (east-west). The last two large blocks of limestone that were blasted free from the working face were never used. A vertical drill hole on the worked face was 3.5 cm (1 3/8 inches) in diameter and 48 cm (19 inches) deep. This drill hole indicates that the lime makers drilled holes to either blast or split off large boulders from the limestone bedrock. The limestone outcrop is about 2.5 to 3 m (8.25 to 9.9 feet) lower than the top of the Rudd Quarry, which is 28 m (92.4 feet) to the west.

The top of the Upper Rudd Lime Kiln contains a depression 75 cm to 1 m (29.5 to 39 7/16 inches) deep (Figure 15). Occasional sandstone blocks are visible around the circumference of the oval shaped depression. The top of the kiln measures about 4.9 m (16.17 feet) east-west and approximately 6 m (19.8 feet) north-south. Reddish brown clay (burned) around the sandstone blocks suggests intense firing episodes. Burned sandstone slabs, chunks of high calcium limestone, chunks of lime, and other evidence of burning were observed within the kiln depression. On the river side (north), the kiln has a 2 m (6.6 feet) long projection that contains the fire box. A tree was previously growing on the northern edge of the kiln but had died and fallen over before the survey. When this tree fell, it may have damaged the top of the kiln, weakening the bank and facilitating erosion.

The northern profile of the lime kiln gradually tapers to a rounded base (Figure 16). However, the exposed profile is only for the portion of the kiln projection containing the fire box. The main walls of the kiln are still buried in the river bank. The exposed portion of the kiln has a profile about 3.7 m (12.21 feet) high. The top of the kiln profile consists of a zone of sandstone slabs and soil approximately 77 cm (30.25 inches) thick that fell into the kiln as the upper walls collapsed. Below the slabs is a zone of reddish brown clay about 50 cm (19.75 inches) thick. Beneath the clay zone is a ca. 55 cm (21 5/8 inches) thick layer of in situ sandstone slabs. At least three courses of these slabs are intact above the brick arch of the fire box. These courses of slabs were laid on top of the sandstone walls on either side of the fire box to form a cap over the top of the fire box. The largest of these sandstone slabs was 50 cm (19.75 inches) long and 48 cm (18 7/8 inches) high. Smaller slabs include examples 15 to 37 cm (6 to 14 5/8 inches) wide. A brick lined fire box about 1.63 m (64.25 inches) high was located just below the sandstone slabs. The interior width of the fire box was 75 cm (29.5 inches). Beyond the exterior walls of the brick fire box was an outer wall constructed from sandstone slabs. The sandstone walls were not uniform in thickness (ca. 25 to 37 cm, 10 to 14 5/8 inches) and

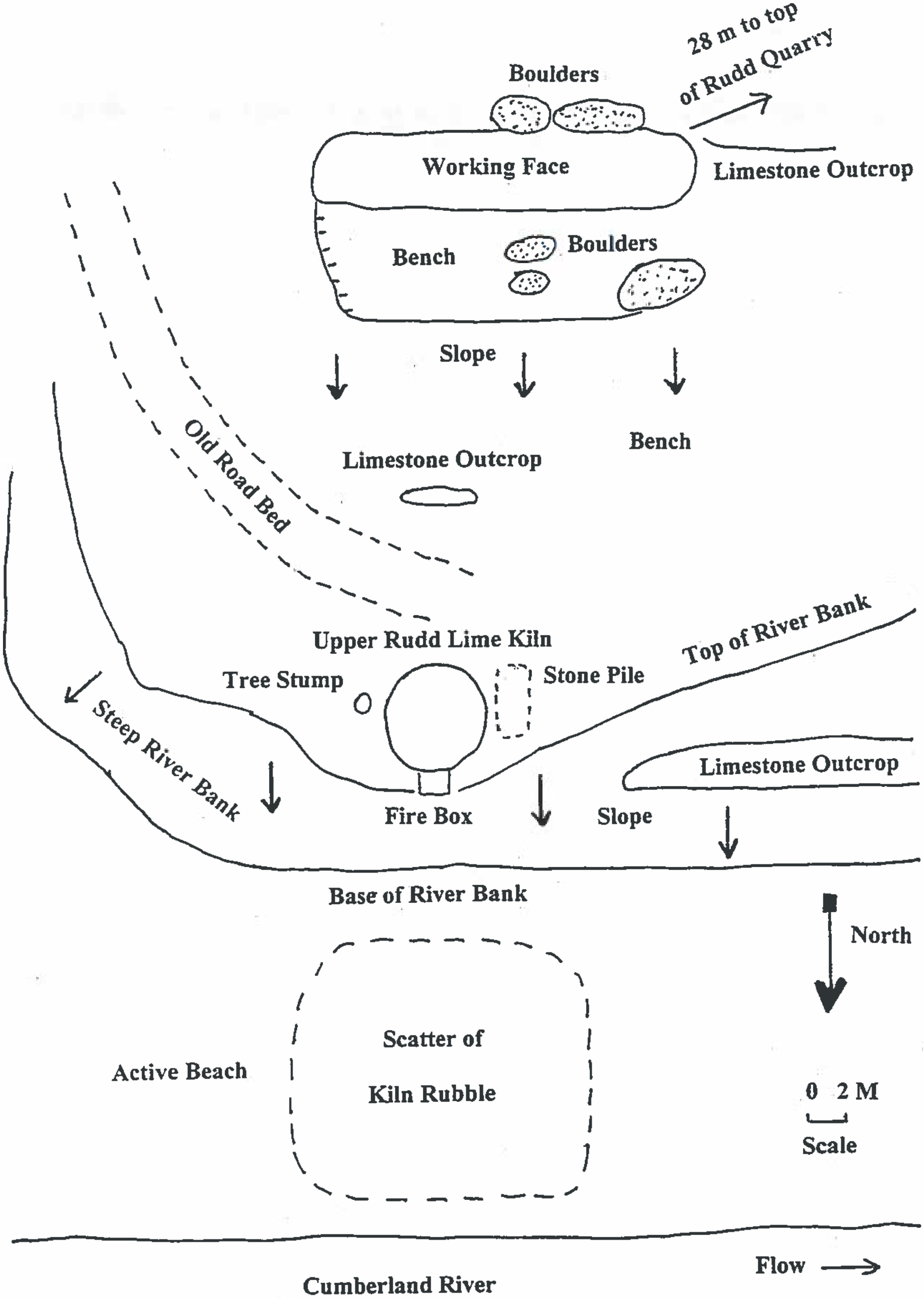


Figure 14. Planview Drawing of the Upper Rudd Lime Kiln and Related Features Including the Limestone Outcrop, Rubble Pile, and Road.

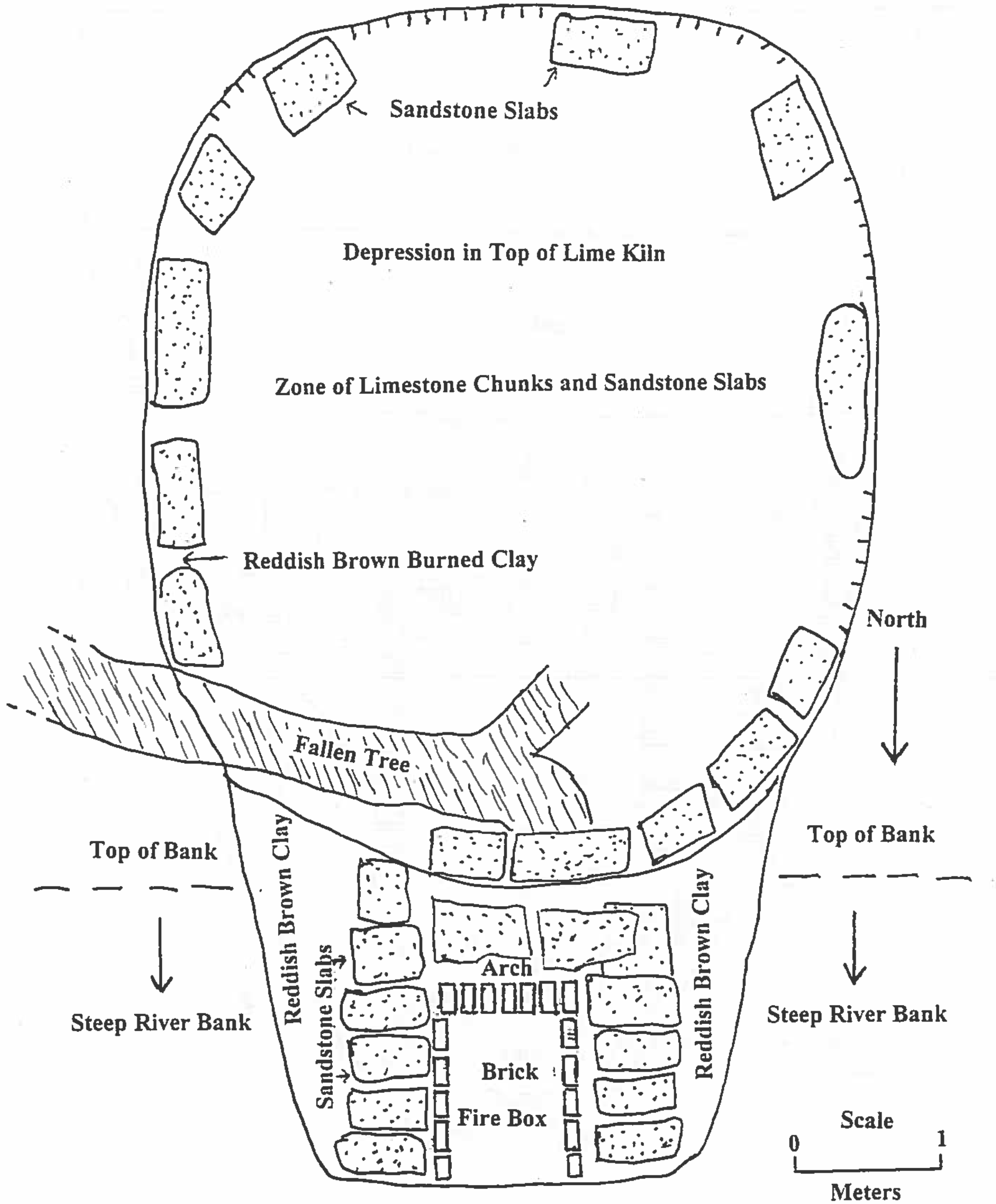


Figure 15. Planview Drawing Showing the Details of the Upper Rudd Lime Kiln.

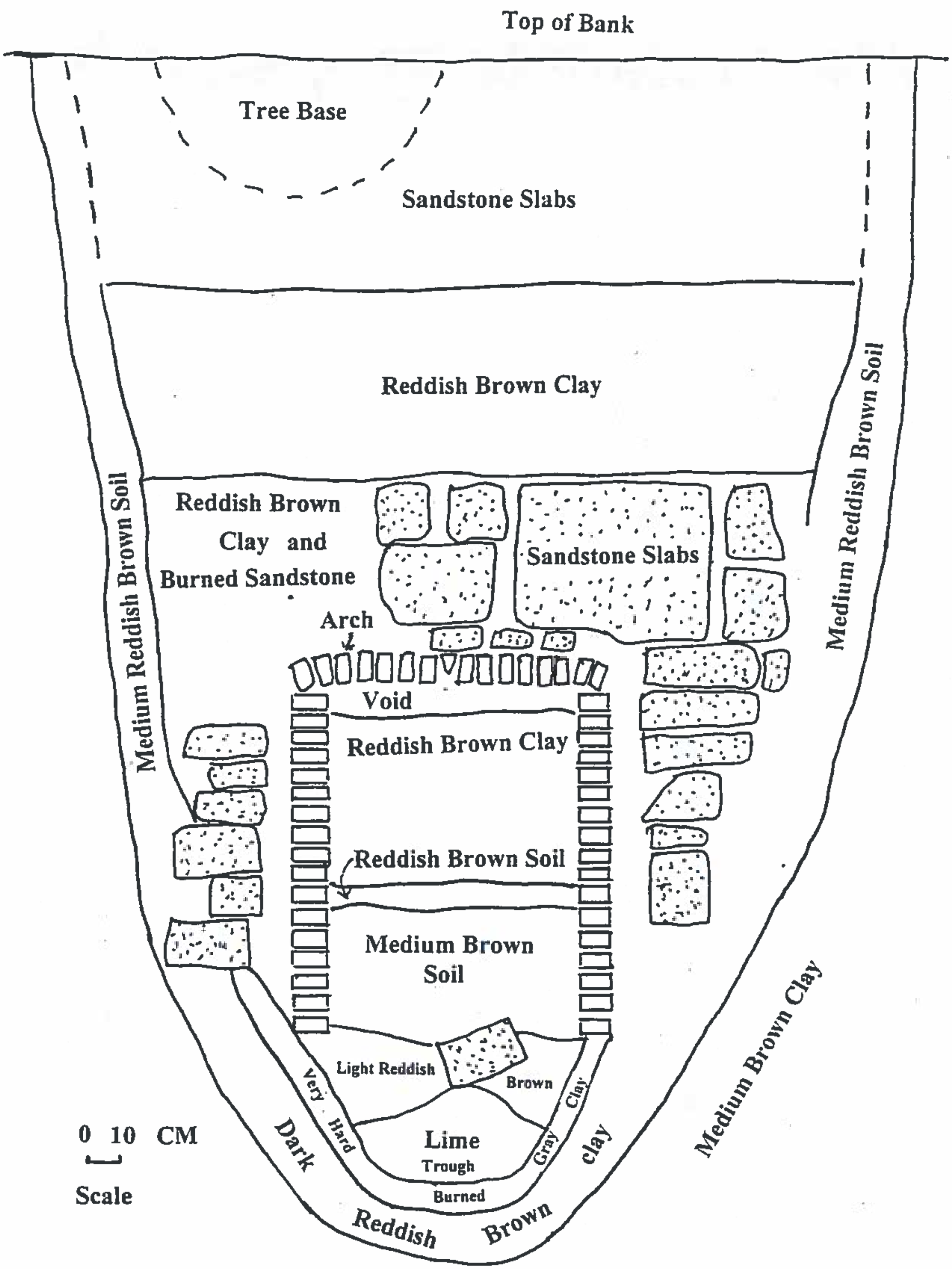


Figure 16. Profile Drawing Showing the Details of the Upper Rudd Lime Kiln. View facing towards south.

were only partially intact. Between the brick walls and the sandstone walls was a layer of reddish brown clay 5 to 13 cm (2 to 5.25 inches) thick. Outside the sandstone walls was a burned medium reddish brown clay zone ranging between 30 to 36 cm (11 7/8 to 14.25 inches) in thickness. At the base of the fire box was a large concentration of lime resting upon a very hard gray fired clay floor (10 cm, 4 inches thick). Below the clay floor was a 15 cm (6 inches) thick zone of dark reddish brown clay that had been burned. Beyond the dark reddish brown clay, an unmodified medium brown clay (that forms the river bank) was present.

At the base of the lime kiln is the brick fire box or drawing area (see Figure 16). This feature is largely obscured by fill and only the outer edges could be documented. The brick lined fire box has an interior about 1.53 m (60.25 inches) high and 75 cm (29.5 inches) wide. The exterior width of the fire box is 98 cm (38.5 inches). The top of the fire box is formed by a low brick arch constructed from 16 bricks laid as headers on their edges. A small wedge shaped brick was used as the key of the arch. A 10 cm (4 inches) high void was present between the base of the arch and the top of the fill. A folding rule was inserted into the dark void which revealed that the space extended at least 1.65 m (65 inches) to the south. Below the void was a 53 cm (20.75 inches) thick zone of burned sandstone and reddish brown clay. A 7 cm (2.75 inches) thick reddish brown burned layer is the next zone. Below that is a zone consisting of a ca. 53 cm (20.75 inches) thick layer of medium brown soil containing small chunks of lime, and a sandstone block measuring 20 cm long (7 7/8 inches) and 15 cm (5 7/8 inches) high. Immediately below the sandstone block is a concentration of pure lime that has a maximum thickness of 30 cm (11 7/8 inches) and a maximum width of 58 cm (22 7/8 inches). The lime layer rests upon a hard burned clay trough (gray clay) that is 40 cm (15.75 inches) wide and 10 cm (4 inches) thick. The trough has glazing on the interior from intense burning.

The brick arch rests upon two parallel brick walls that form the side walls of the of the fire box. The bricks are laid as headers on their sides, one brick wide. In both walls 17 intact courses of brick were exposed. These bricks are 5.5 cm thick (2.25 inches) and 9.5 to 10 cm (3.75 to 4 inches) wide. None of the in situ bricks were sufficiently exposed to measure their length. They were laid in a light gray mortar 1 to 2 cm (3/8 to 13/16 inches) thick. These bricks show evidence of being subjected to heavy burning. Due to the limited exposure, it was not possible to determine the details of the drawing floor or whether there was an interior drawing door or grate in situ. Future observation of the site may provide answers to these questions as erosion continues to expose more of the buried kiln.

The Cumberland River bank drops another 3 m (9.9 feet) or so vertically below the base of the lime kiln to an active beach area. During the visit to the site, the water level was much lower than usual. The excellent conditions permitted the examination of an area of kiln rubble that had fallen into the river near the base of the slope. This area measured about 14 m north-south (46.2 feet) and 15 m (49.5 feet) east-west. The kiln remains included heavily burned sandstone blocks that had been shaped, a few bricks, and clinkers. Also observed were some nails, bolts, and miscellaneous metal artifacts. Since the sandstone blocks had been cleaned by the river and were easily accessible, five specimens representing a range of sizes were measured. The selected sandstone blocks have the following measurements: 25 x 16 x 8 cm (9 7/8 x 6.25 x 3 1/8 inches), 70 x 44 x 16 cm (27.5 x 17.25 x 6.25 inches), 34 x 17 x 16 cm (13.5 x 6.75 x 6.25 inches), 88 x 39 x 16 cm (34 5/8 x 15 3/8 x 6.25 inches), and 25 x 16 x 5 cm (9 7/8 x 6.25 x 2 inches). The 16 cm (6.25 inches) measurement appears to be a common dimension used in selecting sandstone blocks for the kiln.

BRICKS

A sample of three complete bricks and one fragmentary specimen were collected from the kiln rubble on the beach. These specimens are from the portion of the fire box or drawing area at the base of the kiln that collapsed into the river. These common building bricks range from light to medium reddish brown in color. They are all over-fired, dense, and generally well-made bricks with a sandy texture. They lack brand names and frogs. The smooth texture of the struck surface suggests that they may have been water struck (to have the excess clay removed with a striker lubricated with water). The sandy texture is a result of the mold being lubricated with sand to prevent the bricks from sticking. Linear strike lines (rough surface with some gouging) extend across the long axis of one surface which indicates they were soft-mud bricks made in a mold. The bricks are nearly identical in size (one specimen is 9.3 cm wide) with the following measurements: 20.3 cm (8 inches) long, 9.5 cm (3.75 inches) wide, and 5.6 cm (2.25 inches) thick. The complete specimens are slightly warped and one specimen has a crack. Three of the bricks have a light to dark gray glaze with a dull finish. The broken brick reveals a dark reddish brown interior with numerous dark gray inclusions (less than 1 mm and larger up to 1.2 cm). A number of small holes are also present in the brick interior. One brick has some mortar on one face and part of another face. The mortar is a light tan in color, very fine in texture, and 4.5 mm thick. Since the bricks are slightly warped, glazed, and over-fired, they appear to be second quality specimens. However, such minor defects were not an important factor in selecting bricks for the construction of a fire box.

LIMESTONE SAMPLES

Nine rock samples were selected from the interior of the kiln and the worked limestone outcrop. An effort was made to obtain the range of variation present. These samples were submitted to Dr. Garland R. Dever, Jr., Kentucky Geological Survey, for analysis. His examination (Dever 1999) revealed that eight samples were high calcium limestone and one was upper Fredonia sandstone. Dever (1999) describes the four samples from the quarried working face uphill from the kiln as follows:

1. Coarse-to very coarse-grained, "oolitic." All grains have white chalky appearance; most appear peloidal; many with bioclast nucleus; some with relict oolitic structure; sparry cement.

2. Coarse-to very-coarse-grained, oolitic, with scattered crinoidal grains. Many grains have relict oolitic structure; some with bioclast nucleus; some appear peloidal-structureless.

3. Limestone essentially same as # 1.

4. Sandstone, brownish-gray, very fine-grained, slightly angillaceous; slightly calcareous.

The five limestone samples recovered from the top of the Upper Rudd Lime Kiln were described by Dever (1999) as follows:

1. Large sample, weathered. Medium-to very coarse-grained, oolitic (ooids); sparry cement; few fenestrate bryozoan fronds.

2. Medium sample, deeply weathered. Fine- to coarse-grained, bioclastic (mainly crinoidal), in part micrite-enveloped grains.

3. Small sample, weathered. Fine- to very coarse grained, peloidal (in part angular to subangular intraclasts), bioclastic (mainly crinoidal); in part in-place micrograined; few brachipods.

4. Small sample, deeply weathered. Apparently peloidal and crinoidal bioclastic; apparently same as # 3.

5. Small sample, weathered. Medium- to very coarse-grained, oolitic; sparry cement; same as # 1.

To clarify his descriptions, Dr. Dever provided the following word definitions. Bioclastic- particles composed of fragmented remains of organisms, such as shells and skeletal elements. Peloid/peloidal- particles composed of micrograined carbonate, regardless of origin. Intraclast- torn up and reworked fragments of peneontemporaneous sediment.

Chemical analysis of the limestone samples was performed by the Kentucky Geological Survey. Samples from the top of the Upper Rudd Lime Kiln contained between 82.19 and 97.69 % calcium carbonate. Limestone samples collected from the working face contained between 93.85 and 96.62 % calcium carbonate. The lime from the bottom of the kiln contained 84.20 % calcium carbonate. The two most important minor elements present in the lime were magnesium carbonate and silicon dioixide. Very minor elements present in the samples were aluminum oxide, ferric oxide, and sulfur trioxide.

THE RUDD LIMESTONE QUARRY

The abandoned Rudd limestone quarry is located between the two lime kilns. As depicted on the topographic maps, this quarry measures approximately 40 m north-south and 80 m east-west. It is several meters deep. The date of the initial quarrying of limestone at the site is unknown. In November of 1932, the Franklin Limestone Company of Nashville, Tennessee leased the Rudd Quarry to obtain stone for crushing (Livingston County Mineral Lease Book 1a:87-88). About 1934, the lease was transferred from the Franklin Limestone Company to the Waterways Stone Company (Livingston County Mineral Lease Book 1b:105-107). A royalty was paid to Mrs. Rudd at the rate of 2 ½ cents per cubic yard of stone removed from the quarry (Livingston County Mineral Lease Book 1b:105-107). The second lease document indicates that this property was conveyed to G. C. Rudd from G. W. Southern and his wife on March 14, 1916 (Livingston County Mineral Lease Book 1b:106). The quarry appears to predate these leases. Apparently, it was already known that the quarry tract contained a high grade of limestone. Therefore, it is probable that a smaller quarry operated on the tract many years earlier. The Lower Rudd Lime Kiln was probably associated with this earlier quarry. This lime kiln may have been buried with rubble from later quarrying episodes.

The 1929 Smithland 15 minute quadrangle and the 1944 corrected reprint of the 1929 Smithland 15 minute quadrangle do not show the Rudd Quarry (U.S. Geological Survey 1929, 1944). The quarry first appears on the 1954 version of the Burna, Kentucky 7.5 minute quadrangle (U.S. Geological Survey 1954). This late date for the quarry corresponds with oral history (Moodie 1998) that the Rudd Quarry did not open until the late 1940s or early 1950s. Before consulting the maps, it was erroneously assumed that the Rudd Quarry was associated with the Lower Rudd Lime Kiln

(Hockensmith 1996). Now it is known that the Rudd Quarry just further exploited the limestone that the lime makers had used during the 19th century.

. DISCUSSION

In this section, the Upper and Lower Rudd Lime Kilns are briefly compared with other lime kilns that have been documented. Due to space restrictions, this discussion can not make detailed comparisons with all known kilns. The emphasis will be on those kilns that are similar in design. For the benefit of the reader, other styles of lime kilns will be discussed.

A very useful classification of lime kilns by type has been developed by Victor Rolando (1990: 24) based on his documentation of 87 lime kilns in Vermont. These included farm type kilns (ca. 1800-1860s), early-commercial type kilns (ca. 1850-1900s), later-commercial type kilns (ca. 1870s-1920s), and modern type kilns (1900s-1950s). Only two of these types are pertinent for the present study. First, the farm type kilns:

> ...are primitive in appearance, round in shape, built of field stone with field stone or sandstone linings that are only slightly glazed (low-temperature burning). They measure about 4 to 6 feet inside diameter with 1- to 2-foot thick stone walls, 6 to 8 feet high. Built into low embankments in remote areas near small limestone outcrops, the kiln walls are sometimes mounded up with earth to insulate and seal holes. Farm type kilns were fueled by wood and burned limestone for local needs (Rolando 1990: 24).

Second, Rolando (1990:24) noted that early-commercial type kilns:

> ...are idyllic in appearance and are general round. Some ruins contain decorative components (Gothic arches) and are built of field stone or cut blocks with refractory stone or firebrick linings that are somewhat glazed. They measure 6 to 8 feet inside diameter, 2 to 3 foot thick stone walls, and 8 to 10 feet high. Ruins of early-commercial type kilns have usually been found near small quarries, and alongside old roads or abandoned railroads. These ruins are more obvious than farm kiln ruins. They were fueled by wood and burned limestone for local and regional markets.

The Lower Rudd Lime Kiln shares traits with both of Rolando's (1990) kiln types described above. In terms of size, the presence of glazing, and the proximity to a quarry, the Lower Rudd Lime Kiln compares with Rolando's (1990:24) early-commercial type kilns. However, the Lower Rudd Kiln lacks the stone or firebrick lining. On the other hand, it is built into a low embankment and is isolated like Roland's (190:24) farm type kilns. Considering the remoteness of western Kentucky during the 19[th] century, refractory stone and firebrick may not have been readily available in rural Livingston County. Thus, the decision to use clay to line the Lower Rudd Kiln may have been an adaptation which utilized locally available materials.

A round lime kiln near Adams, Massachusetts was described as follows by Nathaniel Hawthorne in 1852 (cited in Robinson 1976:109):

> A rude, round towerlike structure about twenty feet high, heavily built of rough stones, with a hillock of earth heaped about the larger part of its circumference; so that blocks and fragments of marble might be drawn by cart-loads, thrown in at the top. There

> was an opening at the bottom of the tower, like an ovenmouth, but large enough to admit a man in a stooping posture, and provided with a massive iron door. With the smoke ad jets of flame issuing from the chinks and crevices of this door, which seemed to give admittance into the hillside, it resembled nothing so much as the private entrance to infernal regions.

Of the documented lime kilns, it appears that the Cataract Lake Furnaces in Indiana (Dolan and Pace 1973) are most similar to the Lower Rudd Lime Kiln. These were the only other reported lime kilns that were clay lined. While both are circular "ground hog" kilns, the Lower Rudd Kiln is slightly taller and has a greater diameter. However, the Cataract Lake Furnaces were paired and have a much greater combined capacity. Other "ground hog" kilns in Indiana according to Blatchley (1904:225-226) were constructed of stone.

The Upper Rudd Lime Kiln shares traits with both of Rolando's (1990) kiln types described above. In terms of size, the presence of glazing, stone lining, and the proximity to a quarry, the Upper Rudd Lime Kiln compares with Rolando's (1990:24) early-commercial type kilns in Vermont. However, the Upper Rudd Lime Kiln has a much larger interior diameter and greater height than early commercial kilns. On the other hand, it is built into a low embankment and is isolated like Rolando's (1990:24) farm type kilns. Considering the remoteness of rural Livingston County, a decision was probably made to line the Upper Rudd Lime Kiln with sandstone blocks which were locally available materials.

The Upper and Lower Rudd Lime Kilns share both similarities and differences. Comparisons of these kilns are hindered because of their different states of preservation. The Lower Rudd Lime Kiln is largely washed away while the Upper Lime Kiln is only partially exposed in the river bank. In terms of similarities, both kilns are circular, silo-shaped structures built into the sides of steep river banks Second, both kilns were strategically located in order to exploit an outcrop of high calcium limestone and facilitate the top loading of the kilns from benches above them. Third, brick fire boxes and hard burned clay troughs are present at both kilns. Fourth, the clay troughs at both kilns are glazed and are 40 cm wide. Fifth, both kilns were located near the Cumberland River to provide access to cheap transportation by boat. Sixth, the presence of large dead trees within both kilns suggests that they were probably abandoned in the late 19th century.

Several differences are apparent between the Upper and Lower Rudd Lime Kilns. First, the Lower Rudd Lime Kiln is constructed primarily from clay while the Upper Rudd Lime Kiln is constructed from sandstone blocks. Second, the Upper Rudd Lime Kiln is larger than the Lower Rudd Lime Kiln. The Upper Rudd Lime Kiln has a greater diameter (4.9 to 6 m) and height (3.7 m) than the diameter (4 m) and height (2.78 m) of the Lower Rudd Lime Kiln. Third, the bricks used in the construction of the fire boxes of these kilns are very different. This suggests the possibility that they were either built at different times or by different people since the source of bricks was different.

The review of the lime kiln literature revealed that round or circular lime kilns were not as common as the rectangular or square versions. This may or may not be a bias of limited reporting of lime kilns. In Kentucky, the only other round lime kilns are the commercial kilns in Meade County and a small farm kiln in Fayette County. Rectangular or square lime kilns are currently recorded in Green, Logan, and Meade counties, Kentucky. Unfortunately, there are no recorded lime kilns in extreme western Kentucky where the Rudd Lime Kilns are located.

When examining the lime kiln literature in other states, there are few recorded kilns similar to the Rudd Lime Kilns. Circular lime kilns have been recorded in Indiana, Michigan, Ohio, and

Vermont. Rectangular or square lime kilns have been recorded in Alabama, California, Connecticut, Illinois, Michigan, Ohio, Pennsylvania, South Carolina, Tennessee, Utah, and Vermont. In some states lime kilns have been reported but no information is available on their shape. Unfortunately, researchers other than archaeologists mentioned many of the lime kilns which resulted in a lack of specific details for these kilns. Without general measurements and construction details for lime kilns, it is nearly impossible to discuss the similarities and difference in American kiln construction techniques. Hopefully, future researchers will collect sufficient information to allow comparison between lime kilns in different regions of the United States.

CONCLUSIONS

The Rudd Lime Kilns are the first western Kentucky lime kilns to be documented. While they share some similarities with other reported lime kilns, they are somewhat unique when compared to other Kentucky kilns and kilns reported in the literature examined. Other known Kentucky lime kilns are stone lined while those in other states were usually stone or fire brick lined. In terms of their size, the presence of wall glazing (indicating a high heat), and their location on the Cumberland River, the Rudd Lime Kilns appears to be commercial kilns. Further, Boyce Moodie's recovery of an iron door at the Lower Rudd Lime Kiln suggests that it was more advanced than a typical "ground-hog" kiln. Also, both the Rudd Lime kilns had brick fire boxes. Their location near the Cumberland River would have permitted the lime to be sold both locally as well as up and down the river in adjacent counties.

The exact age of the Rudd Lime Kilns is not currently known but their style would suggest that they were probably built sometime after 1850 and abandoned before 1900. The 1860 Population Census for Livingston County listed a 36 year old John Richardson as a lime Merchant (Drennan 1987:92). In the 1850 Census, John Richardson was listed as a farmer (Drennan 1980:102). No other individuals associated with the lime industry were found in the 1870 or 1880 Population Census schedules (United States Federal Census 1870, 1880). It is not known whether he operated a lime kiln in Livingston County or if he acted as a middleman for kiln operators. In an effort to obtain specific information on the lime industry in Livingston County, the 1850, 1860, 1870, and 1880 Manufacturing Census records were consulted. Also, the published summaries of the Manufacturing Census Schedules between 1810 and 1840 were checked for lime producers. Unfortunately, these records yielded no clues concerning the ownership and operating dates for the Upper and Lower Rudd Lime Kilns. These kilns may have been periodic producers of lime and perhaps did not generate sufficient income to be considered in the Manufacturing Census. Another possibility is that the kilns were operated for a brief period of time between the ten year Census intervals. Finally, census takers may have overlooked the kilns since they were located in a very rural setting. Regardless of what happened, these kilns lack the excellent archival data available for so many 19th century sites.

Support structures were probably associated with both lime kilns. At the Tyrone Forge Lime Kiln associated with the American Lime & Stone Company in Blair County, Pennsylvania, wooden structures were shown on an insurance map (Fitzsimons 1990). Fitzsimons (1990:91) noted the presence of "... a one-story kiln-shed of wood construction (which provided shelter for the removal of the calcined lime from the kilns), a one-story slaking shed, also of wood construction, where the calcined lime was permitted to cool, and a series of conveyors and storage sheds for handling and storing the chunks of slaked lime." Undoubtedly, the Rudd Lime Kilns had some type of wooden structures to provide protection for the lime until it could be shipped to intended markets. Likewise, structures were required for the storage or manufacture of wooden barrels used in shipping the lime.

In those areas of the Commonwealth containing high calcium limestone, archaeologists should be aware of the potential for encountering lime kilns during Phase I surveys. Lime kilns may occur in areas that most archaeologists consider to have low potential for sites such as slopes and the bases of hills. Kilns may range from very primitive structures built by farmers for producing agricultural lime to more substantial early commercial lime kilns to advanced commercial lime kilns. Because Kentucky was not a major lime producing state, the history of the industry is very poorly known. Only through careful archaeological study can we begin to understand the development, diversity, and distribution of Kentucky's lime industry. By documenting the remains of Kentucky's lime industry, we can ensure that another important component of our industrial heritage is preserved in the written record. Hopefully, a sample of the lime kilns can be preserved in parks and on private property for future generations to view and appreciate.

ACKNOWLEDGMENTS

Several individuals were very helpful in providing information that aided in the preparation of this paper. First and foremost, the author wishes to thank Boyce R. Moodie, III of Moodie Mineral Company in Paducah. Mr. Moodie discovered the Lower Rudd Lime Kiln and took the author to the site in his boat. He also obtained land owner permission for the author to investigate the site. Further, Mr. Moodie visited the site repeatedly collecting metal artifacts as the river exposed them and documented the site with photographs. In 1998, Mr. Moodie brought the Upper Rudd Lime Kiln to the author's attention. A special thanks is due to property owners J. A. Rudd and Jess Rudd of Smithland who granted permission for the field work. Thomas N. Sanders, Site Protection Program Manager at the Kentucky Heritage Council, allowed the author to document the Lower and Upper Rudd Lime Kilns and prepare this paper as part of his job duties. Special thanks are due to Dr. Garland R. Dever, Jr. with the Kentucky Geological Survey in Lexington. Dr. Dever referred Mr. Moodie to the author in 1993, commented on rock samples obtained from the kilns, and suggested literature sources. William J. Tallent with the New River Lime Company of Covington loaned the author an excellent publication on the manufacture of lime. Victor R. Rolando of Manchester, Vermont (formerly Pittsfield, Massachusetts) generously shared information with the author when they corresponded in 1990 and 1991. The Indiana Geological Survey granted permission to reproduce Figure 1 from Blatchley's 1904 report "The Lime Industry in Indiana". The assistance of Ms. Deborah DeChurch, Editor, Indiana Geological Survey, is gratefully acknowledged. Mr. Ron Bryant, Kentucky Historical Society Library, provided access to the Rare Book Room for directories and also provided assistance in other ways. Larry G. Meadows, Red River Historical Society, shared information on the Black Creek Lime Kiln in Powell County, Kentucky and information from *The Clay City Times* newspaper. Kurt H. Fiegel, Kentucky Department of Transportation, made his copy of Victor Rolando's book available before the author purchased a copy. Thomas R. Wheaton, Jr. of Garrow and Associates of Atlanta provided copies of his papers on the Jimmie Green Lime Kiln in South Carolina. James Hixon and Carl Shields, Kentucky Department of Transportation, provided information on lime kilns from the Kentucky-Indiana Bridge Project at Louisville. Elizabeth D. Benchley provided a copy of her paper on the Greenfield Lime industry in Milwaukee County, Wisconsin. Steve Gordon, Ohio Historical Society, provided information on the Marblehead Lime Kiln in Ottawa County, Ohio and the Chestnut Grove Lime Kiln in Ashtabula County, Ohio. Nancy O'Malley, University of Kentucky, checked the Office of State Archaeology files and provided information on lime kilns from the Internet. Michael R. Polk, Sagebrush Consultants, provided copy of his HAER documentation of the Mantua Lime Kiln in Box Elder County, Utah and suggested sources for further research. Richard Brown of Louisville assisted the author with the documentation of 14 lime kilns in Meade County, Kentucky, which are discussed, in this paper. John T. Carter, formerly with the Department of Surface Mining, accompanied the author to the ruins of the

Rockcastle Lime and Cement Plant at near Pine Hill. Finally, Donald B. Ball, Louisville District of the U.S. Army Corps of Engineers, has graciously shared information on lime kilns and assisted in the getting the earlier studies on the Rudd kilns published. The assistance of each of the above individuals is greatly appreciated.

During the final preparation of this paper several individuals shared information on lime kilns in other states. Floyd Mansberger with Fever River Research in Springfield, Illinois shared sections of a report that dealt with lime kilns. Sam Smith with the Tennessee Division of Archaeology made me aware of a website with information on lime kilns. Glenn Farris, Senior State Archaeologist, California Department of Parks and Recreation graciously provided copies of two reports on lime kilns. Robert W. Piwarzyk of Santa Cruz, California shared information on his lime kiln research. Archaeologist Tom Wheeler with the California Department of Transportation in San Luis Obispo shared copies of two reports on the California lime industry. Ms. Pam Lyons, Kentucky Department of Libraries and Archives was extremely helpful in obtaining some articles on the lime industry through interlibrary loan. My coeditor, Dr. Kenneth C. Carstens of Murray State University, made many helpful comments that improved the quality of this paper. The contribution of all these people is gratefully acknowledged.

REFERENCES CITED

Abbott, Diane B. (editor)

1976 *The Lower Peninsular of Michigan: An Inventory of Historic Engineering and Industrial Sites.* Historic American Engineering Record, National Park Service, Washington, D. C.

Amos, Dewey H.

1974 *Geologic Map of the Burna Quadrangle, Livingston County.* The U. S. Geological Survey, Reston, Virginia.

Atkinson, James R. and Jack D. Elliott, Jr.

1978 *Nance's Ferry: A 19th Century Brick and Lime Making Site, Pickens County, Alabama.* Report submitted to the Mobile District, U. S. Army Corps of Engineers by Mississippi State University.

Ault, Curtis H., Lawrence F. Rooney, and Margaret V. Palmer

1974 *The Lime Industry of Indiana.* Department of Natural Resources, Geological Survey Bulletin 42-J, Bloomington.

Azbe, Victor J.

1946 *Theory and Practice of Lime Manufacture: A Collection of Articles.* Azbe Engineering Corporation, Clayton, Missouri.

Ball, Donald B.

1991 Supplemental Appendix: Recommendations for the Archaeological Assessment of Four Nineteenth Century Industrial Sites at Fort Knox, Kentucky. In *Historical Report on Four Mill Sites on the Fort Knox Military Reservation, Meade County, Kentucky* by James J. Holmberg, pp.159-213. Prepared for the U. S. Army Corps of Engineers, Louisville District, Louisville, Kentucky.

Benchley, Elizabeth D.
1988 The Greenfield Lime Industry 1850-1910, Milwaukee County, Wisconsin. Paper presented at the Midwest Archaeological Conference, Urbana, Illinois.

Berkheiser, Samuel W., Jr. and Donald T. Hoff
1983 The Arthur L. Long Lime Kiln, An Active Record of Yesteryear. *Pennsylvania Geology* 14 (5):9-15.

Blatchley, W. S.
1904 The Lime Industry in Indiana. In the *Indiana Department of Geology and Natural Resources Twenty-Eighth Annual Report*, pp. 211-257.

Briggs, John W.
1969 National Register of Historic Places Nomination form for the Rockland-Rockport Lime, and Merriam, and Shepherd Lime Companies, Rockport, Maine. Prepared by the State Park and Recreation Commission, Augusta, Maine.

Buehler, A. H.
1907 *Lime and Cement Resources of Missouri*. Missouri Geological Survey, Second Series, Volume 6, Rolla.

Burchard, Ernest F.
1914 Sources of Lime. In *Mineral Resources of the United States, Calendar Year 1913, Part II-Nonmetals*, pp. 1511-1555. Government Printing Office, Washington, D.C.

Burnell, George R.
1870 *Rudimentary Treatise on Limes, Cements, Mortars, Concretes, Mastics, Plastering, Etc.* Virtue and Company, London.

Bush, David R., Judith E. Thomas, Renea Martello, and Denyse Fissel
1991 A Cultural Resource Survey for the Proposed Marblehead Ferry Boat Dock for Kelleys Island Boat Lines, Inc. in Danbury Township, Ottawa County, Ohio. David R. Bush, Archaeological Resource Investigations, Eastlake, Ohio.

Cowherd, Bryan
2000 Personal communication to Charles D. Hockensmith and photographs concerning the Cowherd Lime Kiln in Green County, Kentucky.

Department of Commerce and Labor
1911 *Lime: Its Properties and Uses*. Circular of the Bureau of Standards, No. 30. Department of Commerce. Government Printing Office, Washington, D.C.

Dever, Garland R., Jr.
1969 *High-Calcium and Low-Magnesium Limestone Resources in the Region of the Lower Cumberland, Tennessee, and Ohio Valleys, Western Kentucky*. Kentucky Geological Survey, Series 10, Bulletin 5, Lexington.

1993 Letter to Charles D. Hockensmith dated October 5th from the Kentucky Geological Survey containing the results of an analysis of rock samples from the Lower Rudd Lime Kiln in Livingston County, Kentucky. On file at the Kentucky Heritage

Council, Frankfort.

1999 Letter to Charles D. Hockensmith dated March 15th from the Kentucky Geological Survey containing the results of an analysis of rock samples from the Upper Rudd Lime Kiln in Livingston County, Kentucky. On file at the Kentucky Heritage Council, Frankfort.

Dolan, Edward M. and Robert E. Pace
1973 The Cataract Lake Furnaces: Historic Archaeology in Owen County, Indiana. *Proceedings of the Indiana Academy of Science* 83 (1):72-77.

Drennan, Juanita Walker
1980 *1850 Census of Livingston County, Kentucky*. Privately printed, Smithland, Kentucky.

1987 *1860 Census of Livingston County, Kentucky*. Privately printed, Ledbetter, Kentucky.

Eckel, Edwin C.
1928 *Cements, Limes and Plasters: Their Materials, Manufacture and Properties*. John Wiley & Sons, London (3rd edition).

Emley, Warren E.
1914 The Manufacture and Use of Lime. In *Mineral Resources of the United States, Calendar Year 1913, Part II-Nonmetals*, pp. 1556-1593. Government Printing Office, Washington, D.C.

Emley, W. E. and J. M. Porter
1927 Manufacture of Lime. *Circular of the Bureau of Standards, No. 337*. Department of Commerce and Labor. Government Printing Office, Washington, D.C.

Field, Thomas P.
1961 *A Guide to Kentucky Place Names*. Kentucky Geological Survey, Series 10, Special Publication 5, Lexington.

Fitzsimons, Gray (editor)
1990 *Blair County and Cambria County, Pennsylvania: An Inventory of Historic Engineering and Industrial Sites*. Historic American Engineering Record, National Park Service, Washington, D. C.

Gillmore, Q. A.
1874 *Practical Treatise on Limes, Hydraulic Cements, and Mortars*. D. Nostrand, New York (5th edition).

Granger, Joseph E. and Anne T. Bader
1989 Archaeological Site Discovery at Carver's Lake on Upper Paradise Bottom, Meade County, Kentucky. Report submitted to Addington Incorporated, Ashland by Granger Consultants, Louisville.

Grindle, Roger L.
1971 *Quarry and Kiln: The Story of Maine's Lime Industry*. Courier-Gazette, Rockland, Maine.

Hawthorne, Nathaniel
1852 Ethan Brand. In *The Snow Image and Other Twice Told Tales*. Boston.

Hitchcock, Edward, Edward Hitchcock, Jr., Charles Hitchcock, and Albert D. Hager
1861 *Report on the Geology of Vermont*. Edited by Albert D. Hager, Proctorsville, 2 vols.

Hockensmith, Charles D.
1979 *An Archaeological Survey of the Raven Run Nature Sanctuary, Fayette County, Kentucky*. Report No. 1. Office of State Archaeology, University of Kentucky, Lexington.

1996 Archaeological Investigations at the Rudd Lime Kiln, Livingston County, Kentucky. *Ohio Valley Historical Archaeology* 11:115-124.

1999 The Upper Rudd Lime Kiln: An Industrial Archaeological Site Near Lemen Landing, Livingston County, Kentucky. *Ohio Valley Historical Archaeology* 14:95-104.

2004 Archaeological Investigations at the Cowherd Lime Kiln, Near Bengal, Green County, Kentucky. *Ohio Valley Historical Archaeology* 19 [In Press].

n.d. Archaeological Investigations at the Shrull Lime Kiln Near Russellville, Logan County, Kentucky. Draft manuscript on file at the Kentucky Heritage Council, Frankfort.

Hockensmith, Charles D. and Richard M. Brown
2004 Archaeological Investigations at the Pace Lime Kiln, Near Brandenburg, Meade County, Kentucky. *Currents of Change*, Journal of the Falls of the Ohio Archaeological Society 2 (1):1-12, Clarksville, Indiana [In Press].

Jacobs, Elbridge C.
1918 The Lime Industry in Vermont. In *Report of the State Geologist on the Mineral Industries and Geology of Vermont: 1917-1918*, edited by George H. Perkins, pp. 158-164, Bellows Falls.

Jensen, Kenneth
1976 The Lime Industry in Santa Cruz County. Manuscript on file with the University of Santa Cruz Library, Special Collection, Santa Cruz, California.

Jones, E. Griffin
1942 *A History of the American Lime Industry*. Greenberg House, New York.

Kingsley, Ronald F.
1988 Rescue Excavation of an Early 19th Century Lime Burning Kiln, at Geneva State Park, Ashtabula County, Ohio. Report submitted to the Ohio Historical Society, Columbus by Kent State University, Kent, Ohio.

1993 Chestnut Grove: An Early 19th-Century Lime Burning Industry in the Connecticut Western Reserve. *North American Archaeologist* 14 (1): 71-85.

Kulik, Gary and Julia C. Bonham
1978 *Rhode Island: An Inventory of Historic Engineering and Industrial Sites.* Historic American Engineering Record, National Park Service, Washington, D. C.

Lazell, E. W.
1915 *Hydrated Lime: History, Manufacture and Uses in Plaster-Mortar-Concrete.* Jackson-Remlinger Ptg. Company, Pittsburgh.

Livingston County Mineral Lease Books
1932a Lease between G. C. Rudd and the Franklin Limestone Company, Nashville for quarrying limestone. Livingston County Mineral Lease Book 1, pp. 87-88. Livingston County Courthouse, Smithland, Kentucky.

1932b Contract and lease between Pearl Rudd and Waterways Stone Company for quarrying limestone. Livingston County Mineral Lease Book 1, pp. 105-107. Livingston County Courthouse, Smithland, Kentucky.

Long, Amos, Jr.
1966 Pennsylvania Limekilns. *Pennsylvania Folklife* 15 (3):24-37.

McCain, Dan
1999 Lime Kilns on the Harley & Hubbard Property. Manuscript concerning lime kilns at Delphi, Indiana. Copy on file at the Kentucky Heritage Council, Frankfort.

McConnell, A. G.
1986 Personal communication to Charles D. Hockensmith concerning a lime kiln 3.5 miles west of Danville, Kentucky on the McConnell farm. March 5, 1986.

Mansberger, Floyd and Christopher Stratton
1995 Traditional Building Construction in Illinois: A National Register of Historic Places Assessment of Multiple Properties Located on Illinois Department of Conservation Land. Report prepared for The Illinois Department of Conservation, Springfield, Illinois by Fever River research, Springfield, Illinois.

Matthews, E. B. and J. S. Grasty
1910 *The Limestones of Maryland, With Special Reference to Their Use in the Manufacture of Lime and Cement.* Maryland Geological Survey, Volume 8, Part 3, Baltimore.

Meadows, Larry G.
1994 Personal communication to Charles D. Hockensmith concerning the Black Creek Lime Kiln 2.5 miles north of Clay City, Kentucky.

Molloy, Peter M. (editor)
1976 *The Lower Merrimack River Valley: An Inventory of Historic Engineering and Industrial Sites.* Historic American Engineering Record, National Park Service, Washington, D. C.

Moodie, Boyce R., III

1993 Personal communication to Charles D. Hockensmith concerning the Lower Rudd Lime Kiln in Livingston County, Kentucky.

1998 Personal communication to Charles D. Hockensmith concerning the Upper Rudd Lime Kiln in Livingston County, Kentucky.

Orton, Edward, Jr. and Samuel V. Peppel

1906 *The Limestone Resources and the Lime Industry in Ohio*. Geological Survey of Ohio, Fourth Series, Bulletin Number 4, Columbus, Ohio.

Piwarzyk, Robert W.

1994 The Limekilns of the Pogonip. Manuscript on file at the California Department of Parks and Recreation, Sacramento.

1996 The Laguna Limekilns: Boony Doon. Manuscript on file at the California Department of Parks and Recreation, Sacramento.

Piwarzyk, Robert W. and David R. Hoch

2002 The History of the Rockland Lime and Lumber Company, 1887 to 1890. Manuscript on file at the California Department of Parks and Recreation, Sacramento.

Polk, Michael R.

1991 Photographs, Written Historic and Descriptive Data, Matua Lime Kiln [Box Elder County, Utah]. Historic American Engineering Record, National Park Service, Rocky Mountain Regional Office, Denver, Colorado.

Poulson, Karen

1995 Historic Documentation Record, Western Stone Company (Keepataw Site). [Will County, Illinois]. Prepared by Archaeological Research, Inc., Chicago, Illinois for the Illinois Department of Transportation.

Reesink, Carole J.

1979 Iowa Limestone Burning. *The Palimpset* 60: 59-61.

Ries, H.

1903 *Lime and Cement Industries of New York*. New York State Museum Bulletin Number 44, Albany.

Robinson, William F.

1976 The Kilns. In *Abandoned New England: Its Hidden Ruins and Where to Find Them*, by William F. Robinson, pp.106-112. New York Graphic Society, Boston.

Rolando, Victor R.

1990 Industrial Archaeology Survey. *The Society for Historical Archaeology Newsletter* 23 (3):24.

1992 *200 Years of Soot and Sweat: The History and Archaeology of Vermont's Iron, Charcoal, and Lime Industries*. Vermont Archaeological Society. Printed by Dover Litho Printing Company, Dover, Delaware.

Roth, Matthew, Bruce Clouette, and Victor Darnell
1981 *Connecticut: An Inventory of Historic Engineering and Industrial Sites*. Society for Industrial Archeology, National Museum of American History, Washington, D. C.

Searle, Alfred B.
1935 *Limestones & Its Products: Their Nature, Production, and Uses*. Ernest Benn Limited, London.

Shrull, Dale and Becky McIntosh
2000 Letter to David Morgan, Kentucky Heritage Council, concerning a lime kiln at Russellville in Logan County, Kentucky. Letter and photographs on file at the Kentucky Heritage Council, Frankfort.

Striker, Michael, Christopher Jackson, and David Blanton
2000 Results of Phase Ia Archaeological Investigations for the Louisville- Southern Indiana Ohio River Bridges Project in Jeffersonville and Utica Townships, Clark County, Indiana. Report submitted to the Westerly Group, Inc., Farmersburg, Indiana by the ASC Group, Inc., Columbus, Ohio.

The Clay City Times
1905 Ad for R. S. Noel's Black Creek Lime Works in Powell County. *The Clay City Times*, November 23, 1905, Clay City, Kentucky.

United States Federal Census
1870 Population Schedules for the Ninth Census of the United States: Livingston County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1880 Population Schedules for the Tenth Census of the United States: Livingston County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

United States Geological Survey
1929 Smithland, Kentucky 15 Minute Topographic Quadrangle Map. United States Geological Survey, Washington, D.C.

1944 Corrected Reprint of Smithland, Kentucky 15 Minute Topographic Quadrangle Map. United States Geological Survey, Washington, D.C.

1954 Burna, Kentucky 7.5 Minute Topographic Quadrangle Map. United States Geological Survey, Washington, D.C.

1970 Mount Vernon, Kentucky 7.5 Minute Topographic Quadrangle Map. United States Geological Survey, Reston, Virginia.

1977 Lenox, Kentucky 7.5 Minute Topographic Quadrangle Map. United States Geological Survey, Reston, Virginia.

Wall, Arthur W.
1969 Lime Kilns of Rockport. *The Down East Magazine of Maine*. May issue.

Wepler, William R. and Donald R. Cochran
1983 An Archaeological Survey of the Huntington Lake Shoreline. Report submitted to the Louisville District, U. S. Army Corps of Engineers, Louisville by Ball State University, Muncie, Indiana.

West, Karl H., Jr.
1991 Limes Kilns [Massachusetts]. *The Chronicle of the Early American Industries Association* 44 (2):46.

Wheaton, Thomas R., Jr.
1986 *The Jimmie Green Lime Kiln Site.* Booklet prepared for the South Carolina Department of Highways and Public Transportation, Columbia by Garrow and Associates, Atlanta.

1987 Making Lime in the Georgian World: Archaeology at the Jimmie Green Lime Kiln, Berkeley County, South Carolina. Paper presented at the Annual Meeting of the Southeastern Archaeological Conference, Charleston, South Carolina.

Wheeler, Thomas L.
1998 Limekilns and Ranching Features of Gray Whale Ranch. California Department of Parks and Recreation, Resource Management Division, Cultural Heritage Section, Sacramento.

Williams, David G.
1952 Lime Kilns in the Lower Jordan Valley. *Proceedings of the Lehigh County Historical Society* 19:73-96. Allentown, Pennsylvania.

FOOTPRINT OF AN HISTORIC SAWMILL: ARCHAEOLOGICAL INVESTIGATIONS OF THE CRAWFORD-NURRE SAWMILL IN WILLIAMSBURG, KENTUCKY

By

Grant L. Day

and

Jonathan P. Kerr

with contributions from

Jeffrey G. Mauck
Cultural Resource Analysts, Inc.
Lexington, Kentucky

ABSTRACT

The excavation of the Crawford–Nurre Sawmill site (15Wh165) in Whitley County uncovered the footprint of a steam-powered sawmill that included an engine pad and a boiler foundation. According to archival records, two Ohio businessmen, George S. Crawford and A. Joseph Nurre, built this sawmill, in 1882, to provide raw materials for their lumberyard and wood picture frame and molding company in Cincinnati, Ohio. Like many who invested in Kentucky's timber industry, Crawford and Nurre had little interest in promoting the state's economic development. The history of this sawmill provides a typical example of the capitalistic nature of eastern Kentucky's lumber industry during the late nineteenth century.

INTRODUCTION

Cultural Resource Analysts' personnel completed data recovery excavations of the Crawford-Nurre Sawmill (15Wh165), also called the Upton-Rose Site. The excavations were conducted for the U.S. Army Corps of Engineers, Nashville District, in conjunction with the proposed Williamsburg Flood Protection Project in Whitley County, Kentucky. The Crawford-Nurre sawmill site is situated in Williamsburg, Kentucky, on the edge of the floodplain of the Cumberland River, south of town (Figure 1). The floodplain or riverfront area of Williamsburg was the town's industrial center during the nineteenth century and early twentieth century.

Cultural Resource Analysts first became involved in the proposed levee project in 1996 when they conducted an intensive archeological reconnaissance of one proposed levee segment and borrow area. Archaeological test excavations were conducted subsequent to the survey. Auger probes, test units, and backhoe trenches discovered a variety of historic artifacts and

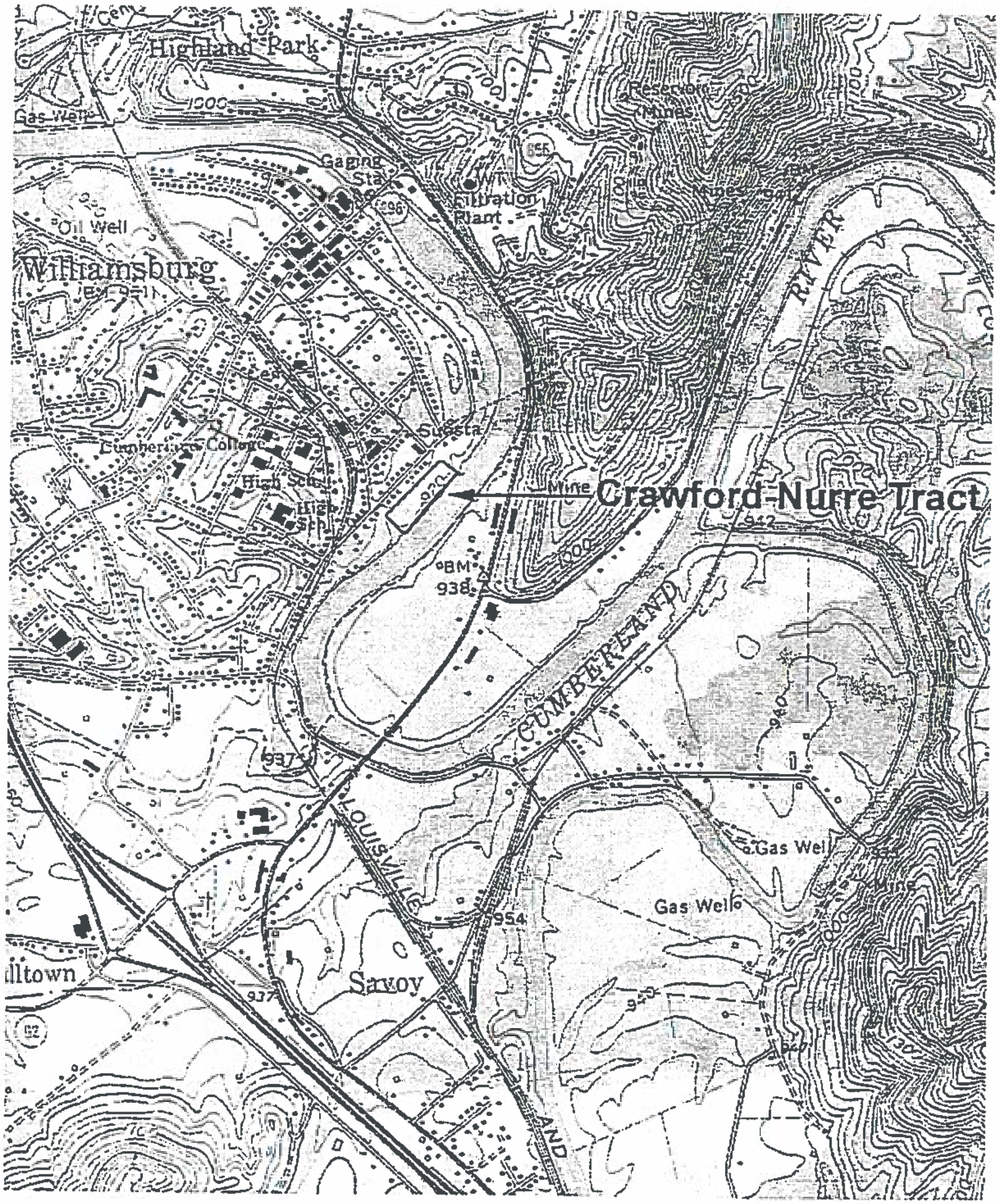


Figure 1. Topographic Map Showing the Location of the Crawford-Nurre Sawmill Site. Adapted from the Williamsburg, KY, U.S.G.S. 7.5 Minute topographic map. The top of the map is north.

several features at the site. Historic artifacts included architectural and domestic materials, as well as railroad spikes, concentrations of stones, brick fragments, burnt clay, animal bone, and an 1886 Indian Head penny. These artifacts suggest a late nineteenth to early twentieth century period of occupation. Four historic features also were encountered during the test excavations. These features consisted of: a large H-shaped sandstone slab foundation or footer; a U-shaped layer of undressed, small to medium-sized sandstone slabs; and two apparent pit features containing animal bones and rock rubble. However, the function of these features was not determined.

ARCHIVAL RESEARCH

Archival research was undertaken to determine if any manufacturing facilities or other structures could be associated with the remains located at the site. Archival records listed a number of manufacturing establishments that may have been located near the site location in the waterfront area of Williamsburg. These establishments included sawmills, gristmills, a blacksmith shop, a tan yard, and a shoe and boot maker. Any of these industries could have been located at the site location. However, mapping out deed descriptions eventually determined that site 15Wh165 was a sawmill built by George S. Crawford and A. Joseph Nurre around 1882.

The Crawford-Nurre mill was established on a tract of land the two businessmen bought from E. L. Denham of Williamsburg on June 2, 1882 for $465 (Whitely County Court House (WCC) 1882:DB 13:467). The deed described the land as:

> Near Williamsburg: beginning at a stake on the bank of the river thence N 37 W 294 feet thence N 44 E 799 feet thence S 59° 30' E 183 feet to a stake on the river bank thence S 36° 30' W 894 feet with the meanders of the river to the beginning (WCC 1882:DB 13:467).

This tract closely conforms to the boundaries of the field in which the site was located. The river is on the east side, a railroad on the west side, and tree lines mark the north and south ends. The land is on the Cumberland River bank just upriver from town and adjacent to a formerly existing railroad spur that was constructed in 1882.

Crawford and Nurre apparently opened their mill shortly after they bought the land in 1882. As noted above, Crawford and Nurre originally paid $465 for the lot. In 1887, after only five years in business, the partners sold the land, "together with the saw mill lately operated upon said ground," to the Kentucky Lumber Company for $8,500 (WCC 1887:DB 15:56). Furthermore, the Kentucky Lumber Company had recently bought out the Cumberland Lumber Company. By eliminating the Crawford-Nurre sawmill, they appeared to have been consolidating much of the milling business at their own large mill on Briar Creek.

Four years later in 1891, the Kentucky Lumber Company sold the old Crawford-Nurre tract to Samuel N. Ford for $1,500 (WCC 1891:DB 23:431). The drastic drop in the value of the property suggested the Crawford-Nurre sawmill had been badly damaged or altered in the previous four years. More likely, the Kentucky Lumber Company bought the Crawford-Nurre mill in 1887, removed the machinery and other equipment, and sold the stripped facility to Ford. Whether or not Ford used the facility could not be determined. Ford did establish the S. N. Ford and Company saw and planing mill between the old Crawford-Nurre mill and the Kentucky Lumber Company mill prior to 1889 as mentioned in a deed (WCC 1889:DB 20:98). The purchase of the Crawford-Nurre lot may have been stimulated by the need for more lumber storage space. However, the large amount of faunal remains discovered at this site suggest it may have been used as a smokehouse or butchering facility. Despite an extensive search of documentary sources, no evidence of such an operation was found.

In 1915, Ford sold part of his property, including the old Crawford-Nurre mill site, to J. Hoffman for one dollar (WCC 1915:DB 80:629). In 1918, Hoffman sold the land to R. S. Rose (WCC 1918:DB 132:639). It has descended through the family to its present owner, Mrs. C. B. Upton.

Although the Crawford-Nurre Sawmill was in operation for a very short time, it is representative of many sawmill operations in Kentucky during that period. Many sawmills were owned by and often operated by out of state interests and the final products of these mills were sent out of state for manufacturing. The potential of this site to yield significant information about Williamsburg's industrial heritage and development prompted the data recovery investigations.

SITE DESCRIPTION

Data recovery excavations uncovered evidence of boiler and steam engine foundations, a large rectangular building foundation, and features associated with a drive system of belts, shafts, and wheels (Figure 2). A large block excavation first uncovered the boiler foundation (Figure 3). The foundation for the boiler consisted of roughly cut, flat, sandstone slabs. The slabs were stacked at least three courses high without the use of mortar. Smaller stones were placed in voids and smaller spaces. The width of each foundation segment varied, but they were generally between 2.25 and 2.5 ft (.69 and .76 m) wide. Two large stones were situated along the eastern end of the foundation; a third was probably missing. The total dimensions of the boiler foundation were approximately 31.0 ft (9.45 m) long by 9.0 ft (2.74 m) wide. The interior foundation segments were not placed symmetrically. Their placement most likely was arranged to support the boiler. The boiler was probably a single cylindrical boiler in a brick setting, resting on the stone foundation. A small pad of stones, similar to those in the boiler foundation, was situated a couple feet south of the boiler foundation. The pad was constructed like the boiler foundation, but the function of this pad could not be determined. The southern side of the boiler also exhibited a deposit that contained abundant amounts of brick fragments.

The boiler's firebox was located at the eastern end of the boiler foundation and consisted of a three-sided brick box 4.0 ft (1.22 m) deep and 6.75 ft (2.06 m) wide. It was constructed from orangish-red handmade brick and mortar was not evident. Only two courses of brick remained. The western and southern walls were two bricks thick and the northern wall was three bricks thick. The interior portion of the firebox exhibited two zones. The upper zone consisted of an ash lens containing copious amounts of brick fragments and rock rubble and numerous burnt square nails, screws, and some container glass. The underlying zone consisted of fire-reddened earth. Few artifacts were contained within this underlying zone, although brick fragments and rubble were present.

Immediately north of the boiler pad was the engine foundation (Figure 3). The engine foundation was constructed of massive sandstone slabs, chinked with smaller stones and covered with mortar. The engine foundation was approximately 21.0 ft (6.40 m) long by 7.25 ft (2.21 m) wide and 5.5 ft (1.68 m) deep. The walls of the pit were stabilized with large sandstone blocks

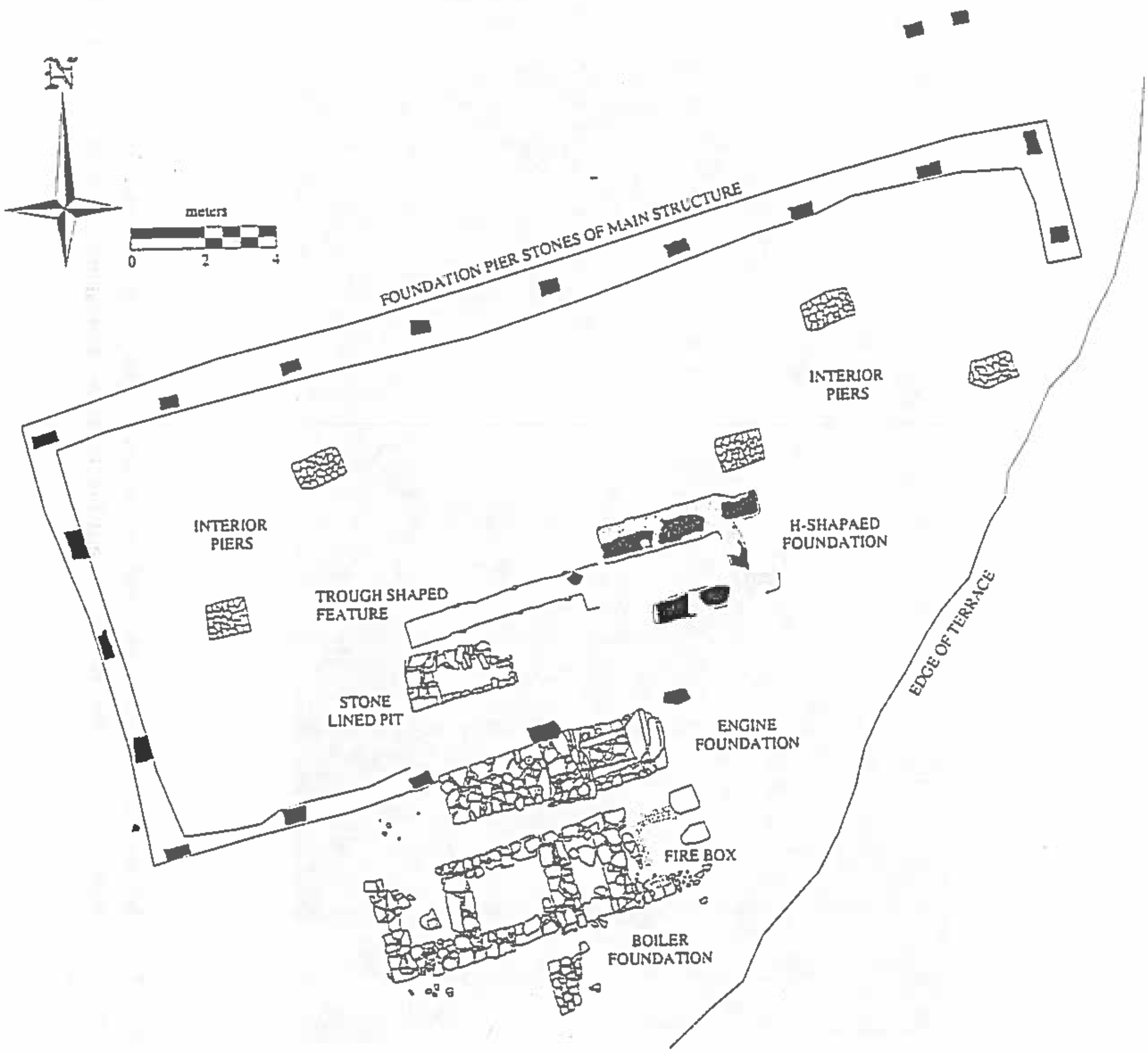


Figure 2. Planview of the Crawford-Nurre Sawmill (15Wh165), Post Excavation.

Figure 3. The Stone Foundations of the Boiler (left) and the Steam Engine (right). Notice the boiler's brick lined firebox located at the eastern end of the boiler foundations and the four one inch threaded tie-down bolts set into the stone at the western end of the engine foundation. View towards the west.

mortared together. Four one inch (2.5 cm) threaded tie-down bolts were set into the stone foundation and extended up to 1.0 ft (.30 m) above the present surface of the foundation. The impression of two timbers that were set into the floor of the foundation was intact (Figure 4). These timbers were spaced 2.75 ft (.84 m) apart from the centers and extended the length of the pit. The timbers in the eastern half were in line with the tie down bolts in the western half of the feature. Although the pit was symmetrical in shape, the foundation was narrower at the western end, 4.75 ft (1.45 m) wide, compared to its eastern end, 6.5 ft (1.98 m) wide.

Both the boiler and engine foundations were situated outside the main structure identified at the site. The main structure was defined by a series of large foundation pier stones. This structure was approximately 96.0 ft (29.26 m) long by 36.0 ft (10.97 m) wide. Three corners and most of four walls were identified during excavations. Only the southeastern corner of the structure could not be identified due to erosion caused by the Cumberland River. Large foundation pier stones were set in the corners and every 6.0 to 9.0 ft (1.83 to 2.74 m) along the walls. The pier stones displayed two morphologies. Along the walls, the foundation piers consisted of large, flat stones supported underneath by a rectangular-shaped arrangement of tightly packed smaller stones. In the corners however, the foundation piers consisted of large flat stones supported underneath by other large flat stones.

Two additional stones were found outside the northeast corner of the structure. They might have been foundation piers for an entry, possibly a stairway or ramp, into the mill. Within the walls of this main structure were additional pier-like features, possibly used to support the central portion of the structure (Figure 5). They were similar in construction to the piers along the outside walls, although the large overlying stones were not present. Each of these pier-like features consisted of fist-sized rocks tightly packed into rectangular pits 4.5 by 2.75 ft (1.37 by .84 m) in size.

Also located within the walls of the main structure were features likely associated with the drive system. The drive system, which relayed power from the steam engine to the machinery in the mill, consisted of a series of shafts, gears and belts. This drive system was housed below the main floor of the mill.

One portion of the drive system consisted of a partially intact stone lined pit (Figure 6). The pit measured 10.0 ft (3.05 m) long, 5.0 ft (1.52 m) wide, and 2.82 ft (.86 m) deep. The stone walls of the pit were badly disturbed, possibly due to robbing activities. Therefore, the original construction and function of the pit could not be accurately determined. The intact portions of the pit walls showed that the stones were laid with mortar. This feature was located approximately 2.0 ft (6.1 m) north of the engine foundation. This feature may have housed a large wheel with a belt attached, a large gear, or possibly, it just allowed access to a portion of the drive system.

A trough shaped feature that probably held a portion of the drive system, such as a drive belt or conveyor belt, also was located within the walls of the main structure. The feature consisted of a long, linear stain containing reddened and darkened sediments. This feature was approximately 17.0 ft (5.18 m) long and 2.0 ft (.61 m) wide with straight walls and a flat base. A large piece of rubberized canvas belt was recovered from the base of the trough. This trough shaped feature was also in line with the H-shaped stone foundation and the functions of these two features may have been associated (Figure 7).

Figure 4. Impression Left by One of the Two Timbers that Were Set into the Floor of the Engine Foundation. View looking down.

Figure 5. One of the Five Interior Stone Pier-like Features Possibly Used to Support the Central Portion of the Structure. View towards the north.

Figure 6. A Partially Intact Stone Lined Pit, Possibly Part of the Drive System that Relayed Power From the Steam Engine to the Machinery in the Mill. View towards the west.

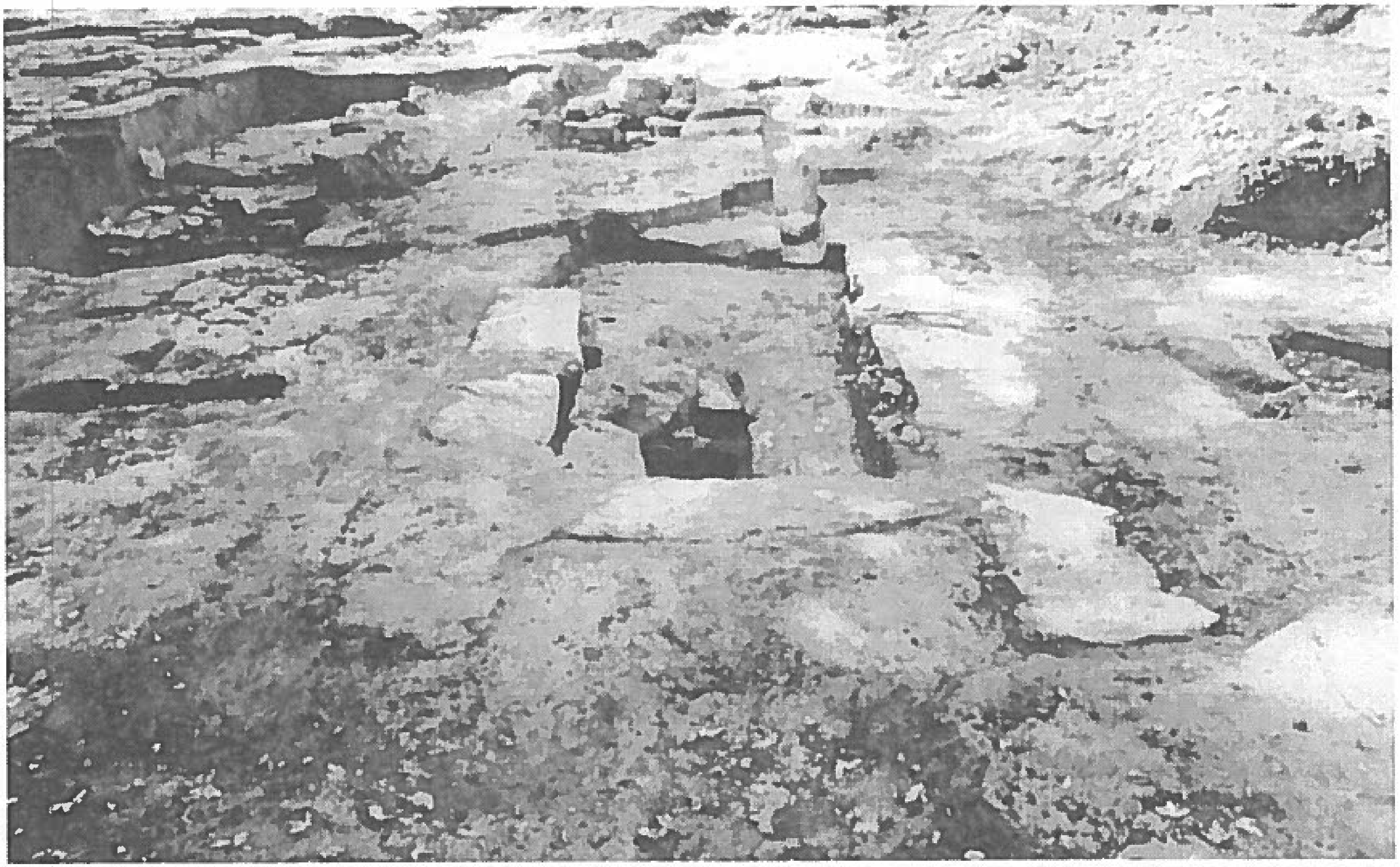


Figure 7. The Stone Foundation of the H-shaped Feature (center foreground) and the Trough Shaped Feature that Probably Held a Portion of the Drive System (top center). Also visible are portions of the boiler foundation (top left corner), the engine foundation (top left), and the partially intact stone lined pit (top center - between the engine foundation and the trough shaped feature). View looking towards the west.

The H-shaped foundation, initially discovered during test excavations, probably supported either the saw apparatus or the apparatus that hauled logs out of the Cumberland River to be milled. The H-shaped foundation was constructed by first digging trenches and then laying large sandstone blocks in the trenches to form the H-shape. The trenches were consistently 1.24-1.3 ft (37.8-39.6 cm) deep. The western, longer arm of the "H" was comprised of a single 0.58 ft (17.7 cm) thick stone overlying an approximately 0.72 ft (22.0 cm) thick layer of smaller rock and coarse sand. The southern, longer arm of the "H" consisted of a single 1.27-1.3 ft (38.7-39.6 cm) thick stone. The shorter arms and the cross of the "H" consisted of numerous thinner stones that were mortared together. Underlying all the stones and along the edges of the trenches was a layer of coarse sand. The surface of the stone foundation was partially covered with a coarse sand mortar that probably fastened overlying portions of the foundation. Furthermore, the sediments surrounding the H-shaped foundation displayed abundant decayed brick fragments and dust, particularly on the northern side of the foundation and between the two long arms of the foundation. This suggested that the foundation might have once incorporated brick.

Even though a large area of the field in which the site was located was stripped, no other structures or features associated with the lumber industry were identified at the site. There may have been additional structures or features in the field surrounding the site that were destroyed by subsequent years of plowing. These structures or features may have included a waste burner, a water tank, a blacksmith shop, an oil house, woodbins, an office, a tool house and storage sheds. Furthermore, the areas surrounding the mill probably were used for lumber storage. This practice is depicted on the Sanborn maps (Sanborn Map Company 1895, 1901, 1906) for the other sawmills in the area. Structures or features associated with storage would include the remains of tramways, scales, and storage warehouses.

The small number of artifacts recovered from the Crawford-Nurre sawmill site that could be directly related to the lumber industry was attributed to two main factors. One factor was the short period of operation. The Crawford-Nurre sawmill was built after the land was purchased in 1882 and operations ceased after the sawmill was sold to the Kentucky Lumber Company in 1887 (WCC 1887:DB 15:56). The other factor was the tendency to scavenge and reuse machinery and building materials, especially in frontier environments where machine made items were difficult to attain. The condition of the foundations at the site and the presence of certain types of artifacts and their condition also would attest to its dismantling. Many cut bolts and nuts and broken tie-down plates were found at the site and large foundation stones were apparently missing.

COMPARATIVE DATA

Although no known historic documents exist that recorded the physical components of the Crawford-Nurre sawmill, historic documents recorded other sawmills in Williamsburg. Some of these other sawmills were recorded on the 1895 and 1901 Sanborn Fire Insurance Maps (Sanborn Map Company 1895 and 1901). The Crawford-Nurre sawmill probably had mechanical components and a configuration similar to the other contemporary sawmills in Williamsburg. The Jones Lumber Company sawmill and the S.N. Ford and Company sawmill are recorded on the 1895 Sanborn map of Williamsburg's riverfront area. The Jones Lumber Company had a triple boiler that powered a 70 hp engine. The type of saw employed is not mentioned (Figure 8). The S. N. Ford and Company had a double boiler that powered a 90 hp engine and the type of saw employed is not mentioned (Figure 9).

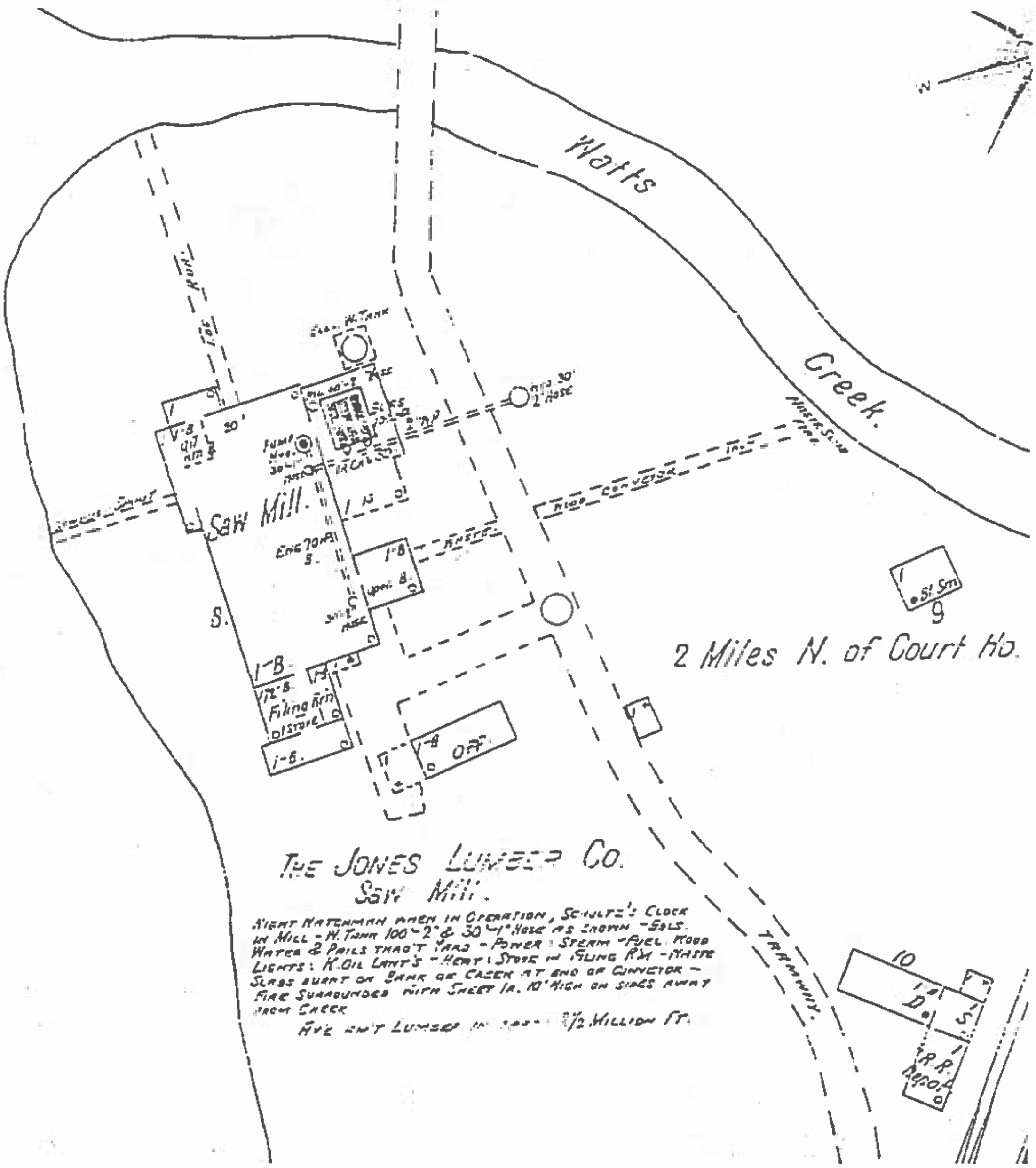


Figure 8. Portion of the 1895 Sanborn Insurance Map of Williamsburg, Kentucky Showing the Jones Lumber Company Saw Mill. Copyright (1895) The Sanborn Map Company, The Sanborn Library, LLC. All Rights Reserved. Further reproduction prohibited without written permission from the The Sanborn Library, LLC.

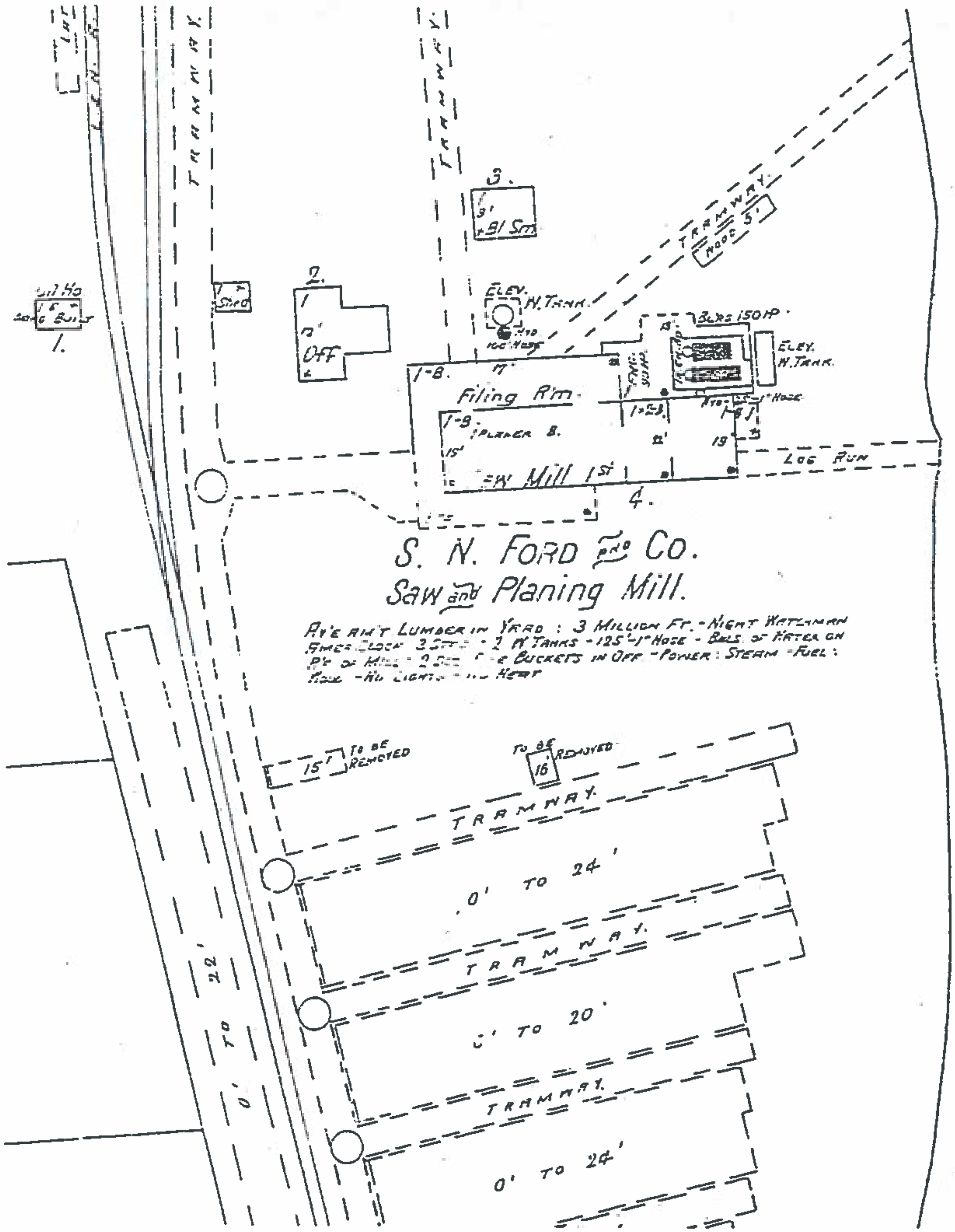


Figure 9. Portion of the 1895 Sanborn Insurance Map of Williamsburg, Kentucky Showing the S. N. Ford and Company Saw Mill. Copyright (1895) The Sanborn Map Company, The Sanborn Library, LLC. All Rights Reserved. Further reproduction prohibited without written permission from the The Sanborn Library, LLC.

The Jones Lumber Company sawmill, the S. N. Ford and Company sawmill, and the Kentucky Lumber Company sawmill are all recorded on the 1901 Sanborn map of Williamsburg's riverfront area. Since 1895, the Jones Lumber Company had rebuilt its sawmill (Figure 10). The Jones Lumber Company also replaced its inefficient triple boiler with a new double boiler and upgraded its old 70 hp engine with a 125 hp engine. The Sanborn map also notes that the Jones Lumber Company sawmill contained a band saw, an edger and a trimmer. The S. N. Ford and Company sawmill was not upgraded and was no longer in operation by 1901 (Figure 11). This may imply that a circular saw was still employed at the S. N. Ford Company and that by 1901 it could no longer compete with surrounding mills or that it was bought out by another company. The Kentucky Lumber Company sawmill had a large triple boiler that powered a "Dynamo" 293 hp engine (Figure 12). The Sanborn map also notes that the Kentucky Lumber Company sawmill contained a band saw, and edger and a trimmer.

It appears that band saws were not commonly used in the Williamsburg area until the late 1890s. The use of band saws is not indicated for any sawmill on the 1895 Sanborn maps but band saw use is indicated for most of the sawmills on the 1901 Sanborn maps. It is probable that circular saws were employed at the sawmills were band saw use was not indicated.

The Crawford-Nurre sawmill was probably arranged similarly to the sawmills represented on the early Sanborn maps (Figures 8 and 9). The Crawford-Nurre sawmill probably employed a sub-100 horsepower engine comparable to the S. N. Ford and Company (90 hp) and the Jones Lumber Company (70 hp). And although there is not any direct evidence about the type of saw being employed at site 15Wh165, it is highly probable that it was a circular saw.

Historic documentation allowed us to interpret portions of the site that were archaeologically lacking. Archival research confirmed that the site was indeed a sawmill as opposed to a grist mill or other type of steam operated industry. Archival research also determined the following: the steam engine probably produced less than 100 hp; the saw mill probably employed a circular saw as opposed to an earlier sash saw or later band saw; and the mill was only in operation for a short period of time between 1882 and 1887. Archival research determined not only who built the sawmill and when, but also allowed the site to be placed within a larger context of the commercial lumber industry.

THE LUMBER INDUSTRY

Beginning in the early 1800s, the commercial lumber industry swept across the United States from the northeast, to the Great Lake States, and finally into the southern and western states (Brown 1923:6). Commercial logging in the southern states began its accent around 1870, peaked in 1919, and then declined as the northwest region took over the market (Brown 1923:3,6). Ronald D. Eller, in his 1982 publication, *Miners, Millhands, and Mountaineers: Industrialization of the Appalachian South, 1880-1930*, reported that between 1890 and 1920 one of the most frenzied timber booms in American History occurred in the Appalachian Mountains. Eastern Kentucky's timber resources provided a vast economic resource that fueled commercial and industrial expansion during the late nineteenth century and early twentieth century.

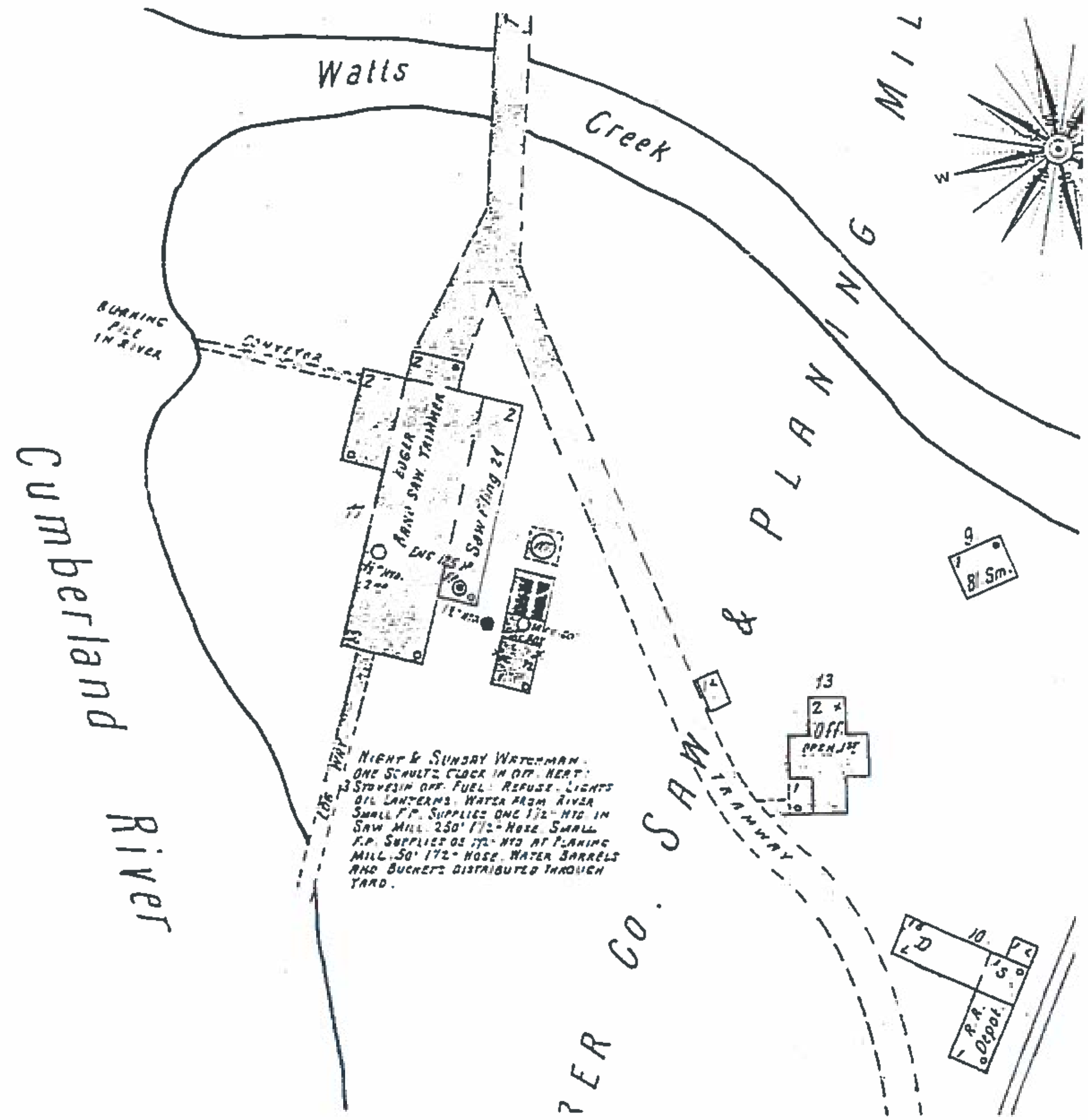


Figure 10. Portion of the 1901 Sanborn Insurance Map of Williamsburg, Kentucky Showing the Jones Lumber Company Saw Mill. Copyright (1901) The Sanborn Map Company, The Sanborn Library, LLC. All Rights Reserved. Further reproduction prohibited without written permission from the The Sanborn Library, LLC.

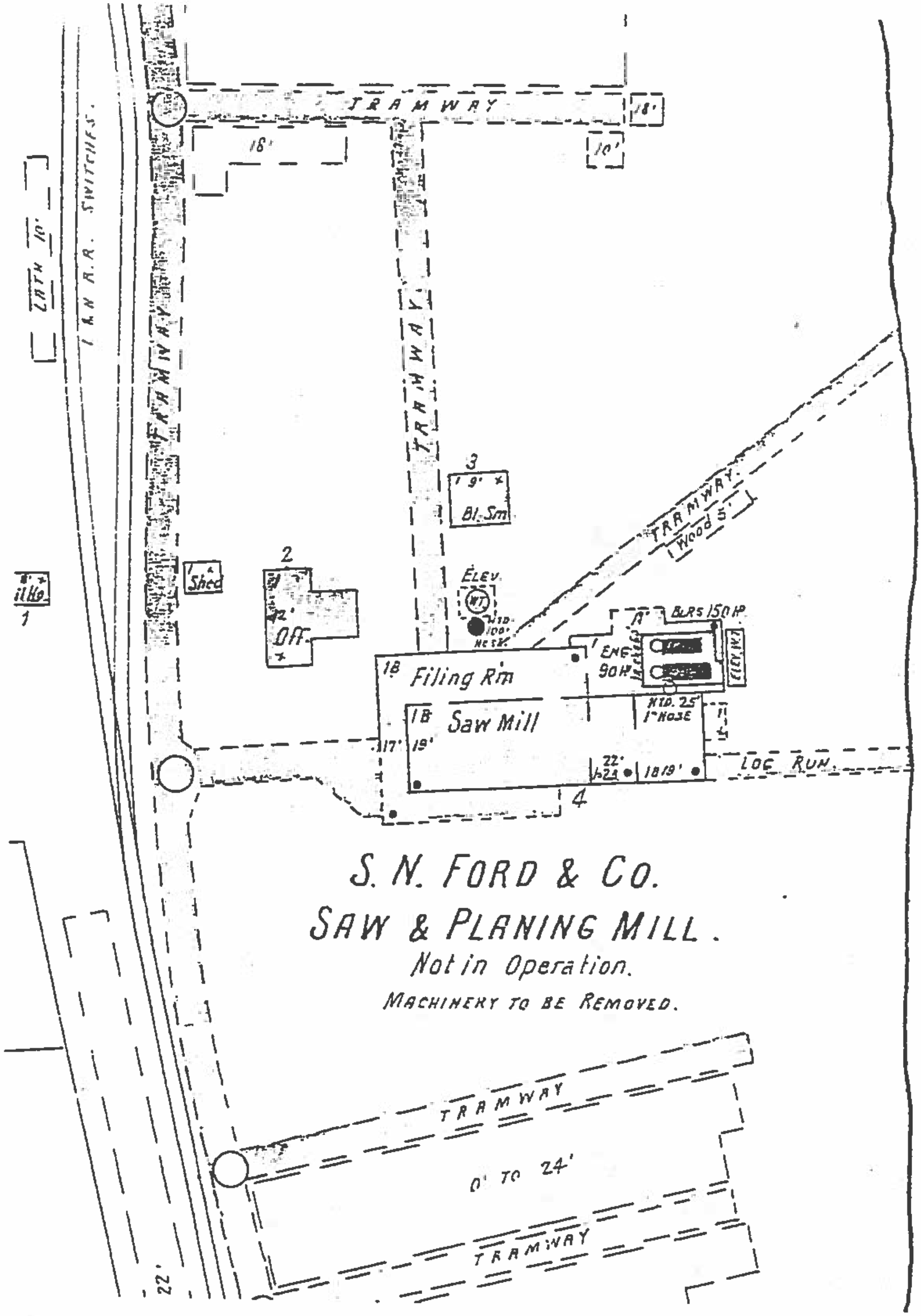


Figure 11. Portion of the 1901 Sanborn Insurance Map of Williamsburg, Kentucky Showing the S. N. Ford and Company Saw Mill. Copyright (1901) The Sanborn Map Company, The Sanborn Library, LLC. All Rights Reserved. Further reproduction prohibited without written permission from the The Sanborn Library, LLC.

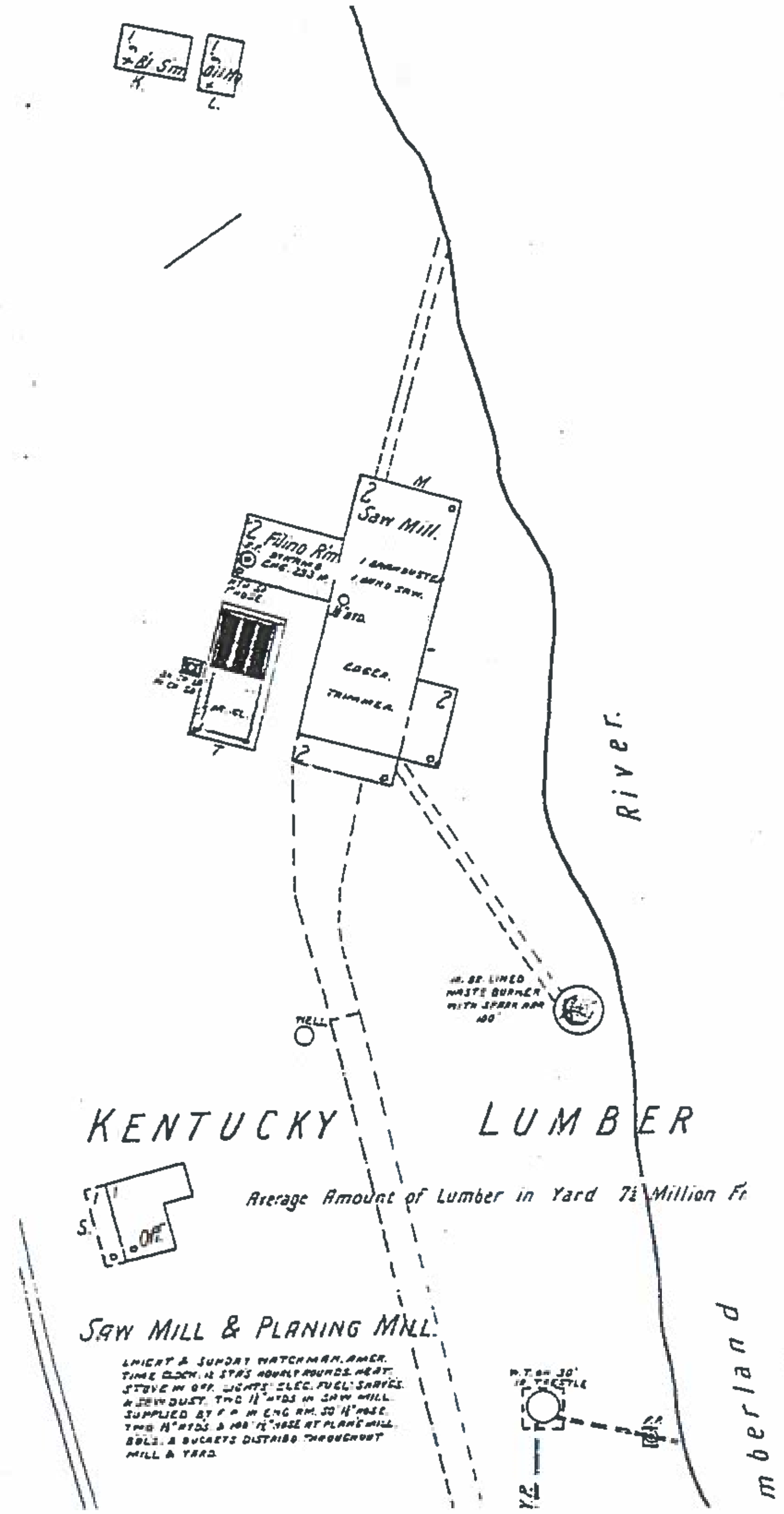


Figure 12. Portion of the 1901 Sanborn Insurance Map of Williamsburg, Kentucky Showing the Kentucky Lumber Company Saw Mill. Copyright (1901) The Sanborn Map Company, The Sanborn Library, LLC. All Rights Reserved. Further reproduction prohibited without written permission from the The Sanborn Library, LLC.

HISTORY OF LOGGING IN EASTERN KENTUCKY

The history of logging in eastern Kentucky can be divided into three phases. The first phase (mid- to late 1700s–1870) is characterized by selective seasonal cutting by farm families using simple technology. The logs they cut were generally for subsistence use and small localized markets. The impact upon the state's vast forest reserves was minimal during the first phase. During the second phase (1870-1890), logging shifted from a seasonal family business to a commercial industry. Kentucky politicians and businessmen began to entice out of state and foreign entrepreneurs to invest in the natural resources of the Appalachian Mountains. The reconstruction and growth after the Civil War also created an increased demand for lumber. The impact upon the state's forest reserves increased drastically during the second phase. The third phase (1890-1920) is characterized by the extensive cutting of large tracts of land by highly integrated logging companies using large-scale equipment. These logging companies expanded railroad lines, built large commercial sawmills, consolidated or bought-out surrounding smaller logging operations, and left large tracts of land completely denuded of timber. The state's forest reserves were nearly exhausted during this third phase. Lumber production in Kentucky drastically declined after 1920.

But perhaps the greatest tragedy for Kentucky's economy, other than the exhaustion of the land and the partial devastation of timber as a resource, was the fact that those raw materials would not form the basis for some other home industry, such as furniture building. In a story that would be told and retold in the commonwealth's economic history, many of the benefits of Kentucky's sizable timber industry would go outside the state (Harrison and Klotter 1997:301). The history of logging in Whitley County, particularly Williamsburg, deviates little from this scenario.

HISTORY OF LOGGING IN WILLIAMSBURG

The earliest known evidence of sawmills in Williamsburg was documented by the 1860 Whitley County manufacturing census. This evidence fell within the period of the first phase of logging in southeastern Kentucky. The census listed eight manufacturing establishments including three saw mills, three gristmills, a blacksmith, a shoe and boot maker, and a tanner (National Archives, Washington D.C. [NA] 1860: Census of the United States, Manufacturing Schedule, Whitley County, Kentucky [CUSMSWCK 8]). The largest enterprise was undoubtedly the A. C. King grist and sawmill located on the Williamsburg riverfront (site 15Wh162). Documentary evidence suggested it was built in the late 1850s. Like many of the sawmills that operated during this time, this particular mill was combined with a gristmill. The power source was a dam across the Cumberland River that supplied water for two waterwheels.

The 1870 manufacturing census listed five manufacturing establishments including the Foley and Jones sawmill and the aforementioned King's mill. The King mill evidently was expanded during the 1860s because the owners claimed a $6,000 investment on the 1870 manufacturing census. On this census, the King family did not list a sawmill, it had either ceased operation or been sold off. The Foley and Jones sawmill was probably associated with the Foley and Jones Gristmill listed on the same census. This company had $1,000 invested in their water-powered facility (NA 1870:CUSMSWCK 9).

Most likely, the goods produced by these early facilities were consumed by a local market. There were no railroads to connect the community to distant markets and the Cumberland Falls prevented river navigation with points downstream. However, Williamsburg's isolation was broken in 1882 with the arrival of the Louisville and Nashville Railroad (Whitley County History Book Committee 1994:25). A spur linked the riverfront manufacturing area to the main line and provided an outlet to distant markets. The arrival of the railroad resulted in the construction of several large sawmills and lumber processing factories in Williamsburg.

At this time, the scope of logging in eastern Kentucky was well into its second phase. Several additional mills, including the Crawford-Nurre sawmill, were established or expanded as the railroad neared its completion in 1882. One of these mills was the J. R. Allen and Company sawmill. It was located downstream from the Crawford-Nurre mill, near King's mill. According to the wording of an 1882 deed, the J. R. Allen Company purchased additional land from the King family, apparently adjacent to the gristmill (Whitley County Courthouse, Williamsburg, Kentucky [WCC] 1882: Deed Book [DB] 13:31). The deed also mentioned the existence of Green's mill in the immediate vicinity. This may have been a flour mill depicted on 1901 and 1906 Sanborn maps, ¾ of a mile (1.21 km) south of the Williamsburg Court House (Sanborn Map Company 1901, 1906). The flour mill would have been located between Allen's mill and the Crawford-Nurre sawmill. The J. R. Allen and Company appears to have operated until after the turn of the century. In 1907, its owners sold part of the company property to J. B. White but, whether or not this signaled the demise of the business was not clear (WCC 1907:DB 53:462).

The Phares Lumber Company built a mill at the mouth of Briar Creek above town during the last quarter of the nineteenth century, but for some reason, they quickly sold out to the Cumberland Lumber Company (WCC 1882:DB 13:19). Later that same year, the Cumberland Lumber Company sold the property to the Kentucky Lumber Company. Then the Kentucky Lumber Company established a large saw and planing mill at the site (WCC 1882:DB 13:517). The sawmill, but not the planing mill, was destroyed by fire in August of 1895 (Sanborn Map Company 1895). It was rebuilt by 1901 and was in operation until at least 1906, as depicted on a 1906 Sanborn map (Sanborn Map Company 1901, 1906).

In 1889, the Kentucky Lumber Company sold a tract of land downstream from their saw and planing mill at the mouth of Briar Creek to Samuel N. Ford for $795 (WCC 1889:DB 20:98). This property was adjacent to land where Ford was already building a mill. Two years later the Kentucky Lumber Company sold another tract to Ford for $1,500 (WCC 1891:DB 23:431). This tract was the same parcel sold by Crawford and Nurre to the Kentucky Lumber Company in 1887. The Kentucky Lumber Company had bought the Crawford-Nurre sawmill for $8,500 (WCC 1887:DB 15:56). The drastic drop in the value of the property suggested the old Crawford-Nurre mill had been badly damaged or altered in the previous four years. There was no evidence that the mill burned; yet it could have been flooded or suffered a boiler explosion. However, the most plausible explanation was that the Kentucky Lumber Company bought the Crawford-Nurre mill in 1887, removed the machinery and other equipment, and sold the stripped facility to Ford. As noted above, Ford established the S. N. Ford and Company saw and planing mill between the old Crawford-Nurre mill and the Kentucky Lumber Company mill around 1889. The mill was in operation until at least 1901 (Sanborn Map Company 1895, 1901).

Another concern was the Jones Lumber Company. They built a mill before 1895 on the Cumberland River, at the mouth of Watts Creek below (actually north of) the town. This mill was in operation until at least 1906 (Sanborn Map Company 1895, 1901, 1906). By the late 1880s, the combination of Cumberland River timber resources and railroad transportation had transformed Williamsburg from an isolated Appalachian town into a major regional timber processing site (NA 1870:CUSMSWCK 9; NA 1880:CUSMSWCK 10; Whitley County History Book Committee 1994:22-23).

The Kentucky Lumber Company, the S. N. Ford and Company, and the Jones Lumber Company appeared to be the larger lumber companies that brought Williamsburg into the third stage of logging in eastern Kentucky. These companies were owned and operated by nonresident taxpayers, built large commercial sawmills, consolidated or bought-out surrounding smaller logging operations, and left large tracts of land completely denuded of timber.

CRAWFORD AND NURRE

George S. Crawford and A. Joseph Nurre built their sawmill (15Wh165) during a period of transition in the history of eastern Kentucky's logging history. Between 1870 and 1890, the logging industry in eastern Kentucky shifted from a seasonal localized business to an international commercial industry. American industries were growing rapidly and natural resources, such as timber and coal, were needed in order to fuel this growth. Eastern Kentucky contained a relatively untapped and abundant source of both timber and coal. However, commercial routes of transportation through the isolated terrain of eastern Kentucky did not exist until the late nineteenth century. The expansion of railroads into eastern Kentucky during the 1880s and into the early twentieth century allowed large logging companies access to eastern Kentucky's virgin stands of timber. Crawford and Nurre probably built their mill in 1882 because a spur line running from Louisville and Nashville Railroad to the banks of the Cumberland River at Williamsburg was nearing completion. They also may have been enticed by advertisements promoting the wealth of natural resources in eastern Kentucky. The two entrepreneurs had good reason to want to exploit these resources. Crawford owned a lumberyard in Cincinnati's west end and Nurre owned a wood picture frame and molding company in downtown Cincinnati.

CRAWFORD AND NURRE IN CINCINNATI

George S. Crawford was a prominent Cincinnati businessman in the 1880s and 1890s. When he arrived in the city is not clear, since his name does not appear in the city directories until the end of the 1870s. In 1878, he was listed as the manager of the Cincinnati Lumber Company with a residence on West Seventh Street (Williams 1878:240). In 1879, Crawford was identified as the owner of a "saw mill and lumber yard" selling walnut logs, hardwood, and lumber (Williams 1879:244). His operation was located on River Road, just west of Mill Creek and his residence was nearby on Mt. Hope Road in Price Hill, an affluent neighborhood (Williams 1880:254). Crawford was a member of the Cincinnati Chamber of Commerce in 1887-88, and was listed in its directory as a lumber dealer with his yard at the foot of Sixth Street in the Lower East End (Cincinnati Chamber of Commerce 1889:51). In the 1890 Chamber of Commerce Directory, Crawford appeared as President and Treasurer of the Crawford Mill and Lumber Company (Williams 1890:258).

Crawford may have chosen the location of his Cincinnati lumberyard so it would have easy access to the Cincinnati Southern line. The state authorized the railroad in 1869 and it was completed to Somerset, Kentucky in 1877. In February 1880, the first train ran from Cincinnati to Chattanooga (Kenny 1875:12; Works Progress Administration 1943:91). Thus, Crawford may have been using eastern Kentucky timber before the Louisville and Nashville Railroad opened a spur to the Cumberland River bank at Williamsburg.

Crawford's partner, Aloys Joseph Nurre, was born in Germany in 1846 and moved to Cincinnati in 1855 to live with his uncle Joseph Nurre (Goss 1912:183). In 1860, Nurre began learning the picture frame business and a few years later went into business with his uncle (Goss 1912:180). He was successful and soon bought a picture frame molding manufacturing company, which had been founded in 1849. The plant was located on lower Broadway and the show room on lower Main Street. The company specialized in gilt, imitation rosewood, walnut, imitation walnut and frame moldings. According to one source, the firm sold its product in "nearly every state in the Union" (Kenny 1875:183)

As stated, the most important reason for Crawford and Nurre investing in a mill in Whitley County was probably the combination of abundant timber and rail transportation. There may have been other reasons as well. The two entrepreneurs may have been motivated by the potential benefits of what economic historians refer to as "vertical integration," a process of cutting out middlemen by buying up sources of transportation, supply and sales. During the late nineteenth century, American industrialists increasingly turned to vertical integration to maximize profits. The master practitioner was Andrew Carnegie, who dominated the American and world steel industry in the late nineteenth century (Davidson et al. 1990:665-666).

SUMMARY AND CONCLUSIONS

Archaeological and archival investigations of the Crawford-Nurre Sawmill (15Wh165) contributed to our understanding of the technologies that were employed at a sawmill, as well as, the broader issues of economic contexts and the history of the logging industry in eastern Kentucky. The excavation of this sawmill also provides information useful for making technological comparisons to future sawmill sites that may be excavated.

The Crawford-Nurre sawmill was built during a period of transition in the lumber industry. The introduction of new technological innovations, such as the bandsaw, combined with the increasing demand for finished lumber products, brought about changes in the lumber industry. Smaller sawmill operations, such as the Crawford-Nurre mill, were quickly replaced by larger, corporate sawmills. The corporate mill operators used their greater capital to construct rail lines, roads and large capacity mills. They could afford to exploit poorer quality timber and, consequently, were more economically efficient in their use of both timber and labor. Many of these corporate mills were owned and operated by out of state interests who shipped their final products out of state with little concern for promoting Kentucky's economic development or conserving its natural resources.

ACKNOWLEDGEMENTS

The authors thank the field crew who participated in the excavations described in this report. They are Andrew P. Bradbury, Shawn C. French, D. Lief Meadows, Neal B. Moon, Daniel Sulfridge, and Freddie Williford. Access to the site was graciously granted by Mrs. C. B. Upton. Much of the work could not have been accomplished without the skillful operation of a backhoe by Glennis Prewitt. Joanne Wilson Huser, Tressa Brown, and Trina Maples are recognized for

expertly processing and identifying the material remains and for managing the database. Finally, we are grateful to Rob Karwedski, Nashville District of the U. S. Army Corps of Engineers, for his support in the present endeavor.

REFERENCES CITED

Brown, Nelson Courtland

1923 *The American Lumber Industry: Embracing the Principal Features of the Resources, Production, Distribution, and Utilization of Lumber in the United States*. John Wiley & Sons, New York.

Cincinnati Chamber of Commerce

1889 *Fortieth Annual Report for the Commercial Year Ending August 31, 1888*. Ohio Valley Company, Cincinnati.

Davidson, James. W., William. E. Gienapp, Christine. L. Heyrman, Mark. H. Lytle, and Michael. B. Stoff

1990 *Nation of Nations: A Narrative History of the American Republic*. McGraw-Hill, New York.

Eller, Ronald D.

1982 *Miners, Millhands, and Mountaineers: Industrialization of the Appalachian South, 1880-1930*. University of Tennessee Press, Knoxville.

Goss, C. F.

1912 *Cincinnati the Queen City: 1788-1912*, Vol. III. S. J. Clarke, Cincinnati.

Harrison, Lowell. H. and James. C. Klotter

1997 *New History of Kentucky*. University Press of Kentucky, Lexington.

Kenny, D. J.

1875 *Illustrated Cincinnati*. George E. Stevens, Cincinnati.

[NA] National Archives, [CUSMSWCK] Census of the United States, Manufacturing Schedule, Whitley County, Kentucky.

1860 United States Manufacturing Census Records for Whitley County, Kentucky; on file at the National Archives in Washington, D.C.

1870 United States Manufacturing Census Records for Whitley County, Kentucky; on file at the National Archives in Washington, D.C.

Sanborn Map Company

1895 Williamsburg, Whitley County, Kentucky. Sanborn Map Company, New York.

1901 Williamsburg, Whitley County, Kentucky. Sanborn Map Company, New York.

1906 Williamsburg, Whitley County, Kentucky. Sanborn Map Company, New York.

(WCC) Whitley County Court House

Court House Records on file at the Whitley County Court House in Williamsburg, Kentucky.

Whitley County History Book Committee

1994 *Whitley County, Kentucky: History and Families, 1818-1993.* Turner Publishing, Paducah, Kentucky.

Williams, A.

1878 *Williams Cincinnati Directory.* Directory Office, Cincinnati.

1879 *Williams Cincinnati Directory.* Directory Office, Cincinnati.

1880 *Williams Cincinnati Directory.* Directory Office, Cincinnati.

1890 *Williams Cincinnati Directory.* Directory Office, Cincinnati.

Works Progress Administration

1943 *Cincinnati: A Guide to the Queen City and its Neighborhoods.* Weisenhart Press, Cincinnati.

ARCHAEOLOGICAL INVESTIGATIONS AT THE PADUCAH BRICK AND TILE COMPANY/CHAMBLIN AND MURRAY BRICK YARD, PADUCAH, KENTUCKY

By

Charles D. Hockensmith
Kentucky Heritage Council
Frankfort, Kentucky

and

William R. Black, Jr.
Ray Black & Son, Inc.
Paducah, Kentucky

ABSTRACT

The Paducah Brick and Tile Company/Chamblin and Murray Brick Yard is located in the City of Paducah, McCracken County, Kentucky. The company was established in 1893 as the Paducah Brick Works and operated under that name until 1896. Between 1897 and 1906, the company operated as the Chamblin and Murray Brick Yard. In 1907, the company was incorporated as the Paducah Brick and Tile Company and operated under that name until about 1942. The brick yard was later sold and operated as Paducah Brick & Supply Company from 1946 to about 1955. The company initially produced common building bricks, hollow blocks, and drain tiles. During 1911, the company was advertised as being the largest brick plant in western Kentucky, producing 28,000 to 40,000 bricks daily and 400,000 drain tiles annually. By 1921, the company was specializing in common building bricks and drain tiles but seems to have abandoned the production of hollow blocks. In this paper, we present the results of the archaeological and archival investigations for the brick yard. The surviving archaeological remains and a sample of bricks recovered from this significant industrial site are described.

INTRODUCTION

The Paducah Brick and Tile Company (15McN114) was a large brick and tile manufacturing facility located at 1439 South 10th Street (the address subsequently changed to 1439 Murrell Street) in Paducah, Kentucky. Paducah is an Ohio River town in extreme western Kentucky within the Jackson Purchase region. The city of Paducah, the county seat, is located in the northeastern portion of McCracken County just west of the confluence of the Tennessee and Ohio rivers. The company was one of three competing major brick producers (also Hill & Karnes and Katterjohn's Sons) operating in Paducah during the late 19th and early 20th centuries. The Paducah Brick Works was established in 1893 and operated as such until 1896. Between 1897 and 1906, the company operated under the name "Chamblin and Murray Brick Yard". In 1907, the company was incorporated as the Paducah Brick and Tile Company and operated under that name until about 1942. The brick yard was later sold and operated as the Paducah Brick & Supply Company from 1946 to about 1955. The company's products were primarily distributed in western Kentucky and Tennessee (Ries 1922:58).

This article is the first in a planned series that deals with the brick industry in Paducah, Kentucky. The authors first met at a regional archaeological conference in Paducah during the spring of 1997. Because of their mutual interest in bricks and the brick industry, they decided to collaborate on a series of articles dealing with the brick industry in Paducah. The junior author had been studying the brick industry in Paducah and western Kentucky for many years while the senior author had been studying bricks in the eastern part of the state. Except for the junior author's (Black 1987) article entitled "Anomalous Marks in Nineteenth Century Paducah Bricks," little had been previously written about the brick industry in Paducah.

The authors visited the location of the Paducah Brick and Tile Company/ Chamblin and Murray brick yard and discovered that some of the remains were preserved in a wooded area. During late April of 1997, the visible surface remains associated with the brick yard were documented. Some additional observations were made on February 26, 1998. This paper initially discusses the history of the Paducah Brick and Tile Company/Chamblin and Murray brick yard. Next, the surviving archaeological remains are described. A sample of the bricks found at the site are analyzed in detail. The paper ends with some brief conclusions.

THE HISTORY OF THE BRICK YARD

The brick yard operated under several company names during its years of existence. The Paducah Brick Works was established in 1893 by C. H. Chamblin who operated the brick yard in its early years. James A. Murray later became a partner in the brick yard. Between ca. 1897 and 1906, the company was known as the Chamblin and Murray Brick Yard. The company was incorporated as the Paducah Brick & Tile Company on March 6, 1907 by C. H. Chamblin, Arthur Murray, and James A. Murray. By 1911, the Paducah Brick and Tile Company was under the control of James A. Murray, Arthur Murray, and J. A. Murray. Apparently, C. H. Chamblin had either died or sold his stock prior to 1911. The brick yard was operated by the Murrays until about 1942. After a number of years, the business was sold and a new corporation was chartered to run the brick yard. The Paducah Brick and Supply Company was incorporated March 4, 1946 by William H. Hughes, Zola S. Hughes, George N. Saffer, and George Lawrence Saffer. The new company operated the brick yard until about 1955 when it was permanently closed. The following paragraphs present the limited information available about these companies.

PADUCAH BRICK WORKS

The brick yard began as the Paducah Brick Works in 1893 under the proprietorship of C. H. Chamblin. The 1894-1895 Paducah Directory (Scott and Wilcox Directory 1894:209) listed the company as follows: "Paducah Brick Works, C. H. Chamberlin, Proprietor, cor 10th and Elizabeth." Three years after C. H. Chamblin established the company, the following ad was published in the 1896 edition of the *Kentucky State Gazetteer and Business Directory* (Polk 1895: 697):

Paducah Brick Works,
C. H. CHAMBLIN, Proprietor,
CONTRACTOR AND BUILDER.
Office and Works, 1439 S. Tenth Street,
PADUCAH, KENTUCKY.

Since the above ad stated that C. H. Chamblin was both a builder and contractor, perhaps he established the brick yard to produce bricks for his own building projects. The brick yard may have also served as another income producing investment for Chamblin. The 1906-1907 Paducah Directory indicated that Calvin H. Chamblin later served as president of the Builders Association in addition to running the brick yard (Caron Directory Company 1906:121).

CHAMBLIN AND MURRAY BRICK YARD

As previously noted, the company operated as the Chamblin and Murray Brick Yard between 1897 and 1906. The company name undoubtedly represents the initial partnership between C. H. Chamblin and the Murrays before they incorporated the brick yard. The 1904 Paducah City Directory listed the company as "Chamblin & Murray, 1439 S 10th" (Ashton 1904:348). Gardner (1905:122) indicated that Chamberlain & Murray brick yard used both the Arnold and Jonathan Craiger brick machines (the Arnold Craiger was the new name for the older Jonathan Craiger machine). Gardner (1905:122) also provided the following information about Paducah brick making including a reference to the brick yard:

> There are a number of brick plants over the Jackson Purchase engaged in the manufacture of pressed brick, as follows: Hill & Karnes, Katterjohn's Sons, and Chamberlain & Murray are the three brick plants of Paducah, McCracken county. The clay used at these plants is a stiff bluish or dark clay belonging to Dr. Loughridge's Port Hudson division of the Quaternary. Each plant has a capacity of about 25,000 per day.

PADUCAH BRICK AND TILE COMPANY

The Paducah Brick and Tile Company was incorporated on March 6, 1907 by C. H. Chamblin, Arthur Murray, and James A. Murray (Secretary of State 1907). The third article of incorporation stated that "the nature of the business proposed to be carried on by said corporation shall be the manufacture and sale of brick, tile, clay products, building material and the sale of sand, and all other matters pertaining to such business, and the buying and selling of real estate." The stock of the corporation was divided into 400 shares with a value of $100 per share. C. H. Chamblin owned 200 shares while Mary I. Murray owned 100 shares of the stock. Arthur Murray, John A. Murray, James A. Murray, Robert Murray, and Effie Murray each owned 20 shares of the capital stock each. C. H. Chamblin was elected President, James A. Murray as Vice-President, and Arthur Murray as Secretary and Treasurer. The company was chartered for 25 years. A later document filed with the Secretary of State's Office shows that the corporation officially expired on March 8, 1932.

The 1900 U.S. Population Census Schedules for McCracken County listed John Murray and his sons (United States Federal Census 1900). John Murray was listed as a brick maker. The 55 year old Murray was born in Scotland during March of 1845. He obtained American citizenship in Pennsylvania in 1870. Since his sons were all born in Missouri, Murray moved to Kentucky sometime after his youngest son was born. His sons include 25 year old Arthur born in July of 1874 (brick mason), 22 year old John born in February of 1878 (brick maker), 20 year old James born in May of 1880 (brick mason), and 18 year old Robert born in March of 1882 (brick yard hand).

An informative ad was published in *Caron's Directory of the City of Paducah for 1906-7* (Caron Directory Company 1906:583) for the Paducah Brick and Tile Works:

C. H. Chamblin. John Murray.

Paducah Brick and Tile Wks

CHAMBLIN & MURRAY, Props.

CONTRACTORS

And BUILDERS

Telephone 164

SAND MOULD BRICK.

FIRE BRICK AND DRAIN TILE.

Office and Works 1439 S. Tenth St.

CITY OFFICE 118 S. 4th ST.

Caron's Directory of the City of Paducah for 1908-9 (Caron Directory Company 1908:587) listed the company as the "Paducah Brick & Tile C. at 1439 S. 10th."

The 1910 U.S. Population Census Schedules for McCracken County listed James A. Murray as a 24 year old brick manufacturer born in Missouri (United States Federal Census 1910). The 1920 Population Census Schedules for McCracken County listed James A. Murray as a 39 year old brick maker born in Missouri of Scottish parents (United States Federal Census 1920). There is a five year discrepancy in Murray's age suggesting an error in the 1910 Population Census Schedule.

A 1911 publication on Paducah (Howard 1911) included a photograph of the brick yard (Figure 1) and contained the following text:

> **PADUCAH BRICK & TILE CO.**
> A leader among the enterprises of Paducah who utilize the natural advantages of the locality is the Paducah Brick & Tile Co., manufactures of fine building brick and hollow building tile. The company was organized in 1893 and owns an extensive area secreting rich clay deposits and devoted to large buildings, dry-kilns, sheds and storage yards. This is the largest brick plant in western Kentucky, employees a large force of well paid labor and is in operation every day in the year. More than 400,000 drain tile are produced annually and from 28,000 to 40,000 brick daily. The company supplied the building brick for the new Fire Headquarters, Fountain Avenue Fire Station and City Hall, among many other important recent contracts. James A. Murray, the general manager and treasurer of the company, is one of Paducah's most prominent and highly esteemed citizens.

The 1911 photograph shows several interesting details of the brick yard (Figure 1). It appears that the photograph was taken from 10th Street looking towards the west-northwest. The central focal point is a large round kiln with eight or nine flues on the top. A ladder leaning against the left side of the kiln suggest that the firing may have been partially controlled by opening or closing holes in the roof. Wagons (center and right edge) and horses (left center and right center) were probably used for transporting the bricks to the customers. On the right side of the photograph is a large rectangular scove brick kiln. It has a gabled roof supported by a series of posts on each side of the kiln. The end of the kiln has two large brick pillars. Shed roofs flank each side of the kiln to cover the adjacent work areas. The remainder of the structures are small sheds arranged on both sides of the circular kiln. A common feature is the parallel support with a series of horizontal boards nailed between them. These sheds have overlapping roofs. The sheds to the left may cover small brick kilns. The small sheds between the circular kiln and the rectangular kiln may be drying sheds. On the left side of the photograph is a large smoke stack and a two story shed which are probably associated with the coal

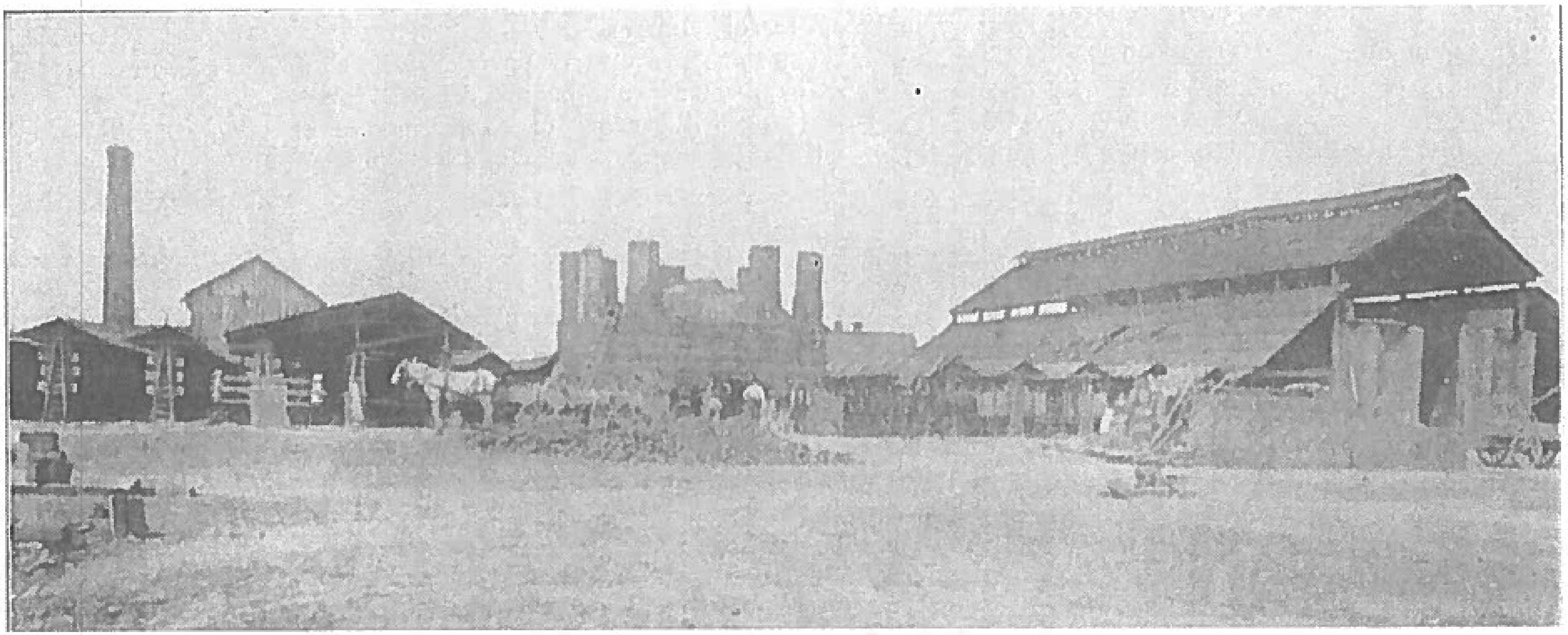


Figure 1. Historic Photograph of the Paducah Brick and Tile Company. Reproduced from Howard 1911.

powered steam engine. Also visible are bricks and a few hollow building tiles.

Additional information was presented in *Caron's Directory of the City of Paducah, KY. For the Years 1912-1913* (Caron Directory Company 1912:627) in the following ad:

Paducah Brick & Tile Co.
Incorporated
Home Phone 164
MANUFACTURERS
HIGH GRADE
Building Brick
Hollow Building Blocks
and
Farm Drain Tile

Caron's Directory of the City of Paducah for the Years 1914-1915 (Caron Directory Company 1914:663) provided the following listing "PADUCAH BRICK & TILE; 1439 Murrell boul (formerly S 10th)." The bottom line of same page indicated that they were "Manufacturers of Brick, Drain and Building Tile." In the next few years the wording in the listings in Paducah City directories remain nearly identical for the brick yard (Caron 1916:624, 1918:577, 1920:644, 1922:660, 1924:767, 1926:821, 1930:873, 1933:712, 1935:757; Baldwin and Young 1937:37; Baldwin, Billing, and Young 1939:32; Caron 1941:738). In the 1935-1936 and the 1941-1942 Paducah City directories, Murray Brick & Tile and Paducah Brick & Tile Company were listed separately for the same address, 1439 Murrell Blvd. (Caron 1935:757, 1941:738).

The Paducah Brick & Tile Company was mentioned in several publications between 1922 and 1942. Ries (1922:58) stated that the Paducah Brick and Tile Company was located on south 10th Street and was a producer of common building bricks with a market in western Kentucky and Tennessee (Ries 1922:58). Ries (1922:58) also stated that "the bricks are molded in a soft-mud machine, and dried on pallet racks. Firing which takes 12 days, is done in Dutch kilns. The clay shows 12 inches settle in 41 courses." Jillson (1926:15) listed the company at 1439 Murrell Blvd., in Paducah, Kentucky. The Directory of Kentucky Mineral Operators (Burroughs 1930:14, 16) which presented information for 1926 listed the Paducah Brick and Tile Company as a producer of common bricks and drain tiles. In a 1927 listing of industries, Jillson (1930:166) listed the "Paducah Brick & Tile Co., 1439 So. 10th St., Paducah, McCracken County." The Paducah Brick & Tile Company was listed in a 1929 publication entitled *Kentucky Natural Resources, Industrial Statistics, Industrial Directory Description by Counties* (Seiller 1929:294). This publication indicated that Paducah Brick & Tile Co. had 62 employees which included 60 colored men and two white men.

Caron's Paducah directory for 1930-1931 carried the following ad (Caron 1930:36):

Paducah Brick & Tile Company
Incorporated
Manufacturers of "Murray Brick"
and dealers in high-class Face
Brick, Sewer Tile and Farm Drain Tile.
JAS. A. MURRAY, General Manager
1439 S. Tenth St. Phone 3325

The 1910 U.S. Population Census schedules listed at least 43 individuals associated with the brick industry in Paducah (United States Census 1910). Since many pages of the 1910 census are too faded to read, the actual number of people in the brick industry may be much greater. Unfortunately, it is not possible to determine which of the three brick yards employed the people listed. However, the occupations listed for the individuals provide insight into the diversity of jobs necessary at a brick yard. The 1910 Census and the 1920 Census schedules include the following job titles: manufacturer, striker, brick setter, temperer, brick turner, brick wheeler, table turner, engineer, sander, teamster, fire man, mold cleaner, dumper, off bearing, and laborer. With the exception of the positions of manufacturer, engineer, temperer, striker, and one teamster which were all white, the remaining jobs were held by Blacks and Mulattos. African Americans played a major role in Paducah's brick industry and undoubtedly an important role at the Paducah Brick and Tile Company's operation.

PADUCAH BRICK & SUPPLY COMPANY

The Paducah Brick and Supply Company was incorporated on March 8, 1946 by William H. Hughes, Zola S. Hughes, George N. Saffer, and George Lawrence Saffer (Secretary of State 1946). Article IIIA stated that the nature of the business shall be "to manufacture brick, tile, and building blocks and any and all similar or dissimilar building materials that may be manufactured from clay, minerals, concrete, stone, or any other substance." The capital stock of the corporation of $16,000 was divided into 160 shares with a value of $100 per share. William H. Hughes owned 117 shares while Zola S. Hughes owned three shares of the stock. George N. Saffer and George Lawrence Saffer each owned 20 shares of the capital stock each. William H. Hughes was elected President, George N. Saffer as Vice-President, and Zola S. Hughes as Secretary and Treasurer. The company was chartered for 99 years. The Paducah Brick and Supply Company was listed in the Paducah City directory for 1947 (Caron 1947:501). The Secretary of State's files contain "Annual Verification Report of Foreign or Domestic Corporations" documents submitted on behalf of the Paducah Brick and Supply Company between 1946 and 1968. William H. Hughes and Zola S. Hughes continued to sign these documents until 1962. Beginning in 1963, C. S. Ward was listed as President and W. L. Taylor as Secretary. The nature of the relationship between Ward and Taylor with the Hughes is currently unknown. The corporate address remained listed at 1439 Murrell Boulevard until 1966. During 1967 and 1968, the address was changed to 901 South 6th Street. Articles of Amendment were filed for the corporation on September 13, 1969 by Vice President J. E. Hughes and Secretary W. L. Taylor. Article 8 was modified to allow the corporation to become indebted up to one million dollars. Surprisingly, the corporation was dissolved a short time later on December 24, 1969.

The Paducah Brick & Supply Company was listed in the Kentucky Industrial Directory between 1949 and 1955. In 1949, Paducah Brick & Supply Co., Inc. was listed as a common brick manufacturer located at 1439 Murrell Blvd., Paducah (Agricultural and Industrial Development Board 1949:211). The Kentucky Industrial Directory for 1951-52 listed the Paducah Brick & Supply Co., Inc. as a common red brick manufacturer located at 1439 South 10th Street, Paducah (Agricultural and Industrial Development Board 1951:223). The Kentucky Industrial Directory for 1953-54 listed the Paducah Brick & Supply Co., Inc. as a common red brick manufacturer located at 1439 South 10th Street, Paducah (Agricultural and Industrial Development Board 1953:220). The Kentucky Industrial Directory for 1955-56 listed the Paducah Brick & Supply Co., Inc. as a common brick manufacturer located at 1439 South 10th Street, Paducah (Agricultural and Industrial Development Board 1955:229). No Paducah brick yards were listed in the Kentucky Industrial Directory for 1957-58 (Kentucky Department of Economic Development 1957:348). Thus, it appears that the brick yard ceased production about 1955 but the corporation was continued on paper until 1969.

Olson (1994:175) provided the following information on the life spans of the Hughes: William Henry Hughes (May 12, 1897- May 10, 1972) and Zola Smedley Frakes Hughes (April 18, 1901-?).

The "On-line Business Database" at the Secretary of State's Office indicated that the Lockwoods revived the last corporation for the brick yard. The Paducah Brick and Supply Company, Inc. was incorporated by H. Linn Lockwood and Lyndel Lockwood on January 29, 1970. The corporation's status was listed as inactive with the last annual report being filed in 1984. It is the understanding of the authors that Mr. Lockwood had difficulty in obtaining the necessary permits to mine clay and operate a new brick yard at that location. As a result, the last corporation never operated a brick yard on the site.

Howard Linn Lockwood (personal communication, 1997) acquired the brick yard site about 1972. Mr. Lockwood was able to provide several details about the surviving brick yard remains at that time. He tore down the drying building, the power plant, and office. The kilns were already gone when he bought the property. The drying house was a one-story brick structure with a shed roof. The power plant was a brick structure that contained a boiler and machines to pull the clay cars up the incline slope. The office was a one-story home that a Mr. Scafford lived in. A barn was located behind the house. Mr. Lockwood stated that there were wooden boxes (brick molds) made from cypress wood that held about eight bricks. During his initial ownership, he had all the trees cut and the property cleaned up. Through time the property has reverted back to forest.

SPATIAL ORGANIZATION OF THE BRICK YARD

While some of the foundations associated with the Paducah Brick and Tile Company are preserved, they represent only a portion of what was once present. Since the brick yard was shown on several Sanborn Insurance maps we have information on the spatial layout of the brick yard and how it changed through time. These maps also allow us to match the ruins to specific structures at the brick yard. The December 1893 map indicates that the brick yard was still under construction when the map was made (Sanborn 1893). At that time, the drying kiln, the Hot Blast, Machine Shop, and Engine Shop were already built. The next map (Sanborn 1897) was produced in October of 1897 Sanborn Map (Figure 2). This map illustrates the layout of the brick yard and contains a scale which allows the estimation of approximate building dimensions. At the northern end of the complex was a one-story office that was about 12 x 18 feet (3.6 x 5.4 m). Approximately 45 feet (13.5 m) south of the office was a circular "updraught kiln" about 38 feet (11.4 m) in diameter. Near the circular kiln was a one-story "Green Pipe Shed" that measured ca. 18 x 54 feet (5.4 x 16.2 m). Adjacent to the south wall of the Green Pipe Shed was the Steam Drying House (previously called drying kiln) which was about 16 x 130 feet (4.8 x 39 m). A Fan Room, about 12 x 22 feet (3.6 x 6.6 m), was attached to the northeast corner of the Steam Drying House. At the southwest end of the Steam Drying House was the one to two story structure that housed the brick and tile machine. This structure was about 20 feet (6 m) wide and 38 feet (11.4 m) long. Directly behind the structure was a round ca. 10 feet (3 m) diameter elevated water tank that was 10 feet (3 m) high. Adjacent to the south side of the brick and tile machine was a one story engine room about 25 x 30 feet (7.5 x 9 m). A coal shed, 10 x 20 feet (3 x 6 m), was attached to the south end of the engine room. About 40 feet (12 m) south of the steam drying house were two rectangular brick kilns. They both were about 30 feet (9 m) wide and 70 feet (21 m) long. The kilns were about 25 feet (7.5 m) apart. Approximately 65 feet (19.5 m) west of the engine room was a pond. The pond was ca. 55 feet (16.5 m) wide and 130 feet (39 m) long. Missing from the map were the drying racks and the clay pit. The map refers to the company as the "Chamblein & Murray Drain, Tile & Brick Wks.". A note on the map indicates that a watchman was present when

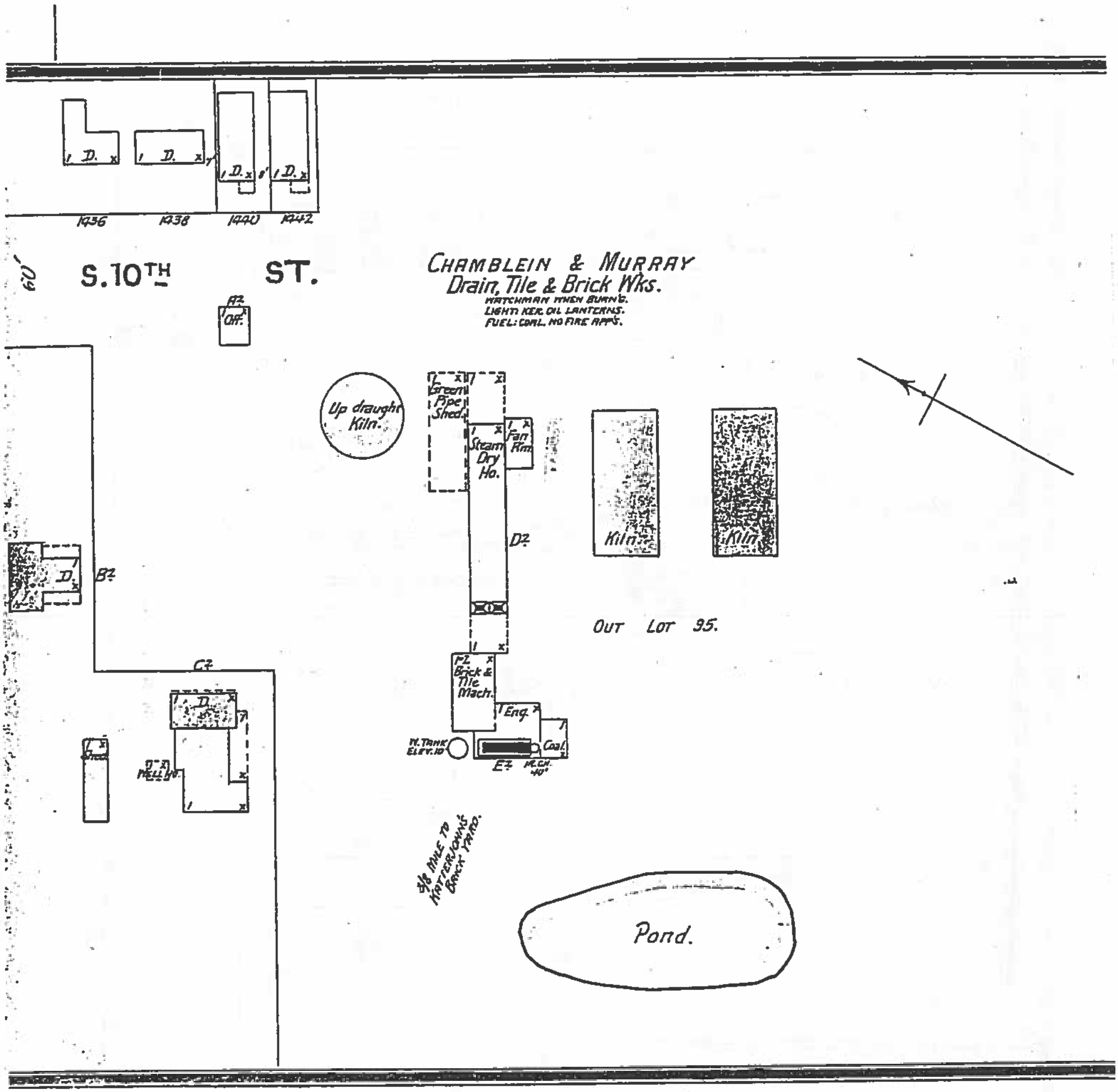


Figure 2. Reduced Portion of the October 1897 Sanborn Insurance Map of Paducah, Kentucky Showing the Chamblin and Murray Brick Yard. Copyright (1897) The Sanborn Map Company, The Sanborn Library, LLC. All Rights Reserved. Further reproduction prohibited without written permission from the The Sanborn Library, LLC.

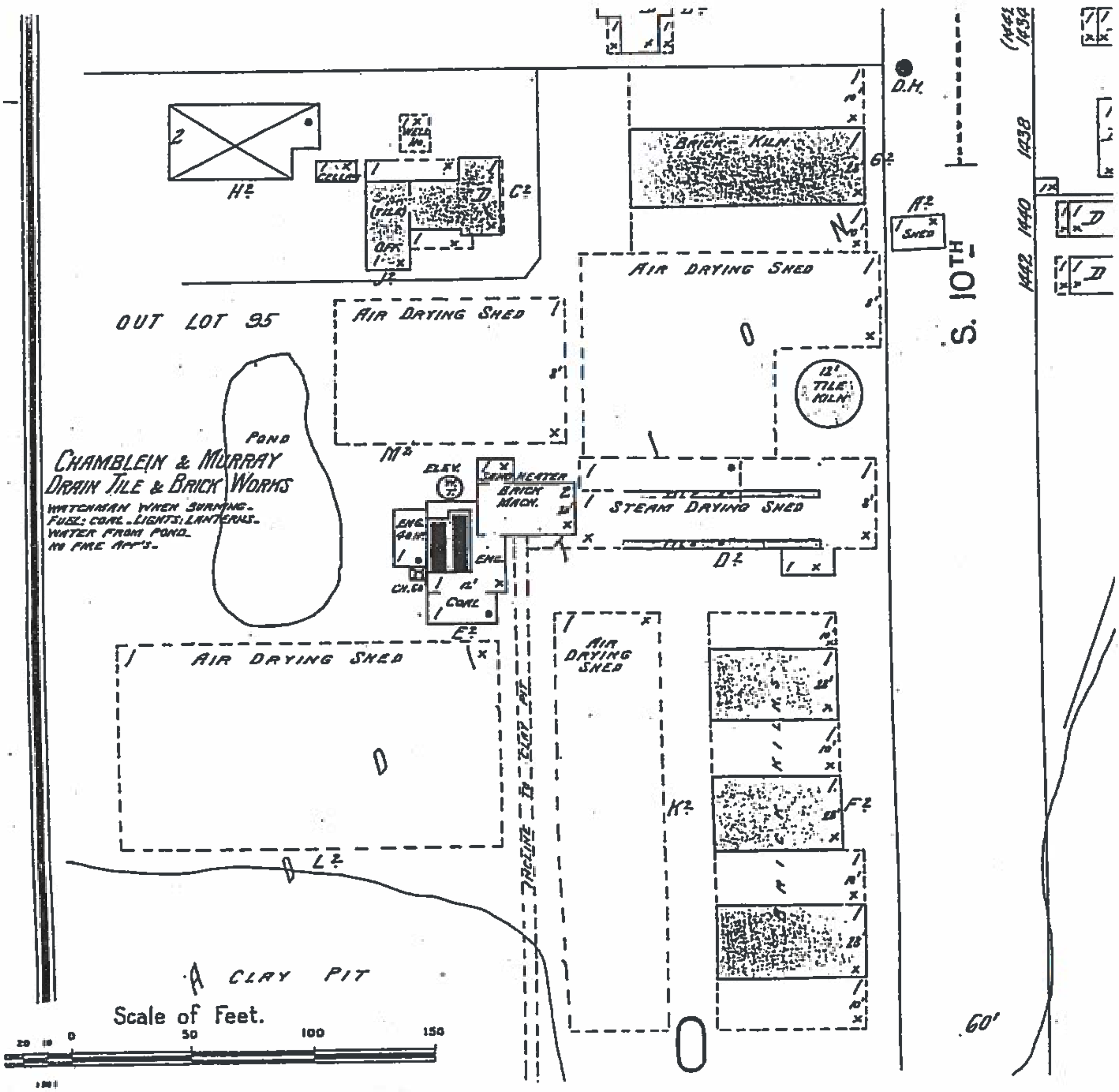


Figure 3. Reduced Portion of the October 1906 Sanborn Insurance Map of Paducah, Kentucky Showing the Chamblin and Murray Brick Yard. Copyright (1906) The Sanborn Map Company, The Sanborn Library, LLC. All Rights Reserved. Further reproduction prohibited without written permission from the The Sanborn Library, LLC.

the kilns were burning. Light was provided by kerosene oil lanterns while coal was used as the fuel source to power the brick yard. Another note on the map mentioned that the Katterjohn Brick Yard was 3/8 of a mile (594 m) away.

Our next view of the complex is the June 1901 Sanborn Insurance Map which shows some additions to the brick yard. The old office has been abandoned and was being used for storage. The new office was located in the rear of a house situated west of the old office. This house was shown as a private residence on the previous map. A new rectangular "Arched Kiln" had been added just north of the circular kiln (now referred to as a 12 foot arched kiln). This new kiln was somewhat smaller than the other two rectangular brick kilns. The two rectangular brick kilns had sheds added between them and a shed on each end. Drying racks had been added to the north wall of the steam drying room, extending from the Green Pipe Shed to the brick and tile machine. The steam drying room, fan room, water tank, and brick and tile machine room appeared to be unchanged. The west end of the steam drying room had a dividing wall (also shown on 1897 Sanborn map) and the area was labeled wooden vent. The engine room had been enlarged and now contained a fire pump and 50 feet (15 m) of ¾ inch (2 cm) hose. The coal shed and the pond appeared the same as they did on the earlier map. The incline is shown for the first time, as running from the brick and tile machine to the clay pit located to the south. The map indicated that the watchman, fuel, and lights remained unchanged. The pond was mentioned as the brick yard's water source.

Five years later, the 1906 Sanborn Insurance Map (Figure 3) shows additional changes to the brick yard (Sanborn 1906). Fortunately, this map has a scale. At the north end of the complex, the small rectangular kiln has been removed and replaced with an air drying shed measuring ca. 88 x 125 feet (26.4 x 37.5 m). A new larger rectangular kiln had been built further north. The new kiln was about 32 feet (9.6 m) wide and 100 feet (30 m) long. Both sides of the kiln have adjacent sheds. The circular kiln was now referred to as the tile kiln. Also, the office had been enlarged and a cellar added to the west yard area. An air drying shed, measuring ca. 60 x 95 feet (18 x 28.5 m) had been added to the area between the office and the brick machine. A sand room (10 x 14 feet; 3 x 4.2 m) and heater were added to the structure housing the brick machine. The steam engine was listed as 40-horse power. A 60 feet (18 m) high smoke stack was associated with the engine room. The engine room had been enlarged to include greater capacity for storing coal. A new rectangular kiln was built at the south end of the yard, at the south end of the two earlier kilns and in alignment with them. It was slightly larger than the adjacent kilns, measuring about 30 x 62 feet (9 x 18.6 m), and has sheds on each side. An air drying shed about 44 x 85 feet (13.2 x 25.5 m) was built in the space between the three rectangular brick kilns and the incline. Another air drying shed (88 x 155 feet, 26.4 x 46.5 m) was added on the west side of the incline, extending between the pond and the clay pit. The elevated water tank appears to have been moved slightly to accommodate new construction.

The 1916 and 1922 maps included a total of only seven pages and did not show the brick yard (Sanborn 1916, 1922). The brick yard showed up for the final time on the 1952 Sanborn Insurance Map as the Paducah Brick and Supply Company. A note on the map indicates that it was not in operation (Sanborn 1952). By this time the circular kiln and the southern most rectangular kiln were gone along with all the drying sheds and water tank. The drying house, brick machine, engine house, office, the large rectangular kiln on the north end and the two rectangular kilns on the south end, and the incline were still shown. The pond was no longer present.

Mr. Harold Lockwood (personal communication, 1997) has owned the property for 20 years. As previously noted, during his ownership, he tore down the drying house, the power house, the office, and some of the brick walls to the incline. He said that the kilns were already gone when he purchased the property. Further, he had the trees cut down and cleaned up the property. He worked on a river boat for years and while he was out of town, people dumped things on his property. There are still large quantities of construction debris, tires, lumber, and miscellaneous trash. The junior author, a third generation Paducah contractor, verified that local contractors used this area for dumping since he was a boy. The discarded bricks (from other contexts) were probably dumped at the brick yard during this period. The main part of the site has reverted back to forest. During the period that this article was being prepared, the City of Paducah acquired the property.

THE ARCHAEOLOGICAL REMAINS

The first step in documenting the Paducah Brick and Tile Company site was to carefully search the woods for remains associated with the brick yard. Because of limited time and man power, shovel probes were not excavated as part of this research. Each foundation or concentration of artifacts was designated with a letter. Letters A through M were assigned to these areas. A sketch map was prepared by pacing distances between the various areas.

The Paducah Brick and Tile Company is located in southwestern portion of the City of Paducah at the end of South 10th Street. For a period of time, the street was called Murrell Blvd. Cross Creek, a tributary of Island Creek, is located about 80 m (264 feet) from the southern boundary of the site. The confluence of the Tennessee and Ohio rivers is 3 km (1.8 miles) to the east. The brick yard is situated on the Ohio River floodplain where clay deposits were abundant.

On April 22 and 23, 1997, a surface archaeological reconnaissance was undertaken at the Paducah Brick and Tile Company ruins. Only those remains visible on the surface were documented. The vegetation had already begun to grow which reduced surface visibility. Most of the site was in forest with bushes, weeds, vines, and leaf cover further obscuring the archaeological remains. The field work focused on producing a sketch map of the site (Figure 4), measuring important features, and documenting the site with photographs. Additional observations were made on February 26, 1998 when field conditions were considerably improved. The visible remains extended over an area 80 meters (264 feet) east-west and 120 meters (396 feet) north-south (9,600 m^2, 104,544 ft^2). These boundaries do not included the large clay pit to the south. Remains include the drying house, the ruins of three rectangular kilns, the machine house, the engine house, the office, the incline to the clay pit, the clay pit, and other features. A collection of bricks was made from each context at the site. Also, a sample of hollow clay building blocks were collected for analysis. No examples of the drainage tiles produced at the site were observed. The drainage tiles may have been buried under later deposits or obscured by modern dumping episodes.

For the purpose of documenting the complex, letter designations (A-M) were assigned to various foundations and features. The following paragraphs describe the remains associated with each area. The types of brick and/or building tile occurring in these areas will be mentioned.

AREA A (DRYING HOUSE)

Area A is the foundation of the steam drying house. It measures is 44.5 m (146.85 feet) long and 5.8 m (19.14 feet) wide. Both soft-mud and stiff-mud bricks were used in the construction of the walls. The walls (two bricks wide) are 20.5 cm (8.2 inches) thick and currently up to 36 cm (14.4 inches) in height. Brick pilasters 42.5 cm (17 inches) wide and 22.5 cm (9 inches) thick were added to the exterior walls to provide extra support. The southern 19 m (62.7 feet) of the structure was constructed from hollow building tiles. Large sections of the structure's wall remain intact where they

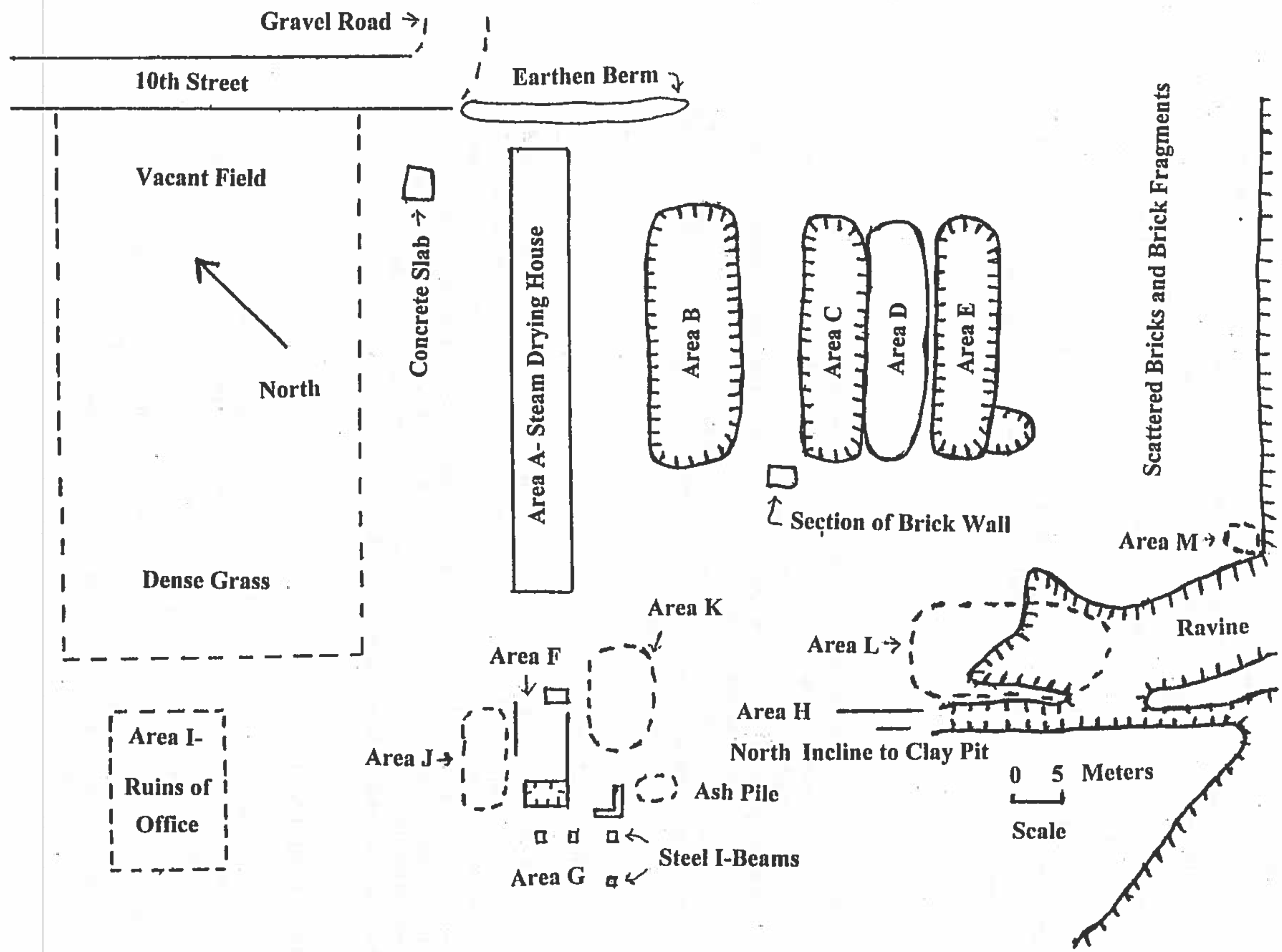


Figure 4. Sketch Map of the Archaeological Remains at the Paducah Brick and Tile Company Site (15McN114).

were pushed over. Also, a small segment of the original wood flooring remains on the southern end of the structure. The floor was supported by 2" by 8" (5 by 20 cm) joists. The actual flooring was 1" by 11" (2.5 by 27.5 cm) boards. The interior of the foundation contains collapsed pilasters and piles of bricks. A few modern perforated stiff-mud bricks have been dumped into the foundation area. There are also miscellaneous iron rods with I-bolts attached. One rod was attached to a central support suggesting that it was part of the original equipment. A sample of five soft-mud bricks and two hollow blocks were collected from Area A.

Current owner, Mr. Howard Lockwood (personal communication, 1997), said that he tore the steam drying house down after he bought the property 20 years ago. He said it was a one-story brick structure with a shed roof. He did not remember the hollow building blocks used on the southern end of the structure.

AREA B (BRICK KILN)

Area B is a depression 26 m (85.8 feet) long and 8 m (26.4 feet) wide is located 8 m (26.4 feet) the east of the drying house. It is probably the remains of a rectangular brick kiln. The depression is currently 30-40 cm (12-16 inches) deep. This area contains a mixture of old remains associated with the kiln and materials that were dumped after the abandonment of the brick yard. The older remains include EVENS & HOWARD fire bricks (mostly fragments), clinkers, a section of a brick wall, and fire brick that were glazed with use. The modern items include stiff-mud bricks (10-hole type), concrete block fragments, metal bands, unmarked fire bricks, plastic, and aluminum. The selected sample consist of one soft-mud brick, two solid stiff-mud bricks, and three fire bricks. The fire brick brands include two EVENS & HOWARD/ ST. LOUIS and one LFB WKS/ LOUISVILLE.

AREA C (BRICK KILN)

Area C is 26 m (85.8 feet) long and 6 m (19.8 feet) wide and is east of Area B. It is also the remains of a rectangular brick kiln. This area is nearly level but has areas that are 20-30 cm (8-12 inches) lower. A combination of original debris and modern trash is present. The older materials include fire bricks (several EVENS & HOWARD fragments), clinkers, small sections of brick walls, refractory blocks, and stiff-mud rejected bricks. The modern materials include concrete, a few fragments of 10-hole stiff-mud bricks, and a 3-hole stiff-mud brick. The selected sample includes four solid stiff-mud bricks and one LFB Wks/ No. 1 fire brick.

AREA D (BRICK KILN)

A raised area (1.5 m; 4.95 feet higher) is just east of Area C was designated Area D. This may be demolition debris from two adjacent brick kilns. Area D measures 25 m (82.5 feet) long and 6 m (19.8 feet) wide. This area contains fire bricks (fragments of EVENS & HOWARD/ ST. LOUIS and LFB WKS/ LOUISVILLE), large unmarked refractory blocks, clinkers, warped wire-cut bricks, fused, and glazed bricks. Recent discards by local contractors include some 10-hole and 3-hole wire-cut stiff-mud bricks. Bricks collected from Area D include one soft-mud brick, four solid stiff-mud bricks, and three fire bricks. The fire brick sample includes one LFB WKS/ LOUISVILLE, one LACEDE/ST. LOUIS, and one unmarked specimen.

AREA E (BRICK KILN)

Area E is a depression 26 m (85.8 feet) long and 6 m (19.8 feet) wide on the east side of Area D. It is probably the remains of the last rectangular brick kiln. This area contains fire bricks (LFB WKS/ LOUISVILLE fragments), solid stiff-mud rejects, clinkers, refractory blocks, and iron parts of machines. Recent construction debris includes yellow 3-hole stiff-mud bricks, 10-hole stiff-mud bricks, concrete, and concrete blocks. The selected sample includes three solid stiff-mud bricks and two fire bricks. The fire bricks include one LFB WKS/ LOUISVILLE and one LFB Wks/ No. 1.

AREA F (BRICK MACHINE STRUCTURE)

Area F is 12 m (39.6 feet) southwest of Area A and 25 m (82.5 feet) northwest of the incline. This area contains segments of brick walls and a brick lined depression (Figure 5). The Sanborn insurance maps indicate that the brick machine was located in this structure. The area is about 5 m (16.5 feet) north-south and 10.5 m (34.65 feet) east-west. The southern wall is about 10.5 m (34.65 feet) long, 20 cm (8 inches) wide, and up to 90 cm (36 inches) high. At the southwest corner of this wall, another wall projects towards Area G. This projecting wall suggest that the structures in Areas F and G may have been connected at one time. Near the center of the south wall is a brick (soft-mud) lined pit along the interior wall (on the north side) of the foundation. This brick lined depression is 2.2 m (7.26 feet) east-west, 2 m (6.6 feet) north-south, and 8 cm 3.2 inches) deep at the south wall. Just east of the depression and also adjacent to the interior of the south wall is a brick platform constructed from soft-mud bricks. The platform is 47 cm (18.8 inches) high and measures 95 cm (3.14 feet) north-south and 65 cm (2.15 feet) east-west. It is hollow on the inside and could have served as a cistern. Immediately south and east of the platform is a pile of ashes and cinders 2 m (6.6 feet) in diameter and 20 cm (8 inches) high. The west wall of Structure F is about 3 m (9.9 feet) long, 43 cm (17.2 inches) wide, and has a maximum height of 60 cm (24 inches). It is built out of wire-cut stiff-mud bricks. There is a 2 m (6.6 feet) space between the west wall and the south wall. The north wall is just a segment in the northeast corner with a 1.25 m (4.13 feet) depression between it and the west wall. The north wall segment is 43 cm (17.2 inches) north-south, 1.65 m (5.45 feet) east-west, and 50 cm (20 inches) high. It is made from solid wire-cut bricks mortared together. Two 2.5 cm (1 inch) diameter bolts, 45 cm (18 inches) long, were set into the top of the north wall segment. Material observed around Area F includes scattered solid stiff-mud bricks and shingles. The sample collected for Area F consist of four soft-mud bricks and one solid stiff-mud brick.

AREA G (ENGINE HOUSE)

Area G is immediately adjacent (to the southwest) to Area F, measures 6 m (19.8 feet) north-south and 3 m (9.9 feet) east-west. The most prominent feature of Area F consist of two large vertical cast iron columns (2.75 m [9.08 feet] apart) that support horizontal twin I-beams (connected at both ends). The I-shaped columns are flared at the tops. They are 3 m (9.9 feet) high, 18.5 cm (7.4 inches) wide, and 15 cm (6 inches) thick. The interiors of these columns were filled-in with soft-mud bricks and fragments of fire bricks. The base of another I-shaped column is located 4 m (13.2 feet) west of the northern most upright column. A smaller (13 x 8 cm; 5.2 x 3.2 inches) T-shaped vertical support base is 2 m (6.6 feet) further west. A ground level wall built from soft-mud bricks (32 cm [12.8 inches] wide and 2 m [6.6 inches] extends between the middle upright column and the T-shaped support. Apparently, there were four of these vertical columns that formed the super structure for the engine house. About 25 m (82.5 feet) to the west-northwest of Area G is the ruins of the company office.

Figure 5. Photograph of Brick Lined Depression at Area F. Photograph facing the southwest.

Figure 6. Photograph of a Surviving Brick Wall at the Northern End of the Incline (Area H). Photograph facing northwest.

The interior of Area G was filled with fire bricks (primarily EVENS & HOWARD/ ST. LOUIS and CANNELTON) and soft-mud bricks. The collected sample consisted of one LFB WKS/STANDARD, one LFB Wks/No 1, one A.P. GREEN/ OZARK DP, and two CANNELTON fire bricks. Such a concentration of fire bricks would be expected at the engine house because of the heat protection required.

AREA H (INCLINE)

Area H is about 22 m (72.6 feet) south of Area C and 25 m (82.5 feet) from Area F. It consists of a linear depression leading down into the clay pit (Figure 6). One segment still has intact parallel brick retaining walls that are 1.7 m (5.61 feet) apart. The exposed walls are 1.85 m (6.1 feet) high and ca. 29.5 cm (11.8 inches) wide. The walls are built from sand textured red soft-mud bricks that have been laid end to end, three bricks wide. This is the remains of the incline where the clay was transported in cars from the clay pit to the brick making equipment. A causeway provided an elevated surface for the track that extended across the clay pit to the brick yard. We met a middle aged gentleman who remembered that a mule was used to pull the car from the clay pit to the brick machine. His dad was a veterinarian who had gone to the brick yard to treat a sick mule.

AREA I (OFFICE)

Area I, the company office, is located ca. 28.5 m (95 feet) northwest of Areas F and G, across a field from the other ruins. The office was about 16 m (52.8 feet) north-south and 11 m (36.3 feet) east-west. The remains of the office contain various sizes of hollow blocks, stiff-mud bricks, an occasional soft-mud brick, floor joist, and portions of the floor. The hollow blocks were associated with the interior walls of the office. Also, large amounts of household trash remain from the last occupation of the house. A brick retaining wall, 11 m (36.3 feet) long and 70 cm (231 feet) high is located a few meters south of the office. It was built with common soft-mud bricks (primarily rejects) which were set in mortar. These rejected bricks include specimens with heavy glazing from over-firing and some warping. Another brick wall attaches to the southeast corner of the first wall and extends for about 13 m (42.9 feet) to the north. This eastern brick wall is 45 cm (18 inches) high and has built-in stairs near its northern end, which is near the center of the office. The three brick steps lead to a section of brick sidewalk leading to the office. A woven wire fence, 3 m (9.9 feet) north of the office, forms the yard boundary. The sample from Area I consist of one soft-mud brick, four solid stiff-mud bricks, and five hollow tile blocks.

AREA J (BRICK PILE)

Area J is a large brick pile along the western side of Areas F and G. The bricks extend over an area 10 m (33 feet) north-south, 4 m (13.2 feet) east-west, and are between 1 and 1.5 m (3.3 -4.95 feet) high. It appears that the soft-mud bricks may be rubble from Areas F and G. There are also some stiff-mud specimens, and a few fire bricks from Area G. Since this area is adjacent to an open field, there has been some modern dumping as well. Obviously modern items include some pressed bricks and concrete blocks. The collected sample from this area consists of four soft-mud bricks and one pressed brick.

AREA K (BRICK PILE)

Area K is a modern brick pile a few meters east of Area F. The pile measures 7 m (23.1 feet) north-south, 9 m (29.7 feet) east-west, and 50 cm (1.65 feet) to 1 m (3.3 feet) in height. A variety of stiff-mud bricks, a pressed brick, and blue glazed hollow building tile were in the pile. The collection consists of one solid stiff-mud brick, ten perforated stiff-mud bricks (3, 5, 10, and 14 hole varieties), and one pressed brick. These specimens were collected to permit the documentation of modern bricks varieties used in Paducah.

AREA L (BRICKS IN RAVINE)

A concentration of bricks dumped into a ravine just north of the incline (Area H) was designated Area L. The bricks were scattered over an area about 20 m (66 feet) north-south and 10 m (33 feet) east-west. These specimens appear to be bricks dumped by contractors after the brick yard closed. The bricks in this area include street paving bricks, a few fire bricks, a few soft-mud bricks, and some miscellaneous specimens. The selected sample include two BANNON'S BLOCK, two ROBBINS PAVERS, one K.V.B. Co./ BLOCK, one MEXICO MO/STANDARD fire brick, and one 2-hole stiff-mud brick.

AREA M (BRICK SCATTER)

Area M is a surface scatter of C & M brand brick fragments. They are located about 17 m (56.1 feet) north of the incline and near the clay pit on the steep slope. The concentration was 2 m (6.6 feet) north-south and 3 m (9.9 feet) east-west. These are broken (2 or smaller) C & M bricks that were discarded. Two of the large fragments were selected for analysis.

CLAY PIT

The clay pit is 26 m (85.8 feet) east of Area E (Figure 7). This area is estimated to be ca. 5-7 m (16.5 -23.1 feet) lower than the brick yard. An elevated causeway extends from the base of the incline towards the northeast for an unknown distance. The size of the clay pit was not recorded since the area is wet and heavily forested. This low lying area is frequently flooded and had standing water at the time of the survey. A single fragment of a C & M brand brick was collected from the clay pit for analysis.

Ries (1922:58) provided the following description of the clay used by the brick yard:

> The clay used is a flood plain clay of the Ohio River, the pit being situated about 400 feet south of the works. The material is a tough red clay, and the bottom of the bank, whose face is about 25 feet high, is 30 feet above river level. Below the red clay is a tough blue clay that was formerly mixed with the upper clay and used in the manufacture of hollow block and tile. It is not used now.

OTHER CONTEXTS

Piles of broken and rejected bricks are scattered across the site. An undesignated area was

Figure 7. The Clay Pit at the Paducah Brick and Tile Company. The photograph is reproduced from Ries (1922, Figure 12), courtesy of the Kentucky Geological Survey, Lexington.

Table 1. Contexts for Brick and Building Blocks Recovered from the Paducah Brick and Tile Company.

Collection Area	Soft-Mud	Solid Stiff-Mud	Perforated Stiff-Mud	Pressed Bricks	Other	Fire Brick	Paving Brick	Tile	Totals
A	5							2	7
B	1	2				3			6
C		4				1			5
D	1	4				3			8
E		3				2			5
F	4	1							5
G						5			5
I	1	4						5	10
J	4			1					5
K		1	10	1					12
L			1		1	1	5		8
M	2								2
Clay Pit	1								1
Totals	19	19	11	2	1	15	5	7	79

observed in February of 1998 when the vegetation was dead. On the eastern edge of the site, about 20-30 m (66-99 feet) north of the incline, on the upper slope of the clay pit are scattered bricks. Piles of bricks and large intact sections of a brick wall are present the clay pit slope. These may be walls from the brick kilns that were bulldozed over the slope after the brick yard was abandoned.

THE BRICK AND BUILDING TILE SAMPLE

During the reconnaissance, 72 bricks and seven hollow building blocks were collected from different areas of the site (Table 1). In terms of context, some of these bricks are from the ruins of kilns and other structures at the brick yard. A number of the bricks are rejects of products produced at the brick yard. The final group of bricks are specimens dumped there after the brick yard closed. These include common building bricks made by both soft-mud and stiff-mud machines, fire bricks, and paving bricks. The following pages describe these various types of bricks and building tiles recovered.

Three functional types of bricks were recovered from the project area. These include common building bricks, paving bricks, and fire bricks. The subsequent pages discuss these categories of bricks. Recovered bricks are described and discussed under the appropriate categories. Most specimens do not have brand names or other identifying characteristic that permit them to be attributed to a particular manufacturer. Fortunately, some of the paving bricks, most of the fire bricks, and a few common bricks have brand names. The different categories of bricks are discussed below with some information on how they were manufactured.

COMMON BUILDING BRICKS

Common building bricks, as the name suggest, are simply ordinary bricks used in the construction of walls. They are made from locally available clays and are usually a reddish brown color. A total of 52 common bricks were collected from the brick yard area. Of these, 19 were made by the soft-mud technique while 30 were manufactured by the stiff-mud technique. Two pressed bricks and one concrete brick complete the sample. These bricks will be discussed in the following paragraphs.

Soft-Mud Bricks

Soft-mud bricks were initially produced in molds by hand. In the mid-19th century, machines were invented that duplicated the hand molding process. By the 20th century, most brick manufacturers were using very efficient brick making machines and hand molding had become uncommon. The molding of bricks by hand involved placing the wet clay into simple wooden molds containing several compartments. The excess clay was struck off by pulling a board or some other straight edge across the top of the mold. This process leaves distinctive parallel lines and sometimes deep gouges where pebbles in the paste were pulled across the struck surface. Bricks produced by this method can vary greatly in size due to variations in mold size and the gradual wearing away of wooden molds by abrasion. Also, hand made bricks may vary in hardness and color since they were fired in crude up-draft kilns with uneven heat.

Machine-made soft-mud bricks were produced in machines that forced wet clay into a series of molds and then automatically removed the excess clay from the top of the mold (Gurcke 1987:19).

The removal of the excess clay from the molds is called a strike. Like hand made bricks, machine made specimens have distinctive strike lines on the surface where the excess clay was pulled across the top of the mold. Often small pebbles are pulled across the struck surface producing parallel grooves. Soft-mud bricks made by machines can vary depending on the type of machine used to produce them. We know that a soft-mud machine was in use at the brick yard in the early 1920s (Ries 1922:58).

The soft-mud bricks were primarily recovered from Areas A, F, and J but were also present in Areas B, D, I, M, and the clay pit. During the years that the company operated as the Chamblin and Murray Brick Yard they produced a soft-mud brick with a C & M brand impressed into one side. However, most of the bricks the company produced did not have any markings. Four bricks were made in a special mold and were designed for use in a cornice at the top of walls. These specimens are also described in the following paragraphs.

Plain Soft-Mud Bricks

Twelve standard size soft-mud bricks without any markings were selected for study from Areas A, B, D, F, and I (Table 2). Ten of these bricks were well-fired and only two were over-fired. Most of these bricks were dense and well-made. All 12 of the bricks were struck along the long axis of the brick and nearly all the specimens have one or more lips resulting from the strikes. In terms of length, these bricks range in size from 19.3 to 21 cm (7 5/8 to 8 1/4 inches). Brick width ranged from 9 to 10.2 cm (3 5/8 to 4 inches). Thickness ranged from 5.6 to 6.2 cm (2 1/4 to 2 3/8 inches). Colors for the plain soft-mud bricks include dark reddish brown (n=9) and medium reddish brown (n=3). They all have a sandy texture indicating sand was used to lubricate the brick molds. All specimens had various amounts of mortar on them indicating that they were used in construction projects at the brick yard. In fact, some of these specimens were recovered from brick walls.

One specimen (A-5) had shallow depressions on both edges revealing how the bricks were stacked in the kiln prior to firing. These depressions show the bricks were placed on edge in a parallel (length-wise) configuration where the bricks overlap with those on the lower course. This specimen is also unusual in shape, being somewhat wedge-shaped. This over-fired brick is 20 cm (7 7/8 inches) long and 5.6 cm (2 1/4 inches) thick. The width is 7 cm (2 3/4 inches) on the narrow end and 9.3 cm (3 11/16) on the wide end. It is not known whether this specimen was intentional made as a wedge or was distorted in the kiln from excessive heat and weight.

The plain soft-mud bricks were well-made with few flaws. Only three bricks had any cracking, one was slightly warped, and only one had glazing from the firing process. No accidental imprints were observed on the sample. Unlike much of the study sample as a whole, most these bricks were not rejects or modern discards. They were good quality bricks that were used for construction projects at the brick yard. It is not known whether they were acquired from another source to get the brick yard started or if they were made by the Paducah Brick and Tile Company.

Bricks With C & M Brand

Several bricks fragments with the C & M brand were located in Area M. Two specimens were selected for analysis from Area M (Figure 8) and one specimen was recovered from the adjacent clay pit. These broken bricks are 11 to 12 cm (4 1/4 inches) long. In terms of other measurements, their width ranges between 9 and 10 cm (3 2 and 4 inches) and their thickness is 5.7 to 6.4 cm (2 1/4

Table 2. Soft-Mud Building Brick Measurements and Degree of Firing for the Paducah Brick and Tile Company Sample.

Specimen No.	Firing	Length-Cm	Length-Inches	Width-Cm	Width-Inches	Thickness-Cm	Thickness-Inches
A-1	WF	20.3	8	9.8	3 7/8	5.8	2 1/4
A-2	WF	19.3	7 5/8	9.3	3 5/8	5.6	2 1/4
A-3	WF	20.3	8	9.8	3 7/8	5.8	2 1/4
A-4	WF	20.3	8	9.8	3 7/8	5.8	2 1/4
A-5	OF	20	7 7/8	9.3	3 11/16	5.6	2 1/4
B-1	WF	20.7	8 1/8	9.7	3 7/8	5.7	2 1/4
D-1	WF	20	7 7/8	9	3 9/16	5.6	2 1/4
F-1	WF	21	8 1/4	10.2	4	6	2 3/8
F-2	WF	21	8 1/4	10.2	4	6.2	2 3/8
F-3	WF	21	8 1/4	9.7	3 7/8	5.7	2 1/4
F-4	WF	20	7 7/8	9	3 9/16	5.7	2 1/4
I-5	OF	19.7	7 7/8	9.3	3 5/8	5.7	2 1/4
J-1	WF	17.5	7	9.6	3 7/8	5.7	2 2/4
J-2	WF	18	7 1/8	9.6	3 7/8	5.7	2 1/4
J-3	WF	18	7 1/8	9.6	3 7/8	5.7	2 2/4
J-4	WF	18	7 1/8	9.6	3 7/8	5.7	2 1/4
M-1	WF	11*	4 1/4*	9.5	3 3/4	6.4	2 ½
M-2	OF	11*	4 1/4*	9	3 ½	5.7	2 1/4
Clay Pit	WF	12*	4 3/4*	10	3 7/8	5.9	2 5/16

Key: WF = Well Fired
OF = Over Fired
* = Broken

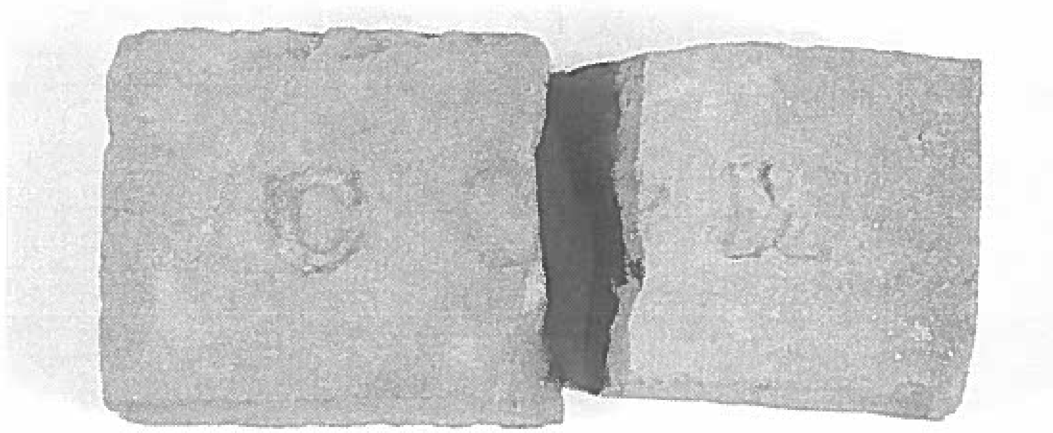


Figure 8. Two Fragments of C & M Brand Soft-Mud Bricks From 15 McN114. The specimen on the left has the "C &" while the specimen on the right has the "M".

Figure 9. Two Soft-Mud Cornice Bricks From 15 McN114. The upper specimen shows the sandy surface opposite the strike while the lower specimen shows the struck surface.

to 2 ½ inches). They were struck across the short axis of the brick and two of the specimens have lips. In term of texture, they are sandy. Two bricks are dark reddish brown and one is medium reddish brown. One fragment has a "C &" and two portions have a "M". The letter height in the brand name ranges from 2.5 to 2.8 cm (1 to 1 1/8 inches) and letter width ranges from 2.5 to 3 cm (1 to 1 3/16 inches). These bricks broke during the firing process or sometime prior to sale.

The junior author has found a number of these bricks in Paducah. A complete specimen that he found is 20.7 cm (8 3/8 inches), 10 cm (3 7/8 inches) wide, and 6.4 cm (2 2 inches) thick. It is dark reddish brown with a sandy texture. This well-fired brick was struck along its short axis. The "C & M" brand has letters 3.5 cm (1 3/8 inches) high, 2.5 to 3.5 cm (1 to 1 3/8 inches) wide, and 5-6 mm (1/4 inch) deep.

In addition, the junior author has also found a different type of brick in Paducah with the "C & M" brand name. These incomplete bricks are whitish to yellowish in color. The exposed interior of one of these specimens revealed coarse paste with white inclusions. They appear to be a type of fire brick. The longest of the four broken bricks examined were 16 to 17 cm (6 1/4 to 6 3/4 inches) long. In terms of other measurements, their width ranges between 9.4 and 10 cm (3 11/16 and 4 inches) and their thickness is 6 to 6.7 cm (2 3/8 to 2 5/8 inches). The "C & M" brand has letters 2.5 cm to 2.7 (ca. 1 inch) high and 2.5 to 3 cm (1 to 1 3/16 inches) wide. These well-fired bricks were struck along their short axis. The "C & M" brand name has a very limited date range. The company only operated as the Chamblin and Murray Brick Yard between 1897 and 1906.

Four soft-mud cornice bricks were recovered from Area J (Figure 9). These bricks may have been a specialty item at the brick yard but it is more likely that they were dumped there later. They are similar but not identical to specimen # 56 in the 1894 Don Valley Pressed Bricks Works catalogue (Bacso 1977:37). These bricks were made in a special mold that had a point comprised of two 45 degree angles. The point has different lengths on each side. On one side the angle starts at 14.5 cm (5 3/4 inches) from the normal end and on the other side it starts 11 cm (4 1/4 inches) from the end. The actual point is 5 cm (2 inches) on the short side and ca. 9.5 cm (4 1/4 inches) on the longer side. These bricks are very close in size; 17.5 to 18 cm (7 to 7 1/8 inches) long, 9.6 cm (3 7/8 inches) wide, and 5.7 cm (2 1/4 inches) thick. They all have a sandy texture, even on the pointed portion. Three of the specimens have one or two lines across the short axis of the struck surface. It not known whether these are cross-wise stacking patterns or where the strike momentarily stopped.

Stiff-Mud Bricks

Stiff-mud bricks were produced by machines that extruded a continuous stiff column of clay, which was cut into individual bricks by wires stretched over a frame (Gurcke 1987:19-21). Bricks produced by this method have curved wire cut lines on the two cut faces. The cut surfaces may also have a wavy cut instead of being smooth. Also, these bricks frequently have holes produced by metal bars placed inside the machine or at a mouth piece. Stiff-mud brick machines were first introduced in the late 19th century. In a study of Knoxville machine made bricks, Greene (1992:90) suggests a tentative date range of 1888 to 1905/1910 for end-cut stiff-mud bricks. Side-cut machine made bricks were tentatively dated from 1905/1910 to the present (Greene 1992:90). Sometime prior to 1930, brick manufacturers were putting three holes into stiff-mud bricks (Kenyon 1930:524). During 1930, H. H. Kenyon (1930:524,536) wrote a very convincing article in a trade journal discussing the advantages of producing bricks with three holes. Among the many advantages listed were a reduction in the use of raw materials, a reduction in brick weight, savings in transportation costs, and a cheaper product for the consumer (Kenyon 1930:524,536). The exact date of when the 10-hole brick was introduced is not known but retired brick layer Kenneth Goin (personal communication, 1996) thought that they were being produced prior to World War II. The 10-hole brick resulted in additional savings in materials and shipping costs. Thirty stiff-mud bricks were collected representing several types (Table 1). The stiff-mud bricks probably represent the last brick manufactured at the brick yard. These specimens are discussed separately as solid and perforated.

Solid Stiff-Mud Bricks

Solid stiff-mud bricks were produced at the brick yard after the company switched to a stiff-mud machine with a wire cutter. Bricks produced by this technology are solid with fine lines (circular or straight) on both wire cut surfaces. The solid stiff-mud bricks are the earliest wire-cut type (Figure 10). Eighteen of these bricks were collected for analysis from Areas B, C, D, E, F, and I (Table 3). A modern stiff-mud brick is also included at the end of this section. Fifteen were over-fired while three were well-fired. This is not surprising for a brick yard site since the well fired specimens would be sold while over-fired specimens would be used at the brick yard or discarded. In terms of length, these bricks range in size from 19.5 cm (7 5/8 inches) to 21.5 cm (8 ½ inches). Seven of these bricks were 8 inches long. Brick width ranged from 9 cm (3 5/8 inches) to 10.7 inches (4 1/4 inches). Thickness ranged from 5.6 cm (2 1/4 inches) to 6.3 cm (8 ½ inches). Color ranges for the solid stiff-mud bricks include dark reddish brown (n=7), medium reddish brown (n=4), light reddish brown (n=5), and dark gray (n=2). Their smooth texture suggests that water was used to prevent them from sticking. A majority of these (n=12) have various amounts of mortar on them suggesting that they were used in kilns and other structures at the brick yard.

Six specimens had shallow depressions revealing how they were stacked in the kiln prior to firing. After firing, the depressions (that show the outline of adjacent bricks that sank into them) are permanently recorded in the finished bricks. These depressions are of interest because they show the orientation and spacing of the bricks, as they were stacked in the kiln. This patterning may be further illustrated by adhering portions of adjacent bricks that fused to other bricks during the firing process. There were four examples of such fusing in the present sample. Of the specimens with depressions, three were stacked on edge at a 90 degree angle (cross-wise) to those bricks on the lower course. Two specimens were placed on edge in a parallel (length-wise) configuration where the bricks overlap with those on the lower course. One specimen, was half-way (diagonal) between the 90 degree angle and the parallel configuration. The specimens with portions of fused bricks include two that were length-wise and two that were diagonal. Another five bricks revealed the stacking patterns by glazing in the spaces between bricks in the kiln. The glazing patterns indicate that three were cross-wise stacking, one length-wise stacking, and one diagonal stacking. Spacing between the bricks in the kiln ranged between 1.3 and 3.7 cm (2 and 1 2 inches).

The solid stiff-mud brick sample also includes information on flaws and accidental imprints. Since most of these bricks were rejects, flaws are common. Eleven of the specimens have varying degrees of warping from over-firing (Figure 11). Cracks are present on 10 specimens. Glazing is present on 13 specimens (dark gray, etc.). Warping, cracking, and glazing commonly co-occur on over-fired bricks. The only imprints noted on these specimens were fabric impressions on the bottom. The fabric impression is probably from the texture of the conveyor belt that moved the freshly cut bricks.

Figure 10. Solid Stiff-mud Brick From 15McN114.

Figure 11. Solid Stiff-Mud Bricks From 15McN114 Which Are Rejects (Specimens D-4 and D-2).

Table 3. Solid Stiff-Mud Brick Measurements and Degree of Firing for the Paducah Brick and Tile Company.

Specimen No.	Firing	Length-Cm	Length-Inches	Width-Cm	Width-Inches	Thickness-Cm	Thickness-Inches
B-2	OF	20.2	8	9	3 5/8	5.8	2 1/4
B-3	OF	19.8	7 3/4	9.7	3 7/8	5.7	2 1/4
C-1	OF	20.3	8	9.7	3 3/8	5.7	2 1/4
C-2	OF	20.3	8	10	4	5.7	2 1/4
C-3	OF	20.5	8	10.2	4	5.7	2 1/4
C-4	OF	20.3	8	10.2	4	5.7	2 1/4
D-2	OF	19.5	7 5/8	9.5	3 3/4	5.7	2 1/4
D-3	OF	19.5	7 5/8	9	3 ½	5.7	2 1/4
D-4	OF	20.4	8	9	3 ½	5.8	2 1/4
D-5	OF	21.5	8 ½	10	4	5.7	2 1/4
E-1	OF	19.5	7 5/8	9.5	3 3/4	5.7	2 1/4
E-2	OF	20	7 7/8	9	3 5/8	5.6	2 1/4
E-3	OF	19.7	7 3/4	9	3 ½	5.7	2 1/4
F-5	WF	20	7 7/8	9.3	3 5/8	5.7	2 1/4
I-1	WF	21.2	8 3/8	10.7	4 1/4	6.3	2 ½
I-2	WF	21.2	8 3/8	10.7	4 1/4	6.3	2 ½
I-3	OF	20.8	8 1/4	10.4	4 1/8	6.3	2 ½
I-4	OF	20.2	8	9.5	3 3/4	6.2	2 ½

Key:

OF = Over Fired
WF = Well Fired

A modern stiff-mud brick was recovered from Area K. Specimen K-12 is a light yellowish brown specimen that is over sized. It is 29.6 cm (11 3/4 inches) long, 9 cm (3 ½ inches) wide, and 4 cm (1 ½ inches) thick. One face is very smooth with a 7 mm (5/16 inch) wide raised area (broken) running the length of the brick. The remaining three surfaces have wire-cut lines. It is probably used in connection with the 14-hole bricks. .

Perforated Stiff-Mud Bricks

Eleven modern stiff-mud bricks with perforations were recovered from Areas K and L (Table 4). They appear to be excess bricks from jobs that were dumped by contractors sometime after the brick yard closed. The sample is small but very diverse. These include one 2-hole type, four 3-hole bricks, one 5-hole type, three 10-hole type, and two 14-hole type. Some of the specimens have smearing of clay over the edges of the holes. They have a variety of different finishes and textures. These specimens will be discussed in the following paragraphs.

The 2-hole brick is probably an early version of a perforated brick (Figure 12). This dark reddish brown specimen (L-7) is 20.3 cm (8 inches) long, 9 cm (3 ½ inches) wide, and 5.4 cm (2 1/8 inches) thick. The texture is very sandy except for the two sides that were cut by wire. The two round holes are 1.6 cm (5/8 inches) in diameter. The holes are 5.6 cm (2 1/4 inches) apart in a straight line and 5 to 5.5 cm (2 to 2 3/16 inches) from the edge of the brick. This is a well-fired brick with no obvious flaws or other markings. It has mortar on three surfaces indicating that is probably from a demolition project and was dumped at the site in Area L.

The four 3-hole stiff-mud bricks from Area K represent different styles (Figure 13). Specimen K-8 is a dark reddish brown brick with three round holes in a straight line (Figure 12). The end holes are 2.6 cm (1 inch) in diameter while the middle hole is 2.2 cm (7/8 inch) in diameter. The holes are 2.5 cm (1 inch) apart. This well-fired brick has a textured surface on one side and the two ends. The texture is comprised of long narrow strips of clay adhering to the brick in a horizontal pattern (Figure 13, upper middle). Specimen K-9 is a light yellow brick with three round holes in a line. The holes are all 2.7 cm (1 1/16 inches) in diameter and 2 cm (13/16 inch) apart. The side and both ends of the brick are textured with a series of shallow pits in a random configuration (Figure 13, lower middle). A fabric impression from a conveyor belt is visible on the bottom of the brick. Specimen K-10 is a light yellow brick with three oval holes in a line. The holes are all 2.8 x 3.1 cm (1 1/8 x 1 1/4 inches) in size and 1.5 cm (5/8 inches) apart. The side and both ends of the brick are textured with a series of shallow vertical lines (made by nails) in a parallel configuration (Figure 13, bottom). The lines are 1-2 cm (3/8 to 3/4 inches) apart. Finally, specimen K-11 is a light yellowish brown brick with three round holes in a line. The holes are all 2.9 cm (1 1/8 inches) in diameter and 1.7 to 1.8 cm (ca. 11/16 inch) apart. The side and both ends of the brick are textured with a series of vertical lines in a parallel configuration (Figure 13, upper). The lines are 2 to 5 cm (3/4 to 2 inches) apart, 1 mm wide (7/16 inch), and ca. 1.5 mm (5/8 inch) deep. These bricks have the following size ranges: 19.2 to 20.3 cm (7 ½ to 8 inches) in length, 8.8 to 9.5 cm (3 ½ to 3 3/4 inches) in width, and 5.4 to 5.7 cm (2 1/8 to 2 1/4 inches) thick (Table 4).

One 5-hole brick was recovered from Area K (Figure 14). This light reddish brown brick has five rectangular holes in a straight line. The holes are 2 cm (3/4 inches) wide, 4.3 cm (1 5/8 inches) long and are ca. 1.6 (5/8 inches) apart. The brick is 19.8 cm (7 7/8 inches) long, 9.3 cm (3 3/4 inches) wide, and 5.7 cm (2 1/4 inches) thick. Since only one specimen (K-7) of this type was found at the brick yard, it appears that to be a modern discard.

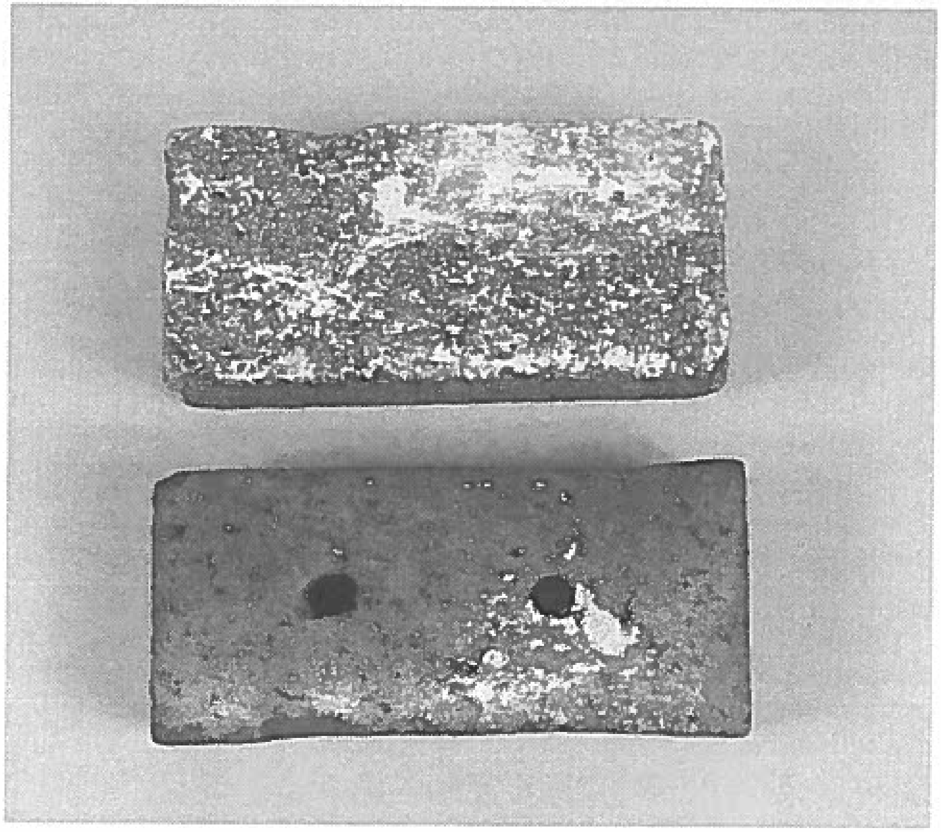


Figure 12. Concrete Brick (upper) and Two-Hole Stiff-Mud Brick (Lower) From 15McN114 (Specimens L-8 and L-7).

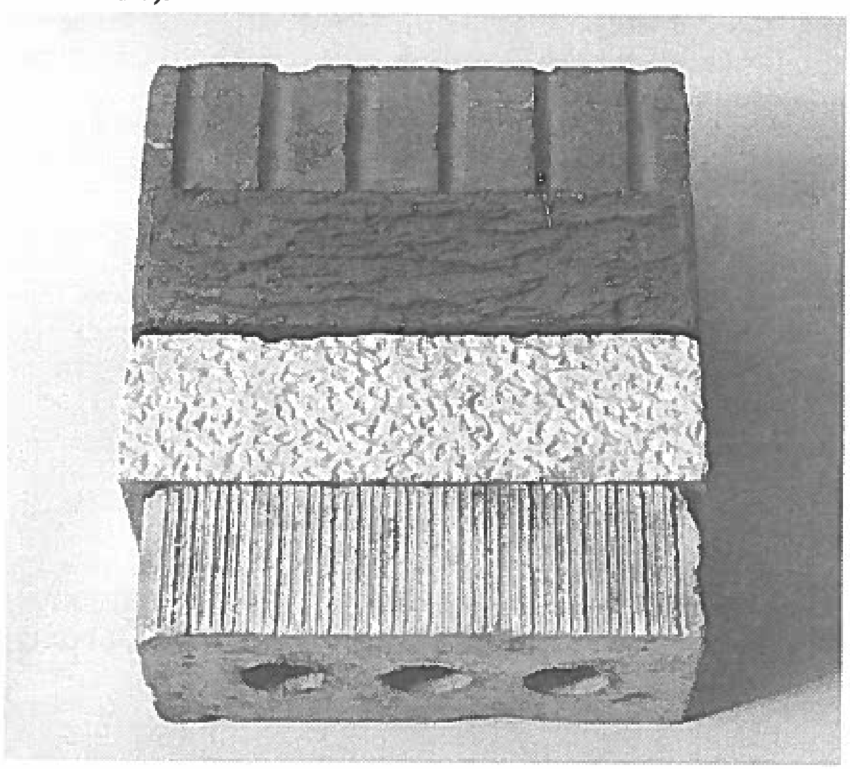


Figure 13. Four Different Types of Finishes on Three-Hole Stiff-Mud Bricks From 15McN114 (Specimens K-11, K-8, K-9, and K-10).

Table 4. Measurements and Other Information for the Modern Wire-Cut and Pressed Bricks Discarded at the Paducah Brick and Tile Company Site.

Specimen Number	Type	Length Cm	Length Inches	Width Cm	Width Inches	Thickness Cm	Thickness Inches	No. of Holes	Hole Shape	Hole Size Cm	Color	Texture
J-5	Pressed	20.9	8 1/8	10.4	4 1/8	5.7	2 1/4	0	NA	NA	YB	None
K-1	WC	29.5	11 5/8	9.2	3 5/8	9.2	3 5/8	14	Oval	1.9 x 2.5	MAB	None
K-2	WC	29.1	11 ½	8.5	3 3/8	6.9	2 11/16	14	Oval	1.8 x 2.3	MRB	None
K-3	WC	20.2	8	9.1	3 5/8	5.7	2 1/4	10	Round	1.9	MRB	BG
K-4	WC	20.3	8	9.5	3 3/4	5.7	2 1/4	10	R & S	1.8	DRB	BG
K-5	WC	20.5	8 1/8	9.4	3 3/4	5.7	2 1/4	10	Round	1.7	DRB	BG
K-6	Pressed	20	7 7/8	9.3	3 3/4	5.7	2 1/4	0	NA	NA	DRB	None
K-7	WC	19.8	7 7/8	9.3	3 3/4	5.7	2 1/4	5	RE	2 x 4.3	LRB	None
K-8	WC	20.3	8	9.5	3 3/4	5.7	2 1/4	3	Round	2.6	DRB	ST
K-9	WC	20.3	8	9	3 ½	5.7	2 1/4	3	Round	2.7	LY	PS
K-10	WC	19.5	7 3/4	9	3 ½	5.5	2 3/16	3	Oval	2.8 x 3	LY	FL
K-11	WC	19.2	7 ½	8.8	3 ½	5.4	2 1/8	3	Round	2.9	LY	FL
K-12	WC	29.6	11 3/4	9	3 ½	4	1 ½	0	NA	NA	LY	None
L-7	WC	20.3	8	9	3 ½	5.4	2 1/8	2	Round	1.6	DRB	SA

Key: Wc=Wire-cut, NA=Not Applicable, R & S= both Round and Square Holes, RE= Rectangular Holes, YB= Yellowish Brown, MRB= Medium Reddish Brown, DRB= Dark Reddish Brown, LRB= Light Reddish Brown, LY= Light Yellow, BG= Big Grooves, ST= Strips of Clay, PS= Pitted Surface, FL= Fine Incised Lines, and, SA= Sandy.

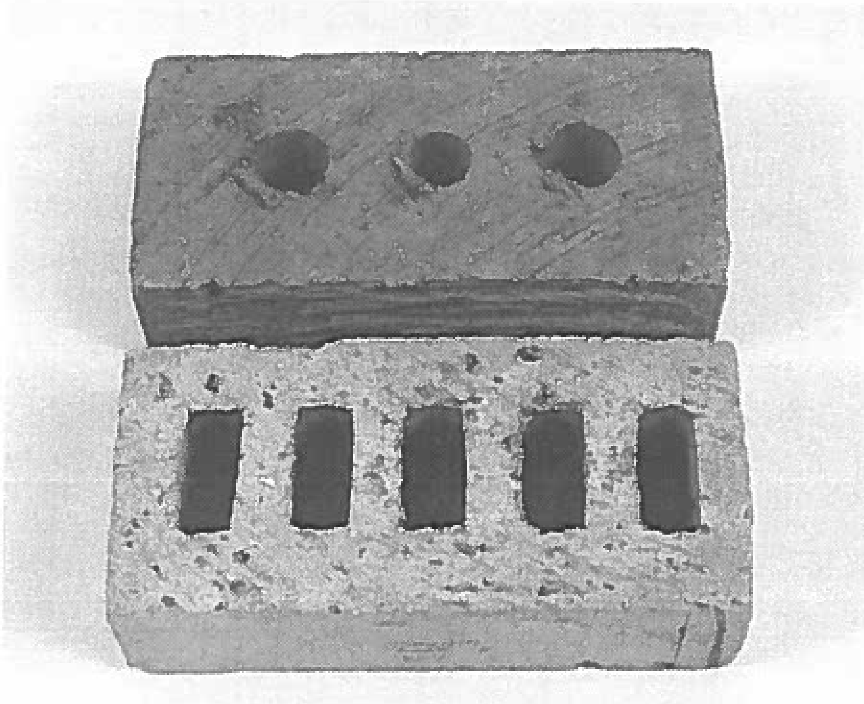


Figure 14. Three-Hole Stiff-Mud Brick (Upper) and Five-Hole Stiff-Mud Brick (Lower) From 15McN114 (Specimens K-8 and K-7).

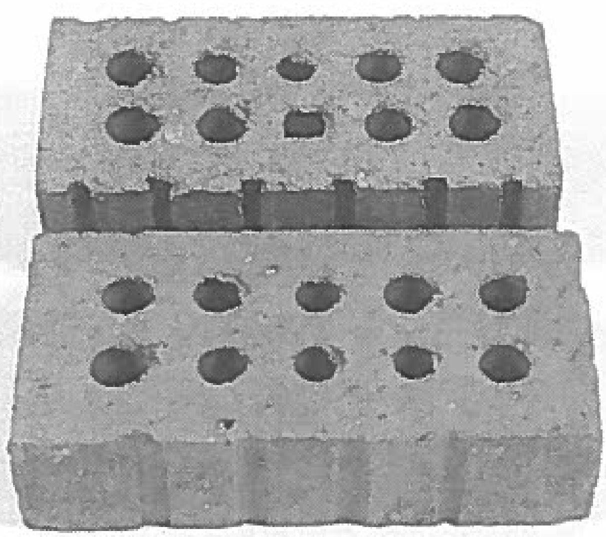


Figure 15. Two Ten-Hole Stiff-Mud Bricks From 15McN114 (Specimens K-4 and K-5).

Three 10-hole stiff-mud bricks were collected from Area K (Figure 15). Specimen K-3 is a medium reddish brown brick with ten round holes organized in two parallel straight lines. All the holes are 1.9 cm (3/4 inches) in diameter and are spaced ca. 1.3 cm (1/2 inches) apart. This well-fired brick has a sandy texture on one side and both ends. The opposite side has six vertical grooves spaced across it. The grooves are 1 cm (7/16) wide, 5.7 cm (2 1/4 inches) long, 4 mm (3/16 inch) deep, and 2 to 2.5 cm (3/4 to 1 inch) apart. Specimen K-4 is a dark reddish brown brick with ten holes in two parallel straight lines. Eight of the nine round holes are 1.8 cm (3/4 inch) in diameter and one central hole is 1.5 cm (5/8 inches) in diameter (Figure 15, top). The tenth hole, in the center, is square (1.5 x 1.5 cm, 5/8 x 5/8 inches). The holes are spaced ca. 1.3 cm (2 inches) apart. All sides but one side are wire cut. The remaining side has six grooves. The grooves have a rectangular profile, are spaced 2 to 2.8 cm (3/4 to 1 3/16 inches) apart, 8 mm (5/16 inch) wide, 8 mm (5/16 inch) deep, and 5.7 cm (2 1/4 inches) long. Specimen K-5 is a dark reddish brown brick with ten holes in two parallel straight lines (Figure 15, bottom). The round holes are 1.7 cm (11/16 inches) in diameter and spaced ca. 1.4 cm (9/16 inches) apart. One side and the ends have a sandy texture. The remaining side has four grooves. The grooves have a rectangular profile, are spaced 2.3 to 4.5 cm (7/8 to 1 7/8 inches) apart, 1 cm (3/8 inch) wide, 3 mm (1/8 inch) deep, and 5.7 cm (2 1/4 inches long). These bricks have the following size ranges: 20.2 to 20.5 cm (8 to 8 1/8 inches) in length, 9.1 to 9.5 cm (3 5/8 to 3 3/4 inches) in width, and 5.7 cm (2 1/4 inches) thick (Table 4).

Two 14-hole stiff-mud bricks were collected from Area K. Specimen K-1 is a medium reddish brown brick with 14 oval holes organized in two parallel straight lines (Figure 16, upper). All the holes are 1.9 x 2.5 cm (3/4 x 1 inch) in size and are spaced ca. 1.3 cm (1/2 inches) apart. The ends and sides of this specimen have a sandy texture. Specimen K-2 is also a medium reddish brown brick with 14 oval holes organized in two parallel straight lines (Figure 16, lower). All the holes are 1.8 x 2.3 cm (3/4 x 7/8 inches) in size and are spaced ca. 1.1 to 1.3 cm (7/16 to ½ inches) apart. The ends and sides of this specimen have a sandy texture. These bricks are very similar but are different sizes. Specimen K-1 is 29.5 cm (11 5/8 inches) long, 9.2 cm (3 5/8 inches) wide, and 9.2 cm (3 5/8 inches) thick. This size brick is called a "utility" brick in the Belden Brick Company's (n.d.) modern catalogue (n.d.:18). Specimen K-2 is 29.1 cm (11 ½ inches) long, 8.5 cm (3 3/8 inches) wide, and 6.9 cm (2 11/16 inches) thick.

Pressed Bricks

Pressed bricks or dry-pressed bricks were made from clay containing only up to 10 % water (Gurcke 1987:22). They are formed with great pressure, usually from above and below, in steel molds (Gurcke 1987:22). Gurcke (1987:22-23) described the process as follows:

> There are three types of dry presses: the mechanical toggle press, the hydraulic press, and the screw press. The operating cycle for all three is relatively simple and quite similar. First a tray containing clay moves over the molds and drops clay into them. After the tray has moved back, the top ram descends and compresses the clay, while the bottom ram remains stationary. This process is then reversed, so that the clay is compressed from both the top and the bottom. Next, both rams ascend. And the tray that is moved forward to refill the molds pushes the formed brick out of the way. The process is then repeated. Dry presses differ mainly in the manner in which pressure is generated. The toggle press is widely used today, while the hydraulic press was important in the past. A typical brick press with a four-compartment mold can make approximately 2,000 bricks per hour.

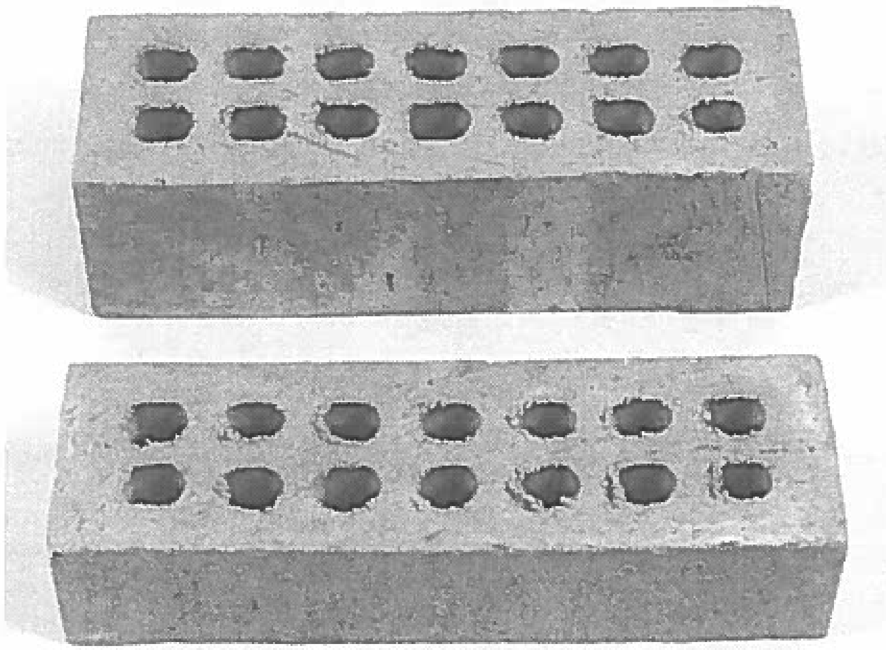


Figure 16. Two 14-Hole Stiff-Mud Bricks From 15McN114 (Specimens K-1 and K-2).

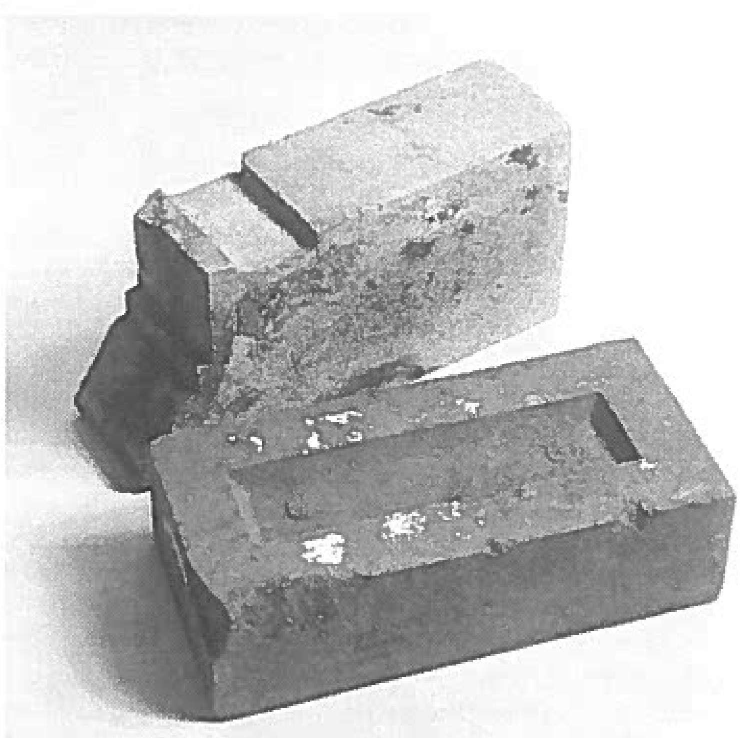


Figure 17. Pressed Bricks From 15McN114: Upper, Molded Cornice Brick (Specimen J-5) and Lower, Building Brick With Frog (Specimen E-4).

Two pressed bricks were recovered from Areas J and K of the site (Table 4). Specimen J-5 is a molded cornice brick (Figure 17, upper). This yellowish brown specimen is 20.9 cm (8 1/8 inches) long, 10.4 cm (4 1/8 inches) wide, and 5.7 cm (2 1/4 inches) thick. It is designed with a very elaborate pattern on the end that protruded from the wall. The exposed portion is black, perhaps from a fire, while the sides had a red mortar.

Specimen K-6 is a dense well-made dark reddish brown building brick. It is 20 cm (7 7/8 inches) long, 9.3 cm (3 3/4 inches) wide, and 5.7 cm (2 1/4 inches) thick. This pressed brick has a frog on the top (Figure 17, lower). The frog is 4 cm (1 9/16 inches) wide, 15 cm (5 7/8 inches) long, and ca. 8 mm (3/16 inch) deep. The sides of the frog taper inward and two screw head impressions (1.3 cm, ½ inch across) are present in the bottom of the frog. On the opposite side of Specimen K-6 are four raised ovals (ca. 1.5 in diameter and 2 mm high) near the corners. Small amounts of white paint are present on the top, bottom, and one end. Both specimens are more expensive type bricks that would have been used in more elaborate structures. These bricks are undoubted part of demolition debris dumped at the site.

Concrete Brick

A single example of a solid concrete brick was recovered from Area L (Table 1). This is a modern brick that was dumped at the brick yard (Figure 13). This specimen (L-8) is a standard size brick but is made of concrete rather than clay. The paste is comprised of very fine crushed stone and very small brown pebbles in a cement matrix. It is a light gray color. The specimen is 19.4 cm (7 5/8 inches) long, 9.1 cm (3 5/8 inches) wide, and 5.7 cm (2 1/4 inches) thick. It has no brand name or distinguishing marks. The presence of gray mortar and white paint on this specimen indicate that it was once in a wall.

The junior author is familiar with concrete bricks and knew George Katterjohn who operated a concrete block company in Paducah. Mr. Katterjohn, who died about 10 years ago, lived to be more than 90 years old. During the 1940s and 1950s, Katterjohn made concrete bricks known as "Katterblox." The concrete bricks were produced in a red color in the mid-1950s. The original Western Baptist Hospital in Paducah was built from these concrete bricks. These bricks were not perfect since they cracked and broke in walls and were difficult to match. This type of brick is making a come back today as supports for rebar in concrete footers of new buildings.

FIRE BRICKS

Fire bricks are specialized bricks made to withstand intense heat. They are made from special clays (fire and flint clays) and are usually larger than common bricks. The heat-resistant nature of these bricks permits their use in fire places, stove liners, and furnaces. They are used by many industries that convert raw materials into finished products with great heat (Havard 1912:10). Early fire brick were made by the soft-mud technique and have strike lines. Later fire bricks were manufactured by the stiff-mud and dry press methods. Usually, these bricks have a brand name on one face to identify their heat resistance qualities. The standard fire brick is rectangular but fire bricks can be made in hundreds of shapes and sizes to meet the needs of the client.

Fifteen fire bricks were recovered from the brick yard (Table 5). Fire bricks were used for fire proofing linings in the brick kilns and the engine house. These bricks are primarily dry pressed types but also include wire-cut stiff-mud specimens that were subsequently pressed to add the brand name.

Table 5. Measurements and Brands for the Fire Bricks Recovered at the Paducah Brick and Tile Company Site.

Specimen Number	Brand	Length Cm	Length Inches	Width Cm	Width Inches	Thickness Cm	Thickness Inches
B-4	L F B WKS LOUISVILLE	22.2	8 3/4	11	4 3/8	6.1	2 7/16
B-5	EVENS & HOWARD ST. LOUIS	22.4	8 7/8	10.2	4	6.2	2 7/16
B-6	EVENS & HOWARD ST. LOUIS	23	9	11	4 1/4	6.2	2 7/16
C-5	LFB Wks No 1	22.3	8 3/4	11.4	4 ½	6.1	2 7/16
D-6	None	21	8 1/4	10.4	4 1/8	5.7	2 1/4
D-7	L F B WKS LOUISVILLE	16.5*	6 ½*	10.7	4 1/4	6	2 3/8
D-8	LACLEDE ST LOUIS	22	8 5/8	22	8 5/8	6-7.7	2 3/8-3
E-4	L F B WKS LOUISVILLE	22.2	8 3/4	11	4 3/8	6.3	2 ½
E-5	LFB Wks No 1	22.2	8 3/8	11.2	4 ½	6.2	2 3/8
G-1	L F B WKS STANDARD	23.2	9 1/8	11.5	4 ½	6.4	2 ½
G-2	LFB Wks No 1	22.5	8 3/4	11.5	4 ½	6.3	2 ½
G-3	A. P. GREEN OZARK D.P.	22.3	8 3/4	11	4 5/16	6.1	2 3/8
G-4	CANNELTON	22.5	8 7/8	11.1	4 3/8	6.2	2 3/8
G-5	CANNELTON	22.7	9	11.1	4 3/8	6.2	2 3/8
L-6	MEXICO MO STANDARD	22.3	8 3/4	10.7	4 1/4	6	2 3/8

Key: * = Broken Specimen

The following brand names were recovered: L F B Wks/ LOUISVILLE, LFB WKS/ No 1, L F B WKS/ STANDARD, LACLEDE/ ST. LOUIS, EVENS & HOWARD/ ST. LOUIS, CANNELTON, A. P. GREEN/ OZARK D. P., and MEXICO MO/ STANDARD. The brand names are in recessed letters. These bricks were manufactured in Kentucky, Indiana, and Missouri. The following paragraphs discuss the recovered specimens by state and brand name.

Kentucky Fire Brick Brands

Three of the recovered brand names were produced by the Louisville Fire Brick Works in Louisville, Kentucky: L F B WKS/ LOUISVILLE, LFB Wks /No 1, and L F B WKS/ STANDARD. The Louisville Fire Bricks Works operated plants in Grahn (Carter County) and in Louisville (Jefferson County), Kentucky. During 1921, the Louisville plant was producing 50,000 9-inch (23 cm) bricks per day (Ries 1922:133) while the two plants at Grahn had the potential to produce a combined total of 60,000 9-inch bricks per day (Ries 1922:190). The Louisville plant ceased production in 1959 and currently serves as the sales office. The Grahn plant is still producing fire bricks. Unfortunately, specific production dates for the Louisville Fire Brick Works brands are not available since old records were discarded during a series of office moves (Bill Shuck, Louisville Fire Brick Works president, personal communication 1996). The current sample is described in the subsequent paragraphs.

Three **"L F B WKS/ LOUISVILLE"** fire bricks were recovered from Areas B, D, and E (Figure 18). These specimens (B-4, D-7, and E-4) have "L F B WKS" on the upper line and "LOUISVILLE" on the second line. The letters in the name are 2 to 2.2 cm (3/4 to 7/8 inch) high, 1.5 to 2 cm (9/16 to 3/4 inch) wide, and 5 mm to 2 cm (1/4 to 3/4 inch) apart. Two of these specimens retain the faint impression of the name plate outline. All three specimens are light yellowish brown color. The paste is a coarse yellow clay containing white inclusions. These bricks were machine pressed into shape. In terms of size, these specimens are 22.2 cm (8 3/4 inches) long, 10.7 to 11 cm (4 1/4 to 4 3/8 inches) wide, and 6 to 6.3 cm (2 3/8 to 2 ½ inches) thick. One specimen has slight glazing on one edge revealing a cross-wise stacking pattern was used in the kiln where it was fired. The L F B WKS/ LOUISVILLE brand was used by the Louisville Fire Brick Works in Louisville, Kentucky about 1935 (Gurcke 1987:260-261). The LOUISVILLE brand by Louisville Fire Brick Works has a date range between 1921 and 1942. The brand as a whole probably has a longer period of production. A 1910 catalogue by the Henry A. Petter Supply Company of Paducah indicates that the L F B WKS brand is much earlier than suggested by Gurcke (Petter 1910:297). The catalogue stated that "grade L. F. B. Wks. is somewhat smaller than the standard size brick, of the same material as the A grade" (Petter 1910:297). Further, "the A Brick will answer for ordinary heat exposures..." (Petter 1910:297).

Three **"L F B Wks/ No. 1"** fire bricks were recovered from Areas C, E, and G (Figure 19). These specimens (C-5, E-5, and G-2) have "L F B Wks" on the upper line and "No. 1" on the second line. The letters in the name are 2 cm (3/4 inch) high, 1.5 to 3 cm (9/16 to 1 3/16 inches) wide, and 6 mm to 1.1 cm (7/16 to ½ inch) apart. Two of the specimens have impressions of screw heads from the name plate. All three specimens are light yellowish brown color. They have a coarse yellow paste with white inclusions. These bricks were produced by a machine that pressed them into shape. They have the following size ranges: 22.2 to 22.5 cm (8 3/4 to 8 7/8 inches) long, 11.2 to 11.5 cm (4 ½ inches) wide, and 6.1 to 6.3 cm (2 7/16 to 2 ½ inches) thick. One specimen has slight glazing indicating a cross-wise stacking patterns in the kiln where it was fired. The L F B Wks/ No. 1 brand was made by the Louisville Fire Brick Works in Louisville, Kentucky. Gurcke (1987:258-261) listed ten different Louisville Fire Brick Works brands that contain "L F B Works" as the first part of the

Figure 18. Kentucky Fire Brick Brands From 15McN114: Upper, LFB WKS/STANDARD (Specimen G-11) and Lower, LFB WKS/LOUISVILLE (Specimen E-4).

Figure 19. Kentucky Fire Brick Brands From 15McN114: Two LFB WKS/No 1 (Specimen C-5 and E-5).

brand. The "No. 1" part of the brand was used by the Louisville Fire Brick Works between 1921 and 1927 (Gurcke 1987:272-273).

One **"L F B WKS/ STANDARD"** fire brick was recovered from Area G (Figure 18). This specimen (G-1) had "L F B WKS" on the upper line and "STANDARD" on the second line. The letters in the name are 1.7 cm (11/16 inch) high, 1.3 cm (2 inch) wide, and 1 to 1.5 cm (7/16 to 5/8 inch) apart. The impression of the top and bottom of the name plate is visible. This specimen is a light yellowish to reddish brown color. The paste is a coarse yellowish brown with white inclusions. This brick was produced by the dry press method. It has the following dimensions: 23.2 cm (9 1/8 inches) long, 11.5 cm (4 ½ inches) wide, and 6.4 cm (2 ½ inches) thick. Slight glazing is present on one edge indicating a cross-wise stacking patterns in the kiln where it was fired. The STANDARD brand was made by the Louisville Fire Brick Works in Louisville, Kentucky between 1921 and 1930 (Gurcke 1987:298-299). Judging from the drawings and information in the Henry A. Petter Supply Company catalogue, the STANDARD brand may refer to the standard size of the brick while the L. F. B. Wks. refers to the heat resistance (Petter 1910:297). The standard brick is shown as being 9 inches long, 4.5 inches wide and 2.5 inches thick (Petter 1910:297). The L. F. B. Wks. is shown as being 8.25 inches long, 4 inches wide and 2.25 inches thick (Petter 1910:297)

Missouri Fire Brick Brands

Five fire bricks made in Missouri by three companies were recovered. The four brands represented include A. P. GREEN/ OZARK D. P., EVENS & HOWARD/ ST. LOUIS, LACLEDE/ ST. LOUIS, and MEXICO MO/ STANDARD. These are discussed in detail below.

A single **"A. P. GREEN/ OZARK D. P."** brand was recovered from Area G (Figure 20). This specimen (G-3) has "A. P. GREEN "on the upper line and "OZARK D. P." on the second line. This pressed brick has rectangular name plate outlines around each line of the brand name. The letters in the name are 2 cm (3/4 inch) high, 1.2 cm (1/2 inch) wide, and 1.1 to 2 cm (2 to 3/4 inch) apart. This light yellowish brown brick has a coarse paste with white inclusions. It was produced by a press. This specimen is 22.3 cm (8 3/4 inches) long, 11 cm (4 5/16 inches) wide, and 6.1 cm (2 3/8 inches) thick. On one side it has alternating strips of red glazing indicating a cross-wise stacking pattern in the kiln where it was fired. Gurcke (1987:278-279) stated that the A. P. Green Fire Brick Company of Missouri produced the Ozark brand between 1927 and 1942. The D. P. brand was produced by A. P. Green Fire Brick Company between 1920 and 1923 (Gurcke 1987:228-229). Since the date ranges are different, the date of the two brands combined is unknown.

Two **"EVENS & HOWARD/ ST. LOUIS"** brand fire bricks were collected from Area B (Figure 21). These specimens (B-5 and B-6) have "EVENS & HOWARD" on the upper line and "ST. LOUIS" on the second line. One specimen has the clear outline of a name plate around the whole name and the two screw impression is also visible. The letters in the name are 1.5 to 1.6 cm (ca. 5/8 inch) high, 1 to 1.5 cm (3/8 to 5/8 inch) wide, 3 to 7 mm (1/8 to 1/4 inch) apart, and 1 to 3 mm deep (1/16 to 1/8 inch). A single specimen is light to medium yellow while the other brick is light orange (burned in kiln). These bricks have a coarse yellow paste with white inclusions. They were produced by the stiff-mud process and had the brand name repressed. These specimens are 22.4 to 23 cm (8 7/8 to 9 inches) long, 10.2 to 11 cm (4 to 4 1/4 inches) wide, and 6.2 cm (2 7/16 inches) thick. One specimen has slight discoloration indicating a cross-wise and diagonal stacking patterns in the kiln where it was fired. The EVENS & HOWARD/ ST. LOUIS brand was used by the Evens & Howard Fire Brick Company in Missouri between 1857 and 1930 (Gurcke 1987:232-233).

Figure 20. Missouri Fire Brick Brands: MEXICO MO./STANDARD (Specimen L-6) and A. P. GREEN/OZARK D. P. (Specimen G-3).

Figure 21. Missouri Fire Brick Brands From 15McN114: EVENS & HOWARD/ST. LOUIS (Specimen B-5).

A double fire brick marked **"LACLEDE/ ST. LOUIS"** was recovered from Area D (Figure 22). This specimen (D-8) has "LACLEDE" on the upper line and "ST. LOUIS" on the second line. The top of the name plate is visible. The letters in the name are 1.5 cm (5/8 inch) high, 1.5 cm (5/8 inch) wide, and 5 to 7 mm (ca. ¼ inch) apart. This light yellow to reddish brown (burned portion) was probably hand molded and wire-cut across the top. This specimen is 22 cm (8 5/8 inches) long, 22 cm (8 5/8 inches) wide, and 6 to 7.5 cm (2 3/8 to 3 inches) thick (wedge shaped in profile). Since this specimen had heavy burning and glazing, it was not possible to determine the method of manufacture. The LACLEDE/ ST. LOUIS brand was used by the Laclede-Christy Clay Products Company of St. Louis, Missouri between 1921 and 1942 (Gurcke 1987:258-259). This refractory block may have been used in a wall between firing tunnels since it is glazed on two edges. The red glazing is thick with holes in it.

A single **"MEXICO MO/ STANDARD"** brand was recovered from Area L (Figure 20). This specimen (L-6) has AMEXICO MO "on the upper line and ASTANDARD" on the second line. The "S" in standard is backwards. The letters in the name are 2 cm (3/4 inch) high, 1.5 cm (11/16 inch) wide, and 0.6 to 1 cm (1/4 to 7/16 inch) apart. This light reddish brown brick has a coarse yellowish brown paste with white and black inclusions. It was produced by the stiff-mud process and had the brand name pressed on. This specimen is 22.3 cm (8 3/4 inches) long, 10.7 cm (4 1/4 inches) wide, and 6 cm (2 3/8 inches) thick. On one side it has a narrow black glazed strip and also a portion of another brick fused to it indicating a cross-wise stacking pattern in the kiln where it was fired. The MEXICO MO brand was used by the A. P. Green Fire Brick Company of Missouri between 1919 and 1931 (Gurcke 1987:264-265). The STANDARD brand was used by the A. P. Green Fire Brick Company of Missouri between 1919 and 1931 (Gurcke 1987:298-299).

Indiana Fire Brick Brands

Two **"CANNELTON"** brand bricks (specimens G-4 and G-5) were recovered from Area G (Figure 23). These letters in the name are 2 to 2.2 cm (13/16 to 7/8 inch) high, 1.5 cm (5/8 inch) wide, and 5 to 8 mm (3/16 to 3/8 inch) apart. One specimen is light yellow while the other brick is light orange brown (burned in kiln). They have a coarse yellow paste with white inclusions. They were produced by the stiff-mud process and had the brand name repressed. These specimens are 22.5 to 22.7 cm (8 7/8 to 9 inches) long, 11.1 cm (4 3/8 inches) wide, and 6.2 cm (2 7/16 inches) thick. Both specimen have discoloration indicating a cross-wise stacking pattern in the kiln where they were fired. The CANNELTON brand was used by the Burns & Hancock Fire Brick & Clay Company in Indiana between 1930 and 1942 (Gurcke 1987:212-213).

Unmarked Fire Brick

One unmarked fire brick was recovered from Area D. This light yellowish brown brick has a coarse yellowish brown paste with white inclusions. It was produced by the dry press method but lacks a brand name. This specimen is 21 cm (8 1/4 inches) long, 10.4 cm (4 1/4 inches) wide, and 5.7 cm (2 1/4 inches) thick. It has some glazing from being used in a kiln at the brick yard. It is not possible to determine the manufacturer for this brick.

Fire Brick Discussion

Fire bricks had to be replaced periodically as the repeated firings broke them down. Thus,

Figure 22. Missouri Fire Brick Brands From 15McN114: LACLEDE/ST. LOUIS (Specimen D-8).

Figure 23. Indiana Fire Brick Brands From 15McN114: CANNELTON (Specimens G-4 and G-5).

different brands may represent various relining episodes as well as the construction of new kilns. With this question in mind, it is useful to examine the date ranges of the recovered bricks. Kentucky fire brick brands, produced by the Louisville Fire brick Works, occur at all the brick kilns (Areas B, C, D, and E) and the engine house (Area G). The brand LFB Wks/LOUISVILLE (1921-1942) was found in Areas B, D, and E while the LFB Wks./ No.1 (1921-1927) brand was found in Areas C, E, and G. The LFB WKS/STANDARD (1921-1930) was only found in Area G.

Missouri fire brick brands were found in areas B, C, D, G, and L and Indiana bricks in Area G. The EVENS & HOWARD/ST. LOUIS brand (ca. 1857-1930) was recovered from Areas B, D, and G. The LACEDE/ST. LOUIS brand (1921-1942) was only found in Area D while the A. P. GREEN/OZARK D P brand (1920 and 1942) was found in Area G. Finally, the MEXICO MO/STANDARD (1919-1931) was found only in Area L. The Indiana CANNELTON brand (1930-1942) was restricted to Area G.

When looking at the overlap of date ranges for the different fire brick brands, a cluster is evident. The date ranges are as follows: Area B, 1921-1930; Area C, 1921-1930; Area D, 1921-1930; and Area E, 1924-1927. It appears that the kilns were relined with new fire bricks sometime during the 1920s. The brick yard owners opted to purchase fire bricks from Kentucky and Missouri manufacturers. These fire bricks could have been easily transported from Louisville or St. Louis by barge or railroad.

The engine house has a more complex series of dates. The Kentucky brands overlap between 1921 and 1927 while the A. P. GREEN/OZARK D P is restricted to ca. 1920-1923. The EVENS & HOWARD brand goes out of production about 1930 while the CANNELTON brand starts in 1930. The engine house may have undergone repairs or expansions in the early 1920s using Kentucky and Missouri fire bricks. Around 1930 or later, the engine house may have experienced additional repairs with Missouri and Indiana fire bricks.

PAVING BRICKS

Paving bricks are large vitrified bricks, which were designed to withstand the weight and abrasion of traffic. They became a popular street paving material by the 1890s. To obtain the desired hardness and vitrification, ground shale was mixed with the clay used in these bricks. Most paving bricks (also called blocks) were produced by stiff-mud machines and were cut into individual bricks with wire cutters. They usually have distinctive circular wire cut lines on both faces. Most of the paving bricks were subsequently put into a press to imprint the brand name and form the lugs. Sometimes the repressing partially obliterated the wire cut lines. Consequently, these bricks exhibit characteristics of both wire cut and pressed bricks.

We don't know the year that the City of Paducah first began paving their streets with bricks. The 1905 *Report of Treasure and Auditor of the City of Paducah, Kentucky* (Paducah 1906:16) noted that:

> There has been stored on the city's property adjacent to the city's electric light plant 50,000 People's Paving Block, that were delivered here for the purpose of relaying the street between the rails on Broadway, which are now subject to your instructions.

Since Gurcke (1987) does not list a "People's Paving Block" it is undoubtedly a typographical error for Peebles Paving Block. The Peebles Paving Brick Company operated a plant in Lewis County, Kentucky (Hockensmith and Brown 2003; Ries 1922:210-212) and two plants in Portsmouth, Ohio (Blankenbecker 1995:71). The junior author has previously found this brand of paving brick in Paducah.

The 1906 *Report of Treasure and Auditor of the City of Paducah, Kentucky* includes a report by the City Engineer. The report mentioned that $54,250.08 was spent on 29,972.92 square yards of brick paving for Third Street from Kentucky Avenue to Fourth Street and Broadway (Paducah 1907:11). Further, the City Engineer (Paducah 1907:13) stated that:

> As I stated in the commencement of this report, we had at the close of the year 1905, 2.09 miles of brick streets. During the year there has been constructed and received 3,563.0 ft. of brick and 7,504.0 ft. of bitulithic, or 0.67 miles of brick and 1.42 miles of bitulithic; therefore, we have at the close of the year, 4.18 miles of reconstructed streets, (2.76 miles of brick and 1.42 miles bitulithic). This does not include that under construction, and which have not been accepted.

Many street paving bricks were located in the vicinity of the incline (Area L) and may have been recycled for the incline walls or just dumped there after the brick yard closed. A total of five paving bricks were selected to represent the range of variation from Area L (Table 6). Recovered brand names include "BANNON'S/BLOCK", "K.V.B.Co./ BLOCK", and ROBBINS PAVER. These specimens are discussed in the following paragraphs.

Two **"BANNON'S/ BLOCK"** paving bricks were selected for study (Figure 24). These specimens (L-1 and L-2) have "BANNON'S" on the upper line and "BLOCK" on the second line. The recessed letters forming the brand name are 1.8 cm (5/8 inches) high, 1.1 to 1.5 cm (1/2 to 5/8 inch) wide, 1.1 to 1.6 cm (1/2 to 5/8 inch) apart, and ca. 2 mm (ca. 3/32 inch) deep. Both specimens are a dark reddish brown color. They have a coarse reddish brown paste with large white and reddish brown inclusions. They were produced by the stiff-mud process and had the brand name repressed. No lugs are present on these specimens. These specimens are 22.3 to 22.4 cm (8 3/4 to 8 7/8 inches) long, ca. 9.4 to 9.8 cm (3 11/16 to 3 7/8 inches) wide, and 7.6 cm (3 inches) thick. Both specimens have discoloration indicating a cross-wise stacking pattern in the kiln where they were fired. These bricks were originally used as street pavers on edge as revealed by the edge wear. The traces of mortar on them could be associated with either street paving or secondary use in a wall. The BANNON'S/ BLOCK brand was made by the Patrick Bannon Company in Louisville, Kentucky. Jim Graves (1994) listed three variations of "BANNON BLOCK(S)" and two variations of "BANNON PAVER(S)". In 1895, Bannon began produced paving bricks at a new plant on Magnolia Avenue (Johnston 1896:522; Polk 1895:487). Patrick Bannon was also president and had a controlling interest in the Kentucky Vitrified Paving Brick Company, which was established in about 1892 (Consolidated Illustrating Company 1895:131-132). It is assumed that Bannon ceased production of their paving bricks prior to 1922 since Ries (1922) states that only one company in Lewis County was still producing paving bricks at that time.

One **K. V. B. Co./ BLOCK** paving brick was recovered (Figure 25). This specimen (L-5) has "K. V. B. Co." on the upper line and "BLOCK" on the second line. The recessed letters forming the brand name are 1.8 cm (ca. 5/8 inch) high, 1.2 cm (1/2 inch) wide, 1.1 cm (1/2 inch) apart, and ca. 2 mm (3/32 inch) deep. This specimen is dark reddish brown color. It has a coarse reddish brown paste with large white and reddish brown inclusions. This brick may be produced by the stiff-mud process and repressed with the brand name. It is so covered with glaze and mortar that the manufacturing technique is difficult to determine. No lugs are present on these specimens. This specimen is 23 cm (9 inches) long, 10.6 cm (4 1/8 inches) wide, and 7.3 cm (2 7/8 inches) thick. This brick was

Figure 24. BANNON'S BLOCK From 15McN114 (Specimen L-1).

Figure 25. K.V.B. Co. BLOCK From 15McN114 (Specimen L-5).

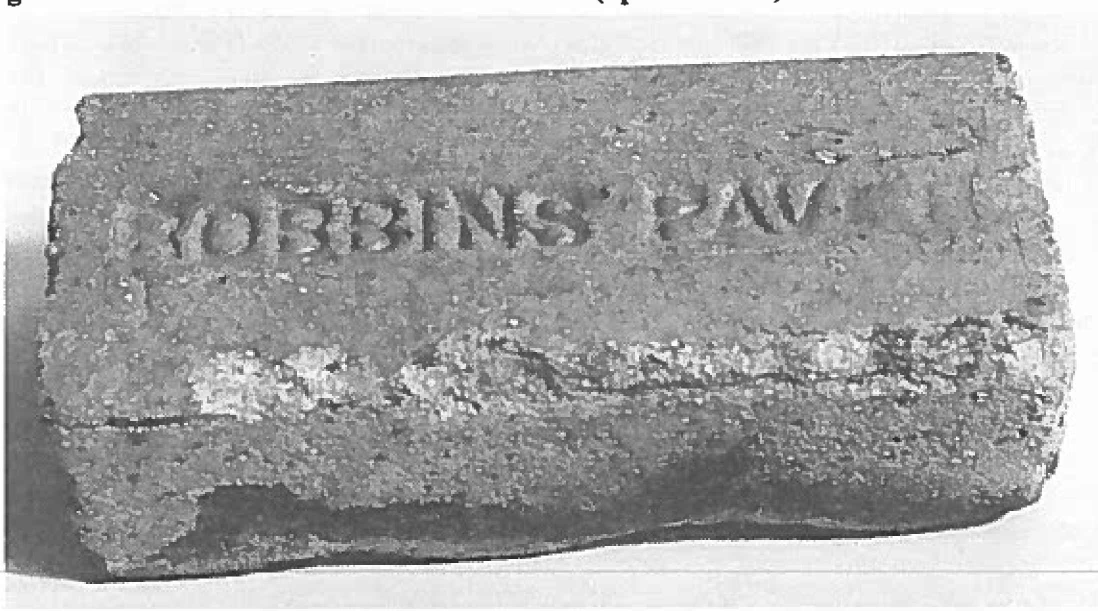


Figure 26. ROBBINS PAVER From 15McN114 (Specimen L-4).

Table 6. Measurements and Brands for the Paving Bricks Recovered at the Paducah Brick and Tile Company Site.

Specimen Number	Brand	Length		Width		Thickness	
		Cm	Inches	Cm	Inches	Cm	Inches
L-1	BANNON'S BLOCK	22.3	8 3/4	9.8	3 7/8	7.6	3
L-2	BANNON'S BLOCK	22.4	8 7/8	9.4	3 11/16	7.6	3
L-3	ROBBINS PAVER	22	8 11/16	10	4	6.1	2 7/16
L-4	ROBBINS PAVER	22	8 11/16	10	4	6.1	2 7/16
L-5	K.V.B.Co. BLOCK	23	9	10.6	4 1/8	7.3	2 7/8

originally made for use as street paver but does not have the normal edge wear. Mortar on this specimen suggest a secondary use, possibly a wall.

The K. V. B. Co./ BLOCK was produced by Kentucky Vitrified Paving Brick Company located at 13th and Lexington Streets in Louisville. Patrick Bannon was the president and had a controlling interest in the Kentucky Vitrified Paving Brick Company, which was established in about 1892 (Consolidated Illustrating Company 1895:131-132). The Kentucky Vitrified Paving Brick Company was listed in an ad for P. Bannon in the *Kentucky State Gazetteer and Business Directory, For 1896* (Polk 1895:487). It is assumed that Kentucky Vitrified Paving Brick Company ceased production of their paving bricks sometime prior to 1922 since Ries (1922) does not mention them.

Two **"ROBBINS PAVER"** paving bricks were selected for study (Figure 26). These specimens (L-3 and L-4) have the brand name in recessed letters across the center of the brick. The letters forming the brand name are 1.6 cm (ca. 5/8 inch) high, 1.1 cm (1/2 inch) wide, 4 mm (3/16 inch) apart, and ca. 3 mm (1/8 inch) deep. Both specimens are a medium reddish brown color. They have a light brown paste with white, black, and red inclusions. They were produced by the dry press method. No lugs are present on these specimens. These specimens are 22 cm (8 11/16 inches) long, ca. 10 cm (4 inches) wide, and 6.1 cm (2 7/16 inches) thick. One specimen has discoloration indicating a cross-wise stacking pattern in the kiln where it was fired. These bricks were originally used on edge as street pavers as revealed by the edge wear. Traces of mortar on them could be associated with either street paving or secondary use in a wall.

The ROBBINS PAVER was made either by the Tennessee Paving Brick Company or its successor the Southern Clay Manufacturing Company at Robbins, Tennessee (Des Jean 1995:2). Bricks were made at the Robbins, Tennessee plant between 1886 and 1937. The authors would suggest that the specimens found in Paducah would mostly date to the 1890s or early years of the 20th century. The junior author has observed that these smaller type ROBBINS PAVER bricks were used for paving side streets in Paducah while the larger pavers were used for main streets.

HOLLOW BLOCKS

Smith (1931:30) provided the following information on structural tile:

> Structural tile or hollow tile are hollow building units made from fired clay and are usually rectangular in cross-section and with one or more parallel cells. In recent years they have found an ever increasing use replacing backing brick foundations, floors, and walls, as fire-proofing inclosing steel framework, and as partitions in the interior of buildings.

The American Society for Testing Materials' 1930 standards (reproduced in Smith 1930:31) provided definitions for various types of hollow tile. These types include load-bearing wall tile, hollow floor tile, foundation tile, side-construction tile, end-construction tile, book-tile, salt-glazed tile, hollow tile fireproofing, split tile, partition tile, furring tile, and porous hollow tile (Smith 1931:31).

Smith (1931:32) provided a brief description of how structural tile was made:

> Structural tile are manufactured in much the same way as building brick. The clay is ground, screened, tempered, pugged, extruded by an auger-machine through a die that simultaneously forms the shell and webs, and wire-cut into the individual tile. The tile are commonly fired in round down-draft periodic kilns.

Seven hollow building blocks were recovered from the drying house (Area A) and the office (Area I). They were produced on a stiff-mud machine and wire cut to the desired length. They were found in small, medium, and large sizes. The following paragraphs described the collected samples.

Three large hollow building blocks were collected from Areas A and I (Figure 27). These unglazed specimens (A-6, I-6, and I-7) range from a light reddish brown to a dark reddish brown. These blocks range in length from 30.1 to 33 cm (11 7/8 to 13 inches) in length, 18.3 to 20 cm (7 1/8 to 7 3/4 inches) in width, and 9.6 to 10 cm (3 3/4 to 4 inches) thick (see Table 7). The two rectangular opening in the blocks ranged from 5.5 x 6.5 cm (2 1/8 x 2 2 inches) to 6.5 x 7 cm (2 9/16 x 2 3/4 inches). Outer wall thickness ranges from 2.2 to 2.5 cm (7/8 to 1 inch). The inner dividing walls ranged from 1.5 to 1.6 cm (5/8 inch) in thickness. The blocks were textured by broad shallow incised lines that were parallel the length of the specimens. One specimen had very distinct stacking impressions on both ends. This specimen revealed that the blocks were stacked on end and were stacked in an overlapping pattern. The same specimen had a piece of another hollow block fragment that fused to it during the firing process. Another specimen contained a belt fabric impression on it. The specimens exhibited different manufacturing flaws, which include gouged areas, cracking, and imperfect wire cutting. All the blocks retain some mortar where they had been laid into a wall.

Two medium size hollow building blocks were collected from Areas A and I (Figures 27 and 28). These unglazed specimens (A-7 and I-8) range from a light reddish brown to a dark reddish brown. These blocks range in length from 15.7 to 22.8 cm (6 1/4 to 7 1/8 inches) in length, 18.1 to 20 cm (7 1/8 to 7 3/4 inches) in width, and 9.3 to 10.4 cm (3 5/8 to 4 1/8 inches) thick (see Table 7). The two rectangular opening in the blocks ranged from 5.3 x 6 cm (2 x 2 5/16 inches) to 6.5 x 7 cm (2 9/16 x 2 3/4 inches). Outer wall thickness ranges from 2.0 to 2.3 cm (3/4 to 7/8 inch). The inner dividing walls ranged from 1.5 to 2 cm (5/8 to 3/4 inch) in thickness. The blocks were textured by shallow parallel incised lines the length of the specimens. In terms of flaws, one specimen was cracked and the other had the outer surface flaking off in layers. Both blocks have some mortar where they had been laid into a wall.

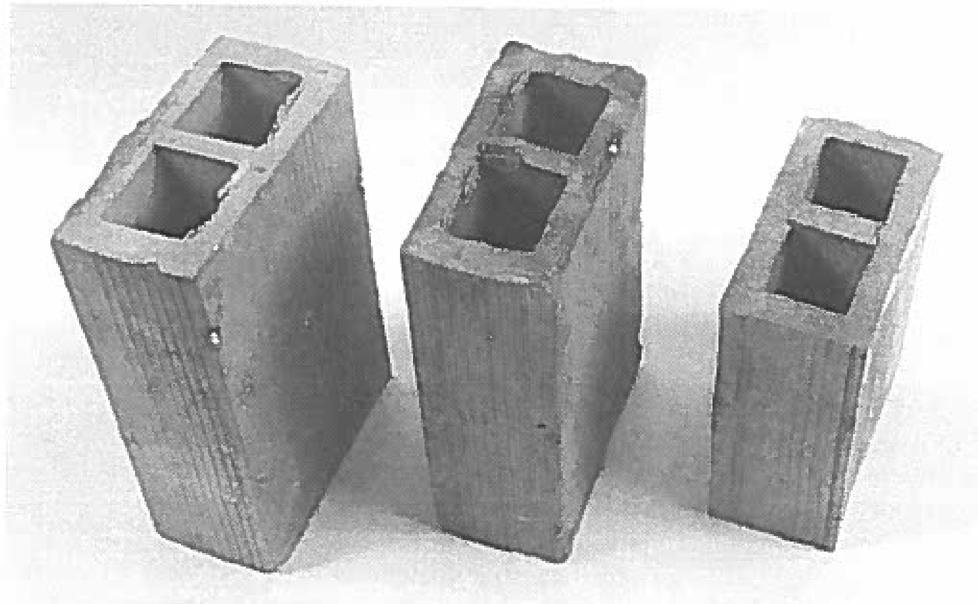


Figure 27. Large and Medium Sizes of Hollow Building Blocks (Specimens I-6, I-7, and I-8).

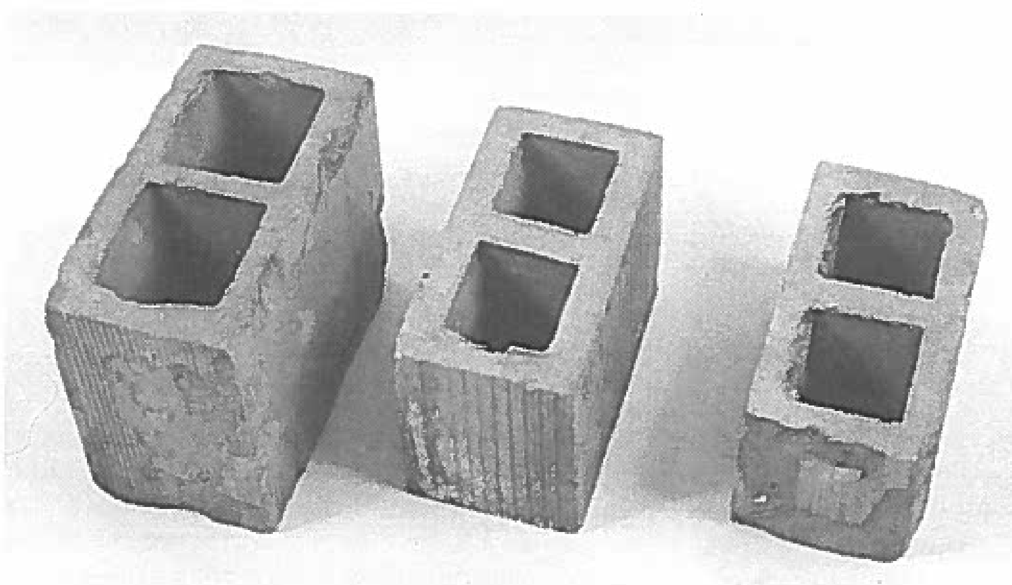


Figure 28. Medium and Small Sizes of Hollow Building Blocks (Specimens A-7, I-9, and I-10).

Table 7. Hollow Building Block Measurements and Degree of Firing at the Paducah Brick and Tile Company.

Specimen Number	Firing	Length		Width		Thickness		Outer Wall Thickness		Openings	
		Cm	Inches	Cm	Inches	Cm	Inches	Cm	Inches	Cm	Inches
A-6	WF	33.0	13	20.0	7 3/4	10.0	4	2.2	7/8	6.5 x 7	2 9/16 x 2 3/4
A-7	WF	15.7	6 1/4	20.0	7 3/4	10.4	4 1/8	2.0	3/4	6.5 x 7	2 9/16 x 2 3/4
I-6	WF	31.1	12 1/4	18.7	7 3/8	9.6	3 3/4	2.5	1.0	5.5 x 6.5	2 1/8 x 2 ½
I-7	OF	30.1	11 7/8	18.3	7 1/8	9.6	3 3/4	2.3	7/8	5.5 x 6.4	2 1/8 x 2 ½
I-8	OF	22.8	9	18.1	7 1/8	9.3	3 5/8	2.2	7/8	5.3 x 5.6	2 x 2 5/16
I-9	WF	12.0	4 3/4	19.0	7 ½	9.6	3 3/4	2.0	3/4	5.5 x 6.5	2 1/8 x 2 ½
I-10	WF	9.5	3 3/4	19.8	7 3/4	9.8	3 7/8	2.0	3/4	5.7 x 6.5	2 1/4 x 2 ½

Two small size hollow building blocks were collected from Area I (Figure 28). These unglazed specimens (I-9 and I-10) range from a medium reddish brown to a dark reddish brown. These blocks range in length from 9.5 to 12 cm (3 3/4 to 4 3/4 inches) in length, 19 to 19.8 cm (7 2 to 7 3/4 inches) in width, and 9.6 to 9.8 cm (3 3/4 to 3 7/8 inches) thick (see Table 7). The two rectangular opening in the blocks ranged from 5.5 x 6.5 cm (2 1/8 x 2 ½ inches) to 5.7 x 6.5 cm (2 1/4 x 2 ½ inches). Outer wall thickness was 2 cm (3/4 inch). The inner dividing walls ranged from 2 to 2.3 cm (3/4 inch) in thickness. The blocks were textured by broad shallow incised lined the length of the specimens in a parallel configuration. In terms of flaws, one specimen was cracked and the other had the outer surface flaking off in spots. Both blocks contain some mortar where they had been laid into a wall.

CONCLUSIONS

The Paducah Brick and Tile Company/ Chamblin and Murray Brick Yard operated about 62 years under several names. The Paducah Brick Works was established in 1893 by C. H. Chamblin who operated the brick yard until about 1896. James A. Murray joined Chamblin as a partner in the brick yard between ca. 1897 and 1906. During this period, the company was known as the Chamblin and Murray Brick Yard. Chamblin and Murray were producing about 25,000 bricks per day in 1904 (Gardner 1905:122). The company was incorporated as the Paducah Brick & Tile Company on March 6, 1907 by C. H. Chamblin, Arthur Murray, and James A. Murray. By 1911, the Paducah Brick and Tile Company was under the control of James A. Murray, Arthur Murray, and J. A. Murray. The company produced more than 400,000 drain tiles annually and from 28,000 to 40,000 brick daily (Howard 1911). By 1922, a soft-mud machine was used to mold the bricks and they were fired in Dutch kilns (Ries 1922:58). The Murray family operated the brick yard until about 1942. Burroughs (1930:14) noted that the Chicago, Burlington & Quincy; the Illinois Central; the Nashville, Chattanooga & St. Louis; and the Paducah & Illinois railroads were transportation options for the Paducah Brick and Tile Company. The Paducah Brick and Supply Company was incorporated March 4, 1946 by William H. Hughes, Zola S. Hughes, George N. Saffer, and George Lawrence Saffer. The new company operated the brick yard until about 1955 when it was permanently closed. Harold Lynn Lockwood revived the Paducah Brick and Supply Company name on January 29, 1970 but was not able to obtain the necessary permits to mine clay at the site.

A sample of 72 bricks and seven hollow building blocks were collected from different areas of the site. These bricks included those that were made at the brick yard, those bought for use at the brick yard, and those dumped at the brick yard after closure. Of these specimens, 52 were common bricks including 19 were made by the soft-mud technique, 30 manufactured by the stiff-mud technique, two pressed bricks, and one concrete brick. The only company brand was the C & M soft-mud bricks produced during the Chamblin and Murray era. Fifteen fire bricks were recovered from the brick yard including the following brand names: L F B Wks/ LOUISVILLE, LFB WKS/ No 1, L F B WKS/ STANDARD, LACLEDE/ ST. LOUIS, EVENS & HOWARD/ ST. LOUIS, CANNELTON, A. P. GREEN/ OZARK D. P., and MEXICO MO/ STANDARD. A total of five paving bricks were collected to represent the range of variation at the brick yard which include the following brand names: BANNON'S/BLOCK, K.V.B. Co./BLOCK, and ROBBINS PAVER. The hollow building blocks sample includes three large, two medium, and two small specimens.

During the archaeological investigations, letters A-M were assigned to track foundations, features, and brick piles. Using the available Sanborn Insurance maps, it was possible to determine the functions of most areas. These areas include: A (steam drying house), B (brick kiln), C (brick kiln), D (brick kiln), E (brick kiln), F (brick machine structure), G (engine house), H (incline to clay pit), I (office), J-M (brick piles or scatters). With the limited surface inspection of the site many types of remains went undetected. Of these, some remains may have been obliterated, others may be too ephemeral to identify, and still other remains may be buried intact just below the surface. Missing remains include the circular kiln (should be in the grassy field), the old office, the brick kiln sheds, the water tank, scattered dying racks, the smoke stack, the pond, etc. Only intensive archaeological investigations can determine the nature of the other remains associated with the brick yard and their preservation. Undoubtedly, intensive shovel probing and test excavations would provide a great deal of information about the brick yard.

It is important for an archaeologist to know the differences between common bricks associated with a brick yard and common bricks that were dumped at an abandoned brick yard. Further, the knowledge is necessary to distinguish between brick yard remains and bricks associated with other types of archaeological sites. At the Paducah Brick and Tile Company ruins, we encountered bricks associated with the brick yard and other bricks that had been dumped after abandonment. A major difference between brick yards and other types of sites will be the quality of the bricks encountered. Bricks discarded at a brick yard or isolated brick kiln usually exhibit obvious flaws. These flaws include warping, heavy glazing, cracking, and sometimes bricks are found fused together. Warping can range from slightly distorted shapes to melted and twisted specimens. Thick glazing often occurs on rejected bricks that were in direct contact with the flames during the firing process. Rejected bricks can contain cracks ranging from small hair line fractures to wide gapping holes. Bricks that get too hot can fuse to adjacent bricks. Researchers should keep in mind that brick yards sold the better quality bricks and had to discard those bricks that were too flawed to be sold.

Usually, rejected bricks lack mortar. Sometimes unsaleable rejects were used in walls at the brick yard. Dumped bricks are better quality specimens that frequently have mortar adhering to them. Also, bricks dumped by contractors usually include specimens made by more recent methods than those at the brick yard. Dumped bricks can include tremendous variety in styles. In order to distinguish between the brick styles and types of manufacture, the archaeologist must be acquainted with the changes in technology through time and the marks resulting from these techniques. Without this knowledge, the researcher will not be able to tell the difference between the brick yard remains and the dumped bricks.

This study of the Paducah Brick and Tile Company brick yard emphasizes the importance of being familiar with different types of bricks. The uninformed researcher could have reached two erroneous conclusions. First, they may have assumed that all the bricks on the site were associated with the brick yard. Second, they may have concluded that all the bricks found were just from dumping episodes. In reality, many of the common bricks were associated with the brick yard while many other bricks were dumped by building contractors years after the abandonment of the brick yard. Likewise, the paving bricks and some of the fire bricks were also dumped after abandonment. Even bricks associated with a brick yard can come from another brick yard. This could include both common bricks and fire bricks. The common bricks could be used in building the office and other initial structures at the brick yard before they begin production. Fire bricks would be purchased for lining brick kilns, steam engine fire boxes, fireplaces, etc. Further, different fire brick brands can be associated with different building episodes or periodic relining of kilns.

STATUS OF KENTUCKY BRICK STUDIES

Studies of bricks and brick companies have tremendous potential for archaeological research. First, brick companies are an important part of America's industrial heritage. They provided bricks for construction of buildings, special bricks for paving of streets and sidewalks, and refractory bricks for protection from intense heat. As such, these sites should be documented and included in the archaeological literature. Currently, the archaeological community is in the initial stages of documenting brick yards. Only two rural brick clamps have been excavated to date. First, Cultural Resource Analysts, Inc. conducted excavations at an early brick clamp (15Sh50) near Shelbyville in Shelby County in connection with the upgrade of State Highway 55 (McKelway, Richmond, and Hand 1997; Wingfield, Richmond, and McKelway 1997). More recently, the University of Kentucky excavated the remains of a small isolated brick kiln (15Bh213) in Bath County, Kentucky in association with the realignment of highway KY 11 (Peres 2002). Another brick kiln site (15Wh161) was located by Cultural Resource Analysts, Inc. at Williamsburg in Whitley County (Kerr 1998:122-126). The ruins of the Maysville Brick Company in Maysville, Mason County were documented by the Kentucky Heritage Council (Hockensmith and Stottman 1996, 1997). Three brick yards have been documented in Paducah by Hockensmith and Black (this volume, 2004, n.d.) including the Paducah Brick and Tile Company (15McN114), the Katterjohn Brick Company (15McN120), and the Allen Brick Yard (15McN115). Hockensmith and Brown (2003) have compiled archival data and analyzed a sample of bricks from the Kentucky Fire Brick Company, the Portsmouth Granite Brick Company, and the Peebles Paving Brick Company that operated at the same site in Firebrick, Lewis County, at different times. In 2003, a portion of the Kentucky Fire Brick Company (15Ro197) at Haldeman in Rowan County was documented in connection with the KY 3318 Bridge over Open Fork Creek (Barber 2003). A small brick clamp (15He873) in Henderson County was subjected to Phase II testing in a coal mine permit area (Versluis 2004). The above brick yards represent only a very small fraction of the many companies across Kentucky that once manufactured bricks for buildings, refractory needs, and street paving.

A second area of research focuses on bricks as artifacts. As Karl Gurcke (1987:147) has noted in his book on *Bricks and Brickmaking* "...archaeologists have tended to neglect bricks as objects of study even though these artifacts may be found in relative abundance at the sites that they are excavating." This statement is also true for Kentucky archaeology (see Hockensmith 2001b). In the senior author's capacity as staff archaeologist at the Kentucky Heritage Council, hundreds of archaeological reports have come across his desk. Some of these reports that mention bricks or pile of bricks at sites but the author(s) make no attempt to describe them and often there is no further discussion of these artifacts. Phase II testing reports and Phase III mitigation reports for historic sites often include photographs of features containing bricks (foundation walls, walks, piers, cisterns, wells, etc.) but provide little or no information about the numerous bricks within the features. Even after urging some archaeologists to provide basic measurements on bricks they encounter during fieldwork, especially those with brand names, information has rarely been forthcoming. Surprisingly, historic archaeologists rarely provide any more information on bricks than do the prehistorians. Consequently, little information is generated about bricks by CRM studies even though many of these artifacts are observed during Phase I surveys. Undoubtedly, the problem is primarily due to archaeologists not being familiar with bricks and assuming that they can yield no useful information. The senior author was of the same mind set until 1994 when he first dealt with a brick yard and became interested in this untapped data source. Bricks can provide information on chronology (dating features), function (different types of bricks), consumerism (selection of certain styles) and origin (trade networks). Understanding bricks requires learning the basic manufacturing techniques and becoming familiar with the marks left on the bricks by those techniques. When bricks have brand names they can often be attributed to a specific company and be dated to a very short time span. Bricks lacking brand names often can be relatively dated on the basis of the manufacturing techniques used to produce them.

Information is gradually accumulating on the brick industry in Kentucky and reports are being prepared that specifically deal with the analysis of bricks. Two earlier studies dealt specifically with Kentucky bricks. Ronald W. Deiss (1987) published an article on five different types of handmade bricks produced by the Shakers at South Union, Kentucky between 1807 and the Civil War. William R. Black, Jr. (1987) wrote an article on 19th century bricks recovered from Paducah, Kentucky that had incidental marks from humans and animals. Several studies by archaeologists have produced information about bricks recovered or observed in their project areas. In a 1986 report on his excavations at Liberty Hall in Frankfort, Robert Fay (1986:25) presented a brief description of the 183 bricks and brick fragments recovered. Nancy O'Malley (1987:41-42) described 55 bricks recovered from her excavations at the Johnson/Bates Farmstead in Jefferson County. In his extensive three volume report on the Phase III excavations at Covington's Riverfront development project, Robert Genheimer (1987) provided information on the bricks with brand names and commented on their origin. Pamela A. Schenian (1987) described three types of hollow ceramic blocks recovered from her excavations of the Company Store at the Onionville Mine Complex in Henderson County. In 1988, Ronald W. Deiss (1988:176-177) presented information on the 314 bricks he collected during his excavations at Kentucky's Old State Capitol in Frankfort. Also during 1988, Robert A. Genheimer (1988:23) briefly discussed the bricks observed during his excavations for Phase II of Frankfort's East Main Street project. M. Jay Stottman and Joseph E. Granger (1993) devoted a chapter in their Highland Park report to bricks that were used in privy construction and brick choices by different social classes in Louisville.

In recent years, addition information has been compiled for Kentucky bricks and brick yards. Summary information has been prepared for specific cities including Frankfort (Hockensmith 1996a, 1997a, 1997b), Lexington (Hockensmith 1998a), Louisville (Hockensmith 2001a, 2003b), and Shelbyville (Hockensmith 2003a). Information has already been collected for future city and county summaries of the brick industry in Kentucky. The senior author recently published "A Brief History of the Brick and Clay Products Industries in Kentucky: 1788-2002" (Hockensmith 2002). Recent brick studies include the Kentucky History Center site (Hockensmith 1996a, 1997a, 1997b), the Maysville Brick Company site (Hockensmith and Stottman 1996, 1997), and the Kentucky River Mills site (Hockensmith 1998b). Sections have been included on bricks in papers on the Rudd Lime Kiln (Hockensmith 1996b:121), the Stedman Mill (Hockensmith 1998c:92), the Foley House (Stottman and Hockensmith 1998:289-290), and the Upper Rudd Lime Kiln (Hockensmith 1999:101). Brick samples have been collected from several counties, which will be reported on in future issues in the Kentucky Heritage Council's "Brick Notes" series. It is hoped that these studies will provide a context for future brick studies and comparative information on different types and ages of bricks found in Kentucky.

Only a few authors have included descriptive sections on bricks in their archaeological reports. Even though bricks are frequently encountered, few archaeologists are adequately describing them. As a result, we have little information on Kentucky bricks and brick brands. Systematic collection of data will provide information on the origin and date ranges for particular brands. Our research is an example of how bricks can be attributed to a particular manufacturer and dated. Rejected bricks with the C & M brand name were found at the ruins of the Chamblin and Murray Brick Yard and were archivally dated between 1897 and 1907. If archaeologists will begin to document brick brands they encounter, this type of information can become available for the state as a whole in the future.

To lay the ground work for future brick studies, archaeologists are encouraged to describe and measure the bricks encountered at the sites that they record or excavate. We also encourage the collection and curation of representative sample of bricks from archaeological sites. A useful sample includes observed variation in size, color, texture, and brand names. As archaeologists become familiar with brick types, they will begin to give bricks the same attention that they are currently giving to two other architectural artifact categories- window glass and nails. In conclusion, we urge archaeologists to seriously consider learning more about bricks and describing them in their archaeological reports. By doing so that we can enhance our understanding of bricks and the brick industry in Kentucky.

ACKNOWLEDGMENTS

We would like to express our gratitude to the Kentucky Heritage Council for funding this research. A special thanks is due to Director David L. Morgan and Site Protection Manager Thomas N. Sanders for allowing the senior author to undertake this study. Tom also commented on this paper and made many helpful suggestions. We are also indebted to Mr. Harold Lockwood who graciously allowed us to document the brick yard on his property and shared his memories about the brick yard. A special thanks is due to Ms. Vonnie Shelton who is in charge of Special Collections at the Paducah Public Library. Ms. Shelton was extremely helpful in locating directories, maps, and books that were of great utility in this study. The Kentucky Geological Survey graciously granted permission to use Figure 12 from Heinrich Ries' (1922) book *The Clay Deposits of Kentucky*. Dr. Carol Ruthven with the Kentucky Geological Survey provided the assistant necessary to obtain permission to use the photograph. The Sanborn Library, LLC granted permission to reproduce portions of the 1897 and 1906 Sanborn Insurance Maps of Paducah, Kentucky. The assistance of Michelle N. Barbieri with the Historical Resources Group of the Sanborn Library is greatly appreciated. Mr. Tim Thornberry with Photographic services in State Government did an excellent job in photographic bricks. Dr. Richard Taylor, owner of Poor Richard's Books, Frankfort, graciously loaned me his original copy of the Henry A. Petter Supply Company catalogue. Dr. Kenneth C. Carstens, Murray State University, made many helpful comments that improved this paper. The assistance of all these individuals is greatly appreciated and contributed to the success of this project.

REFERENCES CITED

Agricultural and Industrial Development Board

1949 *Kentucky Industrial Directory 1949*. Agricultural and Industrial Development Board and Kentucky Chamber of Commerce.

1951 *Kentucky Industrial Directory 1951-52*. Agricultural and Industrial Development Board and Kentucky Chamber of Commerce.

1953 *Kentucky Industrial Directory 1953-54*. Agricultural and Industrial Development Board and Kentucky Chamber of Commerce.

1955 *Kentucky Industrial Directory 1955-56*. Agricultural and Industrial Development Board and Kentucky Chamber of Commerce.

Ashton, Fred B. (Compiler)

1904 *Ashton's Directory of Paducah, KY*. Printed by B. J. Billings.

Baldwin & Young

1937 *The Baldwin and Young Paducah, Kentucky ConSurvey Directory*. Volume I.

Baldwin ConSurvey Company, Springfield, Illinois. The Young Printing Company, Paducah.

Baldwin, Billing, and Young
1939 *The Baldwin, Billing, and Young Paducah, Kentucky ConSurvey Directory.* Volume II. Baldwin ConSurvey Company, Parsons, Kansas. The Young Printing Company, Paducah.

Barber, Jennifer L.
2003 *An Archaeological Survey of the KY 3318 Bridge and Approaches Over Open Fork Creek (Item No. 9-1048.00), Rowan County, Kentucky.* Contract Publication Series 03-70. Report submitted to T.H.E. Engineers, Inc., Lexington by Cultural Resource Analysts, Inc., Lexington.

Basco, Jean
1977 The 1894 Don Valley Pressed Brick Works Catalogue. *APT Bulletin* 9 (1):30-73. The Association for Preservation Technology.

Black, William R., Jr.
1987 Anomalous Marks in Nineteenth Century Paducah Bricks. In *Proceedings of the Symposium on Ohio Valley Urban and Historic Archaeology Volume 5*, edited by Donald B. Ball and Philip J. DiBlasi, pp. 96-104. Louisville, Kentucky.

Blankenbecker, Steve
1995 The Portsmouth District. *Journal of the International Brick Collectors Association* 13 (2):70-76.

Burroughs, Wilbur G.
1930 *Directory of Kentucky Mineral Operators.* Kentucky Geological Survey, Series 6, Volume 32, Frankfort.

Caron Directory Company
1906 *Caron's Directory of the City of Paducah for 1906-7.* Volume II. Caron Directory Company, Louisville.

1908 *Caron's Directory of the City of Paducah for 1908-9.* Volume III. Caron Directory Company, Louisville.

1912 *Caron's Directory of the City of Paducah, Ky. for 1912-13.* Volume V. Caron Directory Company, Louisville.

1914 *Caron's Directory of the City of Paducah, Ky. for 1914-1915.* Volume VI. Caron Directory Company, Louisville.

1916 *Caron's Directory of the City of Paducah, Ky. for 1916-1916.* Volume VII. Caron Directory Company, Louisville.

1918 *Caron's Directory of the City of Paducah, Ky. for 1918-1919.* Volume VIII. Caron Directory Company, Louisville.

1920 *Caron's Directory of the City of Paducah, Ky. for 1920-1921*. Volume IX. Caron Directory Company, Louisville.

1922 *Caron's Directory of the City of Paducah, Ky. for 1922-1923*. Volume X. Caron Directory Company, Louisville.

1924 *Caron's Directory of the City of Paducah, Ky. for 1924-1925*. Volume XI. Caron Directory Company, Louisville.

1926 *Caron's Directory of the City of Paducah, Ky. for 1926-1927*. Volume XII. Caron Directory Company, Louisville.

1930 *Caron's Directory of the City of Paducah, Ky. for 1930-1931*. Volume XIV. Caron Directory Company, Louisville.

1933 *Caron's Directory of the City of Paducah, Ky. for 1933-1934*. Volume XV. Caron Directory Company, Louisville.

1935 *Caron's Directory of the City of Paducah, Ky. for 1935-1936*. Volume XVI. Caron Directory Company, Louisville.

1941 *Caron's Directory of the City of Paducah, Ky. for 1941-1942*. Volume XVII. Caron Directory Company, Louisville.

1947 *Caron's Paducah (McCracken County, KY) City Directory*. Volume XVIII. Caron Directory Company, St. Louis.

Consolidated Illustrating Company

1895 *Louisville of To-Day*. Consolidated Illustrating Company, Louisville, Kentucky.

Deiss, Ronald W.

1987 Shaker Brick Types From South Union, Kentucky. In *Proceedings of the Symposium on Ohio Valley Urban and Historic Archaeology, Volume* 5, edited by Donald B. Ball and Philip J. DiBlasi, pp.90-95. Louisville, Kentucky.

1988 *Archaeological Investigations at Kentucky's Old State Capitol*. Kentucky Historical Society, Frankfort.

Des Jean, Tom

1995 A History of Southern Clay Manufacturing Company at Robbins, Tennessee. In *Historical Archaeology in Kentucky*, edited by Kim A. McBride, W. Stephen McBride, and David Pollack, pp. 1-19. Kentucky Heritage Council, Frankfort.

Fay, Robert P.

1986 *Archaeological Investigations at Liberty Hall, Frankfort, Kentucky*. Kentucky Heritage Council, Frankfort.

Gardner, James H.

1905 Clays and Sands of the Jackson's Purchase Region. In *Clays in Several Parts of Kentucky With Some Account of Sands, Marls and Limestones*. Kentucky Geological

Survey, Series 3, Bulletin 6, pp. 80-123, Lexington.

Genheimer, Robert A.
1987 *Archaeological Testing, Evaluation, and Final Mitigation Excavations at Covington's Riverfront Redevelopment Phase II Site, Kenton County, Kentucky.* Three volume report submitted to the City of Covington by R. G. Archaeological Services, Covington and Cultural Resource Analysts, Lexington.

1988 *An Historical Archaeological Assessment of the East Main Street Phase II Project in Frankfort, Franklin County, Kentucky.* Contract Publication Series 88-25. Cultural Resource Analysts, Lexington.

Goin, Kenneth
1996 Personal communications with Charles D. Hockensmith on bricks. Mr. Goin is a retired brick layer residing in Frankfort, Kentucky.

Graves, Jim
1994 Brick Brands of the United States. Manuscript on file with International Brick Collectors Association, Halstead, Kansas.

Greene, Lance K.
1992 The Penfield is Mightier Than the Sword: Machine-Made Brick in Knoxville and Knox County, Tennessee. In *Proceedings of the Tenth Symposium on Ohio Valley Urban and Historic Archaeology*, edited by Amy L. Young and Charles H. Faulkner, pp. 74-91. Tennessee Anthropological Association Miscellaneous Paper No. 16, Knoxville.

Gurcke, Karl
1987 *Bricks and Brickmaking: A Handbook for Historical Archaeology.* The University of Idaho Press, Moscow.

Havard, F. T.
1912 *Refractories and Furnaces: Properties, Preparation, and Application of Materials Used in the Construction and Operation of Furnaces.* McGraw-Hill Book, New York.

Hockensmith, Charles D.
1996a Bricks and Brick Making in Frankfort: An Archival and Archaeological Study of the Kentucky History Center Site. *Kentucky Heritage Council, Occasional Reports in Archaeology, Number 1*, Frankfort.

1996b Archaeological Investigations at the Rudd Lime Kiln, Livingston County, Kentucky. *Ohio Valley Historical Archaeology* 11:115-124.

1997a Brick Making in Frankfort, Kentucky: 1814-1914. *Journal of the International Brick Collectors Association* 15 (1):16-20; 15 (2):78-93.

1997b A Study of Frankfort Bricks and Brickmaking, Franklin County, Kentucky. *Tennessee Anthropologist* 22 (2):121-176.

1998a The Bobb Brothers & Other Early Lexington, Kentucky Brick Makers, 1788-1816. *Journal of the International Brick Collectors Association* 16 (2):74-81.

1998b A Study of Bricks From the Kentucky River Mills Site, Frankfort, Franklin County. *Kentucky Heritage Council Brick Notes, Number* 1, Frankfort.

1998c Ebenezer Stedman's Mills: A Nineteenth Century Paper, Grist, and Lumber Milling Complex Near Frankfort, Kentucky. *Ohio Valley Historical Archaeology* 13:80-95.

1999 The Upper Rudd Lime Kiln: An Industrial Archaeological Site Near Lemen Landing, Livingston County, Kentucky. *Ohio Valley Historical Archaeology* 14:95-104.

2001a Brick Industry. In *The Encyclopedia of Louisville*, edited by John E. Kleber, pp. 121-122. University Press of Kentucky, Lexington.

2001b The Value of Studying Bricks and Brick Yards: Some Suggestions From Kentucky. *Material Culture* 33 (3):1-28.

2002 A Brief History of the Brick and Clay Products Industries in Kentucky: 1788-2002. *Ohio Valley Historical Archaeology* 17:73-90.

2003a Brick Makers. In *The New History of Shelby County, Kentucky*, edited by John E. Kleber, pp. 140-141. Shelby County Historical Society. Harmony House Publishers, Prospect, Kentucky.

2003b The Brick Industry in Louisville, Kentucky Between 1850 and 1860. *Currents of Change*, Journal of the Falls of the Ohio Archaeological Society 1 (1):69-78, Clarksville, Indiana.

Hockensmith, Charles D. and William R. Black, Jr.

2004 The Katterjohn Brick Company and Their Two Brick Yards in Paducah, McCracken County, Kentucky. *Ohio Valley Historical Archaeology* 19 [In Press].

n.d. The Allen Brick Yard: A Nineteenth Century Brick Manufacturing Site in Paducah, McCracken County, Kentucky. Manuscript in preparation.

Hockensmith, Charles D. and Roy L. Brown

2003 The Kentucky Fire Brick Company, the Portsmouth Granite Brick Company, and the Peebles Paving Brick Company: Three Brick Manufacturers Formerly Operating at Firebrick, Kentucky. *Journal of the International Brick Collectors Association* 21 (2):76-85, 21 (3):132-142, [2004] 22 (1):37-40.

Hockensmith, Charles D. and M. Jay Stottman

1996 The Maysville Brick Company, Mason County, Kentucky. *Journal of the International Brick Collectors Association* 14 (1): 3-16.

1997 Investigations at the Maysville Brick Company: An Example of Industrial Archaeology in Kentucky. *Ohio Valley Historical Archaeology* 12:89-111.

Howard, Bradford (editor)
1911 *Paducah, Kentucky: Its Location, Climate and Resources*. Paducah Evening Sun, Paducah, Kentucky.

Jillson, Willard Rouse
1926 *The Clays of Kentucky*. Kentucky Geological Survey, Series 6, Pamphlet 4, Frankfort.

1930 Administrative Report for the (Sixth) Kentucky Geological Survey, Year 1928 and 1929. In *Geological Survey Affairs* by Willard Rouse Jillson, pp.101-220, Kentucky Geological Survey, Series 6, Volume 35, Frankfort.

Johnston, J. Stoddard
1896 *Memorial History of Louisville from its First Settlement to the Year 1896*. American Biographical Publishing Company, Chicago. Volume 1.

Kentucky Department of Economic Development
1957 *Kentucky Industrial Directory 1957-58*. Kentucky Department of Economic Development in cooperation with the Kentucky Chamber of Commerce, Frankfort.

Kenyon, H. H.
1930 What a Difference! Three Holes Would Make. *Brick and Clay Record*, April 22, 1930, pp. 524 and 536.

Kerr, Jonathan P.
1998 *A Phase I Survey of the Proposed Williamsburg Flood Protection Project and a Phase II National Register Evaluation of Four Sites in Whitley County, Kentucky*. Contract Publication Series 97-39. Report submitted to the Nashville District, U. S. Army Corps of Engineers, Nashville by Cultural Resource Analysts, Inc., Lexington.

Lockwood, Howard Linn
1997 On-site Interview with Charles D. Hockensmith concerning the ruins of the Paducah Brick and Tile Company which he owns. April 23, 1997.

McKelway, Henry S., Michael D. Richmond, and Robert B. Hand
1997 *An Archaeological Reconnaissance of Proposed Parcels of Kentucky State Highway 55 Upgrade, and Phase II Investigations of Site 15Sh50, Shelby County, Kentucky*. Contract Publication Series 96-42. Report submitted to the Commonwealth of Kentucky Transportation Cabinet, Frankfort by Cultural Resource Analysts, Inc., Lexington.

Olson, Roy Fridolf, Jr.
1994 *McCracken County, Kentucky Cemeteries*. Volume Four (Mt. Kenton). Simmons Historical Publications, Melber, Kentucky.

O'Malley, Nancy
1987 *Middle Class Farmers on the Urban Periphery: Historic Archaeological Investigations of the Johnson/Bates Farmstead Site, Jefferson County, Kentucky*. Archaeological Report 162. Program for Cultural Resource Assessment, University of Kentucky, Lexington.

Paducah, City of

1906 *Report of Treasure and Auditor of the City of Paducah, Kentucky for the Year 1905.* Sun Print, Paducah.

1907 *Annual Reports of the City of Paducah, Kentucky for the Year 1906.* Sun Print, Paducah.

Peres, Tanya M.

2002 A Phase II Archaeological Evaluation of Site 15Bh213, Associated With the KY 11 Project, Bath County, Kentucky. Technical Report No. 463. Program for Archaeological Research, Department of Anthropology, University of Kentucky, Lexington. Report submitted to the Kentucky Transportation Cabinet, Frankfort.

Petter, Henry A. Supply Company

1910 *Henry A. Petter Supply Company, Paducah, Kentucky* catalogue. R. R. Donnelley & Sons Company, Chicago.

Polk, R. L. & Co.

1895 *Kentucky State Gazetteer and Business Directory, 1896.* Volume VII. R. L. Polk & Co., Detroit.

Ries, Heinrich

1922 *The Clay Deposits of Kentucky: An Economic Consideration of the Pottery, Brick, and Tile Clays, and Shales of Kentucky, With Notes on their Industrial Development.* Kentucky Geological Survey, Series 6, Volume 8, Frankfort.

Sanborn Insurance Map

1893 Insurance Maps of Paducah, Kentucky. Sanborn Map Company, New York.

1897 Insurance Maps of Paducah, Kentucky. Sanborn Map Company, New York.

1901 Insurance Maps of Paducah, Kentucky. Sanborn Map Company, New York.

1906 Insurance Maps of Paducah, Kentucky. Sanborn Map Company, New York.

1916 Insurance Maps of Paducah, Kentucky. Sanborn Map Company, New York.

1922 Insurance Maps of Paducah, Kentucky. Sanborn Map Company, New York.

1942 Insurance Maps of Paducah, Kentucky. Sanborn Map Company, New York.

1952 Insurance Maps of Paducah, Kentucky. Sanborn Map Company, New York.

Schenian, Pamela A.

1987 There Was a Mine Under Every Hill: An Archaeological Reconnaissance of the Upland Area of Permit 851-0001 and the Investigation of the Onionville Mine Complex at Approximate Green River Mile 31.8, Henderson County, Kentucky. Report submitted to Pyramid Mining, Owensboro, Kentucky by Murray State University, Murray, Kentucky.

Scott & Wilcox
1894 *Scott & Wilcox Directory for Paducah, 1894-95.* (Title page missing).

Secretary of State
1907 Articles of Incorporation for the Paducah Brick & Tile Company. Secretary of State's Office, Frankfort, Kentucky.

1946 Articles of Incorporation for the Paducah Brick and Supply Company. Secretary of State's Office, Frankfort, Kentucky.

Seiller, Edward F.
1929 *Kentucky Natural Resources, Industrial Statistics, Industrial Directory Description by Counties.* Bulletin 34. Bureau of Agriculture, Labor and Statistics.

Shuck, Bill
1996 Personal Communication with Charles D. Hockensmith concerning the Louisville Fire Brick Works. Mr. Shuck is president of Louisville Fire Brick Works, Louisville, Kentucky.

Smith, Richard W.
1931 *Shales and Brick Clays of Georgia.* Bulletin No. 45. Geological Survey of Georgia. Stein Printing Company, Atlanta.

Stottman, M. Jay and Joseph E. Granger
1993 The Archaeology of Louisville's Highland Park Neighborhood, Jefferson County, Kentucky. Report submitted to the Regional Airport Authority of Louisville and Jefferson by Archaeology Resources Consultants Services, Louisville.

Stottman, M. Jay and Charles D. Hockensmith
1998 Archaeological Investigations at the 1795 Elijah Foley House, Fayette County, Kentucky. In *Current Archaeological Research in Kentucky: Volume Five*, edited by Charles D. Hockensmith, Kenneth C. Carstens, Charles Stout, and Sara J. Rivers, pp. 256-313. Kentucky Heritage Council, Frankfort.

The Belden Brick Company
n.d. *Designing With a Difference: A Guide to Special Shapes.* Ca. 1990s catalogue published by The Belden Brick Company, Canton, Ohio.

United States Federal Census
1900 Population Schedules for the Twelfth Census of the United States: McCracken County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1910 Population Schedules for the Thirteenth Census of the United States: McCracken County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

1920 Population Schedules for the Fourteenth Census of the United States: McCracken County, Kentucky. Microfilm on file at the Kentucky Historical Society, Frankfort.

Versluis, Vincent A.
2004 Phase II Archaeological Testing of Sites 15He847, 15He848, 15He850, 15He852,

15He855, 15He863, and 15He873 for a Patriot Coal Mining Permit Area (Permit Application # 851-0030) Near Hebbardsville, Henderson County, Kentucky. Report submitted to Patriot Coal Company, Henderson, Kentucky by Great Rivers Archaeological Services, Burlington, Kentucky.

Wingfield, Derek M., Michael D. Richmond, and Henry S. McKelway
1997 Archaeological Remains of a Mid-Nineteenth Century Brick Clamp: A First Look at Brick Clamps in Kentucky. *Ohio Valley Historical Archaeology* 12:68-88.

MATERIAL CULTURE AND THE BUILT ENVIRONMENT: OBSERVATIONS ON ROCK FENCE CONSTRUCTION IN THE BLUEGRASS REGION OF KENTUCKY

By

Donald B. Ball
Louisville District
U. S. Army Corps of Engineers
Louisville, Kentucky

ABSTRACT

As examples of both material folk culture and archaeological artifacts, the many miles of impressive rock fence found throughout the Bluegrass of north-central Kentucky are subject to both functional and symbolic interpretation. Beyond serving such purely utilitarian purposes as boundary makers or field enclosures, the methods of their construction suggest useful insights into both the craftsmanship of the workers who built these fences and the choices made by the property owners who funded them. This paper will briefly discuss both the function and symbolism of rock fences and recordation suggestions for students of the region engaged in documenting them.

INTRODUCTION

It is ironic that many dedicated archaeologists working within the region will go to extraordinary lengths to recover a small quantity of flint flakes from a prehistoric site but in a rather literal way will trip over some of the largest artifacts to be found upon the landscape and pay them little or no attention. Fences, though exemplifying the tangible remains of past human endeavor, have long been relegated to the domain of cultural geographers (e.g., Evans 1957:100-113; Hart and Mather 1957; Jordan 1966:164-165; Jordan et al. 1997:87-104; Kniffen 1974; Zelinski 1959) and students of material folk culture (e.g., Clarke and Kohn 1976; Evans 1978; Glassie 1969:100; Raup 1947; Riedl et al. 1976; Sizemore 1994:161-163; Sloane 1974:27-35). In no small manner, such cultural entities have largely been ignored and treated as informationally sterile due to a lack of familiarity with these resources. It is a working premise of this paper that fences - in common with bottle fragments and ceramic sherds - are artifacts in their own right and deserve greater attention than they have received in years past.

Among the more impressive forms of fencing to be seen across the landscape are the massive stone fences encountered in the Bluegrass region of Kentucky. The present brief discussion will focus on two aspects of their study of utility to regional archaeologists: (1) the dual environments -- social and natural -- which occasioned their construction; and (2) suggestions for the field recording of these remains in the context of cultural resource studies. Not all stone fences were created equal. Indeed, the spectrum of social and natural factors centered in the reaches of the Bluegrass fostered diverse rationales for expending the resources required to build such labor intensive fences. A knowledge of these circumstances -- as reflected by the construction attributes of a given fence -- would tangibly assist field investigators in both better documenting these examples of relict stone work and relating a seemingly isolated fence to the farmstead of which it was a functional part.

DUALITY OF THE BUILT ENVIRONMENT

Students of material culture have long debated the appropriate analytical and interpretive framework for the artifacts they study. Where some investigators emphasize the real or imaged practical function of the objects within a study universe, others assert that objects have "meaning" and reflect intangible, symbolic functions (but a sampling of perspectives on the interpretation of material culture are presented in Schlereth 1982). For present purposes, artifactual "meaning" will be defined as those attributed values that extend beyond their purely functional use and reflect internalized (hence non-material) religious, economic, or social conventions held by those who created and used them. It is sometimes appropriate that at least one other factor, the realities of the physical world occupied by the user of a given artifact, should be considered in the process of interpreting material culture. This paper will briefly address the interface of various levels of function, symbolic value, and the natural environment as expressed by one class of artifact -- the rock fences of the Bluegrass physiographic region of Kentucky.

Rock fences as a specialized type of historic construction may be documented in many areas of the eastern and central United States and typically, though not universally, exemplify material culture imported from the British Isles. Examples of these impressive artifacts have been reported in northern New England (Wood 1997:362-378), central New York and southern Pennsylvania, southward to the Valley of Virginia, northeastern West Virginia, southern Indiana, the Tennessee Valley, and westward into southern Wisconsin and eastern Kansas (Glassie 1969:100). Additional examples have also been recorded in the Normandy Reservoir of Coffee County, (central) Tennessee (Riedl et al. 1976:148, 261), the Arkansas Ozarks (Sizemore 1994:162-163), and south-eastern Texas (Jordan 1966:164-165, Figure 8). Intriguingly, rock fences similar to those recorded in Kentucky also appear in Australia (Connah 1988:89). Of present interest are those fences built of either field rock or shaped stone blocks as they were constructed in the Bluegrass region of Kentucky and the contribution their study may make toward better understanding the region's cultural landscape (cf. Chang 1968; Korr 1997).

Long admired as symbolic of the grace and prosperity of Kentucky's Bluegrass region, the many miles of carefully crafted limestone fences found throughout the area have until recently been little studied and greatly misunderstood as to their origins. Myths and misinformation abound regarding these noble vestiges of an early craft. Many contemporary observers, for example, routinely tend to accept as fact that the "typical" rock fence was constructed by slaves with miscellaneous pieces of field rock removed from cultivated areas. Such fences were the exception, rather than the rule.

Beyond the sheer amount of labor invested in their construction, the nature of such fences required the juxtaposition of ample quantities of suitable stone, qualified craftsmen, and sufficient reason to justify the expense associated with their construction. Among these factors, the present remarks will focus on the multiple reasons for the construction of stone fences.

Students of the landscape have documented a variety of pre-barbed wire fence types used in the nineteenth century. In addition to rock fences, these fence types variously include makeshift fences fashioned from tree stumps (Jordan and Kaups 1989:107) and split rails (cf. Glassie 1969:100; Hart and Mather 1957; Jordan and Kaups 1989; Raup 1947; Zelinsky 1959) to more fashionable palen fences (Evans 1978), and slat-and-wire fences (Clarke and Kohn 1976:16-17). Being wholly or predominately of wood, all were subject to both decay and ongoing maintenance and some (notably split rail fences) were excessively consumptive of arable land. For example, it has been estimated that a typical rail fence consumed a swath of ground 10 feet (3.0 m) wide and that a 1.0 mile (1.6 km) stretch of such a fence would remove from cultivation just over 1.2 acres (0.49 ha) of tillable ground. Indeed, such fences have been rightly thought of as producing "...only taxes and weeds" (Hart and Mather 1957:6). It is little wonder that more progressive (or financially better off) landowners would search for a more durable type of fencing.

In a purely utilitarian sense, the early construction of rock fences was prompted by a desire to build a long lasting fence of readily available materials. Though the earliest such fences in the region were largely practical in nature and only minimally reflected ostentatious tastes, the relatively high value placed on each acre of Bluegrass land tended to place this property beyond the reach of many of the region's less affluent settlers. Indeed, the settlement history of the fabled Bluegrass reflects an early concentration of westward bound gentry from the Old Dominion into a rich land formerly closed to colonization. These oft-times well educated gentlemen with a taste for the finer things in life brought with them both the vision and financial means to build formal estates reflecting their social position. Notably, the construction of these labor intensive fences began (as early as the 1770's) well before the depletion of the area's forest reserves. In this regard, these structures served both esthetic and symbolic functions beyond their mundane practical applications.

Available evidence suggests that three distinct waves of craftsmen were engaged in building rock fences. From 1777 (the earliest known year of construction of a rock fence in the Bluegrass) until the 1840's, the region's rock fences reflect influence from northern England, Scotland, and/or Ulster (northern Ireland). During the period ca. 1850 to ca. 1890, most stonemasons in Kentucky came from Ireland, while after 1900 the preponderance of fence builders were local Black craftsmen.

Each group of workers approached their craft in different ways and influenced those who were to follow. Scottish walls, for example, tended to contain "thoroughbands" or "tie courses", long stones which spanned the short axis of a fence to tie its two faces together for greater stability. In contrast, the angled coping (cap) stones long associated with "classic" fence construction in the region (cf. Glassie 1968:99-100) appears to have been introduced by Irish tradesmen in the mid-nineteenth century. Contemporary construction methods incorporate a concrete block core and mortared facing stones. Collectively, these many hands labored to construct literally several hundreds of miles of sturdy fences impervious to virtually all forces of nature except the whims of future generations.

Though there is some evidence that a limited number of slaves were engaged in building such fences (in most instances likely serving as a source of labor for quarrying and transporting stone), Black stonemasons were apparently few and far between throughout most of the nineteenth century. This is not to say, however, that Blacks were not closely associated with the construction of rock fences. Indeed, the years between the emancipation brought by the Civil War and the end of the Victorian era reflected a major change in the composition of the work force actively engaged in building rock fences. An examination of U.S. Census schedules has revealed that in 1850 and 1860 a total of 16 free Black stonemasons resided in the entirety of

Kentucky. In contrast, of some 34 stonemasons who resided in Bourbon County alone in 1860, only two were Black while 26 of the total were from Ireland; in the same year in nearby Woodford County, of 33 stonemasons, none were Black, yet 21 of the total number were born in Ireland. By 1910, this frequency was almost totally reversed. In that year, 23 of 31 stonemasons recorded in Bourbon County were Black and only one was from Ireland. Similarly, the Woodford County census schedules for 1910 show that 16 of 22 stonemasons were Black with but two of the remainder from Ireland. Effectively, after 1900, the majority of rock fences built in the region were constructed by Black contractors.

The glory days of stone fence construction, however, were numbered. As farms in the region began to subdivide in the 1870's, smaller-scale farmers and cash-poor owners of some larger holdings became increasingly cost conscious regarding both initial construction costs and the ever rising cost of labor associated with any repairs which might be required. Not surprisingly, newer forms of less expensive fencing, such as woven and barbed wire, rapidly became more commonplace. Many miles of stone fences in the area began to be dismantled in the 1890s and later in response to state laws regulating road construction and establishing mandatory road right of ways. Fences situated within the right of way could be relocated back from the road by the property owner, donated to the state for use as road material, or removed by the state and piled on the owner's property at his expense. Others were demolished during the 1930s by WPA laborers, fed into portable steam powered rock crushers, and used as fill for ongoing road repair projects.

In common with any artifact type, stone fences reflect their own particular diagnostic attributes. Indeed, within the Bluegrass the research of Murray-Wooley and Raitz (1992) has served to demonstrate the wide variety of differences to be encountered within the area. For present purposes, it is sufficient to note that these studies have revealed divergent sets of rationale responsible for the use of two distinct building methods which served markedly different purposes. In turn, these construction methods were adapted to several varieties of fencing and walls. "Plain" fences (Figure 1) within the Bluegrass region tend to be infrequently encountered; such efforts were typically used as silt dams in erosion prone shallow gullies and retaining walls around springs. Alternately, fences with "coping" stones (Figure 2) -- a series of leaning stones rocks along the length of their upper surface -- are more characteristic of the region.

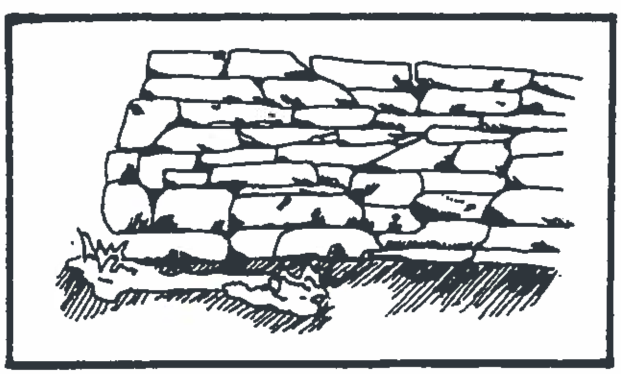


Figure 1. "Plain" Rock Fence - Typically Used for Retaining Walls and Silt Dams (reproduced from Riedl et al. 1976:261).

It may be taken as a given that the construction of any stone fence required the commitment of substantial resources, be it the capital expended by a wealthy property owner or the sweat of a yeoman farmer. The construction of such a fence by the owner of a prosperous farm would likely have involved a team of professional stonemasons working under contract. Typically, such masons preferred working with freshly quarried stone which could be more easily shaped into flat blocks. Such quarries occurred in three settings -- in exposed rock creek beds, along rock bluffs, and excavated pits. Not infrequently, these better constructed fences

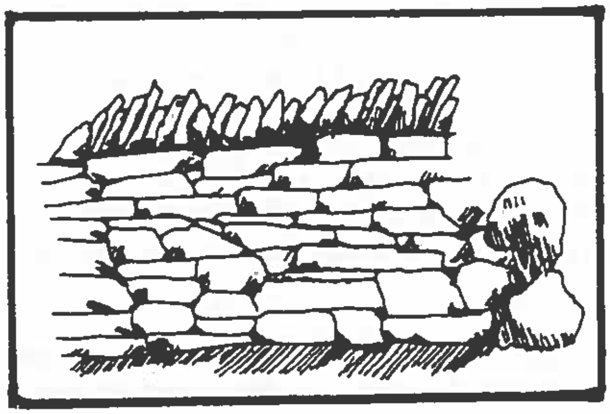


Figure 2. Fence with "Coping" Stones - Typical of Regional Construction (reproduced from Riedl et al. 1976:261).

entailed the excavation of a formal builder's trench for the placement of foundation footers below ground level. Despite the fact that an "ideal" work crew consisted of at least four men (two stone masons and two assistants), progress on these fences was typically measured in feet per day and a good crew could lay about 1.0 rod (16.5 feet/5.0 meters) of fence per work day. The very nature of this construction indicates close proximity to a source of suitable rock and long abandoned quarries are frequently observed near extant or former fence rows. Fences built of shaped rock were viewed at the time of their construction as symbolic of both wealth and social position. In terms of archaeological expectations, it is likely that some property owners directed that greater attention be given to those fences immediately adjacent to the main residence and fronting public thoroughfares much as more contemporary homeowners will opt to install a stone or brick facade on an otherwise less impressive frame structure.

PRACTICAL CONSIDERATIONS

Personal observations of area topography made during the course of recent travels through the countryside of Fayette County, nestled in the heart of the Bluegrass region, indicate that the nature of the land itself may have played a significant role in influencing the early adoption of stone fences in the area. While the weathered limestone of the Bluegrass has produced particularly deep soils in some areas, in other portions of the region the topsoils tend to be especially thin, varying from but ca. 6 inches (15 cm) to about 2.0 feet (0.61 m). As exposed by modern road cuts surrounding modern Lexington, these soils typically tend to contain numerous small to sizable fragments of eroded limestone. These soils in turn overlay the mildly karstic limestone deposits which occur throughout the entire region (cf. McFarlan 1961:167). As various areas were not suitable for the construction of fences utilizing emplaced posts, a viable -- though considerably more labor intensive - alternative was a stone fence.

In marked contrast to the tendency to build fences of shaped stones on the more prosperous farms of the region, farmers attempting to work less productive shallower and rockier soils typically tended to erect such fences as an expedient means of deposing of unwanted field rock which was an impediment to plowing (more extensive information on these sub-areas of the Bluegrass can be gleaned from sources such as Bailey and Winsor 1964; Davis 1927; McFarlan 1961:167-174; McGrain and Currens 1978; Sims et al. 1968; and Weisenberger and Isgrig 1977). Being heavily weathered and of variable configuration, such rocks could not be neatly stacked and were not desirable as material for "proper" rock fences. Fieldstone in excess of that required for fence construction was frequently dumped into piles on hillsides or in ravines to retard erosion. Accordingly, no associated quarries will be encountered in proximity to these walls. Aside from serving as a convenient means of field rock disposal, the practice of constructing such fences until late in the nineteenth century may well have been influenced by the nature of the shallow soils encountered in various portions of the Bluegrass because it was either difficult or impossible to excavate a posthole for the construction of virtually any other type of practical field enclosure.

The depth of a "typical" posthole is affected by size of the post (both length and diameter), intended purpose of the fence, soil conditions, and the inclinations of the person(s) actually doing the work. Though it is reasonable to suggest that the dimensions (depth and circumference) of any series of such holes might be subject to great variability, as a frame of reference it is noted that contemporary commercial fence posts are 8.0 feet (2.44 m) long and generally 4.0-6.0 inches (10-15 cm) in diameter. On the basis of personal experience, line posts are typically set to a depth of about 2.5 feet (0.76 m) while heavier (large diameter) corner and adjacent support posts situated at the ends of fields or the junction of two fences might be placed to a depth of approximately 3.0 feet (0.91 m). This "ideal" depth of placement, however, was noted in conditions of extremely sandy, easily excavated (with the aid of a post hole digger) soils. Conversations with individuals knowledgeable of regional farming practices revealed that some posts (e.g., those surrounding a chicken coop) might be placed at depths of but 12-18 inches (30-46 cm). Posts intended to contain larger livestock such as cattle or horses should be excavated to depths of 24-30 inches (61-76 cm). Stone fences built in areas of shallow or excessively rocky soil may reasonably be interpreted as artifacts of practical necessity rather than as symbols of their owner's financial and resources.

ROCK FENCES AS ARCHAEOLOGICAL SITES

Beyond discussing historical and interpretive intangibles, it is appropriate that rock fences be specifically addressed as archaeological sites and comments be made regarding approaches toward recording these remains when encountered in the field. The most pressing point is that field archaeologists should recognize that in effect they are confronted with a site which may be but 2.5 feet (0.76 meter) wide yet a half a mile (0.80 km) in length. When at all possible, the route of a given fence should be recorded on both field maps (typically 7.5' U.S. Geological Survey quadrangles) and by means of G.P.S. (Global Positioning System) coordinates.

At a minimum, basic field observations should record the context of the fence or wall, "typical" height and width measurements at a sampling of points along its length (some displacement may have occurred as a result of trees growing immediately adjacent to the fence), and a description of its construction (field rock or shaped stone, number of visible courses of stone, dry laid or mortared, and other features such as tie rocks which completely spanned the wall's short axis) and style (e.g., built of field rock and surmounted by diagonal cap stones). It should be noted that many stone fences were constructed wider at their bases than across the uppermost course of stones. While photographs of intact wall segments are certainly of interest, collapsed areas are also worthy of note for the input they provide on construction details (e.g., rubble fill) which might not otherwise be visible. Attention should also be devoted to locating associated quarries in proximity to shaped stone fences.

CONCLUDING REMARKS

It is contended that a working familiarity with regional rock fence construction techniques is necessary to better interpret these relict land use features. Notably, an understanding of the divergent motivations for constructing these massive and impressive features will provide useful insights into the circumstances of their creators and regional land use patterns. Regional investigators would find that a review of Murray-Wooley and Raitz (1992), other fence studies (e.g., Division of Planning 1990; Glassie 1968; Hart and Mather 1957; Raup 1947; Riedl et al. 1976; Zelinsky 1959), and masonry techniques (e.g., McKee 1975; Tufnell 1995) would provide a useful foundation for the recordation, interpretation, and appreciation of these diminishing cultural resources in Kentucky's Bluegrass and other areas.

ACKNOWLEDGMENTS

The present paper has benefited from discussions with and/or information provided by Mr. Charles D. Hockensmith (Kentucky Heritage Council, Frankfort), Mr. John S. Kessler (Falls of Rough), Mr. Marty Perry (Kentucky Heritage Council, Frankfort), Ms. Trina C. Maples (Lexington), Mr. Ben P. Walker (Louisville), and Mr. Robert W. Woodyard (Louisville). The assistance of each individual is greatly appreciated.

REFERENCES CITED

Bailey, Harry Hudson and Joseph H. Winsor
1964 *Kentucky Soils*. Miscellaneous Publication No. 308. University of Kentucky Agricultural Experiment Station, Lexington.

Chang, K. C. (editor)
1968 *Settlement Archaeology*. National Press Books, Palo Alto, California.

Clarke, Kenneth and Ira Kohn
1976 *Kentucky's Age of Wood*. University Press of Kentucky, Lexington.

Connah, Graham
1988 *'Of the Hut I Builded': The Archaeology of Australia's History*. Cambridge University Press, Cambridge.

Davis, Darrell H.
1927 *The Geography of the Bluegrass Region of Kentucky*. Kentucky Geological Survey Series 6, Vol. 23, Frankfort.

Division of Planning
1990 *The Stone Fences of Fayette County*. Division of Planning, Lexington-Fayette Urban County Government, Lexington.

Evans, E. Estyn
1957 *Irish Folkways*. Routledge & Kegan Paul, London.

Evans, E. Raymond
1978 The Palen Fence: An Example of Appalachian Folk Culture. *Tennessee Anthropologist* 3 (1):93-99.

Glassie, Henry
1968 *Pattern in the Material Folk Culture of the Eastern United States*. University of Pennsylvania Press, Philadelphia.

Hart, John Fraser and Eugene Cotton Mather
1957 The American Fence. *Landscape* 6 (3):4-9.

Jordan, Terry G.
1966 *German Seed in Texas Soil: Immigrant Farmers in Nineteenth-Century Texas*. University of Texas Press, Austin.

Jordan, Terry G. and Matti Kaups
1989 *The American Backwoods Frontier: An Ethnic and Ecological Interpretation*. Johns Hopkins University Press, Baltimore and London.

Jordan, Terry G., Jon T. Kilpinen, and Charles F. Gritzner
1997 *The Mountain West: Interpreting the Folk Landscape*. Johns Hopkins University Press, Baltimore and London.

Kniffen, Fred B.
1974 Material Culture in the Geographic Interpretation of the Landscape. In *The Human Mirror: Material and Spatial Images of Man*, edited by Miles Richardson, pp. 252-267. Louisiana State University, Baton Rogue.

Korr, Jeremy
1997 A Proposed Model for Cultural Landscape Study. *Material Culture* 29 (3):1-18.

McFarlan, Arthur C.
1961 *Geology of Kentucky* (2nd, revised edition). University of Kentucky, Lexington.

McGrain, Preston and James C. Currens
1978 *Topography of Kentucky*. Special Publication No. 25, Kentucky Geological Survey, University of Kentucky, Lexington.

McKee, Harley J.
1973 *Introduction to Early American Masonry: Stone, Brick, Mortar and Plaster*. National Trust for Historic Preservation/Columbia University, Washington.

Murray-Wooley, Carolyn and Karl Raitz
1992 *Rock Fences of the Bluegrass*. University Press of Kentucky, Lexington.

Raup, H. F.
1947 The Fence in the Cultural Landscape. *Western Folklore* 6 (1):1-12.

Riedl, Norbert F., Donald B. Ball, and Anthony P. Cavender
1976 *A Survey of Traditional Architecture and Related Material Folk Culture Patterns in the Normandy Reservoir, Coffee County, Tennessee*. Report of Investigations No. 17. Department of Anthropology, University of Tennessee, Knoxville.

Sims, Raymond P., Darwin G. Preston, Alfred J. Richardson, John H. Newton, Dan Isgrig, and Robert L. Blevins
1968 *Soil Survey of Fayette County, Kentucky*. U.S. Department of Agriculture, Soil Conservation Service. Government Printing Office, Washington, D.C.

Schlereth, Thomas J. (editor)
1982 *Material Culture Studies in America*. American Association for State and Local History, Nashville.

Sizemore, Jean
1994 *Ozark Vernacular Houses: A Study of Rural Homeplaces in the Arkansas Ozarks, 1830-1930*. University of Arkansas Press, Fayetteville.

Sloane, Eric
1974 *Our Vanishing Landscape*. Ballantine Books, New York.

Tufnell, Richard N.
1995 *Building & Repairing Kentucky Stone Fences*. Drystone Masonry Conservancy, Inc., Lexington.

Weisenberger, Billy C. and Dan Isgrig
1977 *Soil Survey of Scott County, Kentucky*. U.S. Department of Agriculture, Soil Conservation Service. Government Printing Office, Washington, D.C.

Wood, Pamela (editor)
1977 *The Salt Book*. Anchor Books, Anchor Press/Doubleday, Garden City, New York.

Zelinsky, Wilbur
1959 Walls and Fences. *Landscape* 8 (3):14-18.

WINDOW GLASS AND THE GOWER HOUSE (15Lv178): AN APPLICATION OF DONALD BALL'S DATING FORMULA

By

Sara J. Rivers
Anthropology Program
Murray State University
Murray, Kentucky

ABSTRACT

Window glass is one of the most abundant types of artifacts found on historic sites. The Gower House Site (15Lv178) is no different in this respect. The proper analysis of the Gower House window glass assemblage might be revealing about the history of the site, including its construction and the two hundred years of deposits that are now being excavated. The following is a report of the analysis conducted with the window glass from the Gower House detached kitchen area including a description of the site, a brief history of American window glass manufacture, a discussion of the potential information that window glass can give archaeologists, and an analysis of the Gower House glass with special attention to the application of Donald Ball's (1983) window glass dating formula.

INTRODUCTION

The Gower House (15Lv178) is a historic tavern and hotel located in Smithland, Livingston County, Kentucky at the confluence of the Cumberland and Ohio Rivers. A town with a rich historical background, Smithland's economy was built upon steamboat travel and trade in the nineteenth century. The Gower House was occupied from the early nineteenth-century until the 1960s and it now stands empty and awaiting renovation. In an attempt to salvage the archaeological record before renovations destroy the deposits surrounding Gower House, Dr. Kenneth C. Carstens and his students at Murray State University have undertaken extensive research at the site. Thus far, the research team has conducted a surface survey of the inlot area, begun salvage excavations of a detached kitchen area, and located the foundation of a razed structure which had mirrored the standing portion of Gower House. The survey and excavation of the detached kitchen area revealed historical artifacts reflective of a tavern and hotel. Ceramics, bone, and glass make up the majority of the assemblage indicating food service and preparation. Window glass makes up a great deal of this assemblage.

Excavation of the Gower House detached kitchen area has characteristics which should be noted. First, the units thus far excavated have been excavated by a number of people. Unit 1 was excavated by Jay Stottman and the Kentucky Archaeological Survey, and was the only test unit to be excavated by natural stratigraphic levels. The remaining four units of the detached kitchen area were excavated at 10 cm intervals. These excavations were conducted by supervised volunteers from local high schools and Introduction to Archaeology classes at Murray State. A recent flood in Smithland collapsed the original test pit walls, making accurate profiles elusive. It also should be noted that excavation is not complete, and Units 1-5, the detached kitchen area, are presently at different levels of excavation. Unit 4 has been excavated only to four levels because it is almost entirely filled by the stone foundation of the kitchen. It is believed, however, that window glass analysis at this point is valid because original window glass should be deposited at a time of demolition or repair, not at construction and thus the original glass already should have been excavated.

While these problems serve to complicate the matter of artifact analysis, they also increase the need for it. Studying window glass is well worth the effort if it can reveal anything about the stratigraphy of the detached kitchen area. It also may allow for a better estimate of a date for the levels still being excavated.

OBJECTIVES

For archaeologists, the value of window glass is related primarily to its potential to provide dates for a site. This makes window glass particularly valuable at Gower House because the earliest records of Gower House, including documentation of its construction were destroyed in a fire in 1831 (Berryman 1997). While many dates have been proposed for the construction of Gower House, none have proven definitive. Thus the objective of this study is to determine a construction date, and also to explore other characteristics of window glass that may provide additional information about the Gower House.

OBSTACLES

There are obstacles facing the window glass analyst that must be outlined at the start because they are what determine research methods and analysis. Flat glass has two very frustrating variations: thickness and color. What makes these elements frustrating is not that one cannot make scientific assessments about thickness and color, one certainly can. The problem is that the implications of variation in color and thickness, while they are certainly valuable, are also difficult to sort out.

For example, the problem of color is that there are an infinite number of tints that glass can exhibit. How, in such a situation, can one create categories in which each artifact can fit? More often than not the line between green tinted glass and blue tinted glass is as blurry as any distinction can be. Some pieces of glass are definitely tinted green and others are certainly blue. It is all of the hundreds of pieces that are some combination of the two that make classification so difficult.

The source of the dilemma lies in manufacturing. The one unifying characteristic of all types of window glass manufacture is that glass is made in batches. Each batch contains the needed raw materials and chemicals, but until the twentieth-century, there was no way to be certain that each batch contained the same amount of each ingredient. As a result every batch resulted in glass with unique characteristics. Thus an archaeological assemblage of window glass is not the type of thing that definitively can be divided into a few distinct color categories.

Thickness is much the same. During most of the nineteenth-century, window glass was made by hand. This created inevitable variation in thickness not only between batches, but also within each pane of glass.

Nevertheless, thickness and color do have chronological implications in window glass assemblages, and given that window glass is one of the most common artifacts on historic sites, it is well worth the effort it takes to make sense of it.

WINDOW GLASS MANUFACTURE

In order to create any kind of typological scheme for window glass, one must first understand how it was made. This summary will focus on the period of the Gower House, the nineteenth and twentieth centuries.

CROWN GLASS

In 1800 the predominant type of window glass in the United States was crown glass. Crown glass is made by the creation of a globe of glass at the end of a blow pipe which was then opened at one end and spun until it formed a great disk attached to the blow pipe at its center (Frank 1982:25; Rogers and Beard 1938; Wilson 1976). This method dominated glass manufacture until about 1840 when it was replaced by the more economical cylinder glass which will be discussed later (Ison 1990). Crown glass is extremely thin, said to range in thickness from 0.92 mm (0.036 in) to 1.14 mm (.045 in) (Ison 1990). However, there is a great deal of variation in crown glass thickness. According to Wilson (1976) an ad for crown glass made in Boston in the late 1700s describes it as "good and brilliant glass that was quite thick and strong," indicating that thickness was a favorable trait. Frank (1982), however, says that thinner glass was more desirable because it let more light flow through the rather dark colored glass of the day. Thus it is unclear whether the higher quality glass was thick or thin, but it is certain that there was variation. In addition, each disk made contains its own variation between thickness at the center versus thickness at the perimeter. The only way to determine the degree of this variation would be to study a sizable assemblage of whole disks.

CYLINDER GLASS

Cylinder glass is made by again creating a bubble of glass at the end of a blowpipe but then swinging it to lengthen it into a cylinder which is then cut and heated to lay flat (Rogers and Beard 1938:141; Wilson 1976). Cylinder glass is thicker than crown glass by about 40 percent (Ison 1990). This is probably because the stress put on it by swinging would not allow it to be extremely thin without breaking. This glass type should have an average thickness of 1.28 mm (0.050 in) to 1.42 mm (0.056 in) and the thickness did increase through time as thicker glass became more desirable (Ison 1990).

PLATE GLASS

Plate glass did not become dominant until its production was mechanized in the 1930s when large factories could roll it out and polish it in mass quantities (Ison 1990; Rogers and Beard 1938). Variation of plate glass is not nearly as significant as in cylinder and crown glass because mechanization stabilized both thickness and color. Plate glass still dominates the window glass industry today.

COMPOSITION

The chemical composition of glass has changed throughout the past two hundred years primarily in an effort to attain a perfectly clear color. Unfortunately for the archaeologist, color changes resulting from new chemistry innovations do not necessarily coincide with changes in manufacturing techniques and no universal rules exist connecting particular time periods to particular colors. Sufficed to say that as time passed, manufacturers were able to come up with chemicals which made glass clearer and so a general trend from darker to clearer glass exists (Ison 1990). This certainly should not be applied in such a way as to place two pieces of glass side by side and declare the darker one older, but when whole assemblages of window glass show a trend in color change from one archaeological level to another a pattern exists which does have chronological implications.

DISCUSSION

Because the nineteenth century is dominated by two very different types of window glass manufacture the application of a single linear formula to the whole century would be to disregard the 40% increase in thickness of cylinder glass over crown glass. Both types of glass did increase in thickness over their own periods of production, but they still need to be separated when dating formulas are calculated.

DONALD BALL'S DATING FORMULA

In 1983 Donald Ball developed a linear formula for dating window glass based on the theory that thickness increased throughout the nineteenth-century. Ball's (1983) formula stated that:

$$D = \frac{M - 1.00\text{ mm}}{0.0286} + 1800$$

where D is the date and M is the mean thickness in millimeters of the glass assemblage. This formula was originally designed to apply to sites from 1800 to at least 1870 (Ball 1983). Ball (personal communication 1997) has revised that statement, however, and now says that the formula is close to the actual date until 1840 and becomes inapplicable after 1845. This makes sense given that 1840 is the date given for the beginning of cylinder glass domination (Ison 1990). Thus the Ball formula applies to a specific type of glass within a specific date range. For those sites which were built between 1800 and 1840 Ball's (1983) formula has proven to be very close. An example is a study done by Carkskadden and Morton (1988) on the glass from a Muskingum Valley site of known occupation from about 1816 to 1820. This study produced a date about a year earlier than the documented date of construction (Carskadden and Morton 1988).

What implications does this have for Gower House? Ball's (1983) formula, because it is accurate for only the first half of the nineteenth-century, is only applicable to the first quarter of Gower House's occupation. But it is that early quarter of deposition that this study is attempting to date.

METHODS AND RESULTS

COLOR ANALYSIS

Some analysts have divided glass into three color categories; clear, blue, and green (Ball 1983; Ball and Bader 1997; Carskadden and Morton 1988). These categories, however, encompass an extremely variable assemblage of artifacts when applied to Gower House. As previously mentioned, the distinction between blue and green glass can be very subjective. Thus rather than dividing the glass assemblage into color categories, each sample of glass from each unit level was examined as a whole for overall color characteristics. Generalizations were then made and added to the notes describing the whole sample in terms of dark, medium, or light tints. These assessments were made based upon the tint as it appeared relative to the whole glass assemblage.

While this method is very general, the application of a few color categories in an assemblage with so much variability could be misleading. Many different tints of glass were often produced simultaneously. The chronological overlap of color tints makes a particularist approach illogical. Thus because the trend from dark to clear glass is a very general one, occurring over a very long period of time, the Gower House glass was examined for general trends that might correlate the color of glass with stratigraphy through time.

The result of this analysis is what would be expected: the deeper the level, the darker, and thus older the glass (Table 1).

THICKNESS

The thickness of each window glass fragment was measured to the nearest hundredth of a millimeter with an electronic micrometer. Some analysts have measured each piece of glass three times, and averaged those measurements to account for thickness variation within each piece (Roenke 1978). Each fragment in the Gower House sample, however, was measured only once at the center of the piece according to the advice of Grosscup (1979) who felt that "one measurement on each sherd would be sufficient as long as the sample is fairly large and we are dealing with modal distributions." These measurements were entered into a spreadsheet to facilitate the calculation of a mean thickness measurement. This measurement was then plugged into Ball's (1983) formula to determine a date for the sample from each unit level.

Although panes of glass are replaced as they break, and it is very possible that the original glass of Gower House's windows could be found in all levels, it is expected that as depth increases, the mean date of the glass should decrease. The resulting dates do not conform to the rule that as the level deepens, the date becomes older, however (Tables 2-6). Instead, the dates show a *general* trend towards older glass being below newer glass (Figure 1). This is especially true of Units 1-3 which are side by side and have been excavated to the same level (Figure 2).

RESULTS

The latest date given for a sample of glass at the site is 1833, which came from Unit 3 Level 8. For a site which was inhabited up until the 1960s, clearly these dates are very low. This is probably because the adjustment has not yet been made to account for Ball's (1983) formula becoming inaccurate after 1845. A typology will need to be created to separate the pre-1845 glass from the post-1845 years.

Table 1. Generalizations of Glass Tints Per Unit Level of the Gower House Detached Kitchen Area. Asterisks indicate no artifacts and the first description when two are given is the predominant one and the last is the least abundant (Example; medium/light/clear = mostly medium tinted glass, some lightly tinted glass, and a few clear pieces of glass). A hyphen indicates a pretty even mixture.

	UNIT 1	UNIT 2	UNIT 3	UNIT 4	UNIT 5
LEVEL 1	light/clear	light /clear	light/clear	light/medium/ clear	clear/light/ medium
LEVEL 2	light/clear/ medium	light/clear	light/medium	light	light-medium
LEVEL 3	light/medium /dark	light-medium	light-medium	medium/light	medium/light
LEVEL 4	medium/dark	light-medium	light/medium	light/medium	medium/light
LEVEL 5	medium/dark	medium	light/medium	***	light/medium
LEVEL 6	medium/dark	light	medium/light	***	***
LEVEL 7	medium/dark	medium/light	light	***	medium
LEVEL 8	medium/dark	light-medium	light	***	***

Table 2. Unit 1, Mean Thicknesses and Date Results.

Unit Level	n=	Mean Thickness (to nearest 0.01 mm)	Date
1	58	1.62	1822
2	75	1.63	1822
3	165	1.32	1811
4	263	1.27	1809
5	15	1.32	1811
6	33	1.33	1811
7	8	1.13	1804

Table 3. Unit 2, Mean Thicknesses and Date Results.

Unit Level	n=	Mean Thickness (to nearest 0.01 mm)	Date
1	84	1.67	1823
2	52	1.58	1820
3	23	1.50	1817
4	35	1.34	1812
5	19	1.32	1811
6	6	1.21	1806
7	6	1.26	1809
8	17	1.27	1809

Table 4. Unit 3, Mean Thicknesses and Date Results.

Unit Level	n=	Mean Thickness (to nearest 0.01 mm)	Date
1	121	1.83	1829
2	63	1.55	1819
3	55	1.29	1810
4	6	1.38	1813
5	4	1.29	1810
6	5	1.07	1802
7	2	1.20	1807
8	2	1.95	1833

Table 5. Unit 4, Mean Thicknesses and Date Results.

Unit Level	n=	Mean Thickness (to nearest 0.01 mm)	Date
1	109	1.99	1835
2	54	1.54	1819
3	3	1.64	1822
4	8	1.36	1813

Table 6. Unit 5, Mean Thicknesses and Date Results.

Unit Level	n=	Mean Thickness (to nearest 0.01 mm)	Date
1	14	1.58	1820
2	300	1.60	1821
3	81	1.35	1812
4	19	1.30	1810
5	12	1.59	1821
6	0	---	---
7	1	1.26	1809

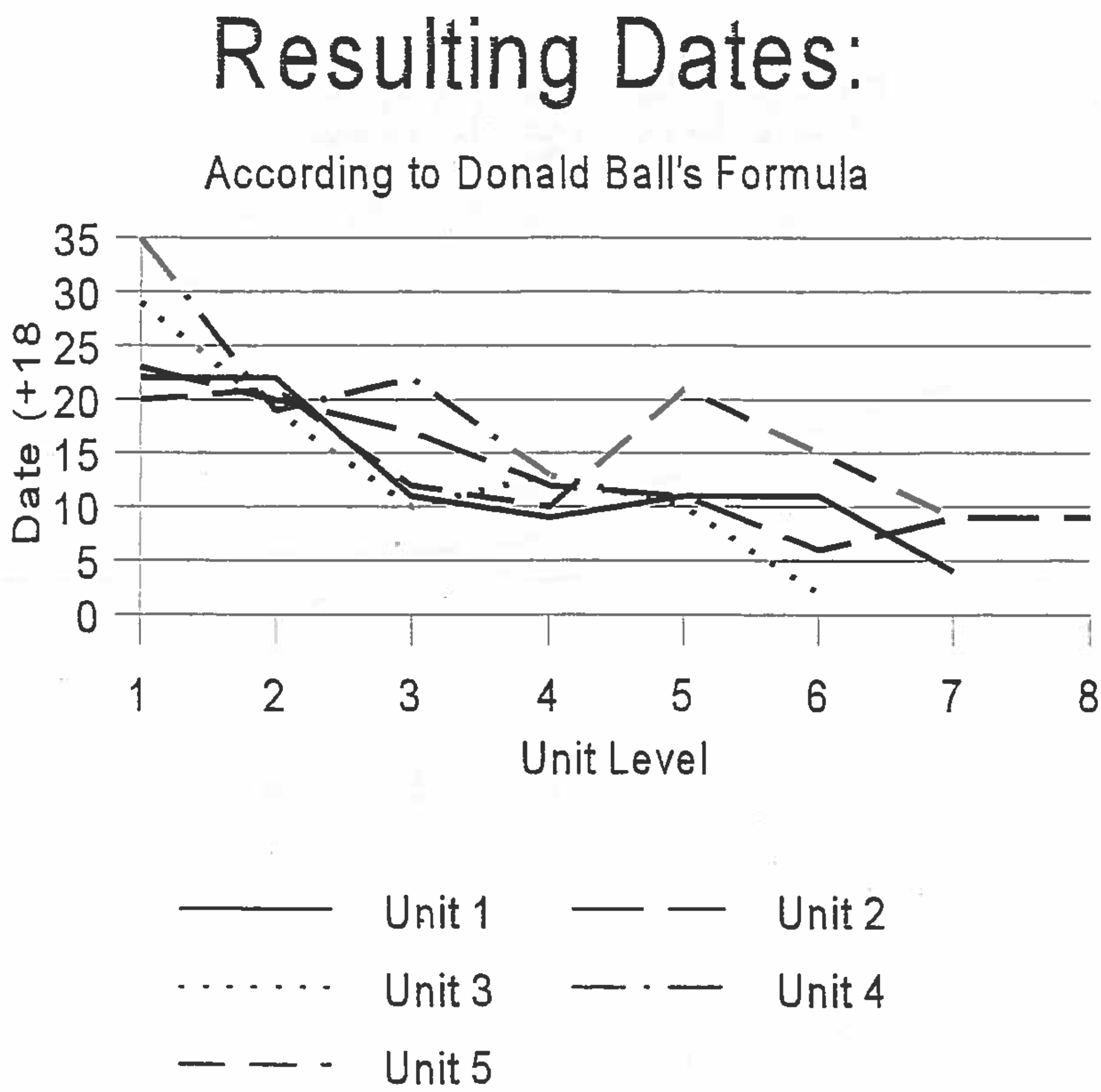


Figure 1. Resulting Dates from Donald Ball's Dating Formula.

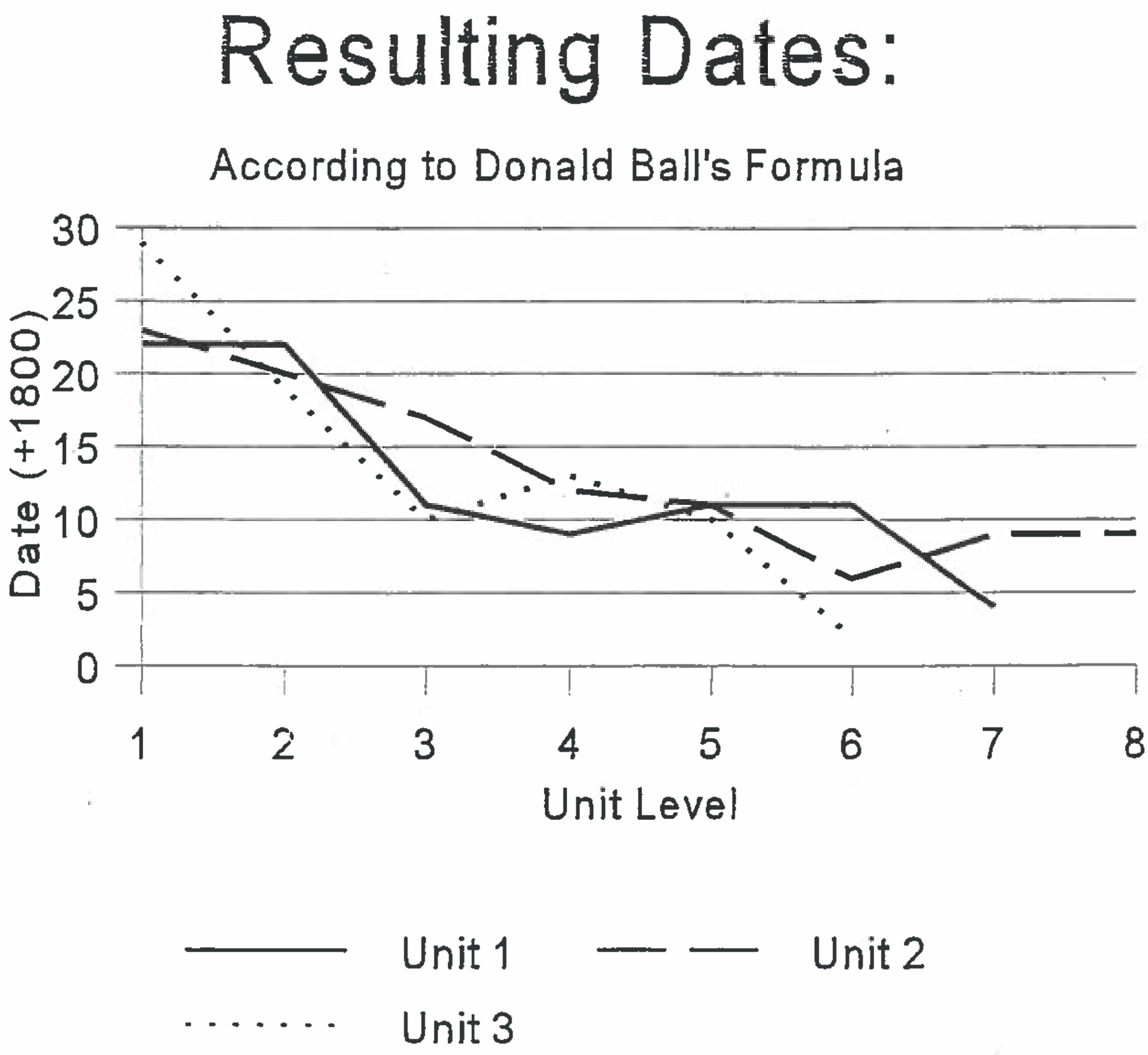


Figure 2. Resulting Dates from Donald Ball's Dating Formula Without Units 4-5.

TYPOLOGY

Crown glass is more transparent than cylinder glass. It has a better finish because it is never laid out on any surface, and concentric circles can sometimes be seen on it (Ison 1990). The wear that a piece of glass obtains while in use and while deposited in the ground, however, can alter it enough to make it look like every other piece of scratched up flat glass. Additionally, overlap between thin cylinder glass and thick crown glass prevents the use of a thickness measurement to accurately sort the two types. The best one can do is determine a minimum number of pieces of crown glass.

According to historical literature, cylinder glass was not made as thin as crown glass, which averaged from 0.91 mm (0.036 in) to 1.14 mm (0.045 in) (Ison 1990). Thus for purposes of separation, all pieces of glass below 1.14 mm were counted and classified as crown glass. It is not sound to apply Ball's (1983) formula to those pieces of glass determined to be crown glass by this study because 1.14 mm is an experimental cut off, not a determination of typology. It is a given that some of the glass from the sample in what will be labeled "other" should be included in the application of the formula and not to include them would be to create inaccurately low dates.

One can also count a minimum number of pieces of modern plate glass. Around 1860 a standard thickness for glass was developed through mechanization which began with a thickness of about 1.70 mm (0.070 in) (Ison 1990). In order to account for some overlap and to make sorting easier, a cut off of 2.00 mm was used to separate the newer standardized glass from other types. All pieces of glass falling between 1.14 mm and 2.00 mm were designated as "other" because this group should contain both thick crown glass, cylinder glass and thin plate glass. Counts were made and percentages were figured for each unit level (Tables 7-11). This study revealed that all of the units excavated to 80 cm or more exhibited a dominance of crown glass or a major rise in crown glass towards the bottom of the excavation units (Figures 3-7).

The lower levels at Gower House exhibit a dominance of glass used before 1845, which means that Ball's (1983) formula can be applied to these unit levels. This legitimizes the dates already calculated for the lower levels of each test unit.

Unfortunately for the Gower House, it is precisely these levels that have the smallest sample size of glass, so the results lose some power, but the combination of these dates provides a decent approximation of a date for construction of the Gower House detached kitchen which will be discussed in the conclusion.

UNIT 1

It is beneficial to take a closer look at Unit 1 because it was excavated by natural levels and did show some unique characteristics (Figure 8). Of particular interest is Stratum 4 with the largest sample size of any level by nearly 100 artifacts at n=263. These pieces of glass are also strikingly similar in tint and thickness indicating that the sample is the result of some type of demolition where many of the same window types were deposited at once. Stratum 4 is described as ash fill with charcoal (Stottman 1996). Stottman (1996) notes that, "A higher frequency of window glass would be expected with demolition type activities or repair activities," and that Stratum 4, "may actually represent clean-up and repair activities to the structure." The date calculated for this unit level is 1809. It is believed that this sample is representative of the deposition of the original detached kitchen windows and that 1809 is a strong candidate for a date of construction.

Table 7. Unit 1 Type Frequencies of Glass Where all Glass With a Width of 1.14 mm or Less is Crown, all Glass Greater than 2.00 mm in Width is Plate, and the Rest is Unidentifiable by Thickness and Classified as "Other."

LEVEL	n=	CROWN	%	PLATE	%	OTHER	%
1	58	4	7%	17	29%	37	64%
2	75	13	17%	24	32%	38	51%
3	165	36	22%	4	2%	125	76%
4	263	61	23%	0	---	202	77%
5	15	4	27%	0	---	11	73%
6	33	7	21%	0	---	26	79%
7	5	2	40%	0	---	3	60%
8	3	2	67%	0	---	1	33%

The other units were examined to look for a correlation of this hypothesis. A check of the levels which would have included this elevation in Units 2-5, however, illustrates that the window glass sample is not nearly as large, and Unit 1 appears to be a concentration.

DISCUSSION AND CONCLUSIONS

It is very difficult to make scientific assessments of window glass on sites with a long period of occupation. The ideal time to analyze window glass is when one is studying a site of limited occupation which happens to fall somewhere in the time range and region of a dating formula such as Ball's (1983). Occupations over a long period of time which extend into the nineteenth and twentieth centuries require much more understanding in order for the window glass to be accurately assessed, and in this case the study becomes less scientific and more intuitive.

The application of Ball's (1983) window glass dating formula to the Gower House assemblage is only partially valid because the Gower House was inhabited long after the temporal usefulness of the formula. Any glass which may have replaced windows in the Gower House after 1845 can not accurately be dated with Ball's (1983) formula. This study has attempted to sort out glass which can be dated from the glass that cannot. The method used to sort was identifying those pieces of glass that were definitely crown glass and thus applicable to Ball's (1983) formula. This was examined for patterns in stratigraphy. Because the lower levels of the test units illustrate a rise in crown glass and a decline of other types of glass, it is believed that the resultant dates of Ball's (1983) formula from these levels is significant. The dates of levels seven and eight from each unit were averaged, resulting in an 1812 date (Table 12). The mode date of all unit levels is 1811, and as previously mentioned, the significant Unit 1 Stratum 4 resulted in a date of 1809. Thus the result of this analysis is a date for the construction of the Gower House detached kitchen of approximately 1809-1812, a very feasible date given all that has already been learned about the site.

Table 8. Unit 2 Type Frequencies of Glass Where all Glass With a Width of 1.14 mm or Less is Crown, all Glass Greater than 2.00 mm in Width is Plate, and the Rest is Unidentifiable and Classified as "Other."

LEVEL	n=	CROWN	%	PLATE	%	OTHER	%
1	84	11	13%	35	42%	38	45%
2	52	8	16%	9	17%	35	67%
3	23	2	9%	1	4%	20	87%
4	35	3	9%	0	—	32	91%
5	19	3	16%	0	—	16	84%
6	6	3	50%	0	—	3	50%
7	6	1	17%	0	—	5	83%
8	17	6	35%	0	—	11	65%

Table 9. Unit 3 Type Frequencies of Glass Where all Glass With a Width of 1.14 mm or Less is Crown, all Glass Greater than 2.00 mm in Width is Plate, and the Rest is Unidentifiable and Classified as "Other."

LEVEL	n=	CROWN	%	PLATE	%	OTHER	%
1	121	8	7%	45	37%	68	56%
2	63	6	10%	9	14%	48	76%
3	55	16	29%	1	2%	38	69%
4	6	0	—	0	—	6	100 %
5	4	0	—	0	—	4	100 %
6	5	4	80%	0	—	1	20%
7	2	1	50%	0	—	1	50%
8	2	0	—	1	50%	1	50%

Table 10. Unit 4 Type Frequencies of Glass Where all Glass With a Width of 1.14 mm or Less is Crown, all Glass Greater than 2.00 mm in Width is Plate, and the Rest is Unidentifiable and Classified as "Other."

LEVEL	n=	CROWN	%	PLATE	%	OTHER	%
1	109	6	6%	55	50%	48	44%
2	54	14	26%	11	20%	29	54%
3	3	0	—	1	33%	2	67%
4	8	1	12.5 %	1	12.5 %	6	75%

Table 11. Unit 5 Type Frequencies of Glass Where all Glass With a Width of 1.14 mm or Less is Crown, all Glass Greater than 2.00 mm in Width is Plate, and the Rest is Unidentifiable and Classified as "Other."

LEVEL	n=	CROWN	%	PLATE	%	OTHER	%
1	14	0	—	0	—	14	100 %
2	300	40	13%	64	21%	196	65%
3	81	15	19%	1	1%	65	80%
4	19	4	21%	0	—	15	79%
5	12	0	—	2	17%	10	83%
6	0	—	—	—	—	—	—
7	1	0	—	0	—	1	100 %
8	0	—	—	—	—	—	—

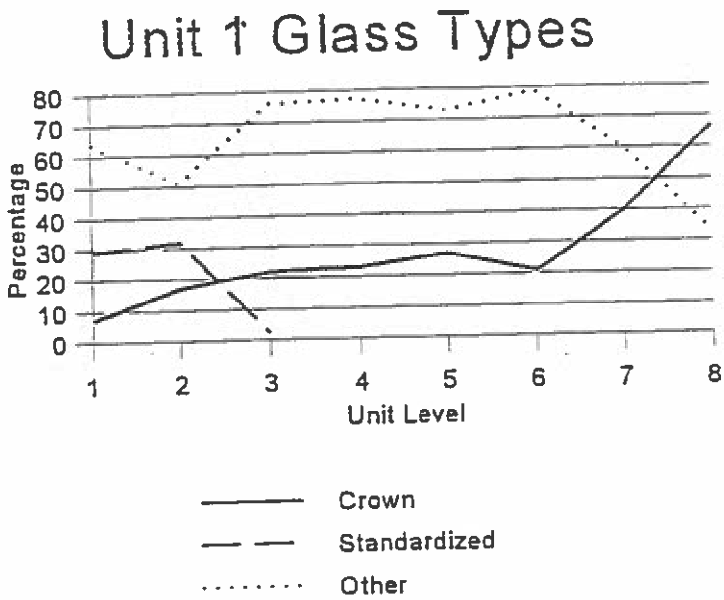


Figure 3. Glass Types in Unit 1.

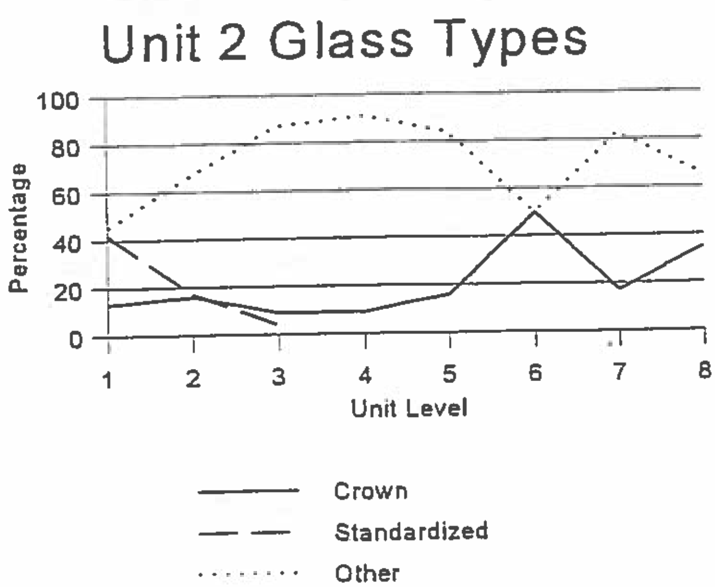


Figure 4. Glass Types in Unit 2.

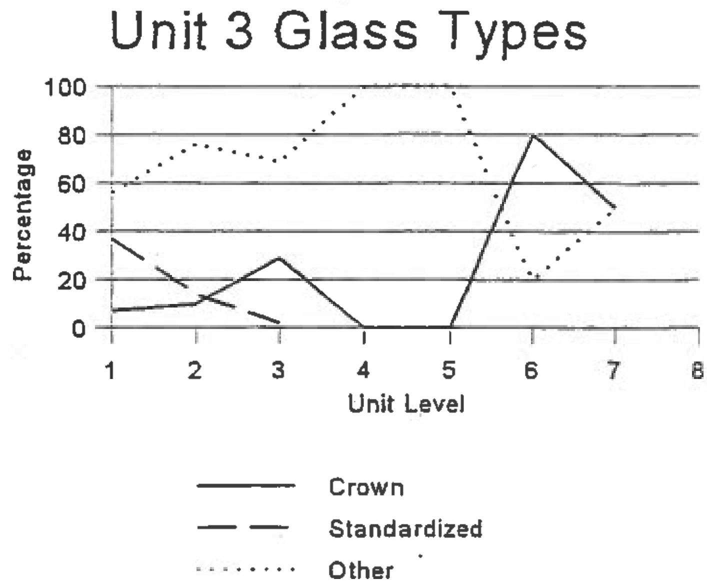


Figure 5. Glass Types in Unit 3.

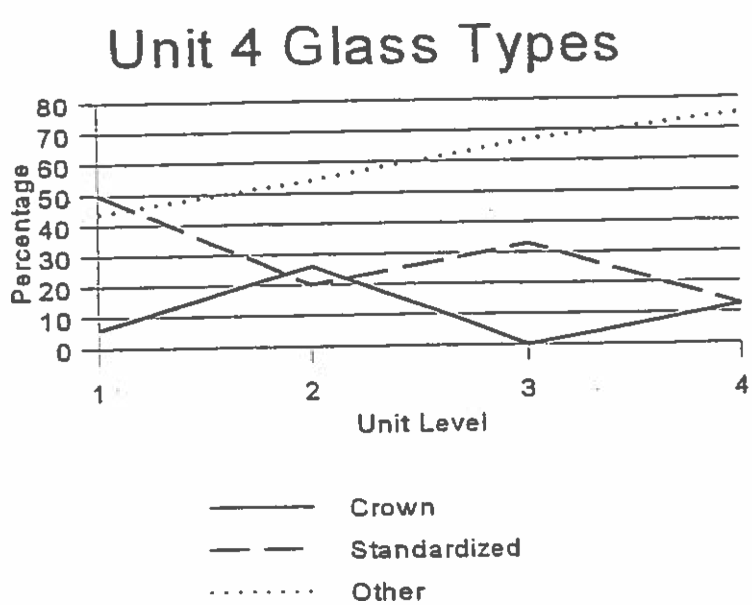


Figure 6. Glass Types in Unit 4.

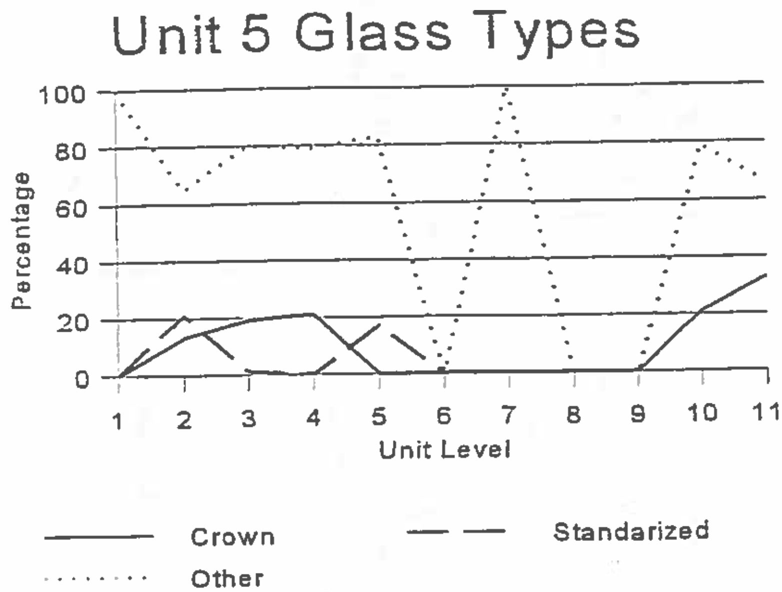


Figure 7. Glass Types in Unit 5.

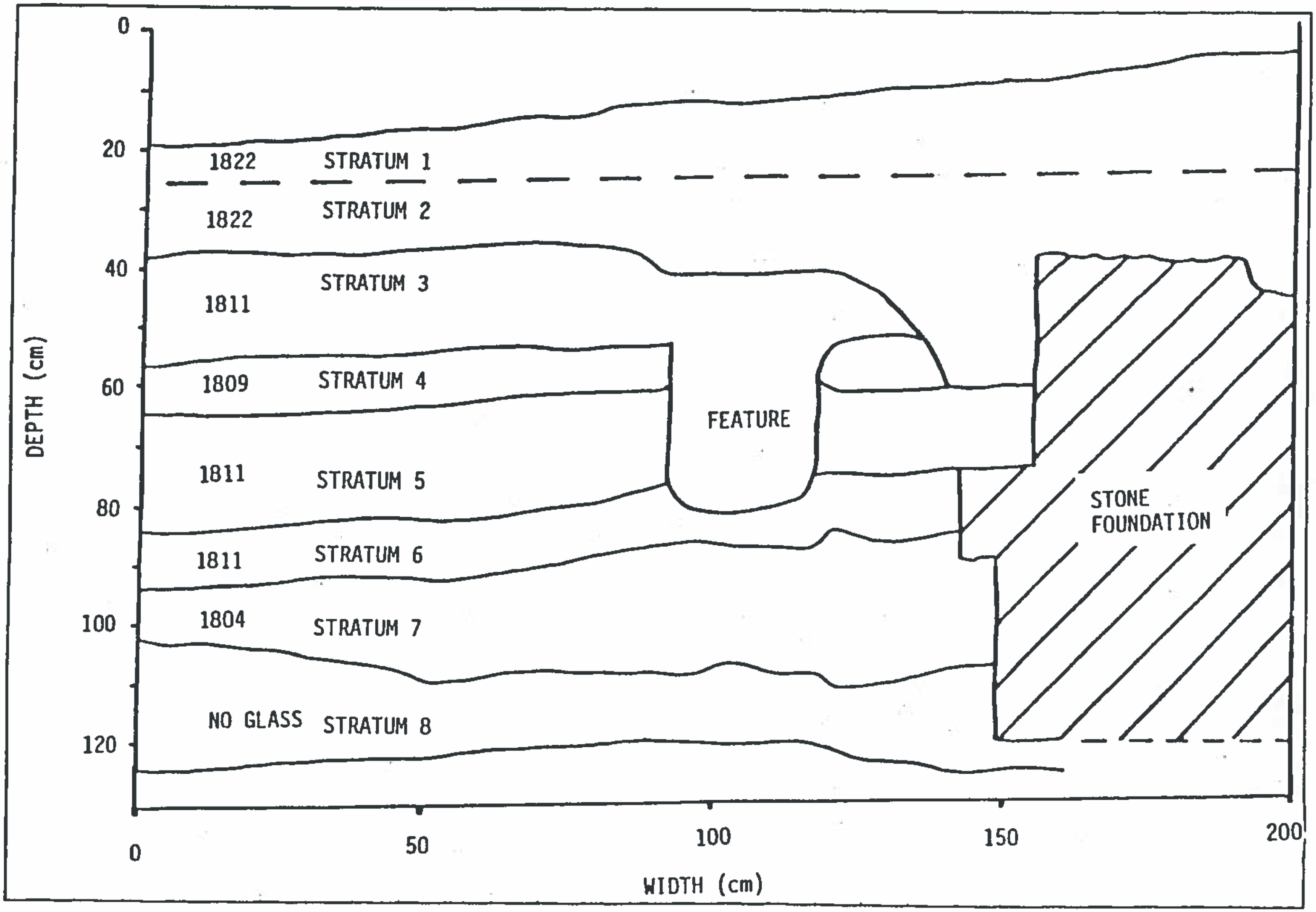


Figure 8. Profile of the North Wall of Unit 1 Showing Strata and the Coinciding Date According to Don Ball's Formula (Adapted from Stottman 1997).

Table 12. Average of Dates Considered Legitimate.

UNIT, LEVEL	N=	DATE
Unit 1, Level 7	8	1804
Unit 2, Level 7	6	1809
Unit 2, Level 8	17	1809
Unit 3, Level 7	2	1807
Unit 3, Level 8	2	1833
Unit 5, Level 7	1	1809
	TOTAL= 36	MODE= 1809 MEAN= 1812

ACKNOWLEDGMENTS

The author extends sincere thanks to Donald Ball for his help and guidance with collecting sources and answering questions. Thanks is also due to Ken Carstens and Kit Wesler for their continued support, and Ken Allgood for giving references and making sure all of the glass was sent straight to the author's desk. Finally, the author thanks the Kentucky Archaeological Survey, the Kentucky Heritage Council, and the owners of Gower House, Robert Roberts and Diane and Danny Fraily for their continued support of Gower House research.

REFERENCES CITED

Ball, Donald B.

1983 Approaches Toward the Dating of 19th Century Ohio Flat Glass. In *Proceedings of the Symposium on Ohio Valley Urban and Historical Archaeology, Volume* I, edited by Donald B. Ball and Phillip J. DiBlasi, pp. 129-137. Louisville, Kentucky.

Ball, Donald B. and Anne T. Bader

1997 Limited Archaeological Investigations at the David Crabill House, A National Register Property at the Clarence J. Brown Reservoir, Clark County, Ohio. Report submitted to the U. S. Army Corps of Engineers, Louisville District, Louisville, Kentucky.

Berryman, Carrie Anne

1997 Folklore and Historic Research Concerning the Gower House (15Lv178). Paper presented at the Southeastern Archaeological Conference, November 5-8, 1997, Baton Rouge, Louisiana.

Carskadden, Jeff and James Morton

1988 Application of Ball's Flat Glass Dating Formula at an Early 19th Century Iron Makers' Cabin, Muskingum County, Ohio. *Ohio Valley Historical Archaeology*

6:74-82.

Frank, Susan
1982 *Glass and Archaeology*. Academic Press, New York, New York.

Grosscup, Gordon L.
1979 Review of "Flat Glass: Its Use as a Dating Tool for Nineteenth Century Archaeological Sites in the Pacific Northwest and Eslewhere", by Karl G. Roenke. *Historical Archaeology* 13:123-124).

Ison, Betty Sue
1990 Window Glass in Kentucky, 1790-1940: Potential Characteristics and Variation of the Archaeological Assemblage as Produced by the Processes of Manufacture, Distribution, Use, and Deposition. M. A. thesis, Department of Anthropology, University of Kentucky, Lexington.

Roenke, Karl G.
1978 Flat Glass: Its Use as a Dating Tool for Nineteenth Century Archaeological Sites in the Pacific Northwest and Elsewhere. *Northwestern Anthropological Research Notes Memoir* No. 4. University of Idaho, Moscow.

Rogers, Frances and Alice Beard
1938 *5000 Years of Glass*. Frederick A Stokes Company, New York, New York.

Stottman, M. Jay
1997 A Report of the Excavation of Unit #1 at the Gower House (15Lv178). Report submitted to the Kentucky Archaeological Survey, Louisville, Kentucky.

Wilson, Kenneth M.
1976 Window Glass in America. In *Building Early America: Contributions Toward the History of a Great Industry*, edited by Charles E. Peterson, pp. 150-164. Chilton Book Company, Radnor, Pennsylvania.

GUNS IN THE BLUEGRASS: FIREARM RELATED ARTIFACTS FROM McCONNELL STATION (15BB75), BOURBON COUNTY, KENTUCKY

By

Donald B. Ball
Louisville District
U.S. Army Corps of Engineers
Louisville, Kentucky

ABSTRACT

The interpretive potential of firearms related artifacts recovered from civilian sites is frequently under appreciated by many historic archaeologists. This examination of an assemblage of arms related materials from an early station and subsequent farmstead in Bourbon County, Kentucky, affords several informative insights into firearms ownership and use in this portion of the Commonwealth from the years following the Civil War until the Great Depression era. The nature of these materials has allowed for an assessment of the variety of weapons and Minimum Number of Firearms (MNF) at the two homes known to have stood at this site, the economics and applications of firearms usage, hunting patterns, and the market share held by various ammunition manufacturers.

INTRODUCTION

Though firearms and associated artifacts are typically few in number on any given site, historical archaeologists have long been aware of the presence of munitions related materials throughout the region. Indeed, materials of this nature have been recovered from a variety of civilian sites within the general Ohio Valley region and have yielded both interesting and useful insights into the appearance and use of these items since the early colonial period. But a sampling of such regional studies includes sites such as the James White Second Home Site (ca. 1788-1852) in Knoxville (Knox County), Tennessee (Faulkner 1984:136-140); Zumwalt's Fort (late 1790s-ca. 1930), a pioneer homestead in St. Charles County, Missouri (Cotter and Gilbert 1979; Waselkov 1979:80); the Kelley farmstead in Lawrence County, Ohio (Thomas 1996:29, 31); the First Hermitage Site (1804-1860) on the grounds of President Andrew Jackson's plantation near Nashville (Davidson County), Tennessee (Smith, ed. 1976:192-194); Waveland (1847-1956+), a plantation in Fayette County, Kentucky (Pollack and Hockensmith 1985:45); and the ca. 1880-1885 Crawford-Nurre sawmill in Williamsburg (Whitley County) Kentucky (Ball 1998). Routinely small in size, such munition assemblages tend to reflect hunting related activities. Firearms ownership and use was not restricted to rural areas. Intriguingly, every major urban archaeological project undertaken to date within Frankfort, the state capitol of Kentucky, has also yielded firearm related artifacts (Ball 1996; Deiss 1988:75-77; Essary et al. 1993:40, 53; Fay 1986:102-104; Genheimer 1988:94).

This study specifically addresses an assemblage of firearm related artifacts recovered from two house sites at McConnell Station (15Bb475) on the west side of Paris Pike in Bourbon County, (north-central) Kentucky. The earliest of the two structures may have been constructed as early as 1788 by William McConnell (O'Malley 1987:71). He died in 1823 and is reported to have been buried in a family cemetery on the property (O'Malley 1987:72). His farmstead consisted of at least 1,000 acres (404.7 ha) (O'Malley 1987:72-74). Preliminary identification of the materials recovered from excavations undertaken in 1998 have dated the first structure from ca. 1790 to about 1870. The, second and chronologically later house, dated from the late nineteenth or early twentieth century. This structure ceased to exist prior to the 1960s. As will be discussed below in greater detail, both the nature and distribution of these materials have provided a number of insights into firearm ownership and use in this portion of the state. A report for these investigations is presently being prepared by Grant Day of Cultural Resource Analysts, Inc., of Lexington, Kentucky.

ARTIFACT TYPOLOGY

Extensive Phase III excavations at and near the remains of two domestic structures at McConnell Station recovered a total of 94 firearm related artifacts. Earlier Phase II excavations at this site yielded a total of 18 artifacts identified as firearm related materials: 7 - .22 BB rimfire caps; 4 - .22 Short rimfire cases; 1 - .32 "extra short" rimfire case; 2 - .32 centerfire cases produced by the Union Metallic Cartridge Company (UMC), 1 - .38 "short" centerfire produced by UMC; "two crushed brass casings that are also probably ammunition"; and 1 minie ball of unspecified caliber, design, and weight (O'Malley 1992:55). The bulk of these materials date from the 1850s-1870s or likely later. With the exception of the minie ball, these items are generally replicated in the present assemblage. These materials were not re-analyzed as part of the present study.

For ready reference, the Phase III materials are inventoried by artifact type and the provenience from which they were retrieved in Table 1. Metal preservation was generally good within this sample though a number of cases had been partially to totally crushed through the years. All of the recovered sample was reflective of civilian firearm use. Though numerically small, the examination of these remains allow for the extrapolation of minor but interesting insights into the ownership and use of firearms in this portion of Kentucky's Blue Grass region from shortly after the Civil War to sometime prior to World War II.

Despite the shift within archaeology toward the utilization of metric measurements, the present comments will retain traditional English units as expressed in caliber, gauge, projectile weight, and cartridge case dimensions. As appropriate, these units will be further defined within the text. The following comments and interpretive observations will address two straightforward but interrelated questions concerning this assemblage: "What was found?" and "What is learned from it?" The order of artifact discussion will follow the arrangement appearing in Table 1. A subsequent section will assess various approaches toward the analysis and interpretation of these artifacts as they relate to the use and ownership of firearms at the McConnell Station site.

CARTRIDGE CASES

Though "cartridges" existed as early as ca. 1570 (NRA 1989:35), the metal encased form known today was an outgrowth of the development of ignition (priming) compounds created by mixing fulminates and other explosive materials for use in percussion cap weapons. Following the 1807 introduction of fulminate of mercury as a primer in lieu of finely ground (FFFFg)

Table 1. Inventory of Firearms Related Artifacts from McConnell Station.

	Provenience			
Artifact	Structure 1	Midden Area	Structure 2	Fence Row
Rimfire				
.22 Short RF	2	-	30	-
.22 Long/Long Rifle RF	6	1	27	5
.30 Short RF	1	-	-	-
.32 Short RF	2	2	2	-
Centerfire Handgun				
.32 S&W	-	-	2	-
.38 S&W	-	-	4	-
Shotgun (paper wall)				
12 gauge	1	-	4	1
Projectiles				
.54 caliber bullet	1	-	-	-
small lead object	1	-	-	-
shot pellet	1	-	-	-
Gunflint				
honey color - small	1	-	-	-
Area totals =	16	3	69	6
Total firearm artifacts = 94				

gunpowder, a number of early self-contained cartridge types were developed. These included a paper cased cartridge containing an integral centerfire primer made by Samuel Pauly of Switzerland in 1812, pinfire cartridges developed by Casimir Lafaucheux in France in 1835 (NRA 1981:34-35), and needlefire cartridges produced by Johann von Dreyse in Prussia in 1840 (NRA 1989:37-40). Among these various creations was a tape primed revolver invented by American dentist Dr. Edward Maynard in 1845. His method employed a small amount of fulminate compound suspended between two elongated but narrow strips of paper which were rolled and placed in the upper handle of the weapon. Though tape primed weapons have long been obsolete, Maynard's invention has survived into the modern age as paper caps used by generations of children as a form of amusement (Coates and Thomas 1990:73; NRA1989: 40).

The year 1845 also witnessed the appearance in France of the .22 Flobert BB Cap. Developed by Louis Flobert for use in arcade target rifles, this humble cartridge represented a modified (rimmed) percussion cap which closed around the base of a bullet. This diminutive cartridge, powered only by its priming compound and restricted to short distance shooting, lead to the development of the .22 Short round in 1857 for use in the first Smith and Wesson revolvers (Barnes 1997:380; Supica and Nahas 1996:37). The final decades of the nineteenth century produced numerous permutations of ignition systems (the most notable of which were Boxer and Berdan centerfire primers; NRA 1989), case dimensions and configuration, powder charge and type (the first "smokeless" gunpowders were introduced in the late 1800s), and projectile size, design, and composition (for example, the first metal jacketed bullets were produced in the 1880s in response to the increased velocities of then new "smokeless" powder) as literally hundreds of cartridges were developed for both civilian and military applications (cf. Ball 1997a; Barber 1987; Barnes 1997; Coates and Thomas 1990:73-74; Datig 1956; 1958; 1967; Ezell 1981:678-692; Hogg 1978:28-33; Hoyem 1981; 1990; Huon 1988; Layman 1997:121-128; 1998:62-80; Lewis 1972; Logan 1948; McDowell 1984: NRA 1989:40-46; Suydam 1973; Thomas 1991:94-97; Treadwell 1873). Well before the end of the Civil War, all muzzle loading small arms were effectively obsolete.

The entirety of the sample universe of cartridge cases was fabricated from drawn brass (see Frost 1990, Hamilton 1916, and Lewis 1972 for discussions on metallic cartridge case manufacture). The majority of the recovered cartridge cases and shotgun shell bases had suffered from varying degrees of deterioration and other damage. In some instances, elements of the case and/or headstamp (maker's mark) were sufficiently intact to allow for accurate identification. A comparison of the dimensional attributes of these cases (Tables 2 and 3) revealed the presence of several types of cartridge cases predominately representing handgun applications.

Rimfire Cartridges. Of the 84 recovered cartridge cases, 78 (92.86%) reflected rimfire (RF) ignition types. Among this assemblage were a total of 71 examples of .22 caliber cases (caliber being a measure of bullet diameter in increments of 0.01" or 0.001"). Thirty two cases were derived from .22 Short (introduced 1857) ammunition and another 39 represented either .22 Long (introduced 1871) or similarly dimensioned .22 Long Rifle (introduced 1887) cartridges. Of 32 .22 Short RF cases, 28 bore legible headstamps indicating production by Allen & Wheelock (n=1; 3.57%), Winchester Repeating Arms Company (n=2; 7.14%), Peters Cartridge Company (n=3; 10.72%), and Union Metallic Cartridge Company or Remington Arms Company (n=22; 78.57%). Thirty-eight of the 39 recovered .22 Long or Long Rifle RF cases bore legible headstamps indicating manufacture by the Union Metallic Cartridge Company or Remington Arms Company (n=2; 5.26%) and Western Cartridge Company (n=36; 94.74%). Ammunition of this type was widely used in numerous makes and models of derringers, revolvers, and rifles (cf. Hogg and Weeks 1992; NRA 1981; Schwing 1998); it is not possible to determine the type of weapon in which these rounds were fired. These cartridges (particularly .22 Long Rifle) remain in active production and literally billions of rounds are manufactured each year.

A single example of a .30 Short rimfire case was recovered from Structure 1 (cat. #2364). Originating in the early 1860s, this round was used in the Sharp's four barrel pocket pistol (cf. Schwing 1998:795), other models of derringers, and single shot pistols (Barnes 1997:384; Suydam 1973:67). This round was loaded with 5-6 grains of blackpowder and a 50-58 grain round nosed lead bullet. Production was discontinued about 1919 (Barnes 1997:384). Though the recovered example bore no headstamp, the base is marked with two small opposing "dot" shaped tool marks resulting from the manufacturing process utilized in forming of the case. This configuration has been attributed to the firm of Allen & Wheelock of Worchester, Massachusetts, which produced rimfire ammunition from 1858 to 1874 (Barber 1987:13-14, 185).

Six cases identified as .32 Short Rimfire were recovered from various areas of the site (cf. Table 2). This case was introduced in 1860 and remained in limited production as recently

Table 2. Provenience, Dimensional, and Chronological Data for Factory and Recovered Rimfire Cartridge Cases.

Cartridge type/ Provenience (unit)	Catalog number	Rim diameter	Base diameter	Length	Headstamp	Chronology
.22 Short RF	Factory	0.273"	0.225"	0.432"	--	1857+
Structure 1 (1)	2177	0.270"	0.228"	0.423"	impressed "U"	1885+
Structure 1 (277)	4588	0.264"	0.235"	0.435"	raised "A&W"	1858-1874
Structure 2 (9)	1517	0.266"	0.226"	0.418"	illegible	1857+
Structure 2 (12)	1697	0.265"	0.228"	0.425"	impressed "H"	1880s+
Structure 2 (196)*	2905	0.268"	0.218"	0.414"	impressed "U"	1885+
Structure 2 (209)	3091	0.265"	0.225"	0.425"	impressed slanted "P"	1895-1923
Structure 2 (236)*	4357	0.265"	0.230"	0.414"	illegible	1857+
Structure 2 (239)	3470	0.270"	0.228"	0.426"	impressed "U"	1885+
Structure 2 (242)	3494	0.269"	0.226"	0.424"	impressed "U"	"
Structure 2 (250)*	4104	0.264"	0.232"	0.435"	impressed - illegible	1857+
Structure 2 (250)	4123	0.268"	0.225"	0.427"	impressed "U"	1885+
Structure 2 (250)*	4135(1)	0.271"	0.225"	0.432"	impressed "U"	"
Structure 2 (250)	4135(2)	0.270"	0.226"	0.424"	impressed "U"	"
Structure 2 (250)	4135(3)	0.265"	0.226"	0.424"	impressed "H"	1880s+
Structure 2 (250)	4135(4)	0.269"	0.229"	0.429"	impressed "U"	1885+
Structure 2 (252)*	4189	0.265"	0.225"	0.419"	impressed "U"	"
Structure 2 (252)*	4195	0.265"	0.243"	0.415"	impressed "U"	"
Structure 2 (253)	4215	0.260"	0.232"	0.435"	impressed slanted "P"	1895-1923
Structure 2 (255)*	4397(1)	0.268"	0.223"	0.418"	impressed "U"	1885+
Structure 2 (255)*	4397(2)	0.270"	0.225"	0.436"	impressed "U"	"
Structure 2 (255)*	4398	0.265"	0.236"	0.431"	impressed · slanted "P"	1895-1923
Structure 2 (255)*	4399	0.268"	0.230"	0.432"	impressed "U"	1885+
Structure 2 (257)*	4471	0.265"	0.225"	0.421"	illegible	1857+
Structure 2 (261)*	4995	0.255"	N/A	0.425"	impressed "U"	1885+
Structure 2 (261)*	5023	0.265"	0.226"	0.422"	impressed "U"	"
Structure 2 (261)	5043(1)	0.270"	0.234"	0.445"	impressed "U"	"
Structure 2 (261)	5043(2)	0.266"	0.225"	0.421"	impressed "U"	"
Structure 2 (261)	5043(3)	0.269"	0.223"	0.425"	impressed "U"	"
Structure 2 (261)	5043(4)	0.272"	0.223"	0.422"	impressed "U"	"
Structure 2 (261)	5043(5)	0.272"	0.222"	0.422"	impressed "U"	"
Structure 2 (261)	5043(6)	0.260"	0.225"	0.420"	impressed "U"	"
Structure 2 (261)	5043(7)	0.269"	0.226"	0.420"	impressed "U"	"
.22 Long RF	Factory	0.275"	0.225"	0.595"	--	1871+
.22 Long Rifle RF	Factory	0.275"	0.225"	0.595"	--	1887+
Structure 1 (1)*	2157	0.265"	0.258"	>0.5.73"	illegible	1871+
Structure 1 (1)	2178	0.271"	0.236"	0.604"	[diamond]	1908+
Structure 1 (156)	2969	0.271"	0.246"	0.609"	[diamond]	"

Structure 1 (156)*	3165	0.275"	0.252"	0.609"	[diamond]	"
Structure 1 (273)*	5250	0.266"	0.219"	>0.535"	impressed "U"	1885+
Structure 1 (283)	5708	0.268"	0.232"	0.614"	[diamond]	1908+
Midden area (256)*	4450	N/A	N/A	0.610"	impressed "U"	1885+
Cartridge type/ Provenience (unit)	Catalog number	Rim diameter	Base diameter	Length	Headstamp	Chronology
.22 Long/Long Rifle						
Structure 2 (11)*	1627	0.269"	0.235"	0.605"	[diamond]	1908+
Structure 2 (18)*	1872	0.265"	0.240"	.600"	[diamond]	"
Structure 2 (18)*	1884	N/A	N/A	0.614"	[diamond]	"
Structure 2 (102)*	4332	0.267"	0.239"	0.595"	[diamond]	"
Structure 2 (103)*	4342	0.268"	N/A	0.621"	[diamond]	"
Structure 2 (196)*	2906	0.269"	N/A	0.595"	[diamond}	"
Structure 2 (203)*	3985	0.265"	0.241"	0.608"	[diamond]	"
Structure 2 (203)	3999	0.268"	0.245"	0.615"	[diamond]	"
Structure 2 (203)*	4022(1)	0.270"	0.245"	0.605"	[diamond]	"
Structure 2 (203)*	4022(2)	0.269"	0.244"	0.605"	[diamond]	"
Structure 2 (209)*	3090	0.260"	N/A	0.605"	[diamond]	"
Structure 2 (223)*	3640	0.265"	0.250"	0.595"	[diamond]	"
Structure 2 (226)*	3794	0.265"	0.256"	0.614"	[diamond]	"
Structure 2 (232)*	3435	0.264"	N/A	0.611"	[diamond]	"
Structure 2 (236)*	4369	0.262"	N/A	0.605"	[diamond]	"
Structure 2 (246)*	3837	0.268"	0.245"	0.606"	[diamond]	"
Structure 2 (246)*	3838	0.268"	0.238"	0.610"	[diamond]	"
Structure 2 (250)	4136(1)	0.265"	0.239"	0.616"	[diamond]	"
Structure 2 (250)*	4136(2)	0.258"	N/A	>0.580"	[diamond]	"
Structure 2 (252)*	4176	N/A	N/A	0.620"	[diamond]	"
Structure 2 (252)*	4188	N/A	N/A	<0.645"	[diamond]	"
Structure 2 (253)*	3947	N/A	N/A	0.595"	[diamond]	"
Structure 2 (253)*	4208	N/A	N/A	0.614"	[diamond]	"
Structure 2 (258)*	4483	0.268"	0.235"	0.598"	[diamond]	"
Structure 2 (261)*	5022	0.270"	0.232"	0.612"	[diamond]	"
Structure 2 (261)	5042	0.268"	0.230"	0.602"	[diamond]	"
Structure 2 (262)*	4682	0.269"	0.218"	0.614"	[diamond]	"
Fence row (16)*	1832	0.266"	N/A	0.596"	[diamond]	"
Fence row (17)*	1855	0.268"	0.238"	0.609"	[diamond]	"
Fence row (21)*	1901	0.270"	0.242"	0.612"	[diamond]	"
Fence row (26)	1977	0.271"	0.236"	0.628"	[diamond]	"
Fence row (26)*	1992	0.265"	N/A	<0.595"	[diamond]	"
.30 Short RF	Factory	0.346"	0.292"	0.515"	--	1861-1919
Structure 1 (23)	2364	0.346"	0.296"	0.521"	basal tool marks - see text	1858-1874
.32 Short RF	Factory	0.377"	0.318"	0.575"	--	1860-1972
Structure 1 (44)*	2041	0.379"	0.310"	0.566"	none	"
Structure 1 (277)	5458	0.374"	0.328"	0.557"	none	"

Midden area (7)*	1455	>0.359"	N/A	<0.622"	impressed straight "P"	1923-1940(?)
Midden area (7)	1490	0.376"	0.325"	0.585"	impressed "U"	1885+
Structure 2 (197)*	2996	0.368"	0.320"	0.578"	impressed "U"	"
Structure 2 (212)	3299	0.372"	0.324"	0.558"	raised "US" in circular depression	ca. 1885-1909

* Crushed, bent, and/or corroded.
Sources: Ball (1997a); Barber (1987); Barnes 1997); Suydam (1973).

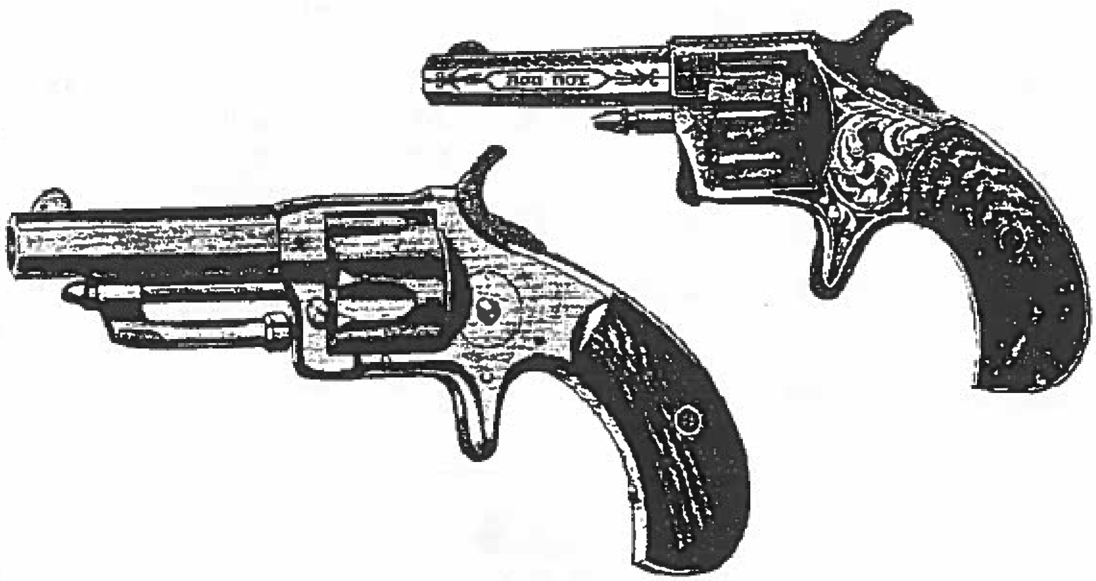


Figure 1. Examples of Late-19th Century Spur Trigger Revolvers Using Rimfire Cartridges (reproduced from Rowe 1982:48).

as 1990. Although weapons chambered for this cartridge were produced as late as 1936, for all practical purposes it was obsolete by ca. 1940. It was initially used in revolvers manufactured by Smith & Wesson but was later adapted to a variety of other handguns (e.g., Colt, Allen, Blue Jacket, Enterprise, Favorite, Whitney, and others; see Figure 1) and rifles (e.g., Remington, Stevens, and Winchester) (Barnes 1997:385). This cartridge was originally produced with an 80 grain lead bullet of 0.316" diameter and loaded with nine grains of blackpowder (Barnes 1997:385, 394).

Centerfire Pistol Cartridges. A total of six centerfire cartridges were of types normally associated with use in revolvers (Table 3). Two examples of the .32 S&W cartridge (cat. #'s 4368 and 5041) were recovered from Structure 1. These rounds were introduced in 1878 for use in Smith & Wesson revolvers (Figure 2) and remain in active production. One reason for their continued appeal has been this round's adaptability to a wide variety of relatively lightweight and inexpensive handguns (Barnes 1997:243). This cartridge was originally loaded with nine grains of black powder and fired a 0.312" diameter lead bullet weighing 85 grains (Barnes 1997:243, 274).

Table 3. Provenience, Dimensional, and Chronological Data for Factory and Recovered Centerfire Handgun Cartridge Cases.

Cartridge type/ Provenience (unit)	Catalog number	Rim diameter	Base diameter	Length	Headstamp	Chronology
.32 S&W	Factory	0.375"	0.335"	0.61"	–	1878+
Structure 2 (261)*	5041	0.374"	0.345"	0.588"	"U M C/ —"	1878-1916
Structure 2 (236)*	4368	0.372"	0.342"	0.596"	"U - - C/ 32 S--"	1878-1936
.38 S&W	Factory	0.433"	0.386"	0.78"	–	1877+
Structure 2 (203)*	4023	0.435"	N/A	N/A	illegible	"
Structure 2 (250)	4124	0.432"	0.384"	0.765"	"PETERS/ .38 S&W"	1887-1962
Structure 2 (250)	4137	0.430"	0.385"	0.765"	"U.M.C./ S H/ .38 S&W."	1877-1916
Structure 2 (250)	4981	0.430"	0.383"	0.760"	"U.M.C./ S H/ .38 S&W."	"

* Crushed
Sources: Barber (1987); Barnes (1997).

Figure 2. Smith & Wesson .32 Caliber Model 2 "Top Break" Double Action Revolver, 1880-1883, ca. 43,500 produced (reproduced from Hart, ed. 1982:60).

A total of four .38 S&W cartridge cases were excavated at Structure 2 (cat. #'s 4023, 4124, 4137, and 4981). This cartridge was introduced about 1877 and remains in active production. Well suited for use in lighter weight revolvers, this round was originally loaded with blackpowder and fired a 0.359" diameter 145 grain lead bullet (Barnes 1997:257, 274). Both .32 S&W and .38 S&W cartridges were used in a wide variety of inexpensive to moderately priced revolvers manufactured from the late nineteenth to early twentieth centuries (cf. Schwing 1998; Webster 1958).

SHOTGUN SHELLS

In common with their pistol and rifle counterparts, the development of self-contained loads for shotguns began at least as early as 1836 with the invention of a pinfire round by Frenchman Casimir Lefaucheaux, one year after his introduction of a similarly ignited pistol cartridge. Notably, the weapon which fired this round was a side-by-side double barreled, hinged frame shotgun which served to provide the classic double barreled design still in production (Hogg 1978:216). The shell itself, except for the pin protruding from the lower portion of its brass wall, was effectively identical in configuration to shells produced at the present time. Such shotgun shells were in regular production until at least the late 1800s (Barnes 1993:391).

The advent of self-contained shotgun shells and a related need to establish standards for the firearms industry were instrumental in the passage of the Gun Barrel Proof Act of 1868 by the British Parliament. This act defined gauge as the number of identical round lead balls which could be made from one pound (453.662 grams or 0.454 kilograms) of lead. Thus, a designation such as "12 gauge" means that the unrestricted bore of a given weapon is equal to the diameter (0.729" or 18.5 mm) of a round ball of lead weighing precisely 1/12 of a pound (1.33 ounces = 583.33 grains = 37.8 grams) (NRA 1989:182-184). Centerfire shotgun shells in their current form were developed after the Civil War and were variously manufactured with either solid brass cases or, for reasons of economy, wound paper base wads and moisture resistant paper walls (Barnes 1997:396). The more widely produced pre-World War I paper walled shells included (in decreasing size) 4, 8, 10, 12, 14, 16, 20, 24, 28, and 32 gauge (cf. Ball 1997b:132; Barnes 1997:395-408; Stadt 1995). Of these, only the 10, 12, 16, 20, and 28 gauge remain in regular production in the United States and the standard shotgun shell for most sporting, military, and law enforcement applications is the 12 gauge.

A total of six shotgun shells were represented in the aggregate assemblage (Table 4), all of which were 12 gauge and of wound paper base wad construction (introduced in the 1870s; cf. Ball 1997b). In common with the recovered cartridge cases, most examples were corroded and/or bent to varying degrees. All bore legible headstamps revealing manufacture by the Union Metallic Cartridge Company (n=1; 16.67%) and Winchester Arms Company (n=5; 83.33%). Aspects of the production of these shells as they relate to artifact interpretation will be discussed below.

PROJECTILES

Three known or possible lead projectiles were recovered from various areas of Structure 1. The largest of these was an elongated, round nosed bullet (Unit 283/ cat. # 5705) measuring 0.540" in diameter, 0.877" in length, and weighing 411.5 grains. The base of this piece is flat

Table 4. Provenience, Dimensional, and Chronological Data for Factory and Recovered Shotgun Shells.

Shotshell type/ Provenience (unit)	Catalog number	Rim diameter	Base diameter	Length	Headstamp	Chronology
12 gauge (paper wall)	Factory	0.886"	0.850"	varies	--	1877+
Structure 1 (57)	4773	0.865"	0.820"	0.227"	"U M C CO/ No 12/ S G"	1878-1916 (maximum)
Structure 2 (9)*	1503	0.872"	0.820"	>0.274"	"WINCHESTER/ No 12/ REPEATER"	1900-1938
Structure 2 (12)*	1698	0.872"	0.818"	0.513"	"WINCHESTER/ No 12/ REPEATER" primer - "WRACO/ -- No" (w/ 3 crimping rings)	1900-1938
Structure 2 (250)*	4138	0.856"	0.804"	>0.469"	"WINCHESTER/ No 12/ REPEATER" (w/ 3 crimping rings)	1900-1938
Structure 2 (250)*	5029	0.868"	0.812"	0.380"	"WINCHESTER/ No 12/ REPEATER" (2 crimping rings visible)	1900-1938
Fence row (199)*	3041	0.868"	0.808"	>0.395"	"WINCHESTER/ No 12/ REPEATER" primer - "WRA/ E W N -" (w/ 3 crimping rings)	1900-1938

* Crushed and/or corroded.
Sources: Ball (1997b); Matunas and Griffin (1995:366-370), Stadt (1995).

and exhibits scars indicating mold rather than swage production. Three shallow grease grooves are situated along the lower wall of the projectile. Although there is a minor amount of nose deformation, there is no clear indication of rifling imprints on this piece. The size and configuration of this item indicates derivation from a ca. .54-.55 caliber black powder rifle cartridge. A comparison with data presented by Barnes (1997) indicates that the "best fit" application for this bullet was the .56-52 Spencer round introduced in 1866 and discontinued about 1920. This was a slightly tapered (cf. Ball 1997a:117) rimfire rifle round.

A small circular and concave lead object (cat. # 4834) resembling a completely exfoliated small caliber bullet was recovered from Unit 170. Its diameter is ca. 0.414" and height (thickness) is ca. 0.136". This piece weighs 16.0 grains. This item exhibits no evidence of rifling and was likely derived from some non-firearm related lead work on the farmstead.

One very deformed piece of lead shot (cat. # 5800) was recovered from Unit 188. In its generally flattened condition, this item measures ca. 0.195" in thickness and ca. 0.258" in diameter. It weights 15.2 grains. On the basis of weight, this pellet most closely corresponds with contemporary size F shot produced in a diameter of 0.22" with a count of 27 pellets per ounce. This size is 0.002" smaller than number 4 Buck shot (cf. Matunas and Griffin 1995:68) and would be useful for small to medium sized fur bearing animals or larger birds such as turkeys.

GUN FLINT

The production, distribution, and use of gunflints and related gunspalls have long captured the attention of historic archaeologists, firearms historians, geologists, and antiquarians. But a small sampling of the diverse literature on these mundane items includes studies by Clarke (1935), de Lotbiniere (1984); Hamilton (1980:138-163), Hamilton, ed. (1982:135-196), Hamilton and Emory (1988), Knowles and Barnes (1937), Noël Hume (1976:219-221), Skertchly (1984), White (1975), and Witthoft (1966). For present purposes, it is sufficient to present excerpts from Brown's (1980:79) study of early American firearms:

> ...with the proliferation of snapping [gun] locks ca. 1575 chert became popular because it was less inclined to fracture or crumble. Chert is identified by its glossy appearance and it was readily procured from glacial deposits.
>
> Gunspalls were chipped from a suitable piece of chert with a small hammer and displayed thin, irregularly dressed bodies tapering to a sharp, central striking point. Standard gunspalls emerged in France ca. 1650, characterized by a chipped body and a rounded heel abruptly tapering to the striking point, and thereafter most European gunspalls followed the French pattern.
>
> The gunspall gradually began to be replaced by the gunflint ca. 1670 when the Neolithic method of flint knapping reemerged in Europe. Long blades of flint were struck from a large piece of flint by a flint striker (hammer), broken into manageable size, and then carefully knapped by controlling the pressure applied to the knapping tool when shaping the gunflint into its final form.
>
> Flint quarrying and knapping were well established in France by 1675...A decade later English flint quarries were flourishing...during the flintlock era the flint industry was monopolized by governments to ensure adequate supplies at reasonable cost.
>
> By 1675 gunflints could be readily distinguished as English or European by shape and color. The European gunflint, or Continental gunflint as it is often termed, was derived from the gunspall design. The English displayed irregular, slanting sides, a square heel, and a tapered striking point extending from the bottom of the body rather than centered. European gunflints range in color from

pearl grey to honey yellow and the English variety are dark grey or black. The French gunflint...dominated the world market until 1794 when the revolutionary government banned exports.

A single dark yellow ("honey") colored gun flint with reddish inclusions (cat. # 2146) was recovered from unit 88 at Structure 1. This specimen was fashioned from a flint spall and measures 0.990" in length, 0.902" wide along the striking edge, 0.789" along the cock (attachment) edge, and a maximum 0.269" in thickness. The striking edge has a working angle of ca. 45 degrees and displays minor wear (flake removal) resulting from use while the cock end is slightly rounded, extensively worked, and is angled at about 70 degrees. The "back" or flat side exhibits a portion of the bulb of percussion along one long axis resulting from detachment from the parent nodule. A portion of the nodule's cortex remains on this area of the flint. Gunflints of this size were used on both pistols (Figure 3) and muskets (cf. Schock and Dowell 1983:62). On the basis of both material and method of manufacture, it is reasonable to attribute this example to French production. Although flint ignition on firearms was replaced by the development of the percussion cap in 1822 by Joshua Shaw (cf. NRA 1989:38), such weapons remained in active use until the time of the Civil War and afterwards. A study of gunflints recovered from various sites in Kentucky prompted Schock and Dowell (1983:67) to conclude that "...French gunflints were still common on American sites during the first part of the nineteenth century".

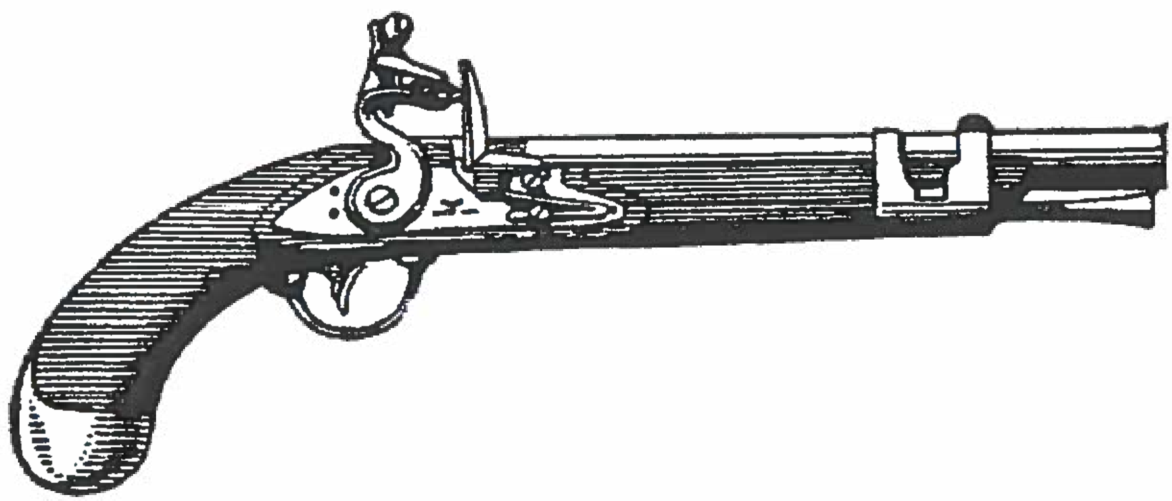


Figure 3. Early American Military Flintlock Pistol (reproduced from Hart, ed. 1982:57).

INTERPRETIVE REMARKS

The analysis of the firearms related materials from the McConnell Station excavations has produced several intriguing insights into the use and role of weapons on these farmsteads in the Bluegrass region of central Kentucky. Among the various interpretive avenues examined are assessments of the assemblage chronology, the general nature of site firearms use, the number of firearms represented on each site, an overview of shotgun hunting applications, and area access to munitions markets.

The aggregate assemblage essentially represents two temporally divergent though spatially close sites. Yielding but 16 firearm related artifacts, the chronology of Structure 1 extends from ca. 1800 (represented by a single honey colored French gunflint) to the third quarter of the nineteenth century as evidenced by relatively early cartridge cases such as an A&W headstamped .22 Short RF (1858-1874) and a comparably dated .30 Short RF attributable to the firm of Allen & Wheelock. The occupancy of Structure 2 in the fourth quarter of the nineteenth century is firmly established by the appearance of various early centerfire cartridges intended for use in revolvers (i.e., .32 and .38 S&W rounds introduced 1878 and 1887, respectively) and .22 Short, Long, or Long Rifle RF cases bearing headstamps such as the impressed "U" (introduced 1885) and a raised "US" in a circular depression (1885-1909). The continued occupancy of Structure 2 into the twentieth century is clearly demonstrated by (among other examples) the abundance of .22 Long or Long Rifle RF cases marked with a diamond headstamp (used by the Western Cartridge Company and introduced in January 1908) and Winchester Repeater shotshell bases dating from 1900-1938. In general terms, the recovered firearm materials allow for dating Structure 1 from ca. 1800 to the fourth quarter of the nineteenth century and Structure 2 from the fourth quarter of the nineteenth century to about 1940 (see Table 5).

For purposes of this assessment, the cartridge case sample was separated into three general categories of likely use: general shooting (represented by all .22 caliber Short, Long, and Long Rifle cases), self defense (all cartridges normally associated with handguns), and hunting (all shotshell bases). As summarized in Table 6, general shooting activities -- target practice and small game hunting -- accounted for 78.89% (n=71) of the recovered cases. Self defense applications and handgun marksmanship resulted in the expenditure of 14.44% (n=13) of the cartridge cases while hunting accounted for 6.67% (n=6) of the recovered rounds.

A related vein of inquiry relates to the number of firearms actually used or present at each house site during the course of its active occupation. The process of determining the Minimum Number of Firearms (MNF) per site (Table 7) is advanced upon the working presumption that the families living in these structures were in fact the owners and users of the weapons which fired these rounds. Factors such as casual discard by visitors or souvenirs of an outing in the country being inadvertently lost can not be discounted. It is further presumed that the recovered cases are in fact reasonably representative of the degree of use of their associated firearms by the occupants of each structure. Accordingly, the types and varieties of cases recovered from these areas suggests that a minimum of nine cartridge firearms were owned by the former residents of these domiciles. As determined by this analysis, this aggregate firearm census consisted of at least two weapons chambered for .22 caliber rimfire ammunition, five handguns (all revolvers), and two shotguns. A tenth and unidentified firearm is represented by the single recovered gunflint.

It is not unexpected that the calculation of a firearm/ammunition ratio (cf. Table 5) reveals that the most widely used cartridges were fired in weapons chambered for .22 caliber rimfire ammunition with 35.5 rounds expended per firearm. As these cases cannot be confidently segregated by weapon type, the occurrence of any .22 caliber case must be interpreted as representing only one weapon though in all likelihood more than one firearm using this cartridge was present. Such ammunition was -- and is -- the least expensive cartridge type.

Table 5. Summary of Cartridge Case and Shotgun Shell Headstamps and Tool Marks.

Headstamp/ Tool marks	Manufacturer and dates of cartridge production	Location	Headstamp chronology
A&W (raised)	Allan & Wheelock (1858-1874)	Worchester, Massachusetts	1858-1874 (maximum)
tool marks - two opposing small dots on base	Allan & Wheelock (1858-1874)	Worchester, Massachusetts	1858-1874 (maximum)
[diamond]	Western Cartridge Company (1898-1944) Olin Industries (1944-1954) Olin Mathieson Chemical Corporation (1954-1969) Olin Corporation (1969+)	East Alton, Illinois	1908 to at least ca. 1940
H (impressed)	Winchester Repeating Arms Company (1867-present)	Bridgeport, Connecticut (1867-1871) New Haven, Connecticut (1871-P)	1867+
P (slanting)	Peters Cartridge Company	Kings Mill, Ohio	1895-1923
P (straight)	Peters Cartridge Company	Kings Mill, Ohio	1923-1934
PETERS	Peters Cartridge Company	Kings Mill, Ohio	1895-1962 (maximum)
U (impressed)	Union Metallic Cartridge Company (1867-1916) Remington Arms Company (1916+)	Bridgeport, Connecticut	1885+
UMC	Union Metallic Cartridge Company (1867-1916)	Bridgeport, Connecticut	1885+
UMCCO	Union Metallic Cartridge Company (1867-1916)	Bridgeport, Connecticut	1885+
US (raised in impressed circle)	United States Cartridge Company (1869-1936)	Lowell, Massachusetts	ca.1885-1909
WINCHESTER REPEATER	Winchester Repeating Arms Company (1867-present)	Bridgeport, Connecticut (1867-1871) New Haven, Connecticut (1871-P)	1900-1938

Sources: Ball (1997b); Barber (1987); Stadt (1995).

Table 6. Application of Cartridge Types by Function.

Application/ cartridge type	Item N=	Subtotal N=	Subtotal %=
General shooting			
.22 RF (S/ L/ LR)	71	71	78.89%
Self defense			
Handgun - .30-.32 RF	7		
Handgun - .32-.38 CF	6	13	14.44%
Shotgun (all)	6	6	6.67%
Total/ Percentages		90	100.00%

Table 7. Minimum Number of Firearms (MNI) Represented within the Aggregate Cartridge Case Assemblage.

Site Area	.22 RF (all)	Handguns (revolvers)	Shotguns	MNF per Site
Structure 1	1	1 (.30 Short RF) 1 (.32 Short RF)	1 (12 gauge)	4
Structure 2, midden, and fence row	1	1 (.32 Short RF) 1 (.32 S&W) 1 (.38 S&W)	1 (12 ga.)	5
Firearms by type	2	5	2	9
Number of related rounds	71	13	6	90
Firearm/ Ammunition ratio	1:35.5	1:2.6	1:3.0	1:10.0

Neither shotgun nor handgun use was relatively extensive. The shotgun firearm/ammunition ratio of 3.0 shells per weapon was little different than the handgun firearm/ammunition ratio 2.6 rounds per firearm.

A comparison of ammunition costs as reflected in major mail order house catalogues from the 1890s through the 1920s (Table 8) serves to place these shooting preferences in an economic context. Clearly, the majority of .22 caliber rimfire cartridges (i.e., .22 Short, Long, and Long Rifle) were the least expensive marginally effective rounds available. Their extensive use is not surprising in light of the cost per shell (.22 Short) ranging from just under \$.0025 in the 1890s to just over \$.003 in 1927. Though blackpowder loaded paper wall 12 gauge shotgun shells could be purchased for as little as \$.0136 in 1895 and \$.0268 in 1927, it should be noted that in relative terms, these shells were variably almost six to nine times as expensive as the less powerful .22 caliber rimfire cartridges. The marked difference in price could only be justified by the consumer in terms of the increased likelihood of this weapon in securing game.

The nature of the recovered rimfire and centerfire pistol cartridges indicates that they were likely expended in any of a number of low and medium priced revolvers of the period. In contrast to the cases from the sample universe, rounds such as the .45 Long Colt and .44 S&W would be associated with better grade "top of the line" firearms. Centerfire cartridge cases intended for use in semi-automatic handguns are conspicuous by their absence. All recovered examples were straight walled, rimmed types indicating their use in revolvers in marked contrast to the "rimless" cartridges developed specifically for use in early (and subsequent) semi-automatic handguns which were beginning to appear on the American market about 1900 following pioneering work on these weapons by German-American Hugo Borchardt, Germans Georg Luger and Theodor Bergmann, American John Moses Browning, Englishman Sir Hiram Stevens Maxim, Austro-Hungarians Andreas William Schwarzlose and Josef Laumann, and others (cf. Ezell:1981; Hogg 1978; Hogg and Weeks 1992). Such weapons became increasingly popular after ca. 1920 with the return of World War I veterans who had been exposed to the U.S. Army's Colt Model 1911 .45 ACP and other semi-automatic pistols of that period.

Table 8. Cost of Ammunition from 1895-1927.

Cartridge/ Shotgun Shell	1895 Montgomery Ward & Co.	1897 Sears Roebuck	1902 Sears Roebuck	1923 Sears Roebuck	1927 Sears Roebuck
Source	Dover Publications (1969:470. 473, 475)	Isreal, ed. (1976)	Bounty Books (1969:322-323)	Schroeder, ed. (1973:790-791)	Mirkin (1970:508-509)
Rimfire					
.22 Short	$.12/50	$.12/50	$.12/50	$.18/50*	$.16/50*
.22 Long	$.15/50	$.15/50	$.14/50	$.24/50*	$.22/50*
.22 Long Rifle	$.15/50	$.15/50	$.14/50	$.28/50*	$.25/50*
.30 Short	$.23/50	$.23/50	$.22/50	N/A	N/A
.32 Short	$.26/50	$.26/50	$.24/50	$.45/50	$.41/50
Centerfire Pistol					
.32 S&W	$.44/50	$.44/50	$.39/50	$.77/50	N/A
.38 S&W	$.54/50	$.54/50	$.48/50	$.89/50	N/A
Shotgun shell					
12 gauge (paper)	$.34-.45/25	$.30-.40/25	$.34-.45/25	$.73-.81/25	$.67-.71/25

* Smokeless powder (all other listings loaded with blackpowder).
** Empty brass cases only; many such hulls were intended.to be reloaded by the shooter.
N/A: Not listed in cited reference(s).

An examination of one shotshell attribute - base height - affords insight into the likely use of this weapon within the project environs. Among the six recovered shotshell bases, only five wound paper bases were sufficiently intact to allow for measuring the height of the shellhead (i.e., brass base). As arranged by height, this data is presented in Table 9. The examined sample fell into two generalized height ranges: "low" (n=1) and "medium" (n=4) (cf. Ball 1997b:135).

Table 9. Comparison of Shotshell Base Heights.

Shellhead Height	Gauge/ Bore	Structure (Unit/Cat. #)
"Low" brass		
0.227"	12	Structure 1 (57/ 4773)
0.380"	12	Structure 2 (250/ 5029)
"Medium" brass		
>0.395"	12	Fence row (199/ 3041)
>0.469"	12	Structure 2 (250/ 5029)
0.513"	12	Structure 2 (12/ 1698)

The height of the brass was used by the manufacturer to accommodate an inversely dimensioned wound paper base wad. In other words, a "high" base accommodated a low paper wad while a "low" base was used with a comparatively higher paper wad. The potential interpretive significance of the relative height of the brass head of the shotgun shell has been explained as follows:

> During the paper-shell era, solid paper wads (in the shell base) were made in high, medium, and low configurations, depending on the [amount of] powder being used. A high base wad was called for when small powder volumes were used.
>
> The brass height was inversely related to base height. If the top of the brass was at the same level as the top of the base wad, tubes would often separate at the head when the cartridge was fired. So low-based shells - those with a large, heavy powder charge - used high brass so the brass would be above the top of the base wad (NRA 1989:185; see also Barnes 1997:396).

The chronology of the shotshell sample indicates that these items were originally loaded with black powder, a material of rather uniform volume per given unit of weight. In practical terms, a "high" base and its related low paper wad would accommodate a lesser number of lead pellets of comparatively larger diameter. Alternately, a "low" base and its higher paper wad would be best suited for use with smaller diameter shot consisting of many more pellets per shell. In terms of area shooting practices, the shotgun was likely employed on a generally even basis between hunting for small mammals and birds ("low" brass) and medium sized mammals ("medium" brass).

The recovery of 82 cartridges cases and shotshell bases displaying legible headstamps provided the opportunity to access market share and distribution network effectiveness (Table 10). Represented were cartridges and shotgun shells produced by at least six different ammunition manufacturers. Present in the assemblage were materials made by (in decreasing order of frequency): Western Cartridge Company (n=36; 43.90%); Union Metallic Cartridge Company (n=31; 37.80%); Winchester Repeating Arms Company (n=7; 8.54%); Peters Cartridge Company (n=5; 6.10%); Allan & Wheelock (n=2; 2.44%); and United States Cartridge Company (n=1; 1.22%). Though certainly indicating a clear preference for American produced ammunition, the diversity of firms represented likewise indicates ready access to supply

Table 10. Ammunition by Type and Manufacturer.

Manufacturer	.22 Short	.22 L/LR	other RF	.32 & .38 S&W CF	12 Gauge	Company Total
Allen & Wheelock	1	-	1	-	-	2
Peters Cartridge Company	3	-	1	1		5
Union Metallic Cartridge Company	22*	2*	2*	4	1	31
United States Cartridge Company	-	-	1	-		1
Western Cartridge Company	-	36	-	-	-	36
Winchester Repeating Arms Company	2	-	-	-	5	7
Ammunition type subtotal	28	38	5	5	6	82
Subtotal percent =	34.14	46.34	6.10	6.10	7.32	100.00%

* The impressed "U" headstamp used on rimfire ammunition by Union Metallic Cartridge Company was retained after corporate merger with Remington Arms Company in 1916. This headstamp is still used.

channels. This availability was enhanced by the large inventories of ammunition offered via mail order (all such deliveries were required to be made by freight) during the late nineteenth century. It is interesting to observe the relatively low market share of ammunition produced by the Peters Cartridge Company (in independent operation from 1887-1934; Barber 1987:83; Logan 1948:10) in light of that firm's location in Kings Mill, Ohio, about 20 miles (32 km) northeast of downtown Cincinnati.

In summary, the present analysis of firearm related artifacts from the McConnell Station site has served to indicate several useful and informative avenues of investigation for archaeologists. Though most prior intensive studies of such remains have focused on military installations (e.g., Mansberger and Stratton 1996:93-98, 126; Staski and Johnson 1992) or battlefields and encampments (e.g., Fox 1993; Fox and Scott 1991; Haecker 1994; Sivilich

1996), there is much to be learned from materials collected from purely civilian sites. Beyond mere identification, data relevant to the number of firearms present on sites, the economics of firearm usage, hunting patterns, site chronology, and the marketing of ammunition can potentially be addressed.

ACKNOWLEDGEMENTS

This study appears with the gracious permission of Mr. John L. Mettille, Jr. (Division of Environmental Analysis) of the Kentucky Transportation Cabinet (Frankfort), the sponsoring agency for the excavations which recovered these materials. The artifacts discussed herein were made available for study by, and this analysis reproduced courtesy of, Mr. Charles Niquette (President, Cultural Resource Analysts, Inc., Lexington, Kentucky) and CRA staff personnel Mr. Grant Day and Ms. Trina C. Maples. The author gratefully acknowledges the kind assistance and cooperation of these individuals for the opportunity to examine this most informative assemblage and disseminate this information.

REFERENCES CITED

Ball, Donald B.

1996 Firearms on the 19th Century Urban Landscape: A View from the Kentucky History Center Site (15FR115), Frankfort, Kentucky. *Ohio Valley Historical Archaeology* 11:87-94.

1997a An Introduction to Metallic Cartridge Case Terminology, Identification, and Headstamps. *Ohio Valley Historical Archaeology* 12:112-129.

1997b Types, Headstamps, and Chronology of Winchester Shotgun Shells, 1877-1973. *Ohio Valley Historical Archaeology* 12:130-140.

1998 Firearm Related Artifacts from the Crawford-Nurre Saw Mill Site (15WH165), Whitley County, Kentucky. *Ohio Valley Historical Archaeology* 13:93-102.

Barber, John L.

1987 *The Rimfire Cartridge in the United States and Canada: An Illustrated History of Its Manufacturers and Their Products.* Armory Publications, Tacoma, Washington.

Barnes, Frank C.

1993 *Cartridges of the World* (7th edition). Books, Inc., Northbrook, Illinois.

1997 *Cartridges of the World* (8th edition). DBI Books, Northbrook, Illinois.

Bounty Books

1969 *The 1902 Edition of the Sears Roebuck Catalogue.* Bounty Books/Crown Publishers, New York.

Brown, M. L.
1980 *Firearms in Colonial America: The Impact on History and Technology, 1492-1792*. Smithsonian Institution, Washington, D.C.

Clarke, Rainbird
1935 The Flint Knapping Industry at Brandon. *Antiquity* 9:38-56.

Coates, Earl J. and Dean S. Thomas
1990 *An Introduction to Civil War Small Arms*. Thomas Publications, Gettysburg, Pennsylvania.

Cotter, John W. and B. Miles Gilbert
1979 Cartridges. In "Zumwalt's Fort: An Archaeological Study of Frontier Process in Missouri" by Gregory Waselkov. *Missouri Archaeologist* 40:82-84.

Datig, Fred A.
1956 *Cartridges for Collectors - Volume I (Centerfire)*. Borden Publishing Co., Alhambra, California.

1958 *Cartridges for Collectors - Volume II (Centerfire-Rimfire-Patent Ignition)*. Borden Publishing Co., Los Angeles, California.

1967 *Cartridges for Collectors - Volume III (Centerfire-Rimfire-Plastic)*. Borden Publishing Co., Alhambra, California.

Deiss, Ronald W.
1988 *Archaeological Investigations at Kentucky's Old State Capitol*. Kentucky Historical Society, Frankfort.

de Lotbiniere, Seymour
1984 Gunflint Recognition. *International Journal of Nautical Archaeology and Underwater Exploration* 13 (3): 206-210.

Dover Publications
1969 *Unabridged Facsimile: Catalogue No 57 - Montgomery Ward & Co. Catalogue and Buyers' Guide Spring & Summer 1895*. Dover Publications, Inc., New York.

Essary, Mark E., William A Huser, Jr., and John F. Scarry
1993 *A Phase I Subsurface Cultural Reconnaissance of Portions of Seven City Blocks for the Proposed South Frankfort Floodwall, Franklin County, Kentucky*. Archaeological Report 295. Program for Cultural Resource Assessment, Department of Anthropology, University of Kentucky, Lexington.

Ezell, Edward C.
1981 *Handguns of the World: Military Revolvers and Self-Loaders from 1870 to 1945*. Stackpole Books, Harrisburg, Pennsylvania.

Faulkner, Charles H.
1984 *An Archaeological and Historical Study of the James White Second Home Site*.

Report of Investigations No. 28. Department of Anthropology, University of Tennessee, Knoxville.

Fay, Robert P.
1986 *Archaeological Investigations at Liberty Hall, Frankfort, Kentucky.* Kentucky Heritage Council, Frankfort.

Fox, Richard Allan, Jr.
1993 *Archaeology, History, and Custer's Last Battle.* University of Oklahoma Press, Norman and London.

Fox, Richard A., Jr. and Douglas D. Scott
1991 The Post-Civil War Battlefield Pattern: An Example from the Custer Battlefield. *Historical Archaeology* 25 (2):92-103.

Frost, George E.
1990 *Ammunition Making: An Insider's Story.* National Rifle Association, Washington, D. C.

Genheimer, Robert A.
1988 *An Historical Archaeological Assessment of the East Main Street Phase II Project in Frankfort, Franklin County, Kentucky.* Contract Publication Series 88-25. Cultural Resource Analysts, Inc., Lexington, Kentucky.

Haecker, Charles M.
1994 *A Thunder of Cannon: Archaeology of the Mexican-American War Battlefield of Palo Alto.* Professional Papers No. 52. Southwest Cultural Resources Center, National Park Service - Divisions of Anthropology and History, Southwest Regional Office, Santa Fe, New Mexico.

Hamilton, Douglas T.
1916 *Cartridge Manufacture.* Industrial Press, New York.

Hamilton, T. M.
1980 *Colonial Frontier Guns.* The Fur Press, Chadron, Nebraska.

Hamilton, T. M. (editor)
1982 *Indian Trade Guns.* Pioneer Press, Union City, Tennessee.

Hamilton, T. M. and K. O. Emory
1988 *Eighteenth-Century Gunflints from Fort Michilimackinac and Other Colonial Sites.* Archaeological Completion Report Series No. 13. Mackinac Island State Park Commission, Mackinac Island, Michigan.

Hart, Harold H. (editor)
1982 *Weapons and Armor: A Pictorial Archive of Woodcuts & Engravings.* Dover Publications, New York.

Hogg, Ian V.
1978 *The Illustrated Encyclopedia of Firearms.* Chatwell Books, Inc./Book Sales, Inc.,

Secausus, New Jersey.

Hogg, Ian and John Weeks
1992 *Pistols of the World* (3rd edition). DBI Books, Inc., Northbrook, Illinois.

Hoyem, George A.
1981 *History and Development of Small Arms Ammunition: Volume I - Martial Long Arms, Flintlock Through Rimfire*. Armory Publications, Tacoma.

1990 *The History and Development of Small Arms Ammunition: Volume II - Centerfire: Primitive, and Martial Long Arms* (2nd/revised edition). Armory Publications, Tacoma.

Huon, Jean
1988 *Military Rifle and Machine Gun Cartridges* (English edition). Ironside International Publishers, Alexandria, Virginia.

Isreal, Fred L. (editor)
1976 *1897 Sears Roebuck Catalogue*. Chelsea House Publishers, New York.

Knowles, Sir Francis H. S. and Alfred S. Barnes
1937 Manufacture of Gun-flints. *Antiquity* 12:201-207.

Layman, George J.
1997 *A Guide to the Ballard Breechloader*. Pioneer Press, Union City, Tennessee.

1998 *A Guide to the Maynard Breechloader* (2nd/revised edition). Pioneer Press, Union City, Tennessee.

Lewis, Berkeley R.
1972 *Small Arms Ammunition at the International Exposition Philadelphia, 1876.* Smithsonian Studies in History and Technology No. 11. Smithsonian Institution Press, Washington.

Logan, Herschel C.
1948 *Cartridges: A Pictorial Digest of Small Arms Ammunition.* Standard Publications, Huntington, West Virginia.

Mansberger, Floyd and Christopher Stratton
1996 *"Perfectly Panic Struck": The Archaeology of the Apple River Fort (Jo Daviess County, Illinois).* Fever River Research, Springfield, Illinois.

Matunus, Edward A. and Thomas J. Griffin (editors)
1995 *Shotshell Reloading Handbook* (4th edition). Lyman Products Corporation, Middlefield, Connecticut.

McDowell, R. Bruce
1984 *Development of the Henry Cartridge and Self-contained Cartridges for the Toggle-linked Winchesters*. A. M. B., Metuchen, New Jersey.

Mirken, Alan

1970 *1927 Edition of the Sears, Roebuck Catalogue.* Bounty Books/Crown Publishers, New York.

National Rifle Association (NRA)

1981 *American Handguns and Their Makers.* National Rifle Association of America, Washington.

1989 *NRA Firearms Fact Book* (3rd edition). National Rifle Association of America, Washington.

Noël Hume, Ivor

1976 *A Guide to Artifacts of Colonial America.* Alfred A. Knopf, New York.

O'Malley, Nancy

1987 *"Stockading Up": A Study of Pioneer Stations in the Inner Bluegrass Region of Kentucky.* Archaeological Report 127. Program for Archaeological Assessment, Department of Anthropology, University of Kentucky, Lexington.

1992 *Archaeological Test Excavations at Two Sites Along Paris Pike, Bourbon County, Kentucky.* Archaeological Report 291. Program for Archaeological Assessment, Department of Anthropology, University of Kentucky, Lexington.

Pollack, David and Charles D. Hockensmith

1985 *Archaeological Investigations at Waveland State Shrine, Fayette County, Kentucky.* Kentucky Heritage Council, Frankfort.

Rowe, William

1982 *Goods and Merchandise: A Cornucopia of Nineteenth-Century Cuts.* Dover Publications, New York.

Schock, Jack M. and Michael Dowell

1983 Some Early Gunflints Found in Kentucky. *Proceedings of the Symposium on Ohio Valley Urban and Historic Archaeology* 1:58-67.

Schroeder, Joseph J., Jr. (editor)

1973 *1923 Sears, Roebuck Catalogue.* Digest Books, Inc., Northfield, Illinois.

Schwing, Ned

1998 *1998 Standard Catalog of Firearms* (8th edition). Krause Publications, Iola, Wisconsin.

Sivilich, Daniel M.

1996 Analyzing Musket Balls to Interpret a Revolutionary War Site. *Historical Archaeology* 30 (2):101-109.

Skertchly, Sydney B. J.

1984 *The Manufacture of Gunflints.* Museum Restoration Service, Bloomfield, Ontario (originally published 1879, London).

Smith, Samuel D. (editor)
1976 *An Archaeological and Historical Assessment of the First Hermitage*. Jointly published by the Division of Archaeology, Tennessee Department of Conservation and The Ladies Hermitage Association, Nashville.

Stadt, Ronald W.
1995 *Winchester Shotguns and Shotshells from the Hammer Double to the Model 59* (2nd edition). Krause Publications, Iola, Wisconsin.

Staski, Edward and Paul S. Johnson
1992 Munition Artifacts from Fort Fillmore, New Mexico. *Historical Archaeology* 26 (2):66-73.

Supica, Jim and Richard Nahas
1996 *Standard Catalog of Smith & Wesson*. Krause Publications, Iola, Wisconsin.

Suydam, Charles R.
1973 *The American Cartridge: An Illustrated Study of the Rimfire Cartridge in the United States* (revised edition). Borden Publishing Co., Alhambra, California.

Thomas, H. H.
1991 *The Story of Allen and Wheelock Firearms*. Pioneer Press, Union City, Tennessee (reprint of 1965 1st edition).

Thomas, Judith E.
1996 The Kelley Historic Site (33LE160): Investigation of an Early 19th Century Homestead on the Ohio River. *Ohio Valley Historical Archaeology* 11:19-40.

Treadwell, Major T. J.
1873 *Metallic Cartridges (Regulation and Experimental) as Manufactured and Tested at the Frankford Arsenal, Philadelphia, Pennsylvania*. Government Printing Office, Washington (reprinted, n.d., The Armoury, West Hurley, New York).

Waselkov, Gregory A.
1979 Zumwalt's Fort: An Archaeological Study of Frontier Process in Missouri. *Missouri Archaeologist* 40:1-129.

Webster, Donald B.
1958 *Suicide Specials*. Stackpole Company, Harrisburg, Pennsylvania.

White, Stephen W.
1975 On the Origin of Gunspalls. *Historical Archaeology* 9:65-73.

Witthoft, John
1966 A History of Gunflints. *Pennsylvania Archaeologist* 36 (1-2):12-49.