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A Geoarchaeological Investigation of the Rush Creek Site, Cannon County, Tennessee

Michael W. Morris
University of Tennessee, Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Michael W. Morris entitled "A Geoarchaeological Investigation of the Rush Creek Site, Cannon County, Tennessee." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Anthropology.

Walter E. Klippel, Major Professor

We have read this thesis and recommend its acceptance:

Charles H. Faulkner, John Foss

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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A GEOARCHAEOLOGICAL INVESTIGATION
OF THE RUSH CREEK SITE
CANNON COUNTY, TENNESSEE

A Thesis

Presented for the

Master of Arts Degree

The University of Tennessee, Knoxville

Michael W. Morris

August 1989

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Signature Michael W. Dunn

Date 26 JULY 1989

To my parents,

I would like not to cut any new channels of consciousness but simply dig deeper into old ones that have become silted in with the debris of thoughts grown stale and platitudes too often repeated. "What's new?" is an interesting and broadening eternal question, but one which, if pursued exclusively, results only in an endless parade of trivia and fashion, the silt of tomorrow. I would like, instead, to be concerned with the question "What is best?," a question which cuts deeply rather than broadly, a question whose answers tend to move the silt downstream. There are eras of human history in which the channels of though have been too deeply cut and no change was possible, and nothing new ever happened, and "best" was a matter of dogma, but that is not the situation now. Now the stream of our common consciouness seems to be obliterating its own banks, losing its central direction and purpose, flooding the lowlands, disconnecting and isolating the highlands and to no particular purpose other than the wasteful fulfillment of its own internal momentum. Some channel deepening seems called for.

Robert M. Pirsig, Zen and the Art of Motorcycle Maintenance, 1974.

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Field work conducted at the Rush Creek Site in 1986 was performed by the following individuals; Andrew Bradbury, Ken Cannon, Lance Green, Hank McKelway, Connie O'Hare, Rick Stoops, and Carole Tucker. I apologize for the intense heat and humidity, and salute you for the intestinal fortitude and the mutual admiration for cold pizza and Bogart movies. Hank McKelway especially managed to frustrate the begeebers out of me, constantly turning the fruits of my ideas into applesauce. Thank you for forcing me to rethink even the most seemingly transparent concepts. Gerald Kline of the Tennessee Department of Transportation was most helpful, if not patient, with the on-going of the field operations. The local history of Woodbury was revealed to us by Mr. Bill Smith and Mr. J. Larimer who provided written and oral information concerning the site and mills

in the area. Special thanks goes to the residents of the East Side Trailer Park in McMinnville, Tennessee. Even though their pit bulldogs were chewing throught their leashes and they found no artistic value in A Clockwork Orange, they managed to tolerate eight scruffy, long haired kids who listened to Metallica at deafening levels, and who entertained themselves for hours with plastic bats and funny little balls with holes cut in them. They endeared themselves to us and even offered to adopt Hank, but I figured his wife might object. It was a tempting offer, though.

Laboratory analysis was performed by the following individuals; Walter Klippel (faunal), Gary Crites (botanical), Jo Juchniewicz (lithics), Hank McKelway (subsurface features and historic mill analysis), Andrew Bradbury (knapping), Lance Green (picking), and Carole Tucker (grinning). Terry Faulkner drafted the majority of figures found in this text. Her figures are those drawn with the skill of a true artisan, the remaining are mine. I must also thank Chuck Bentz for his assitance. Five minutes spent with Chuck is like returning to field school over and over again. Dr. Tracy Cox was infinitely helpful with the word processing and printing of this manuscript. I owe him at least a case.

I lovingly acknowledge my parents for deciding not to disown me during this time of pestilence. Their care and support is not something I can repay readily. Gabrielle Santore (whose surname, loosely translated in the Italian, means "the bull refuses to dance for Vesuvius is erupting") provided the emotional support that was most needed and least deserved during this time. Thanks go to Gil and his motorcycle repair shop, Dave Butz, Cal Ripken, Bill, Peter, Mike, and Michael.

ABSTRACT

Geoarchaeological investigations were used to assess the depositional and post-depositional processes that effected the Rush Creek Site (40CN79) in Cannon County, Tennessee. Of particular interest was a buried landform, found in the floodplain of the East Fork Stones River, that was sealed by sterile alluvium. This formation contained both prehistoric and historic artifacts within the same context. The stratigraphy of the site was determined by deep testing to describe the site and the landforms associated with the site. Samples collected from the exposed profiles of the deep test pits were subjected to particle size, pH, carbon, and phosphorus analyses. Statistical parameters derived from the particle size analysis were subjected to multivariate statistical procedures.

Particle size and multivariate analyses demonstrate that variable landforms can be discriminated according to relative age due to the formation of pedogenically derived clay in older landforms, and increased sand content in younger landforms. Carbon and phosphorus analyses show human influence in the buried floodplain formation due to the substantial amount of each found in the midden in comparison to the surrounding landforms. Conflicting radiocarbon dates and historic period research in the area helped to demonstrate that a possible historic truncation episode was responsible for the deposition of historic artifacts within the archaeological context of those of aboriginal origin.

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INTRODUCTION

The Rush Creek Site (40CN79) is located in the Outer Basin region of the Nashville Basin. The site is situated on a Pleistocene age terrace, and on a floodplain bounded by this terrace and the East Fork Stones River, 0.5 km. west of Woodbury in Cannon County, Tennessee (Figure 1). The site lies directly to the west of the confluence of the East Fork Stones River and Rush Creek, 85°05'26" long, 35°49'05" lat. The East Fork Stones River originates in the Highland Rim region to the east, and becomes entrenched at the confluence of Doolittle Creek within the Woodbury town limits. The river meanders downstream producing small, but distinct alluvial terraces and floodplains within the meander bends. The site consists of numerous intrusive subsurface features atop a Pleistocene age terrace, and a buried Holocene age deposit in the floodplain which is sealed by sterile alluvium. Documented buried alluvial landforms within floodplains and terraces in the Nashville Basin (Brackenridge 1982, 1984; Morris 1985, 1986; Turner and Klippel 1989) have produced studies of relict landforms of archaeological significance.

A section of the proposed State Route #1 connecting Woodbury to Murfreesboro, Tennessee would impact the site area. Phase 2 archaeological investigations were conducted by the Division of Archaeology, Tennessee Department of Conservation in 1985. This investigation uncovered concentrations of lithic artifacts and several subsurface features on the Pleistocene age terrace. A cultural "midden" was detected through deep testing in the floodplain area. This midden contained lithic debitage, wood charcoal, faunal remains, and one diagnostic Kirk-type projectile point. A lense of charcoal was discovered in one of the deep test sections and was surmized to be related to a possible Early Archaic component. Geomorphological investigations estimated the midden was formed ca 10,000 yr B.P. subsequent to Early Holocene channel abandonment. Following channel abandonement, a sequence of colluvial sheetwash and alluvial deposits provided

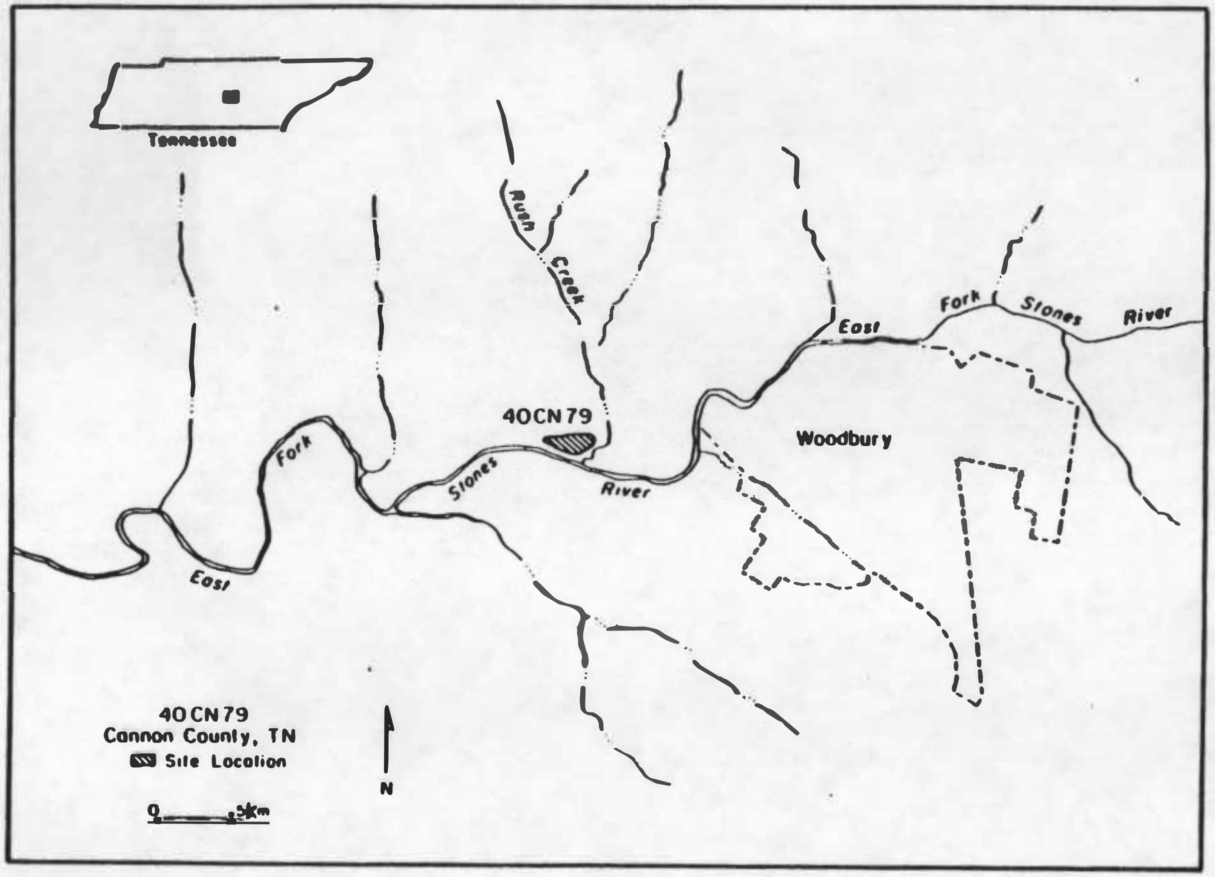


Figure 1. Location of Woodbury and the Rush Creek Site (40CN79).

the parent material for the cultural midden and was subsequently sealed by sterile overburden. Significance of this site was determined:

> On the basis of the archaeological and geomorphological information that has been produced by the Phase 2 testing at 40CN79, limited Phase 3 (data recovery) excavations are recommended. The importance of the site lies primarily in the buried Early Archaic horizon that was defined . . . on the south slope of the site. It is believed that this culture-bearing stratum represents a relatively short term single component occupation. Significantly, it is in a sealed context below culturally sterile colluvial sheetwash and floodplain deposits. This Archaic occupation of this area began initially on the surface of a channel bar deposit and subsequent to that was present on the surfaces of a succession of alluvial and colluvial sheetwash deposits. After abandonement of the area for prehistoric occupation, these deposits containing features and artifactual materials were sealed by sterile alluvial and colluvial sheetwash deposits. Given the presence of moderate quantities of artifactual materials in the culture bearing zone, an adequate recovery of these materials in a Phase 3 excavation should provide information for the definition of the assemblage associated with this type of Archaic settlement. Additionally, the presence of carbonized botanical remains in the midden and the presence of preserved bone materials should be adequate to provide information of the subsistence base. Finally, the clearly defined alluvial and colluvial stratigraphy in this portion of the site can be further studied to determine the geological processes responsible for the formation of the geological deposits in the area of the site. Of particular interest is the presence of preserved wood in the alluvial gravels that underlay the culture-bearing stratum (Spears, et al. 1986: 39-41).

Phase 3 investigations were conducted by the University of Tennessee, Department of Anthropology in 1986. Following the recommendations of the Phase 2 investigations, large areas of the Pleistocene age terrace were opened and further deep testing in the floodplain area was implemented. Phase 2 trenches were reopened and sterile overburden was removed, exposing the buried surface documented in the Phase 2 investigations. Excavation units were placed on this buried surface where it was hoped an investigation into Early Archaic subsistance patterns would ensue.

It was quickly evident that a true Early Archaic component was lacking. One of the first indications of a disrupted context was the discovery of domesticated animal remains on top of and slightly intrusive into the surface of the buried cultural midden. An excavation of a charcoal lense, noted in one of the deep test walls (Feature 18, Phase 2; Area C, Phase 3), uncovered historic artifacts dating to the mid-nineteenth century associated with the buried surface of the midden.

Lithic artifacts were found throughout the buried landform, but no diagnostic artifacts were found. Historic artifacts, animal bone, and angular limestone fragments were found on top of and slightly intrusive into this cultural midden, while lithic artifacts were distributed throughout the midden.

Laboratory analysis confirmed the suspected archaeological context. Botanical analysis revealed plant foodstuffs were rare and wood charcoal analysis concluded a prevalence of floodplain and low terrace adapted species of maple (Acer sp.), sycamore (Platanus occidentalis), black willow (Salix nigra), and ash (Fraxinus sp.). Analysis of the lithic debitage revealed no concentrations of artifacts denoting activity areas, but a homogeneous distrubution of debitage both vertically and horizontally through the midden. Faunal analysis documented the presence of domestic pig (Sus scrofa), and domestic cow (Bos taurus) on the surface of and slighty intrusive into the midden. C-14 analysis presented more problems. A sample extracted from a topographically higher position in the midden denoted a mid-Holocene landform, while a charcoal sample from a lower topographic area of the midden revealed a mid-nineteenth century deposition. Historic period inquiries note the possibility of an historic period mill race which may have truncated the floodplain in this area.

A geoarchaeological analysis was undertaken to unravel this contextual problem. The primary concern in this investigation is to develop an understanding of the depositional sequences of these alluvial landforms at the Rush Creek Site as well as understanding the post-depositional effects of pedogenesis. Of primary concern is the stratigraphic relationships of these landforms and their pedogenic alterations through time for the purpose of documenting chronosequential relationships. Because temporal associations at this site are paramount to understanding the site context, this investigation will attempt to develop a chronosequence of alluvial landforms and subsequent disturbance as it relates to changes in sediment sources, chemical and physical alterations in these landform due to pedogenic effects, and disturbance processes influenced by human activity.

Several lines of inquiry will be undertaken in this geoarchaeological investigation. A stratigraphic assessment will be used to document occurrence of alluvial landforms in the site area.

A pedological investigation will be used to document the various soils and soil forming processes. Statistical analysis of textural parameters will be used to correlate various landform associations. Chemical analysis, including carbon and phosphate analyses, will be used to define and delimit buried surfaces as well as to document human influence on the landform.

CHAPTER 2

GEOARCHAEOLOGY: A BACKGROUND

Geoarchaeology is a new and burgeoning sub-discipline of archaeology that has received considerable attention in recent years (Butzer 1982; Gladfelter 1977, 1981; Hassan 1979; Stein 1985, 1987). Geoarchaeology is the integration of archaeological studies with those of the earth sciences. Such studies include geomorphology, stratigraphy and sedimentation, pedology, and geography. Archaeological sites are viewed as fossil assemblages associated with or contained within landform matrices conforming to natural laws of uniformitarianism. Human impact can influence the development of the landform while, in turn, environmental dynamics can influence man's impact on the landform. By studying the dynamics of change of landforms associated with archaeological sites, geoarchaeology can aid in the interpretation and environmental reconstruction of archaeological contexts.

Geoarchaeology has been defined as "archaeological research using the methods and concepts of the earth sciences" (Butzer 1982: 35). Earth science studies include:

> geography and pedology as well as geology. Each provides component data essential to the study of environmental systems...a competent geo-archaeologist should be able to evaluate diverse sources of empirical data, as generated within the archaeological project and as available from external sources, in order to apply the information to construct an integrated model of a geo-environmental system. Ideally, this model eventually will be linked with information on biota, demography, and material culture to generate a higher order model of prehistorical settlement and subsistence patterning (Butzer 1982: 35).

Geoarchaeology, as a discipline, has a wide range of uses in archaeological inquiry. These uses include; locating archaeological sites, studying regional stratigraphic relationships for recognition of activity areas, analyzing sediments for elucidation of site forming processes, analyzing paleoenvironments, modeling cultural/environmental interactions and developing geochronologies (Hassan 1979: 267). The strength of geoarchaeology is in the integration of archaeological remains

within an environmental context (Gladfelter 1977: 519). Geoarchaeology is a study of the interface between the physical and biological environment as it relates to human activities.

At the core of geoarchaeological research is the concept of the cultural sediment. A sediment is defined as "any particulate matter on the surface of the earth that has been deposited by some process under normal surface conditions" (Stein 1985: 6). Geoarchaeologists examine sediments and chemical residues for the purpose of defining a sediment's history. Because humans act as geomorphic agents, archaeological residues are treated as components of a sedimentary matrix (Butzer 1982: 39). A sediment's history is a function of four factors: the source of the sediment, transportation mechanism of the sediment, the environment of deposition of the sediment, and the post depositional processes which effect the sediment (Stein 1985: 5). Those factors which cannot be ascribed to natural processes can be assumed to have been effected by cultural processes.

Stratigraphy

One of Thomas Jefferson's many contributions to science was the systematic excavation of a burial mound by stratigraphic layers (Willey and Sabloff 1980: 31). From that moment forward, archaeologists have devoted considerable time to the study of the "natural layers" that contain and bound archaeological assemblages. These natural layers contain considerable information regarding the site's spatial and temporal context and provide clues for the depositional and post-depositional episodes that influence archaeological assemblages.

The concepts regarding geologic stratigraphy can be in the understanding of archaeological stratigraphy. One of the basic building blocks is the sedimentary unit. Campbell (1967) denotes stratigraphic units of sedimentary bodies into lamina, laminasets, beds and bedsets. The bed is the basic building block of stratigraphy and a bed can be considered an inferred time-stratigraphic unit of limited areal extent and of relatively short time span (Campbell 1967: 7). One of the more appropriate stratigraphic units is the lithostratigraphic unit which is defined as a:

body of sedimentary, extensive igneous, meta-sedimentary, or metavolcanic strata which is distinguished and delimited on the basis of lithic characteristics and stratigraphic position. A lithostratigraphic unit generally conforms to the Law of Superposition and commonly is stratified and tabular in form (NACOSN 1983: 855).

These lithostratigraphic units can be further subdivided into formations, members, and beds. Other appropriate stratigraphic units include allostratigraphic units which are sedimentary bodies defined by their bounding discontinuities (NACOSN 1983: 865) and chronostratigraphic units which are reference sedimentary units used as temporal markers for similar formations with synchronous boundaries (NACOSN 1983: 868).

The laws regarding stratigraphic succession are applicable to archaeological stratigraphy. Several of these laws, conforming to uniformitarian priciples are defined as follows:

The Law of Superposition: in a series of layers and interfacial features, as originally created, the upper units of stratification are younger and the lower are older.

The Law of Original Horizonality: any archaeological layer deposited in an unconsolidated form will tend towards an horizontal deposition.

The Law of Original Continuity: any archaeological deposit, as originally laid down will be bounded by a basin of deposition, or will thin down to a feather edge.

The Law of Stratigraphic Succession: any given unit of archaeological stratification takes its place in the stratigraphic sequence of a site from its position between the undermost of all units which lie above it and the uppermost of all those units which lie below it and with which it has a physical contact, all other superpositional relationships being regarded as redundant (Harris 1979: 112-113).

Gasche and Tunca (1983) have offered a guide to archaeostratigraphic classification. The principal concept is the definition of lithologic units into ethnostratigraphic and/or chronostratigraphic units. Ethnostratigraphic units are to be classified according to their contents of anthropic origin. The purpose is to organize the sequences of strata in units characterized by artifact classes (Gasche and Tunca 1983: 329). Chronostratigraphic units are defined on the basis of duration and are temporal sequences of strata (Gasche and Tunca 1983: 329). Archaeologists though have been cautioned as

to the inherent confusion in associating stratigraphic units with cultural components which may not conform on a regional basis (Gruber 1978).

Alluvial Geomorphology

Alluvial landforms have been of tremendous importance to archaeologists. Buried landform surfaces in floodplains and terraces are considered prime locations for the study of preserved archaeological remains (Binford 1983). Stream dynamics and morphology, depositional regimes, and environmental forcing factors have had tremendous impact on the presence and disturbance of archaeological sites. For example, it has been estimated that 95% of all Paleolithic artifacts found in fluvatile environments have been redeposited in some degree (Shackley 1978: 55). It is therefore essential to understand these hydrologic regimes and their relationships to archaeological sites.

There are three major types of river regimes; braided, meandering and straight. All natural channels exhibit alternating pools or deep reaches, and riffles or shallow reaches regardless of type or pattern. Braided regimes are characterized by channel diversion around alluvial islands. Meandering regimes generally occur at smaller values of slope than do braiding regimes and meandering regimes exhibit less bankful discharges than braided regimes (Leopold and Maddock 1953, Leopold and Wolman 1957). The shape of these channels tends to be a factor of the texture of the bank. As the clay and silt content of a bank increases downstream, the depth of the channel will increase in relation to the width, and as clay and silt contents decrease downstream, the width of the channel will generally increase in contrast to the depth (Schumm 1969: 17). The clay content of the bank tends to make the matrix more cohesive, and resistant to erosion (Schumm 1969: 28).

An aggrading meandering regime is characterized by the lateral truncation of the stream across the landform. Depending upon the amount of hydraulic discharge downstream, sediments suspended in rivers and streams are deposited in the channels and within the meander bends. This results in asymetric valley profiles characterized by steep slopes on the cutting side of the river in comparison to the gentle slopes of the depositional landforms on the other side. Such assymetric

profiles are described by Brackenridge (1982, 1984). These alluvial landforms consist of floodplains and terraces. The parent material for floodplains and terraces consists primarily of channel deposits and overbank deposits. Channel deposits consist of rounded lag gravel demarcating the presence of a former channel bed (Fahnestock and Hanshild 1962, Cheetham 1976). Overbank deposits consist of lateral accretion generally ascribed to the development of relict sand bars, vertical accretion consisting of silty upper matrices deposited from suspended loads during flood stages, and splay deposits consisting of fine materials deposited with the breeching of natural levees (Lattman 1960: 278-280). Because deposition of a floodplain does not continue indefinitely, the floodplain surface can be converted to a terrace by a major tectonic, climatic, or human event (Wendland 1982). This alters the regime of the river to cause it to entrench itself below its established bed and floodplain. A terrace is then distinguished from a floodplain by the frequency with which each is overflowed (Wolman and Leopold 1957: 87).

Changes in stream dynamics which can lead to changes in depositional regimes and landform development are due to geomorphic thresholds. There are two major types of geomorphic thresholds; extrinsic and intrinsic. An extrinsic threshold is one that is exceeded by the force or process external to the system. An example would be regime changes caused by a climatic event. An intrinsic threshold indicates that changes occur without a change in an external variable. An example would be a long term weathering process reducing the strength of slope materials leading to slope adjustment and mass movement of materials (Schumm 1980: 473-474). Thresholds in streams can be recognized by depositional and non-depostional events. In analyzing a stream's capacity to carry sediment, a stream's critical power threshold can be assessed. A stream's power is power available to carry a sediment load. A stream's critical power is that power needed to carry a sediment load. The threshold of critical power occurs when the stream power and critical are equal. When stream power exceeds critical power during long time spans, additional sediment load is obtained by vertical erosion that cuts V-shaped cross valley profiles and results in strath terraces. When critical power

exceeds stream power there is a decrease in sediment load and grain size (Bull 1979: 453). Critical power thresholds are sensitive to changes in climate, base level, and human impact (Johnson 1982: 223) and result in aggradation or degradation.

Alluvial Pedology

Aspects of pedogenesis and post-depositional alteration of sediments are important to the understanding of the archaeological record. The process of pedogenesis can have a profound impact on the physical and chemical dynamics of archaeological contexts. Soil studies are useful in archaeology by determining the relative age of sites, identifying pedologic, geologic and man influenced horizons, determining occupational sites by soil chemical analyses, determing the erosional-sedimentary history of a site, and determing original soil surfaces of an area (Foss 1976: 234). Ruhe (1983) estimates that most soil orders in the United States with the exception of Ultisols were formed during the Holocene. It is therefore important to understand the pedogenic nature of sediments and the effects on archaeological context.

Jenny (1941) produced the classic work on the factors of soil formation. This work listed five major factors of soil formation; a soil is a function of the climate, biota, relief, parent material, and time. Any variation within any of these factors would produce a different soil distinguished by the developmental effects of these factors. Simonson (1959) outlined a general theory of soil genesis. This theory identified two major processes; the accumulation of parent materials and the differentiation of soil horizons within a profile. Horizon differentiation, which is the distinguishing criteria for separating different soils, is the function of four major factors; additions, losses, translocations, and transformations. Additions include such processes as accumulation of organic matter to the profile. Losses are materials depleted from the soil profile such as the removal of soluble salts and carbonates. Translocations are materials transported through the profile such as movement of clays which form argillic horizons. Transformations are the physical and chemical changes occuring without transportation such as the weathering of primary minerals into secondary

minerals. The pedogenic alteration of sediments can alter the original depositional context of archaeological sites.

The dynamics in the physical properties of soils can disrupt the depositional context of archaeological sites. Such physical effects as human disturbance (Hughes and Lampert 1977) and gravitational influences (Rick 1976) have been documented. One of the most important factors of weathering and geomorphic alteration is water. Water moving across a landform or through a profile can have important affects (McKeague and Arnaud 1969). The packing and antecedent moisture within a soil profile can accentuate or inhibit the movement of water through a profile (McQueen 1961, Aylor and Parlange 1973). Water movement can erode a profile, add parent material to a profile or move materials within a profile which can affect depositional context. The biological, chemical or physical churning of soil materials is called "pedoturbation" (Buol et al. 1973: 89). One such pedoturbational process is the mixing of materials caused by shrink-swell activities within the soil. Wetting and subsequent drying of a profile can influence, under certain conditions, expandible clays. The drying of these clays cause subsurface cracks within the areas of structural weakness. A soil can crack and materials can be transported down through a profile. Coarse textured sediments generally have more stable peds than fine textured sediments. Blocky structured soils have ped faces developed by shear forces while prisms and columns have vertical faces formed mainly by tension cracking (White 1966: 140). This process is known as argilliturbation (Wood and Johnson 1978: 352) and can have considerable affects on depositional contexts (Cahen and Moyersons 1977).

Effects of pedogenesis can produce chemical alterations within a profile. With accelerated weathering, a profile can go into a desilication process which accelerates with acidity (Jackson et al. 1948: 1254). A weakly desilicated profile, representing initial soil weathering, is recognized by a greater number of exchangable bases in relation to SiO_2 content, predominance of 2:1 phylosilicate minerals, and predominance of smectites, chlorite, montmorillinite, vermiculite, and allophane. A moderately desilicated profile has fewer exchangable bases than weakly desilicated profiles, but the

presence of these bases are slightly higher than the SiO_2 content and are represented by 1:1 phyllosilicate minerals with predominance of kaolinite and halloysite. Intensely desilicated profiles have less exchangable bases in relation to SiO_2 content, predominance of aluminum hydroxide minerals and gibbsite. This is also known as laterization and represents the end product of a weathering profile. The primary weathering mechanism for desilication is hydrolysis (Pedro et al. 1969: 464). In well drained soils, eluviation of silica and basic cations (K, Na, Mg, Ca, and others) has taken place for the entire solum in different degrees as a function of time (Jackson 1965: 20). A profile will generally exhibit the movement of the weathering equation to the right from a weakly to a strongly desilicated profile. An exception would be alluvial landforms where the additions of fresh sediment and soluble exchangable bases from the floodwaters can move the equation back to the left reducing the effects of weathering (Jackson et al. 1948: 1259). Many of the materials deposited in archaeological sites are subject to the effects of chemical weathering and/or chemical preservation dependent upon the conditions and chemical nature of the site.

Many archaeological sites associated with alluvial landforms are found buried beneath alluvial sediment. These buried sites are often located on buried surfaces representing former stable landforms. These buried landforms are also refered to as paleosols. Paleosols are soils formed in the past. There are three major types of paleosols: relict soils, buried soils and exhumed soils. Relict soils are soils formed on preexisting landscapes but were never buried by younger sediments. Formation processes date from the time of the original landscape. Buried soils are soils formed on preexisting landscapes and were subsequently buried by younger sediments. Exhumed soils are soils that were buried by younger sediments and reexposed by removal of the younger overburden (Ruhe 1965: 755). Paleosols can be used to aid in the determination of past environments. By comparing paleosols with soils of recent environments, relationships can be understood (Valentine and Dalrymple 1976). Buried paleosols can be recognized by the relict A-horizon or organic accumulation of a former surface (Ruhe 1969: 37). Discrepancies in lithology can be used to assess

a multisequel profile (Ruhe and Daniels 1958: 69) indicating buried surfaces. Stone lines which occur in a profile may also indicate a buried surface (Ruhe 1959: 223). The documentation of paleosols in a landform is important for understanding the depositional history, and becomes of extreme importance when paleosols are associated with archaeological sites.

Rivers can entrench themselves below their established beds and floodplains. This process creates sequences of alluvial landforms called terraces. Many times these landforms are created in the same manner, denoting time as one of the primary soil formation factors of importance. Older to younger alluvial landforms created by similar hydrologic regimes can be refered to as a chronosequence. A chronosequence of New River alluvium in Virginia was examined for four soils formed on successively older terraces (Harris et al. 1980). The study found that with time, there was increasing clay illuviation and an increase in citrate dithionite extractable iron with depth in older landforms. The clay mineralogy indicated a weathering progression from mica-vermiculite to hydroxy interlayered vermiculite to kaolinite (Harris et al. 1980: 862). Birkeland (1978) found with Quaternary age deposits in Baffin Island that within 100,000 years, a chronosequence developed from an oxic horizon in a 200 year old soil to the development of a strong cambic horizon in a 100,000 year old soil (Birkeland 1978: 733). Ruhe (1956) studied a chronosequence in a Wisconsinan loess landform, a Late Sangamon soil, and a Kansan till. The study found that with increasing age there was an increase in thickness of the soil solum, an increase in thickness of the B-horizon, and an increase in clay content (Ruhe 1956: 453-454). In a comparison of soils developed in Kansan, Illinoian and Wisconsinan age drifts in New Jersey and Pennsylvania, Novak et al. (1971) found an increase in particle size with increasing age and increase in extractable iron (Novak et al. 1971: 211-218). A chronosequence of loess derived soils in southeastern Iowa demonstrated increased cation elluviation and increased formation and movement of clay within a soil solum with increasing age (Hutton 1951: 324). The study of a chronosequence can illustrate the changes a landform experiences with time. The comparison can also aid in isolating those pedologic processes that are

developed rather than inherited from the parent material. Once the process of time can be extrapolated, environmental information can be gained by assessing the remaining variability between these landforms.

Alluvial Geoarchaeology

Archaeologists, utilizing earth science concepts, have been integrating investigations of archaeological contexts with studies of depositional histories and post-depositional developments occurring at archaeological sites. Many of these sites are located in alluvial depositional regimes. The analysis of alluvial sediments provides clues toward formation processes, climatic forcing factors, pedogenic alteration, and man-land interactions. Alluvial landforms are sensitive to change, and such change can be documented and correlated with archaeological analyses.

Several studies combining earth science techniques with archaeological inquiries have been undertaken. Ahler (1973a, 1973b) used a series of sediment tests to deduce variability in Rodgers Rockshelter, Missouri. The studies included determination of particle size, mineral content, organic matter, and phosphates. The particle size analysis, using hydrometer and sand sieve methods were subjected to multivariate statistical techniques. Principal components analysis and factor analysis yielded three factors. Weighted average cluster analysis of these three factors yielded ten depositional units. Every major change noted in the archaeological record coincided with the major changes in depositional patterns. The Post-Pleistocene depositional history of Rodgers Rockshelter shows a progression of intense upland erosion and aggradation by the Pomme de Terre River, to a period of severe local hillside erosion and valley degradation, to a period of combined alluvial and colluvial deposition on the T1b terrace. Davidson (1973) used particle size and phosphate analyses to explain the evolution of a large tell at Sitagroi in northeastern Greece. The study was able to determine that local alluvium was used for house construction, growth of the tell was due to house collapse and that house collapse explains the thick sediment layers between living floors. Burgess and Jacobsen (1984) used organic matter and phosphate analyses to determine cultural versus non-cultural

sediments of shelters in Namibia. These are just a sampling of studies demonstrating the utility of integrating earth science studies with archaeological investigations.

Geomorphic studies have been integrated with archaeological investigations concerning questions of site formation processes and variations in environmental parameters. Geomorphic and sediment stratigraphic studies at the Koster site in the lower Illinois River Valley deduced major Holocene environmental changes which may have influenced prehistoric populations (Butzer 1977, 1978). From these geomorphic studies, Butzer deduced rapid valley aggradation from reworked loess after 10,000 yr. B.P. The floodplain stabilized around 5,000 yr. B.P. and showed aggradation again after 2,500 yr. B.P. Butzer also documented the geomorphic erosional affects of human-landscape interactions. The major conclusion was that environmental changes in the valley influenced human adaptive strategies making paleoenvironmental variables critical in archaeological studies. Stein (1982) used pH, phosphorous, organic carbon, clay mineralogy, and particle size analyses to determine the evolution of a shell midden in the Green River Valley of Kentucky. The study determined that during the Pleistocene, outwash transported by the Ohio River dammed the rivers draining west-central Kentucky and created a large lake. The resultant lake bed lacustrine deposits comprised the present Green River floodplain. Restricted movement of the river channel within fine textured river banks aided in the preservation of these shell middens. Gardner and Donahue (1985) used stereographic aerial photography for geomorphic modeling and terrain analysis to aid site location the the Little Platte drainage of Missouri. In this study of alluvial landform development, they concluded that the Little Platte drainage during the Archaic and Early Woodland periods experienced low precipitation levels and could not have sustained the Little Platte as an ephemeral stream, thus explaining the concentrations of archaeological materials in the T1 and T2 terraces. An increase in moisture after 4,000 yr. B.P. may have increased the resource potential for the valley.

Pedologic investigations at archaeological sites can also aid in understanding site formation processes and paleoenvironmental parameters. Foss (1976) used soil studies and integrated them

with Paleoindian sites in the Shenandoah River Valley of northern Virginia and the Delaware River Valley of eastern Pennsylvania. The studies showed that Pleistocene age terrace soils associated with Paleoindian sites showed appreciable horizonation, clay and iron accumulation in the B-horizon, clay coatings on ped surfaces, and moderately developed structure in the B-horizon. Discontinuities found within these Pleistocene age profiles proved important from an archaeological standpoint because of the different age relationships and activities associated with breaks in sedimentary patterns (Foss 1976: 237). The study also showed that the pH's of the terrace and floodplain profiles were effected by recharge of bases by flooding, that organic matter decreased with depth, and that phosphate accumulation increased at lithologic discontinuities associated with archaeological sites (Foss 1976: 243).

Holliday (1985a, 1985b, 1985c) studied two buried soils indentified in early and middle Holocene sediment at the stratified Lubbock Lake archaeological site in Yellowhouse Draw, Texas. The first buried soil formed in organic rich lacustrine and sandy eolian sediments was deposited from 11,000 to 8,500 yr. B.P. and was developed from 8,500 to 6,300 yr. B.P. A common gleyed horizon directly below the A-horizon indicated the soil was formed in a marsh with the water table at or below the surface. The second buried soil was found in highly calcareous lacustrine sediments along the valley axis and in sandy eolian material along the valley margin with deposition and pedogenesis occurring between 6,300-5,000 yr. B.P. The relatively high organic matter content of the A-horizon and mineral leaching of carbonate in the C-horizon suggested that the water table was high in the valley axis facies. The valley margin facies exhibited some evidence of clay illuviation and precipitation of calcium carbonate. The data suggested a regional climatic change toward conditions of increased eolian activity, reduced effective moisture, and possibly warmer temperatures for the Early to the Middle Holocene period, and is believed to have affected human adaptive strategies during these times.

The study of geoarchaeology incorporates a numerous set of disciplines in the evaluation of archaeological contexts. The interdisciplinary nature of geoarchaeology is its primary strength in investigating archaeological problems. A vast array of methods and techniques found within earth science disciplines provides the archaeologist with an arsenal of investigative procedures essential in deducing site formation processes and environmental parameters which influence the deposition and preservation of archaeological sites. Without the establishment of proper archaeological context, questions concerning higher levels of theory about human behavior cannot be established.

CHAPTER 3

ENVIRONMENTAL SETTING

The Rush Creek site and the valley floors of the East Fork Stones River are a part of the Inner Nashville Basin which is also incorporated into the Interior Low Plateaus Physiographic Province of Middle Tennessee and Kentucky (Fenneman 1938) (Figure 2). The adjacent valley slopes are comprised of formations representative of the Outer Nashville Basin and the upland plateau areas are a part of the Highland Rim. The Interior Low Plateaus Province represents a series of sedimentary deposits of Paleozoic age. These deposits are characterized by calcareous limestones and dolomites with some deposits of interbedded shales and sandstones.

The Highland Rim is a cherty Mississippian plateau with erosional remnants of Devonian shales. This is the largest feature of the Interior Low Plateaus Province and covers some 24,087 km^2 of Alabama, Tennessee, and Kentucky. The Highland Rim surrounds the Nashville Basin. Elevation ranges from 289-335 m AMSL in the east and north, and some 289-304 m AMSL in the western area (Edwards et al. 1974: 2).

The Outer Nashville Basin is underlain by more erosion resistant Middle and Late Ordovician limestones. These consist of highly phosphatic and silica enriched limestones of the Maysville and Nashville groups. The area of the Outer Basin is roughly 10,900 km^2. The topography consists of steep slopes, narrow ridges and narrow valley floors. The Outer Basin surrounds the Inner Nashville Basin and rises some 50-100 m above the Inner Basin with elevational ranges of 213-274 m AMSL (Wilson 1949: 75). (Figure 2)

The Inner Nashville Basin is composed of Middle Ordovician limestones mainly of the Stones River Group in the central and most eroded parts of the Nashville Basin. The Inner Basin covers roughly 4,400 km^2. The topography consists of gently rolling relief with isolated hills as

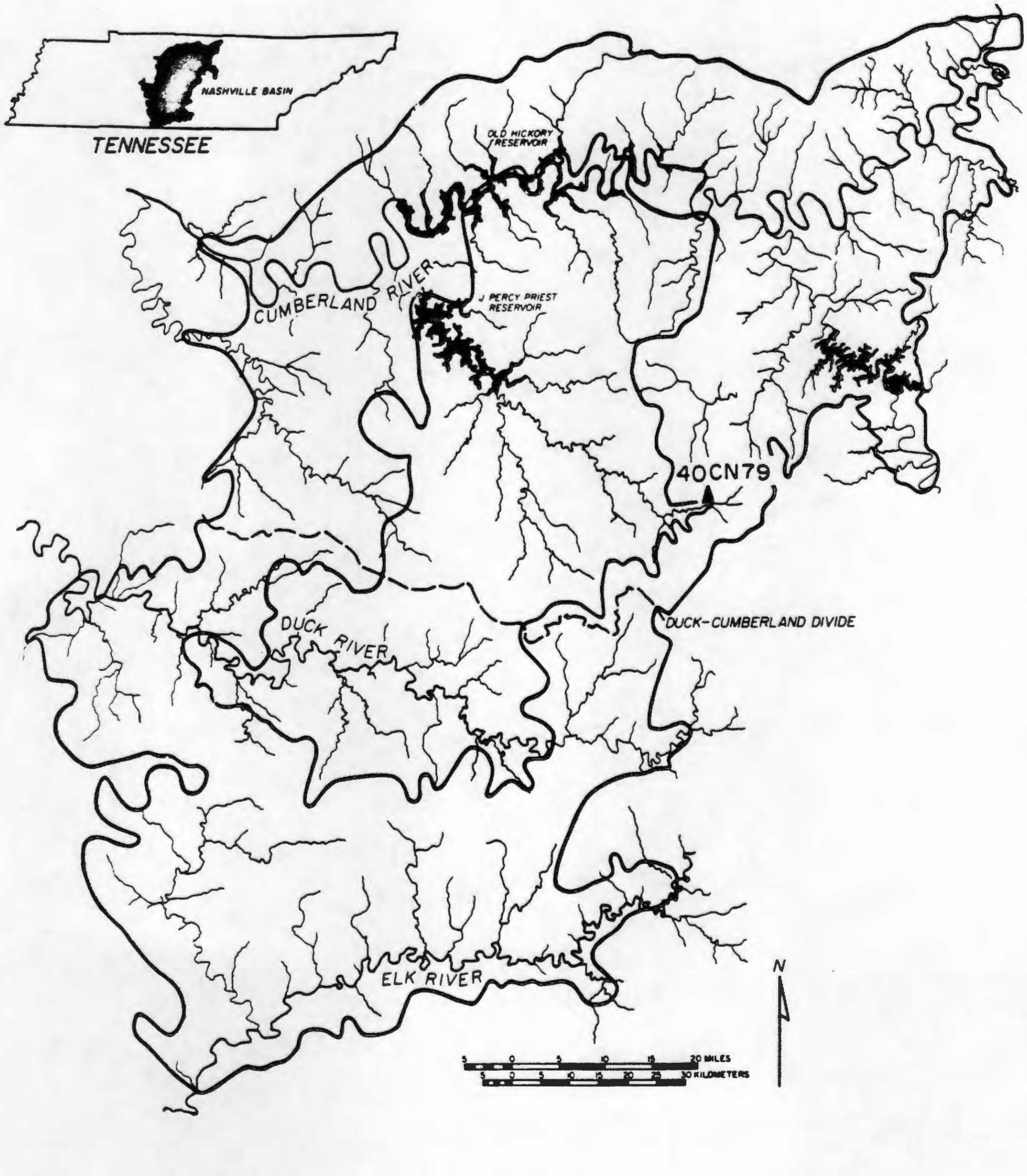


Figure 2. Nashville Basin, Including the Rush Creek Site (40CN79).

outliers of the Outer Basin. Elevation is 155-203 m AMSL and karst features such as sinkholes and caverns are common (Wilson 1949: 24). (Figure 2)

The Rush Creek site occupies alluvial landforms on the north bank of the East Fork Stones River, about .5 km west of Woodbury, Tennessee. The East Fork Stones River originates about 1 km east of Woodbury and flows northwest through the Nashville Basin where it joins the Cumberland River at Neely Bend about 20 km east of the city of Nashville. The Rush Creek site includes a buried floodplain formation and some remnant archaeological features located atop a Pleistocene age terrace. The site is located within a meander bend of the East Fork Stones River adjacent to the Rush Creek confluence to the east.

Regional Geology

The Nashville Basin and Highland Rim are erosional remnants of Paleozoic sedimentation. The Nashville Basin is part of the pre-Cambrain structural dome of the Cincinnati Arch sometimes referred to as the Nashville Dome. The Nashville Dome is part of a gentle anticline that was once structurally high but is now topographically low (Wilson 1949: 334). The present area of the Nashville Basin (15,300 km^2) is believed to be the original area of the Dome (Luther 1977: 37). The Cumberland Plateau to the east represents a series of deltaic sedimentary deposits of Pennsylvanian sandstones and shales. The Cumberland Plateau was formed by progradation of fluvial sediments which originated in the Appalachians and were deposited into the large shallow inland sea that is now the Interior Low Plateaus. The Cumberland Plateau represents a geoform that once surrounded and covered the Dome (Piper 1932: 19).

Throughout the Paleozoic and Mesozoic eras, the Nashville Basin underwent cycles of sedimentation, submergence, uplift, and erosion. These processes eventually weathered the formation until the Pennsylvanian sandstone cap and the cherty Mississippian cap were breached eventually exposing the less resistant Ordovician and Devonian limestones (Luther 1977: 37-38). The curved and weakened surface of the Dome encouraged its truncation as streams developed in the weakened

substrate and the landform succumbed to erosional forces. The Paleozoic formations surrounding the Basin were most resistant and weathered differentially leaving those landforms such as the Pennsylvanian Cumberland Plateau and the Mississippian Highland Rim topographically higher than the Basin (Piper 1932: 19). The gradual retreat of the Cumberland Plateau escarpment exposed a somewhat resistant Mississippian Plateau of cherty substrate. This broad landform known as the Highland Rim is the largest section of the Interior Low Plateaus Province. At its contact with the Nashville Basin, the Highland Rim exposes an irregular escarpment of Mississippian limestones and Devonian shales.

It has been suggested that forces forming the Basin took less than 10 million years and the major drainages of the Basin including the Elk, Duck, Cumberland, and Harpeth rivers continue to follow along stress points in the substrate (Miller 1974: 20). These rivers generally follow an east to west drainage originating in the Highland Rim to the east and flow toward the Tennessee River Valley in the west. These drainages were instigated by tectonic upwarping during Late Pliocene-Early Pleistocene times. The Nashville Basin and Highland Rim experienced a great amount of truncation due to the down-cutting of these drainages. The rivers continued to aggrade until contact was made with some more resistant Ordovician limestones of the Carters, Lebanon, and Ridley formations, primarily found in the Inner Nashville Basin. During Late Pleistocene times, the rivers ceased down-cutting and the river valleys began to fill with alluvial sedimentation from meandering river regimes. This process has left distinct alluvial terraces and floodplains along the valley floors.

The down-cutting of rivers across the Highland Rim and Nashville Basin has exposed several geologic formations, some of distinct economic importance to prehistoric peoples (Figure 3). One of the lower formations exposed by the East Fork Stones River includes the Carters formation. This Ordovician formation consists of fine grained, yellowish brown limestone. The formation is thin bedded in the upper part. The lower part consists of thicker bedded limestone with very slight

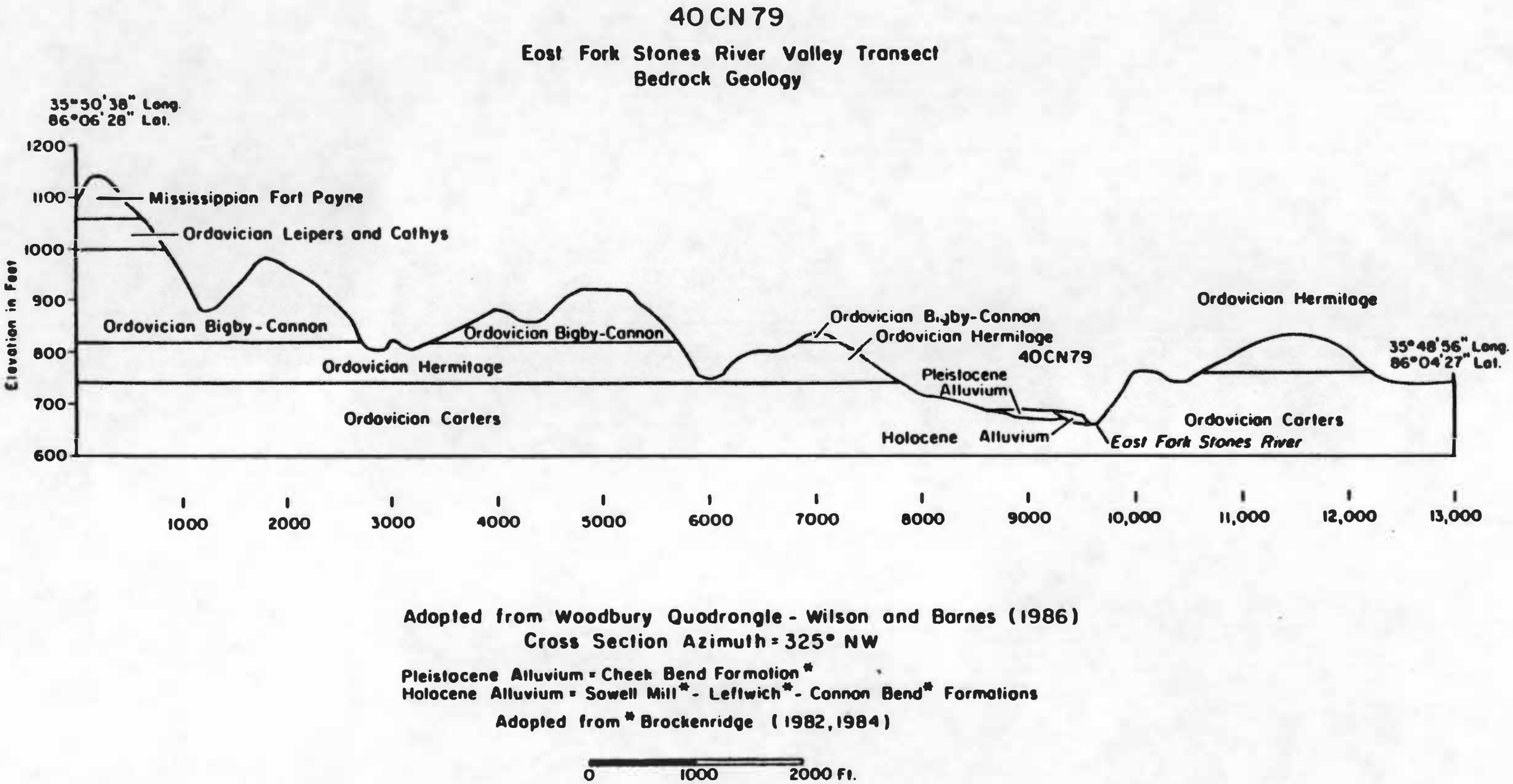


Figure 3. East Fork Stones River Valley Transect, Bedrock Geology.

amounts of chert with scattered mottlings of magnesian limestone and thin bentonite beds. Thickness has been recorded from 50 to 100 feet (Hardeman 1966).

The Hermitage formation is one which overlies the Carters formation. This Ordovician formation consists of thin-bedded to laminated sandy and argillaceous limestone with shale, nodular shaley limestone, coquina, and phosphatic calcarenite. Thickness is 50 to 100 feet (Hardeman 1966).

The Bigby-Cannon formation overlies the Hermitage formation. This formation is Ordovician in age and consists of brownish-grey calcarenite and light grey to brownish-grey cryptograined to medium-grained even-bedded limestone. Thickness of this formation is 50 to 125 feet (Hardeman 1966).

Overlying the Bigby-Cannon formation is the Leipers and Catheys formations. These formations are Ordovician in age and consists of dark-grey, fine-grained, thin to medium bedded limestone; argillaceous, nodular and shaley, medium-dark gray to brownish-grey, fine-grained, thin bedded, fossiliferous limestone; and medium bedded, crossbedded calcarenite. This formation has a thickness of 100 to 250 feet (Wilson and Barnes 1968).

The Fort Payne formation overlies the Leipers and Cathys formations. This formation may have been the most important economically for the prehistoric inhabitants of the Rush Creek site. This formation is Mississippian in age and consists of bedded chert, calcareous and dolomitic silicastone, minor limestone and shale, scattered lenses of crinoidal limestone and thin green shale at the base. The thickness of this formation is about 250 feet (Hardeman 1966). This formation contained the primary chert resource for lithic tool manufacture at the Rush Creek site and could be procured in situ or collected as cobbles from stream beds.

Two formations which overlie the Fort Payne formation and could have been of some economic importance in the area are the St. Louis formation and the Monteagle formation. The St. Louis formation is Mississippian in age and consists of fine-grained, brownish-grey limestone which is dolomitic and cherty. Thickness of this formation is 100 to 280 feet. The Monteagle

formation is Mississippian in age and consists of fragmental and oolitic limestone, light grey and fine grained, brownish gray limestone. Thickness of this formation is 180 to 350 feet (Hardeman 1966). These formations contain a nodular, very fine grained chert which is optimal for lithic manufacture. However, these chert types seem to be relatively absent from the raw material found at the Rush Creek site.

Soils

The soils of the Interior Low Plateaus Physiographic Province exhibit a diversity reflective of the variable bedrock geology and the rolling relief. The floodplains and terraces of the Inner and Outer Nashville Basin are derived from Quaternary alluvium. The Armour-Lynnville-Arrington Association predominates on these landforms which are agriculturally rich and productive (Springer and Elder 1980). The Outer Basin floodplains are very fertile due to their phosphatic nature. They are extremely fertile where they overlie the Hermitage, Bigby-Cannon and Leipers-Cathys formations and are considered some of the richest soils in Tennessee. The Inner Basin floodplains, however, are only moderately high in phosphorous, and are less productive than the Outer Basin floodplains (Edwards et al. 1974).

The upland soils of the Outer Basin are thinly developed on steep slopes and have a high chert content. The Dellrose-Bodine-Mimosa Association predominates in the high ridge tops. The uplands of the Inner Basin are derived from the Carters, Lebanon, and Ridley formation limestones. These limestones are composed of about 90% calcium carbonate which produces soils of low fertility and poor development. Common soils occurring in the uplands of the Inner Basin include those of the Colbert, Ashwood, Rockland, and Barfield series (Edwards et al. 1974: 17).

Soils of the Highland Rim are primarily cherty, acidic, and highly leached. Bodine, Montview, and Dickson soil series predominate in the Highland Rim (Springer and Elder 1980: 28).

The soil series most represented at the Rush Creek site are the Arrington and Armour series. The Arrington series is taxonomically Cumulic Hapludolls (fine-silty, mixed, thermic). They

consist of dark-colored, well drained soils formed in the floodplain and are not subjected to standing water for any period of time, but are subject to overflow. These soils are on nearly level landforms, have good structure, and have a moderately high phosphorous content. Quartz is the dominant mineral in the silt fraction (Edwards et al. 1974).

The northern portion of the Rush Creek site occupies a higher Pleistocene age terrace generally mapped as the Armour series which is taxonomically Ultic Hapludalfs (fine-silty, mixed, thermic). The Armour soils occupy the low benches and gentle footslopes above the floodplains of the rivers of the Nashville Basin. They are generally deep, well drained, and permeable. The chief parent material is alluvium, but silty areas in the upper layers may be alluvium mixed with loess. There is usually an increasing phosphorous content with depth indicating that the parent material may have been alluvium from phosphatic limestone. Aluminum interlayered vermiculite and kaolinite are the chief clay minerals in the soil. A distinct argillic horizon is present and the soil base saturation ranges from 40-60% (Edwards et al. 1974).

Climate

The climate of the Nashville Basin is defined as Humid Mesothermal by Thornwaite's (1931) classification system. The climate is generally mild with adequate precipitation for most vegetation (Edwards et al. 1974: 5). The mean annual temperature is 15.3° C, and the mean annual precipitation is 129 cm (Dickson 1960: 375). The climate is influenced by two major air masses, a Northerly Canadian air mass is primarily winter dominant prevailing between the months of November through March. The Gulf Southerly air mass is summer dominate prevailing between the months of May through September. These air masses rarely exchange throughout the summer months (Smalley 1980: 3).

Precipitation in the Nashville Basin is heaviest between the months of January and April averaging around 37.16 cm (Harmon et al. 1959: 31). Evapotransporation exceeds precipitation between May and October and short droughts are common (Edwards et al. 1974: 7). The average

summer temperature is around 25° C with an absolute maximum temperature of 41° C recorded in July. In the upland Inner Basin, soils that have a root zone capacity of 10.16 cm have a 44% probability that 40 drought days will occur during the months of May through October (Edwards et al. 1974: 7). There is a 45% probability that 10 drought days will occur between August and September (Edwards et al. 1974: 7). The region is frost free 190-205 days out of the year (Smalley 1980: 3). Winters are moderate with a 12° C average temperature and an absolute low temperature of -27° C recorded in January (Dickson 1960: 375). The ground generally remains frozen to a depth of 5 to 15 cm for 2 to 12 days during this time. Compared with soils from the Inner Basin, the soils of the Outer Basin are generally cooler, and absorb more moisture (Slusher and Lytle 1973: 72).

Vegetation

The vegetational suite in the Nashville Basin is defined as Western Mesophytic by Braun (1950: 122). Due to the variability of the bedrock geology, the vegetation in the Nashville Basin is substratum specific indicating that there are no major dominating taxa on the whole. Crites' (1983) study in the Cheek Bend area of the Inner Nashville Basin near Columbia, Tennessee defined four major habitat/forest communities within a 9 km^2 area. In the floodplain areas of the Inner Basin a silver maple-sycamore-green ash association was found. The submesic valley slopes exhibited an oak-dogwood-elm association. A cedar-oak association was found in the xeric uplands and a hickory-cedar-oak association in the subxeric uplands. It was determined that the parent material, topography, soil depth, and moisture content were the primary factors influencing distribution of plant taxa across the landscape.

The diversity of the parent material and topography of the Inner Nashville Basin provides a variety of habitats suitable for a great number of woody and herbaceous taxa. The floodplains of the Inner Basin provide a habitat for those taxa which are flood tolerant. Ash, maple, sycamore, alder, osage orange, gum, willow, and ironwood can be found in these areas (Faulkner 1983: 8, Shaver and Dennison 1928). Edible, herbaceous types which are well suited to floodplain conditions,

can be found within the Inner Basin. These include chickweed, spanish nettle, lambsquarter, common plantain, swamp sunflower, jerusalem artichoke, wild carrot, sedge and water smartweed (Shaver and Dennison 1928). In the xeric uplands of the Inner Basin, one can find limestone outcrops which can cover from 40 to 90% of the ground surface. This area provides prime habitat for xerothrophic plants and cedars, and is often known as the "cedar glades" (Quarterman 1949; 1950). Taxa in the cedar glade areas include eastern red cedar, ash, hickory, sycamore, elm, oak, buckhorn, hackberry, and sassafras (Crites 1983: 40-41). Edible plants in the cedar glade areas include prickly pear, sea-purslane, skunk cabbage, wild carrot and peppergrass (Baskin and Baskin 1975, Quarterman 1950).

The Outer Nashville Basin, considered one of the most productive agricultural regions of Tennessee, once supported a thick deciduous forest. In the terrace and floodplain areas one could find white and winged elm, red oak, black walnut, ash, red bud, and black locust (Shaver and Dennison 1928). Edible plants in this area include weak nettle, pale persicaris, goose grass, and small cane (Shaver and Dennison 1928). The upland slopes of the Outer Basin provide suitable habitats for xeric arboreal taxa. These include oaks, cedars, black locust, and red bud (Springer and Elder 1980: 9). Herbaceous plants in this area include choke cherry, spicebush, dwarf sumac, and southern black haw (Frick 1939).

The vegetation of the Highland Rim is described as including oaks with a dogwood understory and an open herbaceous community (Braun 1950: 154). Other arboreal taxa include maple, beech, tulip tree, hickory, and white ash. Xeric hardwoods such as post oak and black jack oak are also common (Edwards et al. 1974: 9).

Paleoenvironment

Through time the Nashville Basin has been affected by many major dynamic changes in climate, biota, and landform. Several studies document changes in North American climates as functions of air mass and prevailing air stream patterns across North America (Bryson 1966; Bryson and Hare 1974; Bryson and Wendland 1967). During most of the Late Pleistocene, the Midsouth

area was dominated by an Arctic air stream system which kept the area in a state of homeostatis due to cold, boreal climate with little seasonal fluctuation (Bryson and Wendland 1967; Delcourt and Delcourt 1981). The Early Holocene (12,000 to 10,000 yr. B.P.) was distinguished by a more southward penetration of the Arctic air stream and a more northern influence of the Caribbean air mass creating a significant fluctuation in moisture and temperature gradients (Bryson and Wendland 1967; Delcourt 1979). Warm, dry westerly winds blocked the Canadian and Gulf air masses between 8,000 and 4,000 yr. B.P. creating a climatic optimum distinguished by warmer temperatures and drier conditions (Bryson and Wendland 1967; Delcourt 1979). Around 4,000 yr. B.P., the climate returned to a more mesic condition which characterizes this area of Tennessee today (Delcourt and Delcourt 1981).

Paleoecological and paleoenvironmental studies in the Nashville Basin and Interior Low Plateaus have been useful in documenting major environmental changes in these areas. Brackenridge (1982, 1984) has provided a model for sedimentation, aggradation and landform stability in the geomorphologic, geochronologic study of alluvial landforms on the Duck River in the Inner Nashville Basin of Tennessee. Klippel and Parmalee (1982) have provided a documentation of faunal changes in the Inner Nashville Basin from the study of the paleontology of the stratified Cheek Bend Cave site (40MU261). Delcourt's (1979) study of palynological sequences from Anderson Pond in White County, Tennessee documents changes in vegetational suites from Late Pleistocene times to the present.

The Late Pleistocene/Early Holocene transition, which occured around 10,000 yr. B.P., was one which experienced many dynamic environmental changes. During the Early Holocene transitional period there existed a Northern Mixed Coniferous-Northern Hardwood forest. Taxa within this early transitional period included pine, spruce, hemlock, oak and birch. The later portion of this transitional period experienced a gradual change from a northern forest type to a closed canopy mast forest of oak, maple, beech, basswood, elm, walnut, hemlock and gum (Delcourt and Delcourt

1981). Due to the cool, moist climate instigated by this environmental change, there was a major shift in alluvial regimes in the Inner Basin. An excess of moisture raised the river levels considerably creating an unstable floodplain situation from 10,000-7,200 yr. B.P. Under these conditions, the Cannon Bend Formation (T1a1, T1a2), a lower alluvial floodplain formation, was created within the alluvial landforms of the Nashville Basin (Brackenridge 1982, 1984). During this time boreal mammal species were extrapolated from the area (Klippel and Parmalee 1982).

The Hypsithermal interval, a Mid-Holocene climatic optimum from 8,000-4,000 yr. B.P., witnessed a change from the cool moist Early Holocene conditions to a warmer, drier environment. It is during this time that a major paleosol formed on top of the Cannon Bend Formation alluvium around 7,200 yr. B.P. It is estimated that basin discharge and runoff was reduced by 51-65% during this period (Brackenridge 1982, 1984). Prevailing dry westerly winds provided a blocking mechanism deleting the effects of the northerly Canadian and southerly Gulf winds. This blocking action created a drop in mean annual precipitation of around 35 cm (Solomon et al. 1980). The vegetational transition from a closed canopy forest to a mixed mesophytic forest was completed during this period (Delcourt 1979). This period also saw the expansion of the cedar glades in the Inner Basin and a decrease in mesophytic taxa in the Outer Basin. The Mid-Holocene levels in Cheek Bend Cave document the occurrence of the grassland sorcid Cryptotis parva, and also the first appearance of freshwater mussels. A collection of unionid assemblages in these levels tend to infer that the Duck River was shallow and swift during this period (Klippel and Parmalee 1982). The stability of floodplains during this time created a more dependable resource zone for human occupants on floodplains and would be areas of low vulnerability during a droughty period.

The Late Holocene period experienced a return to a cool, moist climate with an increase in precipitation from 5,000-200 yr. B.P. (Solomon et al. 1980). Upland vegetation readjusted to the same areal distribution as it has today. Brackenridge (1982, 1984) recognized a period of fill accretion and terrace instability at 6,200-4,200 yr. B.P. This was a portion of the Leftwich Formation,

a Late Holocene alluvial sequence. A paleosol developed on this formation between 4,200-3,900 yr. B.P. and there were two additional fill accretion and stability episodes between 3,000-2,600 yr. B.P. These were also designated part of the Leftwich Formation (T1b1, T1b2, T1b3) (Brackenridge 1982, 1984). Around 200 years ago, another episode of fill accretion was documented due to increasing landform instability from Historic Period land clearance practices. This produced the Sowell Mill Formation, a thick alluvial formation which blankets the floodplains and higher terraces. This formation is produced by alluvial overbank suspended load deposition (T0a, T0b, T0c), in the Nashville Basin (Brackenridge 1982, 1984).

CHAPTER 4

FIELD METHODS

A deep testing procedure was implemented at the Rush Creek site to determine if buried stratigraphic deposits containing primary cultural material was present and record the stratigraphic and pedologic relationships of the alluvial landforms. A series of eight backhoe trenches was spaced across the area of the site, some of which were re-excavated from trenches opened by Phase 2 testing procedures (Figure 4). All trenches were excavated roughly perpendicular to the river in an attempt to examine as many different landforms as was logistically possible. Trenches were numbered in accordance to their relative position, perpendicular to the river. Trenches in the same relative line were given the same trench number and different section numbers (i.e. TR2.SN). The Trench 1 series was the farthest to the west of the site and the Trench 4 series was located to the far east of the site. The Trench 2 series (TR2.S1, TR2.S1.5, TR2.S2, TR2.S3, and TR2.S4) was used in the construction of the composite cross-section of the site.

Backhoe trenches were dug approximately 1.5 to 2 meters deep or until bedrock was exposed. From the deepest point, a series of steps were excavated to allow easy access into the trench and a quick escape if the trench walls destabilized. After completion of the excavation, the walls of the trench were cut and smoothed with trowels to alleviate the smears and bucket marks, and to aid in showing stratigraphic associations. Elements that appeared in the walls of the trench, including charcoal, rounded pebbles, lithic debitage, and bone fragments, were marked with color coded flagging tape (cf. Turner et al. 1982). Upon completion, the trench wall was then mapped in profile and photographed. The utilization of this technique aided in the designation of stratigraphic associations.

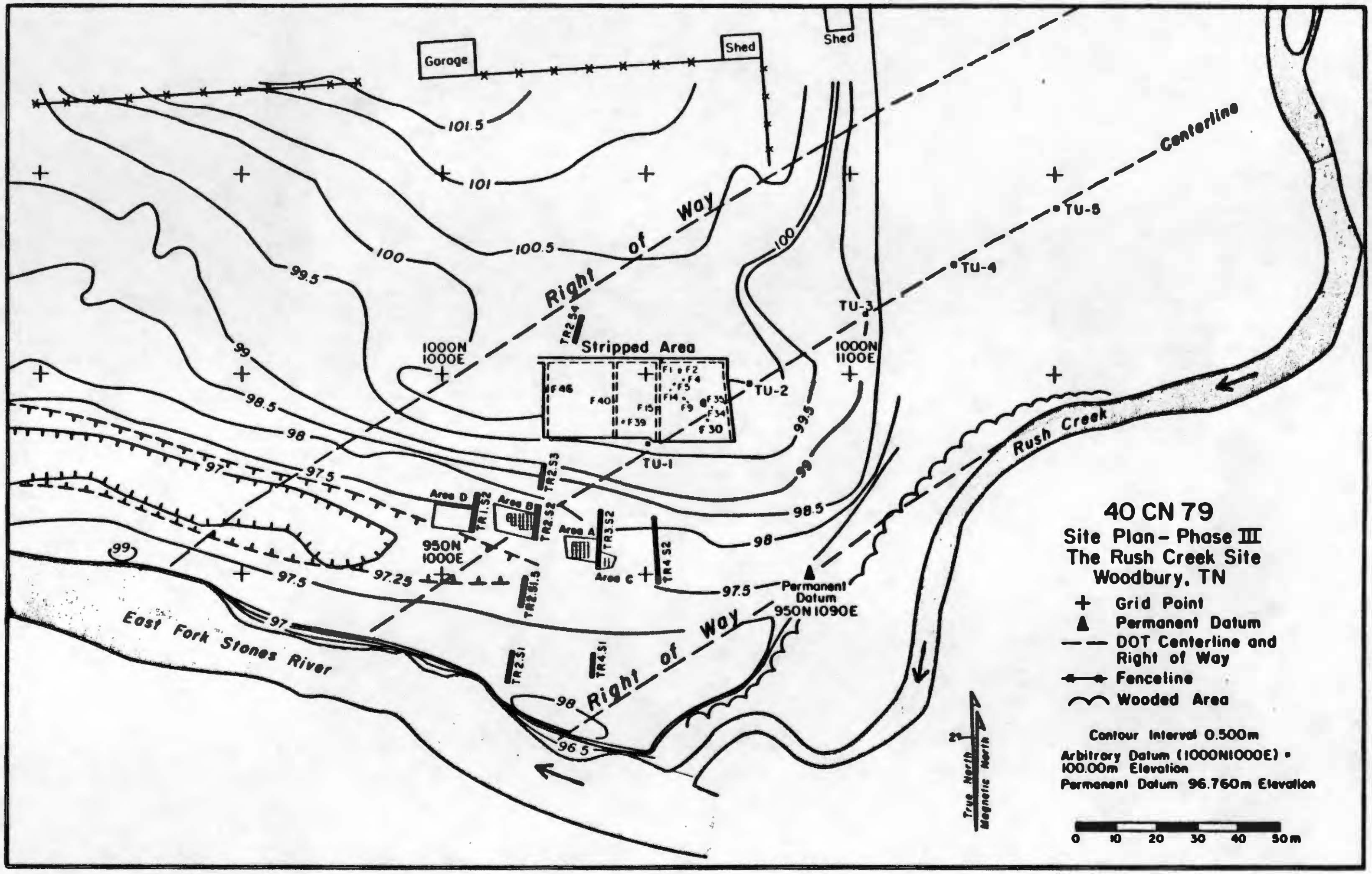


Figure 4. Plan View of the Rush Creek Site (40CN79).

Archaeological Investigations

Previous work performed at the Rush Creek Site included plowzone stripping atop the Pleistocene age terrace and deep testing investigations in the floodplain. Plowzone stripping techniques were used to locate and excavate any subsurface features. Deep testing was performed to examine and define the buried midden described in Phase 2 testing procedures.

An area of approximately 40 m x 20 m was stripped of its plowzone layer with the use of a backhoe. Thirteen features were located within this area known as "Stripped Area A" (Figure 4). Most of the features excavated appeared to be the product of natural disturbances, such as animal burrows, root systems, and tree falls. The features that may have been culturally produced were generally irregular, shallow, and sometimes contained small size lithic debitage. No diagnostic artifacts were recovered, nor any floral or faunal materials apparent. A human burial was recovered, but was found to be in a poor state of preservation with little or no pit outline evident. The site has been subjected to plowing, and the possibility exists that deep features were truncated severely and shallow postmolds completely obliterated.

Archaeological investigations in the floodplain were manifested in three major areas of excavation. Excavation Area A (Figure 4) was located adjacent and to the west of Trench 3. Section 2 of the deep test excavations. The overburden of approximately 8 m x 6 m was cleared with use of a backhoe. A 4 m x 4 m block of 1 m x 1 m units were placed within this cleared area for excavation. Excavations in the T0b sediment demonstrated this formation was relatively sterile with a few lithic artifacts and some charcoal present. The contact between the T0b and the T1 was very distinct with the T1 sediments much darker and firmer than the T0b. The highest density of material was located atop the T1 surface. The majority of the charcoal (65.7%) and limestone (54.7%) was found here. Of particular interest was the discovery of several fragments of bone that were found on the surface and just barely intrusive into the T1 formation. Most of the bone here was indeterminate due to the rather poor state of preservation. However, three identifiable fragments

included one distal right lateral femur fragment of Sus scrofa (domestic pig) was found in the T0b overburden and one right second molar of Sus scrofa was found slightly imbedded in the T1 formation surface. Also, one left first molar of Odocoileus virginianus (white tailed deer) was found in the surface of the T1 formation. There were no diagnostic lithic artifacts found in this excavation.

Excavation Area B (Figure 4) was located adjacent and to the west of Trench 2. Section 2. A block unit of approximately 9 m x 6 m was cleared by a backhoe and 21 1 x 1 m units were placed. The surface of the T1 in this block followed the slope of the underlying bedrock, sloping down from the T2 scarp and leveling off at the base of the slough. The sediment in this excavation was similar to the sediments in Excavation Area A with the exception of the northernmost units where the soil structure exhibited a stronger subangular structure that the remaining T1 sediments. A radiocarbon sample extracted from this particular soil revealed a chronometric date of 5160 ± 210 yr. B.P. (Beta 22072). In the excavation, 94.7 % of all limestone recovered was located at the T1--T0b interface. One tooth fragment of Odocoileus virginianus and one proximal phalange fragment of Bos taurus (domestic cow) were found slightly intrusive into the T1 surface. The remaining artifacts were rather homogeneously dispersed without any clear areas of concentration. Lithic debitage was randomly dispersed although there seemed to be a tendency for smaller debitage to be found toward the base of the units as they were excavated to bedrock.

Excavation Area C (Figure 4) was located adjacent and to the east of Trench 3. Section 2. The area covered roughly 4 m x 4 m. The T0b overburden was excavated to the surface of the T1 formation and a charcoal lense appeared. Wood charcoal samples from this excavation were radiocarbon dated at 150 ± 80 yr. B.P. (Beta 21683). The wood charcoal was identified as sycamore (Platanus occidentalis) and maple (Acer sp.) primarily belonging to floodplain adapted types. There was a great amount of burned limestone found on top of the T1 formation within this charcoal concentration. Associated with this limestone was a ceramic stoneware sherd that probably dated

around the last half of the 19th century. The limestone also appeared burned, and much of the 14 pieces of unidentifiable bone appeared burned.

Soil Descriptions

Pedologic data were recorded for each trench. A trowel was used to ped a section of the wall on each trench. "Pedding" is a process used to expose a trench wall by breaking the soil along its areas of structural weakness. Horizon boundaries were marked with flagging tape and each trench wall was photographed in profile. The horizons were then described and sampled. Samples of about 2,000 grams in size were taken back to the laboratory for testing. Upon completion of all the analysis, stratigraphic and pedologic information was added to the maps of each trench section.

Soil horizons at the site were determined by field examination. Master soil horizons that were identified at the site in each trench section were determined by the following criteria:

> A horizons: Mineral horizons that formed at the surface or below an O horizon and (1) are characterized by an accumulation of humified organic matter intimately mixed with the mineral fraction and not dominated by properties characteristic of E or B horizons...or (2) have properties resulting from cultivation, pasturing, or similar kinds of disturbance (Soil Survey Staff 1981: 4-41).

> B horizons: Horizons that formed below an A, E, or O horizon and are determined by obliteration of all or much of the original rock structure...and by (1) illuvial concentration of silicate clay, iron, aluminum, humus, carbonates, gypsum, or silica, alone or in combination; (2) evidence of removal of carbonates; (3) residual concentration of sequioxides; (4) coatings of sequioxides that make the horizon conspicuously lower in value, higher in chroma, or redder in hue than overlying and underlying horizons without apparent illuviation of iron; (5) alteration that forms silicate clay or liberates oxides or both and that forms granular, blocky, or prismatic structure if volume changes accompany changes in moisture content; or (6) any combination of these (Soil Survey Staff 1981: 4- 41,42).

> C horizons or layers: Horizons or layers, excluding hard bedrock, that are little affected by pedogenic processes and lack properties of O, A, E, or B horizons. Most are mineral layers, but limnic layers,...whether organic or inorganic, are included. The material of C layers may be either like or unlike that from which the solum presumably formed. A C horizon may have been modified even if there is no evidence of pedogenesis (Soil Survey Staff 1981: 4-42).

Lower case letters used to determine specific kinds of master soil horizons which were utilized in this study are as follows:

b Buried genetic horizon: . . . used in mineral soils to indicate identifiable buried genetic horizons if the major features of the buried horizon had been established before it was buried. It is not used in organic soils or to separate an organic layer from a mineral layer. Genetic horizons may or may not have formed in the overlying material, which may be either like or unlike the assumed parent material of the buried soil (Soil Survey Staff 1981: 4-43).

g Strong gleying: . . . used to indicate either that iron has been reduced and removed during soil formation or that saturation with stagnant water has preserved a reduced state. Most of the affected layers have low chroma and many are mottled. The low chroma can be the color of reduced iron or the color of uncoated sand or silt particles from which the iron has been removed. Symbol "g" is not used for soil materials of low chroma, such as some shales or E horizons, unless they have a history of wetness. If "g" is used with "B", pedogenic change in addition to gleying is implied. If no other change has taken place, the horizon is designated Cg (Soil Survey Staff 1981: 4-44).

p Plowing or other disturbance: . . . used to indicate disturbance of the surface layer by cultivation, pasturing, or similar uses. A disturbed organic horizon is designated Op. A disturbed mineral horizon, even though clearly over a E, B, or C horizon is designated Ap (Soil Survey Staff 1981: 4-45).

t Accumulation of silicate clay: . . . used to indicate an accumulation of silicate clay that either has formed in the horizon or has been moved into it by illuviation. The clay can be in the form of coatings on ped surfaces or in pores, lamellae, or bindings between mineral grains (Soil Survey Staff 1981: 4-45).

w Development of color or structure: . . . used with "B" to indicate development of color or structure, or both, with little or no apparent illuvial accumulation of material (Soil Survey Staff 1981: 4-46).

After identification, soil horizons were described using the following criteria:

Color: determined by the Munsell (1975) color chart for moist and dry colors. Any coatings or oxides were also determined along with an estimate of the relative percentage of minor colors in comparison to the dominant color.

Depth: measured in centimeters from the surface, includes upper and lower boundaries.

Texture: the field identification of the relative percentages of gravel, sand, silt and clay content according to criteria for field examination (Soil Survey Staff 1981: 4-51).

Structure: refers to the development of soil aggregates or peds. The size, shape, and degree of development are assessed.

Consistence: the pliability or firmness of soil aggregates determined by field analysis.

Coatings and oxides: determined by the extensiveness of the coatings and the relative percentages of these fractions in comparison to the dominant mineral fraction.

Boundary: refers to the lower boundary of the horizon. It is used to describe the grade and shape of the natural boundaries between horizons.

Coarse fragments: includes field assessment of size and relative percentage of materials greater than 2 mm, and in this analysis lithic debitage, charcoal, bone, limestone, alluvial gravel, and historic artifacts were included. Relative percentage estimates of these were determined by comparison with the dominant mineral fraction.

Roots, pores, and tunnels: used to determine the extent of biotic activity from plants, insects and other animals. Size and relative amounts were determined by field observation.

Discontinuities: designated by an arabic prefix of the master soil horizon. Used to designate lithologic discontinuities and may indicate sequences of soils with differing parent materials of different ages.

The results of the pedologic investigation are found in the soil descriptions in Appendix A.

Stratigraphy

Five major lithostratigraphic units were documented at the Rush Creek site. The depositional model was first implemented in the Columbia Reservoir by Brackenridge (1982, 1984). This model consists of four major stratigraphic formations. These formations are the Cheek Bend Formation (Late Pleistocene, T2), the Cannon Bend Formation (Early Holocene, T1a), the Leftwich Formation (Late Holocene, T1b), and the Sowell Mill Formation (Historic, T0). This formational model was instrumental in the interpretation of the alluvial stratigraphy in the Columbia Reservoir archaeological investigations along the Duck River near Columbia, Tennessee. The Cheek Bend formation is a Pleistocene alluvium which currently occupies the relatively higher position of the second terrace. The Leftwich and Cannon Bend formations are Holocene age alluvium that occupy the floodplains of the Nashville Basin. The Sowell Mill Formation is an historic alluvium that forms a thick overbank deposit near the river's edge, and also consists of fill in a truncated slough at the

juncture of the second terrace and the floodplain of the Rush Creek site. From the stratigraphy observed at the site, this model can apply to the alluvial depositional formations along the East Fork Stones River as well (Figure 5).

T2a Formation. The T2a formation is a Pleistocene alluvium that occupies the lower mantle of the Pleistocene age terrace at the Rush Creek site. It is overlain by the T2b formation and is underlain by Carters limestone bedrock. There is a distinct lithological discontinuity that separates the two T2 formations recognizable by a pebble line indicative of a truncation episode. This formation has a distinct argillic horizon. It has a clay texture with strong medium subangular blocky structure. The moist consistence is firm and sticky with thin continuous clay coatings. Manganese and iron oxides are expressed as coatings and nodules with each comprising about 20% of the sediment matrix. The boundaries between the horizons are gradual and smooth while the boundary between the T2b and the T2a is clear and smooth. Rounded chert gravels comprise about 10% of the sediment matrix. The dominant color is 10YR 6/6 (brownish yellow) with iron oxides expressed as 7.5YR 5/6 (strong brown) and manganese oxides expressed as 7.5YR 3/0 (very dark grey). This description was taken from the sediment column in TR2.S4, 167-189 cm below the surface.

T2b Formation. The T2b formation is a Pleistocene age alluvium that occupies the upper mantle of the second terrace at the Rush Creek site. The archaeological features located on this terrace are intrusive into this formation. It is overlain by a relatively thick plowzone and underlain by the T2a formation. This formation extends from the T2 scarp, runs laterally across the second terrace, and is approximately 75 cm thick on top of the T2. This formation has a relatively distinct argillic horizon. It has a silty clay loam texture with moderate medium subangular blocky structure. Some fine laminations are present. The moist consistence is firm and sticky. The ped surfaces have thin continuous clay coatings and the boundaries between the soil horizons are gradual and smooth.

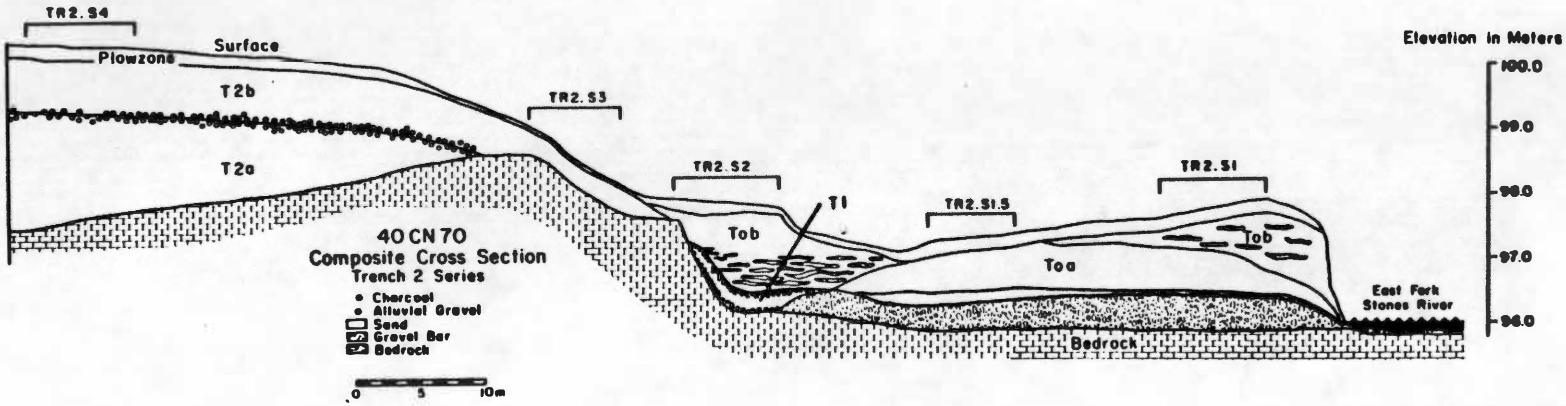


Figure 5. Composite Cross Section of the Trench 2 Series.

The color of the matrix is predominantly 7.5YR 5/4 (brown) with clay coats of 7.5YR 4/4 (dark brown). The type section for this description was taken from the sediment column in TR2.S4 between 60-82 cm below the surface.

T1 Formation. Buried archaeological assemblages are incorporated in the matrix of the T1 formation at the Rush Creek Site. It is difficult to interpret stratigraphically due to the variability in the radiocarbon dates, the presence of historic materials associated with prehistoric assemblages, and the general lack of diagnostic artifacts. This is an alluvial formation that has experienced extensive pedogenic alteration. This formation occupies the lower part of the floodplain slough section at the base of the T2 footslope. It is overlain by T0b deposits in the slough and underlain by Carters limestone bedrock. The formation runs from the southern lip of the floodplain slough approximately 11 meters to the edge of the T2 footslope. Maximum thickness of this formation is about 30 to 40 centimeters. Two paleosols are recognized on the surface of this formation representing episodes of Mid-Holocene landform stability, and historic landform stability. The Mid-Holocene paleosol, C-14 dated at 5160 $\pm$ 210 yr. B.P., is found where the surface of the formation is slightly inclined as it rises up along the T2 footslope. This particular paleosol may only cover about 10 square meters of surface. The historic paleosol is much more extensive and covers the majority of the T1 formation surface. Due to possible historic disturbance, this formation was likely truncated by an erosional episode and the Mid-Holocene paleosol may be representative of the only undisturbed section of the T1 formation. The T1 formation corresponds with the T1b1 formation (Leftwich) in the Columbia Reservoir which dated between 4,200-3,900 yr. B.P. (Brackenridge 1982, 1984).

One of the T1 paleosols covers the majority of the T1 surface and was recognized in the field as a buried "A" horizon. This unit exhibited a silty clay loam texture with moderate, medium subangular blocky structure. The moist consistence is friable and slightly sticky with thin discontinuous clay coatings. There are a few manganese nodules present comprising about 2% of

the matrix. The boundary between the T1 paleosol and the T0b overburden is abrupt and smooth. A few rounded chert pebbles, lithic debitage and charcoal pieces were noted in the field comprising about 5% of the matrix. Archaeological investigations in this formation demonstrated that historic age materials including historic ceramics and domesticate faunal remains were on the surface or slightly intrusive into this soil horizon. Charcoal extracted from a buried surface (identified as Feature 18 in Phase 2 excavations) (Spears et al. 1986), discovered in TR3.S2 yielded a radiocarbon date of 150 ± 80 yr. B.P. This charcoal was associated with a stoneware sherd and several pieces of burned limestone. The majority of the limestone fragments, charcoal, and faunal remains were discovered at this T1 paleosol-T0b overburden contact. It is suggested that a disturbance episode was responsible for the truncation of the T1 landform. The deposition of the charcoal, bone, limestone and historic artifacts was the result of a disturbance episode abandonment and stabilization of the landform. The T1 paleosol was then covered by a thick veneer of historic age alluvium comprised by the T0b formation. The historic T1 paleosol was documented in TR1.S2, TR2.S2, and TR3.S2. The type section for this description was taken from the sediment column for TR2.S2, 133-152 cm below the surface.

The majority of the matrix of the T1 formation is a subsoil which has experienced some development of an argillic horizon. The texture is a silty clay with a moderate coarse subangular blocky structure. The moist consistence is firm and sticky with thin, continuous clay coatings. The boundaries are gradual and smooth. Coarse fragments consist of rounded chert pebbles, lithic debitage, and charcoal which comprise about 10% of the sediment matrix. There is an absence of bone, limestone, and historic materials in this part of the sediment matrix, suggesting major disturbance processes were confined to the surface of the T1 formation. However, there is evidence of site disturbance due to argilliturbation (Wood and Johnson 1978) or shrink-swell processes which may have moved the lithic debitage downward from primary context. The moist color of the matrix is 10YR 3/3 (dark brown). This argillic horizon was found in TR1.S2, TR2.S2, and TR3.S2. The type

section for this description was located in the sediment column in TR2.S2, 165-176 cm below the surface.

At the base of the T1 formation is a gravel bar deposit which overlies Carters limestone bedrock. The texture is a gravelly clay with massive structure that exhibits gleying due to the reducing conditions of a perched water table. The moist consistence is firm and sticky with iron oxide and manganese oxide coatings comprising about 10% of the total matrix. There is a clear, smooth boundary between this gravelly horizon and the overlying argillic horizon. Common large and medium rounded chert gravels and cobbles comprise about 30% of the sediment matrix. Dominant color is 10YR 3/3 (dark brown). Lithic debitage found in this particular soil horizon exhibited some waterwear on the surfaces. This may have been a former Late Pleistocene-Early Holocene lag channel deposit that was covered by a silty alluvium when the river meandered southward in this particular bend. This soil unit was found in TR1.S2, TR2.S2, and TR3.S2. The type section for this description was taken from the sediment column in TR2.S2, 176-180 cm below the surface.

A second paleosol was discovered later in the investigation. This paleosol was barely distinctive from the other T1 paleosol with the exception that it had a much stronger medium subangular blocky structure. This particular paleosol was only located in TR2.S2 and defined as Lithostratigraphic Unit IVa in the Phase 2 investigations (Spears et al. 1986). This unit exists where the footslope of the T2 begins to rise up the terrace scarp. This unit may in fact represent the only preserved portion of the T1; one that was not subjected to lateral disturbance from the historic slough. A Kirk-type projectile point was discovered in the Phase 2 testing (Spears et al. 1986) leading to the suggestion that the unit was Early Holocene in age. However, a charcoal sample from this unit yielded a C-14 date of 5160 $\pm$ 210 yr. B.P. (Beta 22072). This date most closely correlates with the T1b1 paleosol of the Leftwich formation discovered in the Columbia Archaeological Project with dates ranging from 4,200-3,900 yr. B.P. (Brackenridge 1982, 1984). Unfortunately, no diagnostics

were discovered here during Phase 3 mitigation. The occurrence of an Early Holocene deposit with a Kirk association seems suspect and the unit is more likely a Late Archaic association.

The T1 formation at the Rush Creek Site is enigmatic at best. The variety of conflicting evidence makes the archaeological integrity of this formation suspect. Two major conclusions can be drawn from the evidence. The first is that an historic age site disturbance process was primarily responsible for the truncation and intrusion of this formation. The second is that the relatively homogeneous nature of the lithic debitage found within this formation suggests that post-depositional processes such as argilliturbation may have distorted the integrity of the archaeological assemblages. Therefore, the primary context of the site is lacking.

T0a Formation. The T0a formation is a silty alluvium that underlies the T0b formation and overlies Carters limestone bedrock. This formation comprises the majority of the sediment within the floodplain and consists of a silty upper mantle and grades into a gravel bar at its base. This formation runs laterally from the river bank of the East Fork Stones River where exposure is slight, to 32 meters into the interior of the floodplain to the southern edge of the floodplain slough. Its maximum thickness is about 130 cm in the interior of the floodplain. The T0a has been dated at around 1,500 yr. B.P. in the Columbia Reservoir and is considered a Late Holocene landform (Mahaffy 1984).

The silty upper mantle of the T0a formation is relatively homogeneous across the floodplain and has characteristics of slight but evident pedogenic activity. The texture is a silt loam with weak coarse subangular blocky structure. The moist consistence is friable and nonsticky with thin discontinuous clay coatings on the ped surfaces. The boundaries are gradual and smooth with some coarse fragments of angular limestone and rounded chert gravels noted in some portions of the matrix (2-5%). The moist color is 10YR 4/3 (brown) with dry color of 10YR 5/3 (brown). The type section for this description was taken from the sediment column in TR2.S1, 103-119 cm below the surface.

A thin sand lense separates the silty upper mantle from the gravelly base in this formation. The texture is a sandy loam with weak coarse subangular blocky structure. The moist consistence is friable and nonsticky with no clay coatings visible on the ped surfaces. It has a clear, smooth boundary, and rounded chert pebbles comprise about 10% of the matrix. Moist color is a 10YR 5/6 (yellowish brown). The type section for this description was taken from the sediment column in TR2.S1.5, 76-89 cm below the surface.

At the base of the T0a formation is a very distinct gravel bar comprised of rounded chert gravels. This indicates a Late Holocene lag channel. The gravel bar exhibits a sandy gravel texture with granular structure due to the lack of finer sediments. The wet consistence is loose and nonsticky with no clay coatings evident. A few manganese nodules were noted comprising less than 2% of the matrix. Rounded chert gravels and cobbles comprise from 60-80% of the sediment matrix. Color is highly variable primarily expressed in the different exterior colors of the individual gravels, however, a 10YR 6/6 (brownish yellow) tends to predominate. The type section for this description was taken from the sediment column in TR2.S1.5, 89-130 cm below the surface.

The T0a formation is the primary floodplain formation at the Rush Creek site. It comprises most of the floodplain area, at times from the surface to bedrock. Its relative absence in the floodplain slough suggests that this formation may have been truncated due to some erosional process which stripped sediment away from the slough. It is likely that the T0a was deposited prior to this disturbance and truncated prior to the deposition of the T0b formation.

Tob Formation. The T0b formation is one where the primary mode of deposition is alluvial suspended load deposition. This formation is Late Historic in age with a C-14 date of 150 $\pm$ 80 yr. B.P. (Beta 21683) extracted from the base of this formation and atop the T1 paleosol in TR3.S2, 116 cm below the surface. This formation is located atop the levee bank at the river's edge where the thickness of the formation reaches a maximum depth of around 85 cm and thins gradually from the river bank to 21 meters into the interior of the floodplain. In this area the T0b overlies an

earlier floodplain formation, the T0a formation. The T0b formation also was located in the floodplain slough at the base of the T2 scarp where it has infilled a former slough channel that stripped away some of the older floodplain formation. In this area the T0b reaches a maximum depth of 115 cm where it overlies a Middle Holocene formation (T1) and extends 17 meters across this former slough. Due to the relatively young age, this formation has experienced little pedogenic alteration resulting in relatively well preserved varve stratigraphy. The intermittant sand and laminated silt lenses may indicate individual episodes of initial flood water velocity and concomitant ponding. These sand and silt lenses are located toward the base of the formation unit in the slough, but are more dispersed atop the levee near the river bank. Analysis of a similar landform in the Columbia reservoir dated this formation at around 300-400 yr. B.P. and is considered a landform developed during the historic period (Mahaffy 1984).

The dominant matrix of the T0b formation is a silt loam with weak moderate subangular blocky structure. The moist consistence is friable and nonsticky and the soil peds have thin discontinuous clay coatings. There are a few fine manganese nodules present comprising about 2% of the matrix with common pieces of angular limestone and rounded chert pebbles comprising up to 10% of the matrix. The boundary between these horizons in this matrix is generally gradual and smooth with few fine roots and pores. Moist color of the matrix is 10YR 4/3 (brown). Type section for this description was located in the sediment column of TR2.S2, 48-63 cm below the surface.

Sand lenses which can be found intermitantly throughout this formation exhibit a sandy loam texture and a loose granular structure comprised primarily of rounded chert grains. The moist consistence is loose and nonsticky with no visible clay coatings. Manganese nodules are common comprising up to 10% of the matrix and rounded chert pebbles are common. The lenses exhibit abrupt irregular boundaries. There is no evidence of roots and pores and the moist color is 10YR 4/3 (brown). The type section for this description is located in the sediment column in TR2.S2, 112-120 cm below the surface.

Laminated silt lenses can be found interspersed with the sand lenses and at the base of the T0b formational unit. Texture is a silt to silt loam with massive, laminated structure. The moist consistence is friable and nonsticky with no visible clay coatings. There are abrupt, irregular boundaries with some evidence of manganese coatings exhibited on the top and bottom of the lenses. The majority of the matrix has a moist color of 10YR 4/4 (dark yellowish brown) with fine laminae of 10YR 7/4 (very pale brown). The type section for this description is located in the sediment column of TR2.S2, 109-122 cm below the surface.

The identification of the T0b formation at the Rush Creek site was important for several reasons. The identification aided in the determination of areas of the site marked by disturbance processes. It helped to show that its deposition was two directional. The first was in the floodplain slough where sediment was deposited following a low lying depression across the floodplain. The second was deposited laterally from overbank flooding. The historic date on the surface and slightly intrusive into the T1 paleosol indicated an historic age for the initial deposition of this landform and the relatively sandy nature of this sediment in comparison to the underlying T0a formation may be interpreted as increased sediment load due to increased landform instability from historic land clearance processes. Although some colluvial input was noted in sediment originating from the T2 scarp, the primary mode of deposition from this particular formation is alluvial.

Plowzone (PZ). The plowzone at the Rush Creek Site is extensive across the entire landform. Thickness of the plowzone varies from 15 to 30 cm and is thickest where the relief of the landform is relatively flat. The plowzone thins considerably along the T2 scarp where the relief is more steep. This formation developed under cultivation activities where the surface soil was churned and mixed by plowing activities.

The plowzone across the floodplain exhibits a strong medium granular structure with a loose, friable, nonsticky moist consistence. There are no visible clay coatings or evidence of illuviation. The matrix has common medium and fine roots and pores. The texture is a gravelly silt

loam with angular pieces of coarse, medium and fine limestone fragments comprising about 20% of the matrix. Moist color is generally a 10YR 4/4 (dark yellowish brown). This formation does vary with most of the limestone pieces concentrated along the T2 scarp and within the slough of the floodplain. Common rounded chert pebbles are found within the slough of the floodplain and atop the T2. The type section for this description was taken from the sediment column in TR2.S2, 0-32 cm below the surface.

Discussion

The determination of the development of alluvial landforms at the Rush Creek site is important in the interpretation of archaeological context. Various episodes of deposition and disturbance shaped the landform and altered the archaeological integrity of the site. The interpretation of these processes is critical in the interpretation of the Rush Creek Site.

The initial deposition of alluvium at the Rush Creek Site probably began around Late Pleistocene times when the East Fork Stones River ceased downcutting into Carters Formation bedrock and began lateral deposition of alluvium in the meander bends. This process formed the T2 alluvial terrace or Cheek Bend Formation. There was probably a period of stability and truncation between the deposition of the T2a and the T2b. During Early Holocene times, the East Fork Stones River shifted laterally away from the Pleistocene age terrace and began depositing alluvium along its former channel. This landform aggraded until around 5,000 yr. B.P. when the landform stabilized probably due to a Mid-Holocene warming and drying trend. This corresponds with the T1b1 formation (Leftwich Formation) in the Columbia Reservoir (Brackenridge 1982, 1984). The absence of the T1a or Cannon Bend Formation at this site is unexplained. After the T1 formation stabilized the T0a formation (Sowell Mill Formation) was deposited across the floodplain. This formation may have been deposited due to aboriginal land clearance practices which aided in the destabilization of the surrounding landform increasing the sediment load carried by the river. This landform probably continued to slowly aggrade from 1500 yr. B.P. until 200 yr. B.P. when

again excessive landform destabilization by historic clearance and agricultural practices influenced the increasing sediment load carried by the river. This is noted in the sandier nature of the T0b sediment as opposed to the underlying T0a formation. About the same time a disturbance episode across the floodplain became evident. Around 150 yr. B.P. the floodplain was truncated laterally paralleling the river. From Rush Creek to some 200 meters downstream toward the river, a distinct depression was carved by hydrologic activity. This slough downcut through the floodplain stripping the T0a deposits at the base of the T2 scarp and truncated the buried paleosol of the T1 formation. The abandonment of this slough was marked by deposition of historic remains on top of and slightly intrusive into the surface of the T1 formation. This process subsequently mixed some of this historic material with aboriginal materials within the T1 formation. This truncation episode affected all of the T1 surface with the exception of a small pocket of sediment located somewhat further up the slope of the T2 escarpment. After the slough was abandoned, sterile overburden consisting of T0b deposits filled in the slough and softened the gradient of the landform. This process resulted in a cultural midden sealed by sterile overburden.

The archaeological deposits in this stratigraphic situation are rather complex. The majority of the archaeological materials are confined to the T1 strata. However, it has been suggested there is only a small pocket of intact deposits that may have been unaffected by the historic age disturbance. A radiocarbon date of this particular unit of around 5,000 yr. B.P. would indicate a Middle to Late Archaic archaeological association, but no diagnostic artifacts of this period were recovered from this strata. The remainder of the T1 formation appears to have undergone extensive pedogenic alteration due to argilliturbation and shrink-swell activities. The lithic materials in this unit are distributed somewhat homogeneously throughout the sediment with no clear concentrations of material. Historic age materials are found on the surface of the T1 formation. A radiocarbon date of around 150 yr. B.P. on this surface suggests a time of slough abandonment. Historic age materials associated with the base of the T0b and the surface of the T1 include domesticate faunal remains,

ceramics, limestone, and recent charcoal. It is believed a possible mill race may have truncated the site and the present surface of the T1 may demarcate the extent of the disturbance. It is unfortunate that these disturbance episodes affectively altered a rather potential archaeological site.

CHAPTER 5

LABORATORY METHODS

Samples that were collected from the stratigraphic sections at the Rush Creek site were subjected to a battery of tests and analyses. A particle size analysis was implemented to define the parameters in the grain size distribution within each sample. The pH determination of each sample was used to understand the chemical reaction and variability in these samples. A carbon analysis was used to determine carbon percentages and document the presence of buried surfaces. A phosphate analysis was used to determine areas of human activity. Multivariate statistical procedures were used to identify variability between landforms and assess the stratigraphic integrity of the site.

Particle Size Analysis

A particle size analysis was performed on all soil samples collected for the trench sections. These samples were air dried and ground with a mortar and pestle until fine enough to pass through a number 10 (2.0 mm, -1 Ø) sieve. The samples were split and subsamples of 40 grams were taken. An initial particle size analysis was performed using the hydrometer method to assess the silt and clay content (Day 1965). The data were then converted to standard Ø size designations (5.0 Ø, 6.0 Ø, 7.0 Ø, 8.0 Ø, and > 8.0 Ø) (Krumbein 1934).

From the samples tested with the hydrometer method, a sand sieve analysis was incorporated. A series of nested geologic sieves was utilized; 4 mm (-2.0 Ø), 1 mm (-1.0 Ø), 0.5 mm (0.0 Ø), 0.250 mm (2.0 Ø), 0.125 mm (3.0 Ø), and 0.625 mm (4:00 Ø). The sample solution within the settling cylinder was poured through a 0.053 mm (4.4 Ø) wet sieve and the soil sample was dried and added to the 4 mm (-2.0 Ø) sieve. A sieve shaker was used and the sand sample was shaken for 15 minutes. The sample in each screen was weighed and the percentage calculated. For those samples with textures coarser than a loamy fine sand, the samples were split and quartered, and subsamples of at least 200 grams were taken. This subsample was washed through a 2 mm (-1.0 Ø)

geologic sieve. The remaining gravel was dried and weighed and the percentage calculated. This procedure was performed to allow better representation for those samples too coarse to assess with the hydrometer method (Shackley 1975). Percentage data for Ø size designations were recorded in Appendix B.

The particle size data were converted to phi size designations. Phi (Ø) is equal to $-\log_2$ diameter (mm) (Krumbein 1934). The data were then plotted onto arithmetic probability paper as a cumulative frequency based on the percentages of 1.0 Ø units. Points along the cumulative frequency curve were extrapolated for the fifth, sixteenth, twentyfifth, fiftieth, seventyfifth, eightyfourth, and ninetyfifth percentiles as determinants for the statistical parameters of mean, standard deviation, skewness, and kurtosis. The cumulative frequency ranges were calculated for -2.0 Ø to 14.0 Ø.

Textural Analysis

Sediment parameters were determined for each of the samples collected at the Rush Creek site. It is believed that textural parameters can be used to designate and discriminate sediments according to their environments of deposition (Folk and Ward 1957; Mason and Folk 1958; Friedman 1967; Greenwood 1969; Taira and Scholle 1979; McLaren 1981). The primary measures utilized in these studies are mean, standard deviation, skewness, and kurtosis.

Graphic mean. The Graphic Mean (M_z) is regarded as a measure of the grain size most representative of the sample. A graphic mean that tends toward the coarse or negative end of the Ø scale is interpreted as being deposited in an environment of deposition of greater energy than sediments with a mean size that tends toward the fine or positive end of the Ø scale. The graphic mean size (M_z) of a sediment is defined by the equation:

$$M_z = \frac{\emptyset 16\% + \emptyset 50\% + \emptyset 84\%}{3}$$

(Folk and Ward 1957: 12)

The mean particle size in a sediment unit is a reflection of the average size of material transported and deposited regardless of minerological composition (Greenwood 1969: 1351).

Graphic Standard Deviation. The Inclusive Graphic Standard Deviation (σ_i) in a sediment unit is a basic measure of the sorting of the sample. A high standard deviation value represents a more poorly sorted sediment than a low standard deviation value. If the grain size distribution is Gaussian-normal, 68% of the sample will lie within the range $M_z \pm \sigma_i$ (Mason and Folk 1958: 217). Inclusive Graphic Standard Deviation is defined by the equation:

$$\sigma_i = \frac{\phi 84\% - \phi 16\%}{4} + \frac{\phi 95\% - \phi 5\%}{6.6}$$

(Folk and Ward 1957: 13)

Graphic Skewness. Graphic Skewness (Sk_i) measures the symmetry of a sediment distribution. Symmetrical curves have a skewness value of 0.00 and as skewness becomes more extreme, the value approaches a theoretical maximum of +1.00 to -1.00 (Mason and Folk 1958: 217). A skewness value in a sediment reflects the relative frequency of occurrence of energy flucuations of the depositional environment above or below the average (Greenwood 1969: 1351). Skewness is defined by the equation:

$$Sk_i = \frac{\phi 16\% + \phi 84\% - 2\phi 50\%}{2(\phi 84\% - \phi 16\%)} + \frac{\phi 5\% + \phi 95\% - 2\phi 50\%}{2(\phi 95\% - \phi 5\%)}$$

(Folk and Ward 1957: 13)

Verbal limits for skewness distributions are:

-1.00 to -0.30	very negatively skewed
-0.30 to -0.10	negatively skewed
-0.10 to +0.10	nearly symmetrical
+0.10 to +0.30	positively skewed
+0.30 to +1.00	very positively skewed

(Folk and Ward 1957: 14)

Graphic Kurtosis. Graphic Kurtosis (K_G) measures the ratio of the sorting in the extremes of the distribution compared with the sorting in the central part of the distribution (Folk and Ward 1957: 14). A normal curve has a kurtosis value of 1.00. For example, a curve with a kurtosis value of 1.20 is more peaked (leptokurtic) and is better sorted in the central part of the distribution (Ø75% to Ø25%) than in the tails (Ø95% to Ø5%). The spread between the tails is therefore 1.20 times as great as it would be if the distribution were normal (Mason and Folk 1958: 218). A high kurtosis value in a sediment reflects a depositing agent carrying material of a size in the mean of the distribution for a greater length of time than normal (Greenwood 1969: 1351). Graphic Kurtosis is defined by the equation:

$$K_G = \frac{\emptyset 95\% - \emptyset 5\%}{2.44(\emptyset 75\% - \emptyset 25\%)}$$

(Folk and Ward 1957: 14)

Verbal limits of Graphic Kurtosis are defined as:

< 0.67	very platykurtic
0.67 to 0.90	platykurtic
0.90 to 1.11	mesokurtic
1.11 to 1.50	leptokurtic
1.50 to 3.00	very leptokurtic
> 3.00	extremely leptokurtic

(Folk and Ward 1957: 14)

Multivariate Analysis

A multivariate statistical analysis was performed on the sediment samples using the variables Graphic Mean, Inclusive Graphic Standard Deviation, Graphic Skewness, and Graphic Kurtosis. The procedure was performed with the Statgraphics (version 4.2) software package. Because of the extreme coarse nature of the gravel bar and lag channel deposits, the analysis was performed on the finer upper matrices of the alluvial deposits. Multivariate procedures have discerned varying

depositional environments in other studies (Folk and Ward 1957; Mason and Folk 1958; Greenwood 1969). Sediment parameters analyzed by multivariate procedures are controlled by available material; processes of erosion, transport, and deposition; and the energy levels of the environment (Greenwood 1969: 1347). Although it has been cautioned to avoid sediments which have undergone diagenic or pedogenic alterations through time (Greenwood 1969: 1347), this study intends to demonstrate that formation can be discriminated on the basis of pedogenic alterations through time. Data used in the multivariate analysis are recorded in Appendix C.

pH Analysis

The pH of a sediment is a measurement of the negative logarithm of hydrogen ion activity as is determined by a hydrogen sensitive electrode. Two factors which influence the pH of a soil is the soil solution ratio and the equilibrium salt concentration. An increase in either factor will in turn lower the pH (Bohn et al. 1979: 205). Because of the affects of the diffuse double layer effect (Bohn et al. 1979: 141) it is important to position the electrode as close to the colloid surfaces as possible. It is optimal to use an electrode which allows a free diffusion of KCl through a standard plug without actual flow of solution (Schofield and Taylor 1955: 167). Although pH's have been utilized well in archaeological studies (Dietz and Dethlefsen 1963; Gordon and Buikstra 1981), one must be cautioned that a pH analysis is not a catch-all determination of the chemical nature of the sediment, and alternative methods need to be explored for problems of pedogenic alteration of archaeological sites.

A series of pH tests were performed on all of the samples collected. The pH level was tested using a pH meter and a 1:1 soil to deionized distilled water ratio. The pH determinations were compared with pH determinations performed at the Agricultural Extension Service Laboratory in Nashville, Tennessee for the purpose of replicability. Results of the pH analysis are recorded in Appendix D.

Carbon Analysis

The determination of carbon percentages in a sediment sequence can aid in the delimitation of buried land surfaces and demarcate evidence of human activity. Archaeological studies have utilized carbon analyses to define archaeological site parameters (Stein 1982; Ahler 1973b; Foss 1976). Carbon can be added to a landform by root development on the surface, by mixing of organic materials from the surface by pedoturbational processes, or as refuse from faunal and human activity. Carbon content can also be an indicator of the relative leaching of a profile.

Total carbon percentages were determined for all samples from the investigation. The samples were dried and ground with a mortar and pestle fine enough to pass through a 60 mesh (0.250 mm, 2.00 Ø) sieve. A carbon analyzer was used to perform the analysis. Approximately 1 gram of material was weighed and placed in a crucible. The carbon analyzer includes a furnace which heats to a temperature of 1000^{o} C, combusting all carbon in the forms of organic carbon and calcium carbonate. The carbon analyzer automatically computes the weight of the sample tested and correlates this with the amount of carbon dioxide released from the combustion. The carbon analyzer is equipped with a system that measures the carbon dioxide released from a sample and computes this variable into a total carbon percentage. Duplicate samples were used at varying intervals to document replicability of the tests. Results of the analyses are presented in Appendix D.

Phosphate Analysis

Phosphorous in the form of phosphate (PO_5) is an important test for archaeological sites. Phosphorous, which is basic in DNA, increases through the life chain because of its chemical immobility. It is found in a variety of products and foodstuffs which eventually find their way into the soil system. The removal of phosphate is not subject to normal oxidation-reduction processes as with other soluble chemical elements commonly found in soils (Eidt 1977: 1327). The correlation between phosphate concentrations and archaeological sites has been so effective, the government

of Sweden recognizes phosphate determination along grid systems as an appropriate means of site location (Sjoberg 1976: 447). Phosphate analysis has aided in denoting and delimiting many archaeological sites (Proudfoot 1976; Mattingly and Williams 1962; Griffith 1980).

A phosphate analysis was performed on all samples collected at the site. The samples were dried, split and ground fine enough to pass through a 60 mesh (0.250 mm, 2.00 Ø) sieve. Ten gram samples were sent to the University of Tennessee Agricultural Extension Service Laboratory in Nashville, Tennessee. Extractable phosphorous was recorded in pounds per acre and converted to parts per million (ppm) for recording. Results of the phosphate analysis are presented in Appendix D.

CHAPTER 6

RESULTS

The results of all analyses are presented within this chapter. Profile descriptions, texture analyses, carbon analyses, phosphorus analyses and pH's are reported. The results are documented on a trench by trench basis with a general discussion of the results of the multivariate discriminant analysis as a summary.

Trench 2. Section 4

Trench 2. Section 4 represents the Pleistocene age sediments at the Rush Creek site. The parent material consists of old alluvium and a bisequel soil profile is represented. The sequences are separated by a lithologic discontinuity marked by a pebble line appearing at 107 cm in the $2Bt_1$ horizon (Figure 6). The brighter color values of 7.5YR expressed in the clay coatings are the result of oxidized iron (Table 1; see Appendix A for more detailed soil horizon descriptions). There are two argillic horizons represented in each sequum with a 7% increase in clay content from the Ap to the Bt_2 horizon in the upper sequum (T2b), and a 14% increase in clay content from the $2Bt_1$ horizon to the $2Bt_5$ horizon in the lower sequum (T2a) (Figure 7). The high clay content in the lower sequum concurs with the relative age in comparison to the upper sequum. There is also a change from a medium subangular blocky structure in the upper sequum to a strong subangular blocky structure in the lower sequum. The presence of manganese nodules and coatings suggest the permeability of the soil is poor in the lower sequum. The profile in this trench has a higher clay content than the profiles of the floodplain suggesting the clay content is pedogenic rather than sedimentary in origin.

The textural analysis demonstrates that the clay content as well as the coarse fragment content help to discriminate the two soil sequums represented. The mean values of these samples show the means range from 6.70 Ø to 6.06 Ø in the upper sequum (Figure 8). The mean values

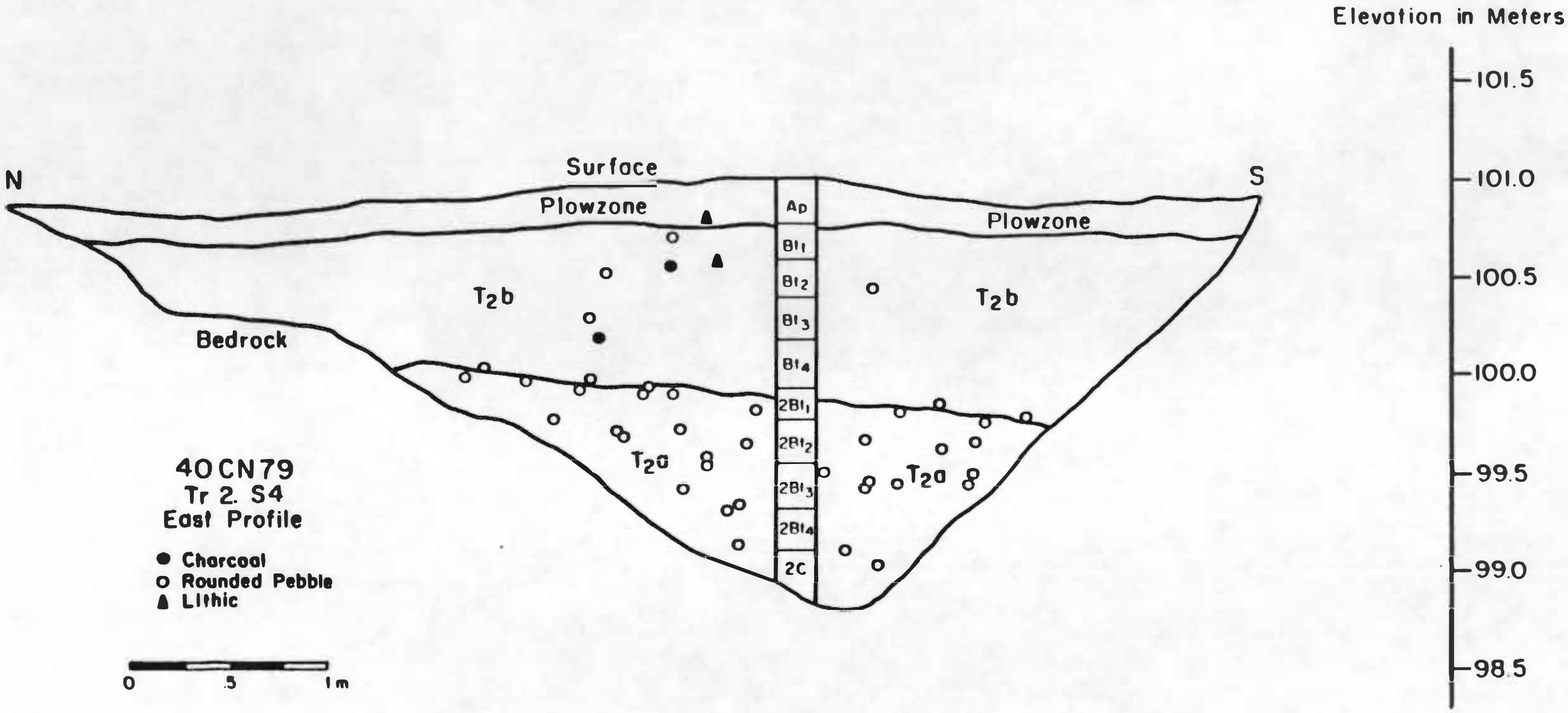


Figure 6. East Profile of Trench 2. Section 4.

Table 1. Soil Horizon Descriptions of Trench 2. Section 4.

Horizon	Depth (cm)	Color	Structure	Texture	Boundary
Ap	0- 22	10YR 4/3	2mgr	sil	
Bt_1	22- 40	7.5YR4/4	2msbk	sicl	cs
Bt_2	40- 60	7.5YR4/6	2msbk	sicl	cs
Bt_3	60- 82	7.5YR5/4	2msbk	sicl	gs
Bt_4	82-107	7.5YR5/6	2msbk	sicl	gs
$2Bt_1$	107-123	7.5YR5/6	2fsbk	sicl	cs
$2Bt_2$	123-145	7.5YR5/6	2msbk	cl	cs
$2Bt_3$	145-167	10YR 5/4	2msbk	cl	gs
$2Bt_4$	167-189	10YR 5/4	2msbk	c	gs
$2Bt_5$	189-208	10YR 6/6	2msbk	c	gs

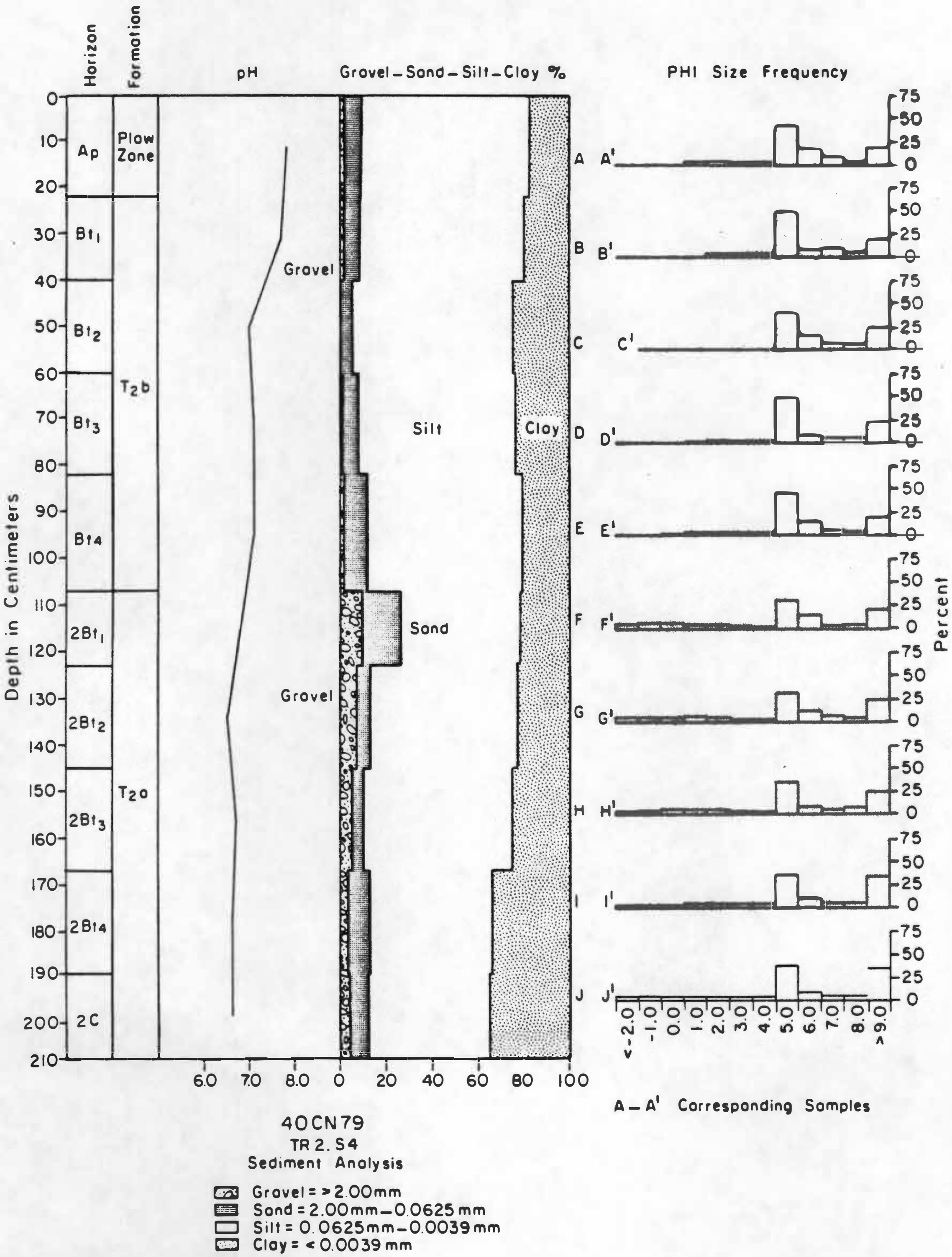


Figure 7. Sediment Analysis of Trench 2. Section 4.

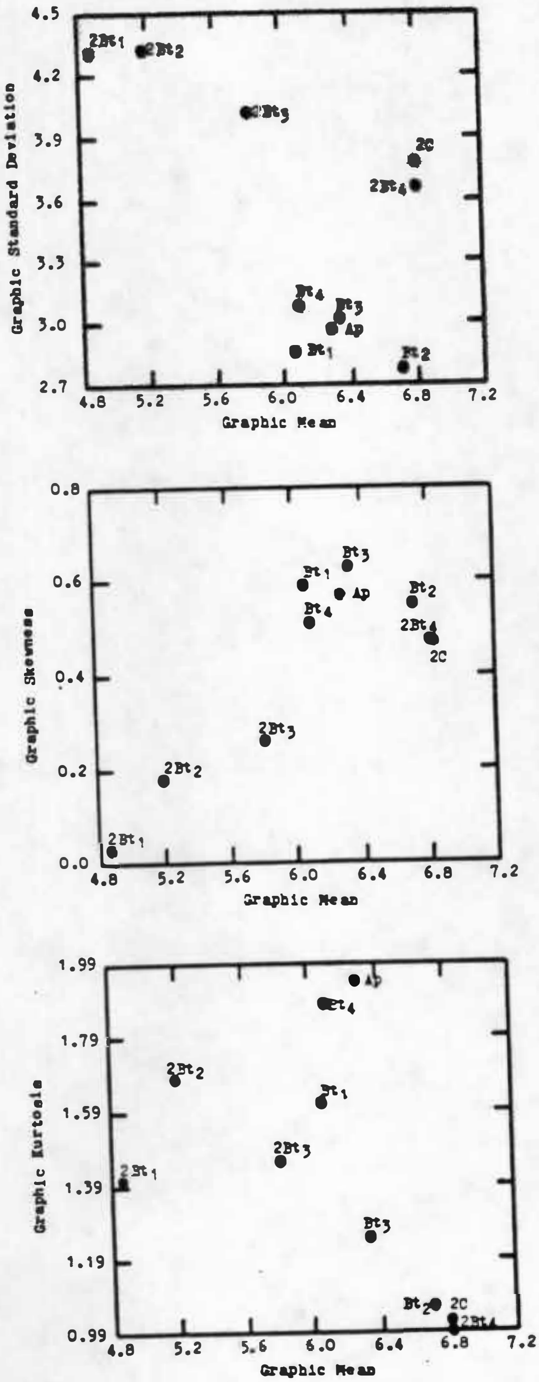


Figure 8. Textural Analysis of Trench 2. Section 4; Graphic Standard Deviation vs. Graphic Mean, Graphic Skewness vs. Graphic Mean, Graphic Kurtosis vs. Graphic Mean.

values in the lower sequum range from 4.87 Ø to 5.81 Ø indicative of the rounded alluvial gravel in the $2Bt_1$ through the $2Bt_3$ horizons designating the lithologic discontinuity between the T2b and the T2a formations. The high mean values in the last two samples ($2Bt_4$ and 2C) are the highest mean values (6.80 Ø and 6.81 Ø) in the profile which represents an increase in clay content and the drop of the alluvial gravel at 167 cm. The standard deviation values show that the upper sequum where values range from 2.78 Ø to 3.08 Ø are better sorted than the lower sequum whose values range from 3.66 Ø to 4.32 Ø (Figure 8). The alluvial gravel and the clay content in the lower sequum tend to spread the distribution of Ø sizes from the mean grain size. The skewness values show that the skewnesses of the upper sequum are very positively skewed in comparison to the samples in the lower sequum which show nearly symmetrical and positive skewnesses. The high clay content in this trench generally skews the distribution to the fine end of the scale but the presence of alluvial gravel in the lower sequum pushes the skewness values back toward the coarse end of the scale. The relative lack of gravel and the higher clay content moves the skewness values back toward the very positive end in the two bottom samples. The kurtosis values show that the samples with the highest clay contents (Bt_2, $2Bt_4$, and $2Bt_5$) are mesokurtic or as evenly sorted in the tails as in the central part of the distrubution. The remaining samples range from leptokurtic to very leptokurtic.

The auxiliary analyses of carbon, phosphate and pH denote their relative age of this landform in comparison to the floodplain and the bisequel nature of the soil (Figure 9). The greatest percentage of carbon (1.20%) is in the Ap horizon or surface of the profile. The carbon decreases steadily to 0.17% in the Bt_4. An increase to 0.20% in the $2Bt_1$ horizon demarcates the presence of the buried surface of the T2a formation. Another steady decrease is present to the bottom of the soil unit (0.16%). The phosphorus analysis shows an increase of phosphorus from 22 ppm at the surface to 36 ppm at the $2Bt_3$ horizon. The increasing phosphorus in the profile tends to correlate with the increasing clay content in the argillic horizon of the upper sequum. Because the clay mineral fraction of a soil is the most chemically reactive, the phosphorus content may be

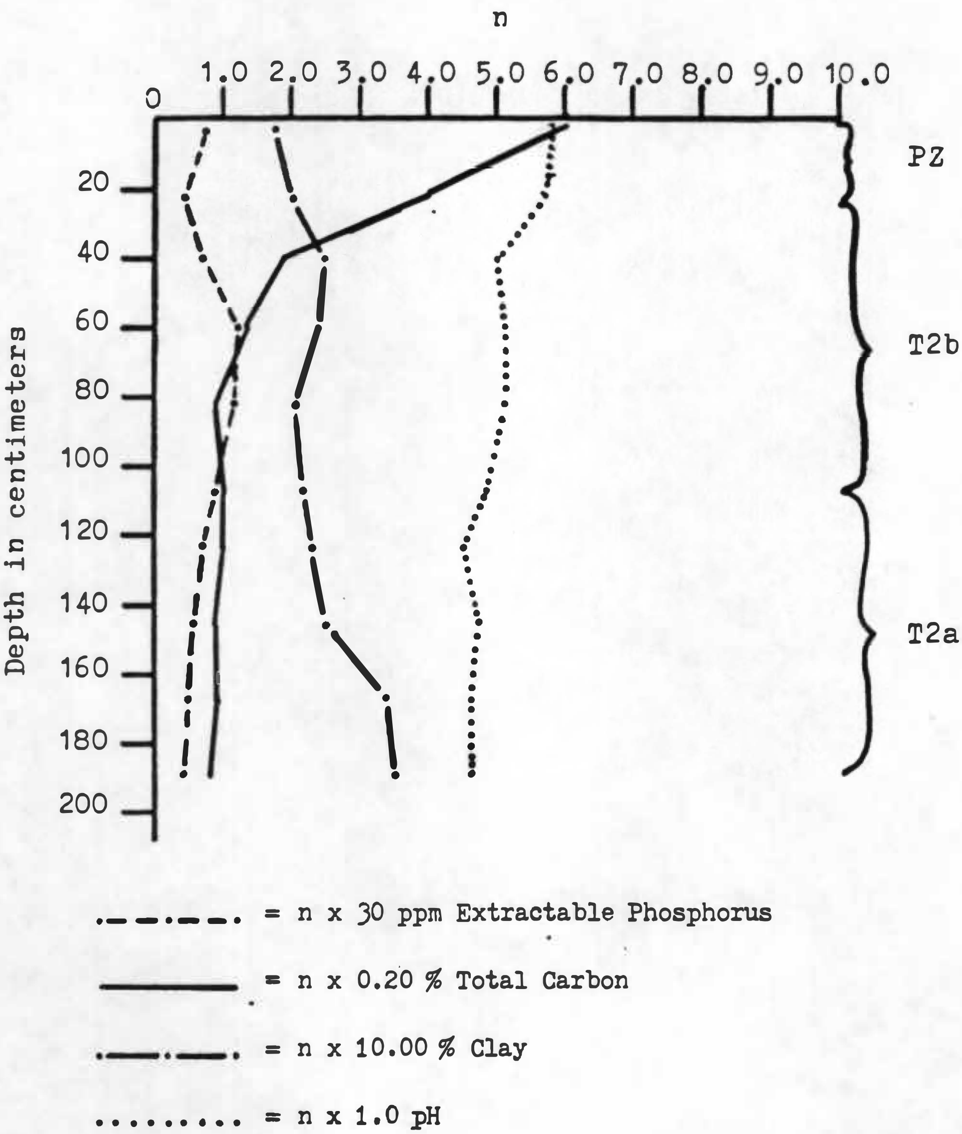


Figure 9. Chemical Analysis of Trench 2. Section 4.

prone to the same illuvial process as the clay content. There is no increase in phosphorus at the lithologic discontinuity, instead a steady decrease to 12 ppm at the bottom of the profile is noted. The pH analysis shows a steady decrease from 5.8 pH at the surface to 4.6 pH at the base of the unit. This indicates the profile is relatively well weathered, but the pH's may be high enough to tentatively classify the profile as an Alfisol (Figure 9).

Trench 1. Section 2

Trench 1. Section 2 is located in the slough area of the floodplain at the base of the T2 escarpment. There is a bisequel profile represented by a dark clayey buried soil of early to mid-Holocene age buried by historic age overburden. The overburden (T0b) is a silty clay loam to sandy loam deposit (Figure 10). There is some evidence of pedogenic alteration, but the alteration is slight with granular and weak subangular blocky structure. There is an abrupt boundary with the Holocene deposit (T1) with a sandy loam overlying a clay loam (Table 2). There is a 4% increase in clay from the bottom of the T0b to the top of the T1 and the argillic horizon in the T1 exhibits a 6% increase in clay from the T0b formation (Figure 11). The color of the T1 has a lower hue and chroma than the overlying T0b and exhibits a moderately developed subangular blocky and prismatic structure with illuvial clay coatings that are thin and continuous. Charcoal is present in the T1, especially in the 2Ab horizon. There is a gravel bar at the base of the unit which has undergone some gleying resultant of reducing conditions caused by a perched water table. The discontinuity between the T1 and the T0b should be reflected in the laboratory analysis.

The major textural parameter which separates the T0b from the T1 in this trench is the mean grain size (Figure 12). The means of the T0b range from 4.64 Ø to 5.87 Ø while the T1 means range from 5.96 Ø to 6.30 Ø. The higher clay content in the T1 is indicative of pedogenic alteration of primary minerals into secondary clay minerals. The standard deviation values are more randomly distributed throughout the profile. The basic pattern in this sorting index shows the samples in the upper sections of each soil sequum (Bw_1 and 2Ab) are better sorted than the lower portions. The

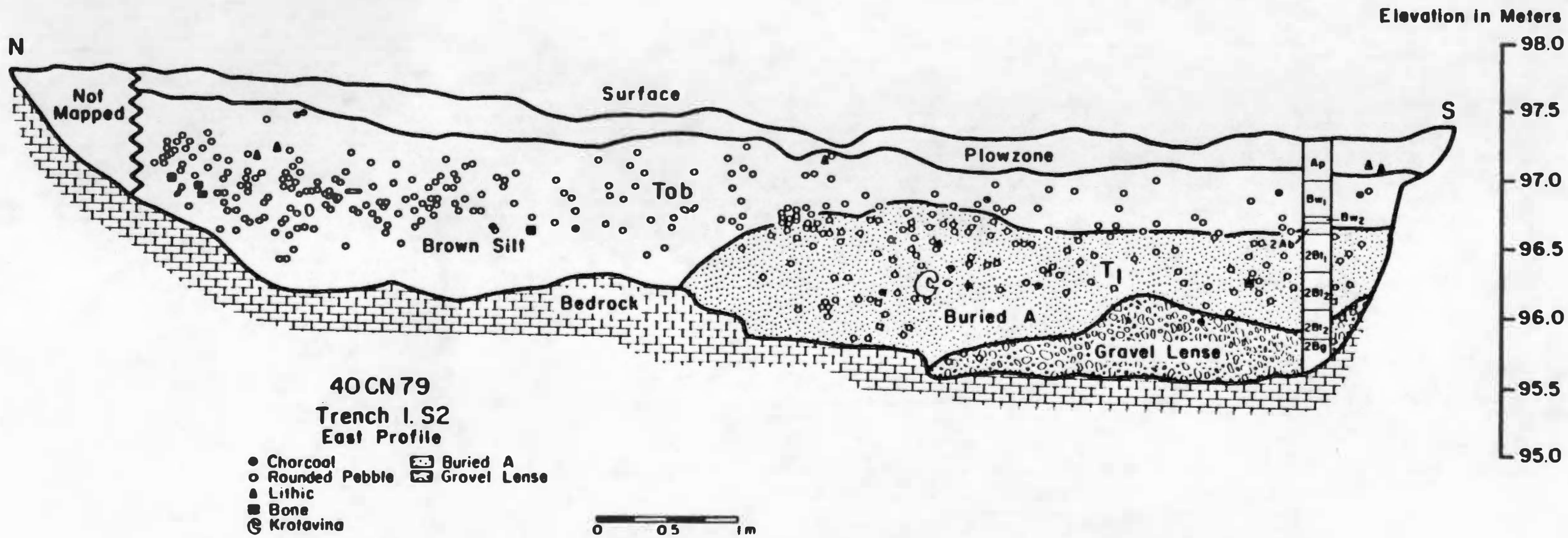


Figure 10. East Profile of Trench 1. Section 2.

Table 2. Soil Horizon Descriptions of Trench 1. Section 2.

Horizon	Depth (cm)	Color	Structure	Texture	Boundary
Ap	0- 29	10YR 4/3	2msbk	sil	
Bw_1	29- 55	10YR 4/3	1csbk	sicl	cs
Bw_2	55- 59	10YR 4/3	0fgr	sl	cs
2Ab	59- 68	10YR 3/2	1cpr	cl	cs
$2Bt_1b$	68- 95	10YR 3/2	2msbk	cl	gs
$2Bt_2b$	95-122	10YR 3/3	2msbk	cl	gs
$2Bt_3b$	122-144	10YR 3/3	1msbk	scl	gs
2Bgb	144-185	10YR 3/3	0m	gscl	cs

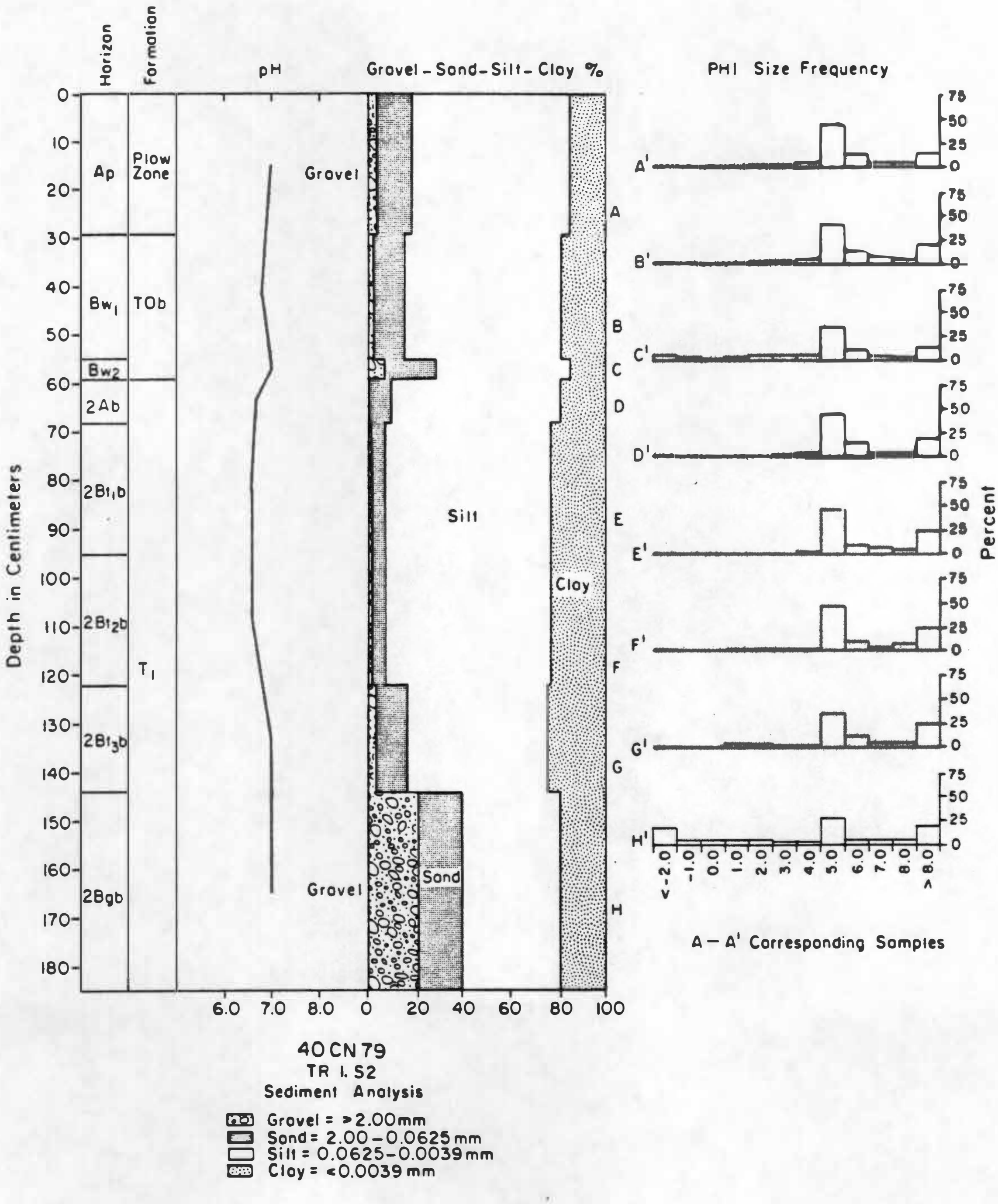


Figure 11. Sediment Analysis of Trench 1. Section 2.

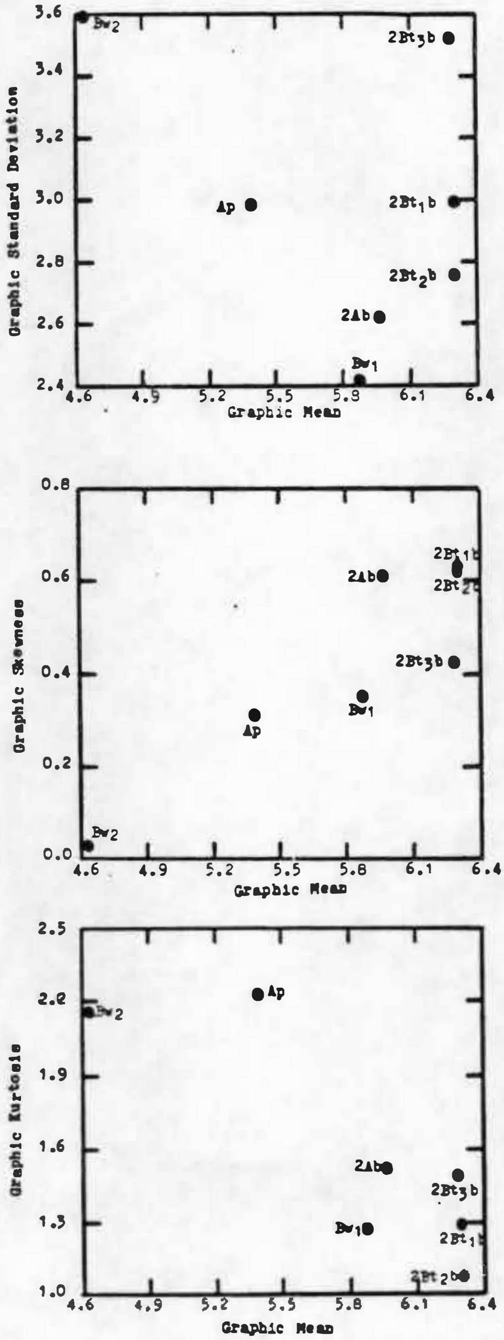


Figure 12. Textural Analysis of Trench 1. Section 2; Graphic Standard Deviation vs. Graphic Mean, Graphic Skewness vs. Graphic Mean, Graphic Kurtosis vs. Graphic Mean.

skewness values show the samples in the T1 are more finely skewed with ranges of 0.42 Ø to 0.63 Ø than the T0b samples which range from 0.03 Ø to 0.35 Ø. The high clay content in the T1 reflects this pattern. The kurtosis values show that the T1 samples are more closely patterned with values of 1.07 Ø to 1.52 Ø while the T0b samples range from being leptokurtic (1.27 Ø) to very leptokurtic (2.23 Ø). The clay content in the samples tends to be the major discriminating factor between the T0b and the T1 formations.

The auxiliary laboratory analyses tend to reflect the bisequel nature of this profile. The carbon analysis shows the high accumulation of carbon in the surface at 1.28% in the Ap horizon (Figure 13). There is a steady decrease in carbon to 0.96% in the Bw_2 horizon. The carbon increases in the 2Ab horizon at 1.25% which rivals the Ap horizon content. There is a steady decrease to 0.65% in the lower gravel bar. Because the greatest content of carbon in the T1 formation is not in the 2Ab horizon, but in the $2Bt_2b$ horizon, the translocation of carbon through the profile is implied. The phosphorus distribution in the profile shows similar patterns. The greatest content is 300 ppm at the surface and a decrease through the T0b formation is observed to 60 ppm in the Bw_2 horizon. A sharp increase is observed in the 2Ab horizon of 120 ppm, followed by a sharp decrease to 75 ppm in the $2Bt_1b$ horizon, to a steady increase in phosphorus in the gleyed 2Bgb horizon of 300 ppm. The graphic peaks in carbon and phosphate tend to show the T1 as a legitimate buried surface where organic matter once accumulated. The increase in phosphorus in the T1 may also show that phosphorous may have illuviated through the profile. The pH's of this profile range from 6.6 to 7.0 pH due to the phosphatic nature of the parent material.

Trench 2. Section 2

Trench 2. Section 2 represents a bisequel profile with an early to mid-Holocene alluvium (T1) buried by an Historic alluvium (T0b). This trench is located in the slough area at the base of the T2 scarp. The T0b formation in this profile exhibits a silt loam texture in the upper matrix with some pedogenic alteration in the Bw horizons, and intermittant granular sand lenses and massive

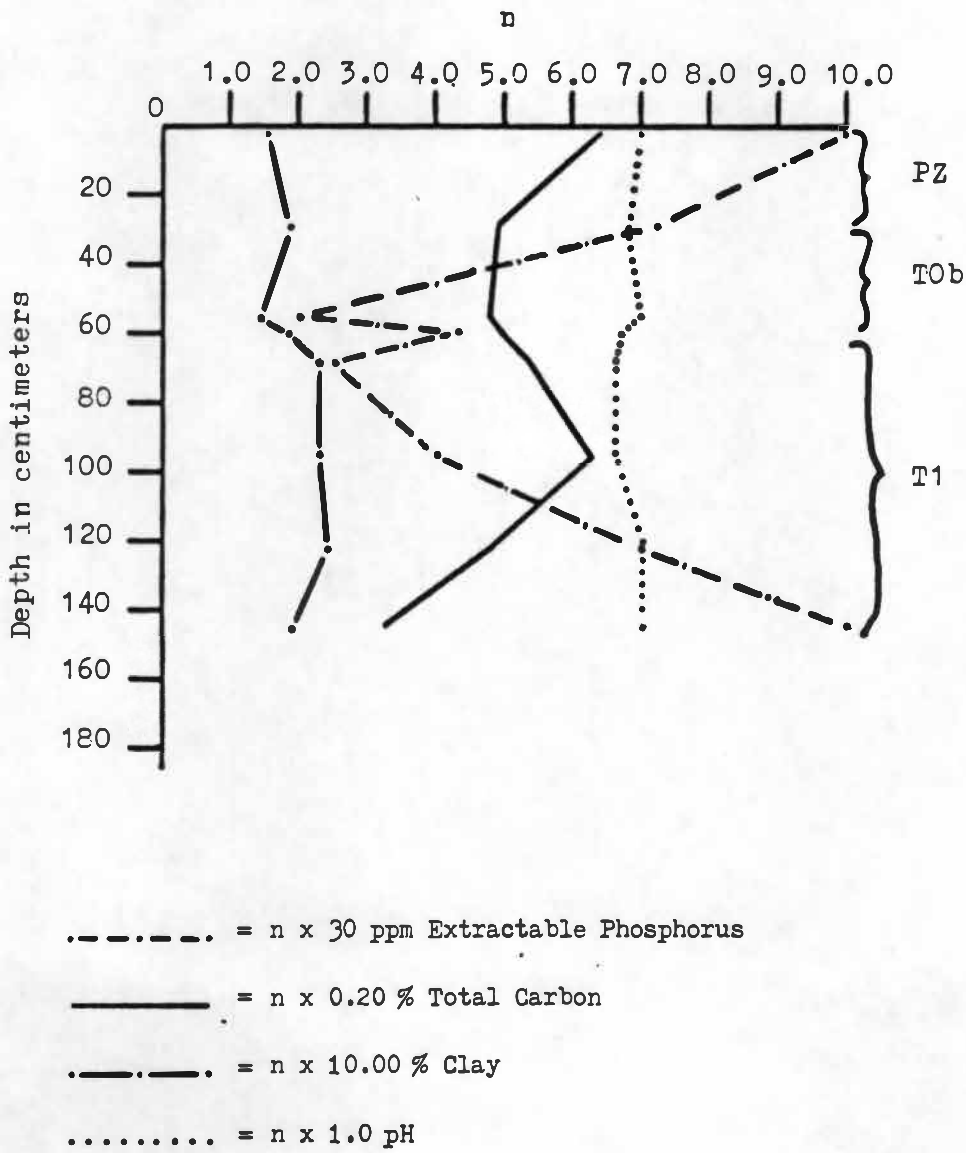


Figure 13. Chemical Analysis of Trench 1. Section 2.

lamenated silt lenses in the lower C horizons (Figure 14). These intermittant sand and silt lenses may be indicative of a hydrologic regime governed by damming of the river causing a decrease in water velocity depositing fine sediments, and water release processes which increase water velocity and deposit coarser grained sediments. These sand and silt lenses overlie the T1 formation and exhibit an abrupt boundary. The sediments of the T1 formation is darker in color and higher in clay content than the overlying T0b deposits (Table 3). There is greater soil development with moderate subangular blocky structure and thin continuous illuvial clay coatings. The surface of the T1 on the 2Ab horizon had visible charcoal fragments and some animal bone with lithic debitage. The lower horizons of the T1 only contained lithic debitage. There is a gravel bar at the base of the T1 which exhibited some gleying from a perched water table and overlay limestone bedrock (Figure 15).

The textural analysis performed on the samples in this profile demonstrate that mean grain size is the most important factor separating T0b samples and T1 samples (Figure 16). The T1 formation exhibits the highest mean values in the profile in the 2Ab and $2Bt_1b$ horizons with values of 5.96 Ø and 6.00 Ø, respectively. The intermittent sand-silt lenses in the T0b also descriminate with sand lense values ranging from 4.51 Ø to 4.75 Ø, and silt lense means ranging from 5.59 Ø to 5.89 Ø. The standard deviations show the sand lenses in the T0b are more poorly sorted than the remaining samples in the profile. The skewness values demonstrate that the grain size distributions of the sand lenses of the T0b are more symmetrical than the remaining samples. Kurtosis values in the profile exhibit little patterning with all samples exhibiting leptokurtic to very leptokurtic distributions.

The auxiliary laboratory analyses tend to confirm the bisequel nature of this profile (Figure 17). The carbon analysis shows the greatest accumulation of carbon in the Ap horizon at 1.30%. There is a steady decrease in carbon to 0.39% in the C_7 horizon of the T0b reflective of a typical weathering profile. A slight increase to 0.54% is observed in the C_8 horizon and another increase to 0.84% in the 2Ab horizon of the T1 formation. The T1 formation exhibits an increasing carbon

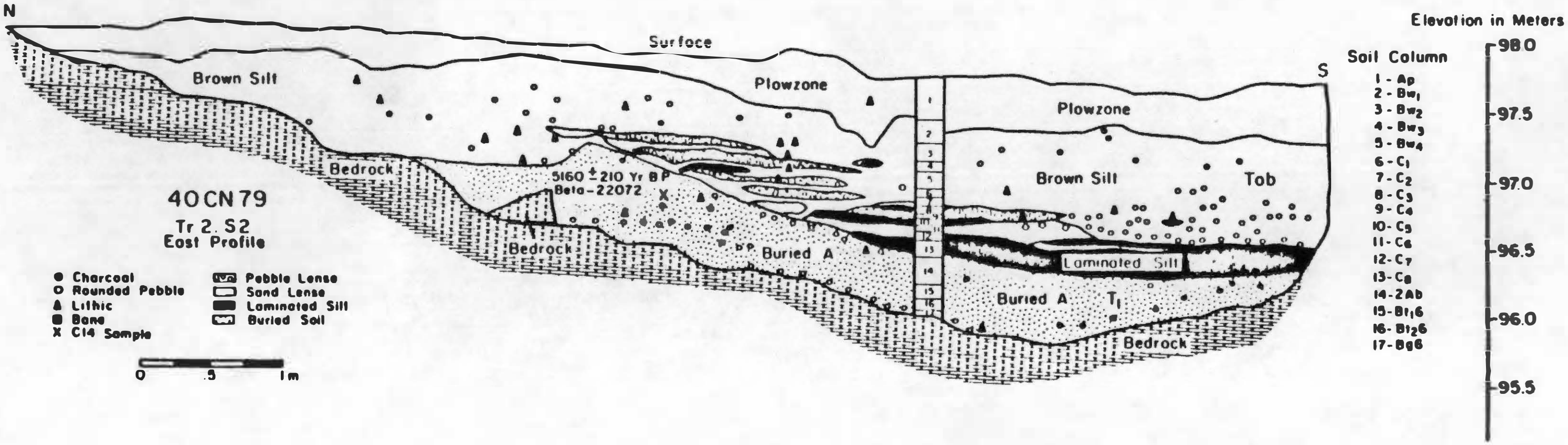


Figure 14. East Profile of Trench 2. Section 2.

Table 3. Soil Horizon Descriptions of Trench 2. Section 2.

Horizon	Depth (cm)	Color	Structure	Texture	Boundary
Ap	0- 32	10YR 4/4	2mgr	sil	
Bw_1	32- 48	10YR 4/3	1msbk	sil	cs
Bw_2	48- 63	10YR 4/3	1msbk	sil	gs
Bw_3	63- 70	10YR 4/3	2mgr	sl	ci
Bw_4	70- 83	10YR 4/3	1csbk	sil	as
C_1	83- 88	10YR 4/3	1fgr	sl	ai
C_2	88- 95	10YR 4/4	0m	sil	ai
C_3	95-100	10YR 4/4	1fgr	sl	ai
C_4	100-102	10YR 4/4	0m	sil	ai
C_5	102-109	10YR 4/4	1fgr	sl	ai
C_6	109-112	10YR 4/4	0m	sil	ai
C_7	112-120	10YR 4/3	1fgr	sl	ai
C_8	120-133	10YR 4/4	0m	sil	as
2Ab	133-152	10YR 3/3	1msbk	sicl	as
$2Bt_1b$	152-165	10YR 3/3	1msbk	cl	gs
$2Bt_2b$	165-176	10YR 3/3	1csbk	cl	gs
2Bgb	176-180	10YR 3/3	0m	gcl	cs

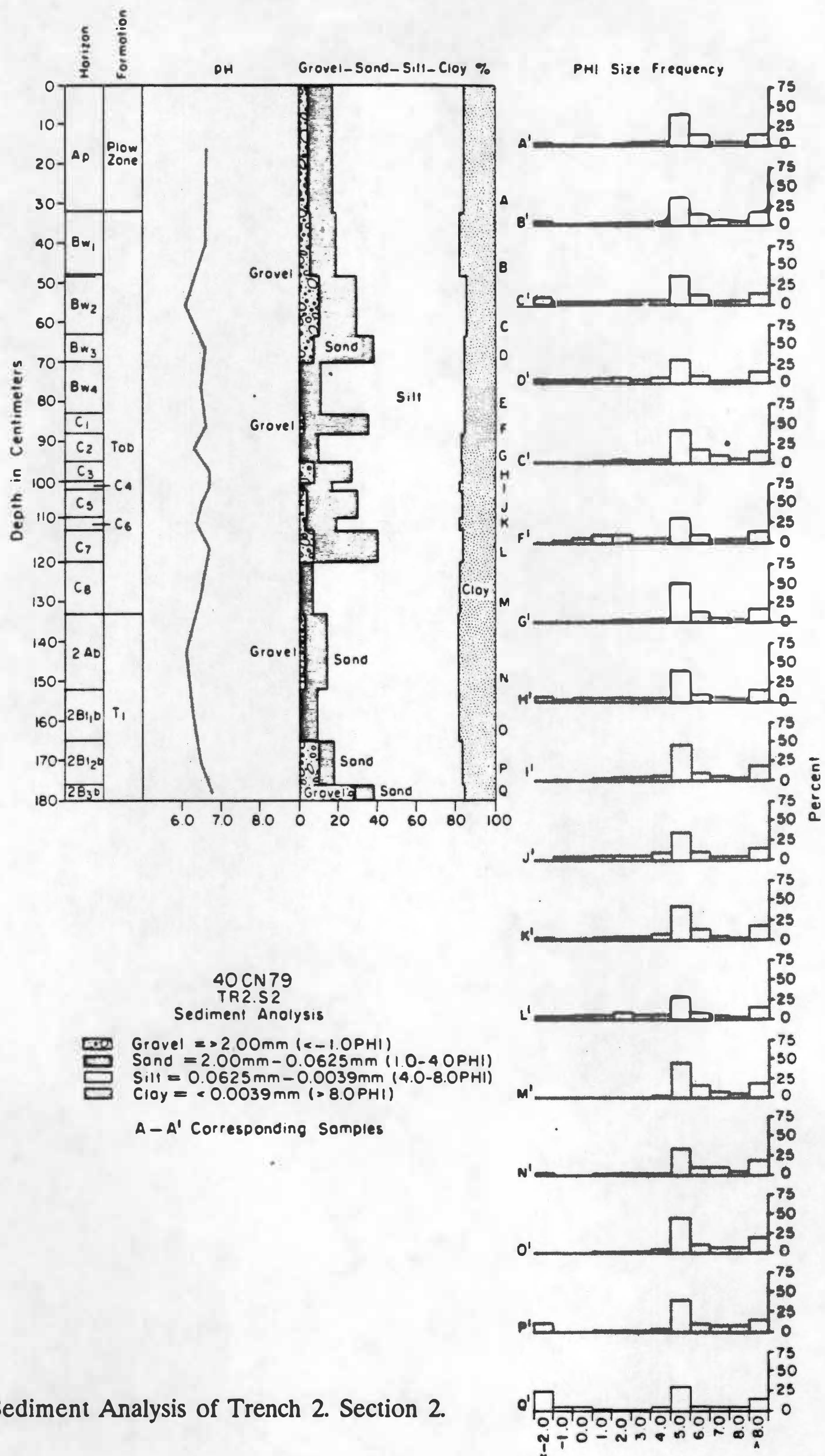


Figure 15. Sediment Analysis of Trench 2. Section 2.

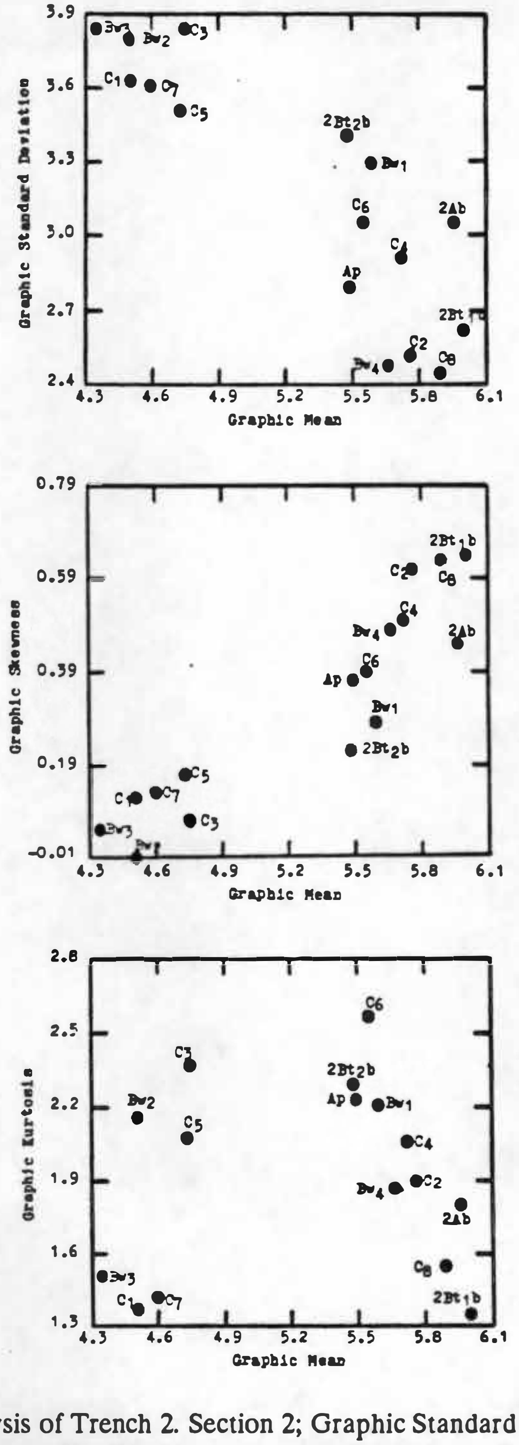


Figure 16. Textural Analysis of Trench 2. Section 2; Graphic Standard Deviation vs. Graphic Mean, Graphic Skewness vs. Graphic Mean, Graphic Kurtosis vs. Graphic Mean.

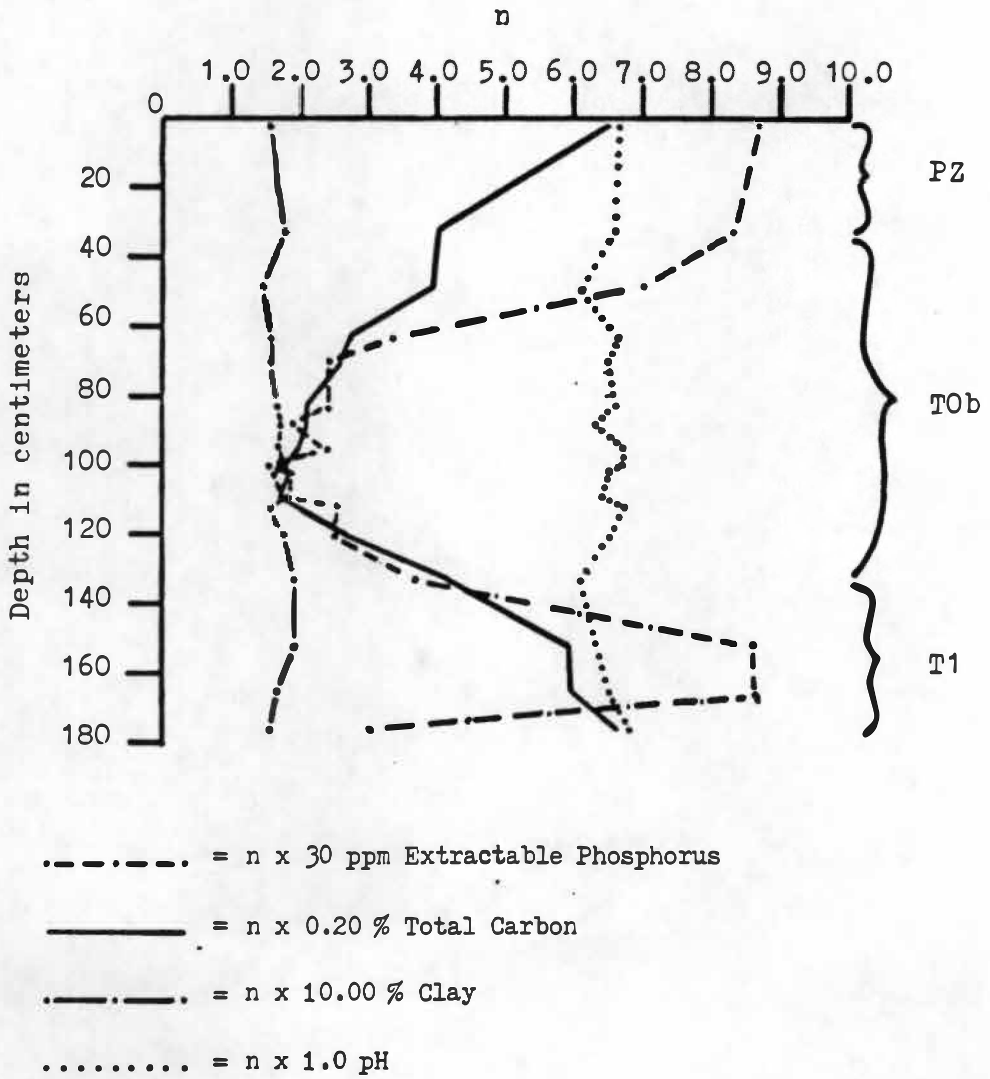


Figure 17. Chemical Analysis of Trench 2. Section 2.

content to the base of the profile of 1.21% in the 2Bgb horizon. This demarcates a former buried surface. The phosphorus analysis exhibits similar patterning. A high concentration of phosphorus of 260 ppm is observed at the surface of the profile which steadily decreased to 56 ppm in the C_2 horizon. In the interbedded sand and silt lenses, the phosphorus content increases within the sandier lenses in comparison to the siltier lenses. There is a significant increase in phosphorus from the C_8 horizon (75 ppm) to the 2Ab horizon (110 ppm). The phosphorus content peaks in the $2Bt_1b$ and $2Bt_2b$ horizons at 260 ppm and decreases to 90 ppm in the gravel bar at the base of the unit. This evidence indicates the T1 was a former buried surface with phosphorus accumulating from organic refuse at the former surface. The high levels of phosphorus with decreasing depth in the T1 formation indicates phosphorus may have been translocated. The pH's of the profile, which range from 6.1 to 6.8 pH, seem to indicate a relatively unweathered parent material.

Trench 3. Section 2

Trench 3. Section 2 is located in the slough of the floodplain at the base of the T2 scarp. This profile exhibits a bisequal profile with an early to mid-Holocene soil (T1) buried by T0b formation historic age deposits (Figure 18). The soil development of the T1 landform exhibits greater development of soil structure, darker colors, and presence of continuous clay coatings (Table 4). The T0b sediments show some pedogenic development in the upper matrix, but have massive laminated silt lenses in the lower portion of the matrix (Figure 19). The interbedded sand lenses found in TR2.S2 were not present here but the laminated silt lenses are present. These silt lenses also exhibit a high clay content (24.00%), but it is believed this clay is sedimentary rather than pedogenic in origin due to the lack of soil development. There is an abrupt boundary separating T0b and T1 sediments. Charcoal samples extracted from the surface of this interface was dated at 150 $\pm$ 80 yr. B.P. (Beta 21683). Historic age stoneware sherds were also found in an excavation unit 1 meter from the sediment column on the surface of the T1 formation. Lithic artifacts and charcoal fragments were found in the T1 matrix below the buried surface.

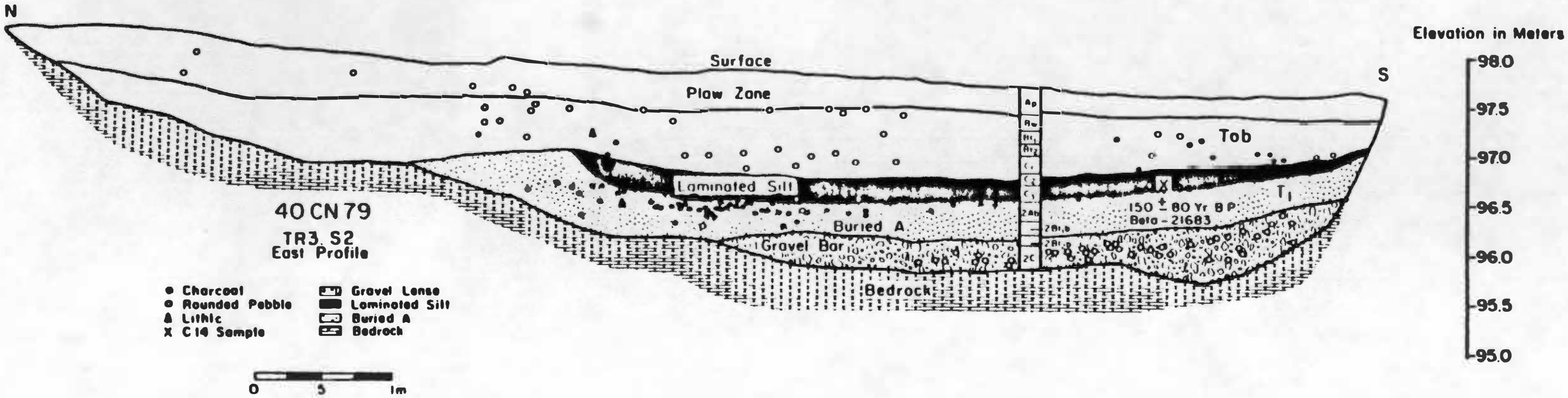


Figure 18. East Profile of Trench 3. Section 2.

Table 4. Soil Horizon Descriptions of Trench 3. Section 2.

Horizon	Depth (cm)	Color	Structure	Texture	Boundary
Ap	0- 26	10YR 4/3	2mgr	sil	
Bw	26- 44	10YR 4/3	1msbk	sil	gs
Bt_1	44- 58	10YR 4/3	1csbk	sicl	gs
Bt_2	58- 70	10YR 4/4	2msbk	sicl	gs
C_1	70- 87	10YR 4/4	0m	sil	cs
C_2	87- 99	10YR 4/4	0m	sil	gs
C_3	99-116	10YR 4/3	0m	sil	gs
2Ab	116-135	10YR 3/3	2msbk	sicl	cs
$2Bt_1b$	135-149	10YR 3/3	2msbk	cl	gs
$2Bt_2b$	149-159	10YR 3/3	2msbk	cl	gs
2C	159-177	10YR 4/4	0gr	gs	cs

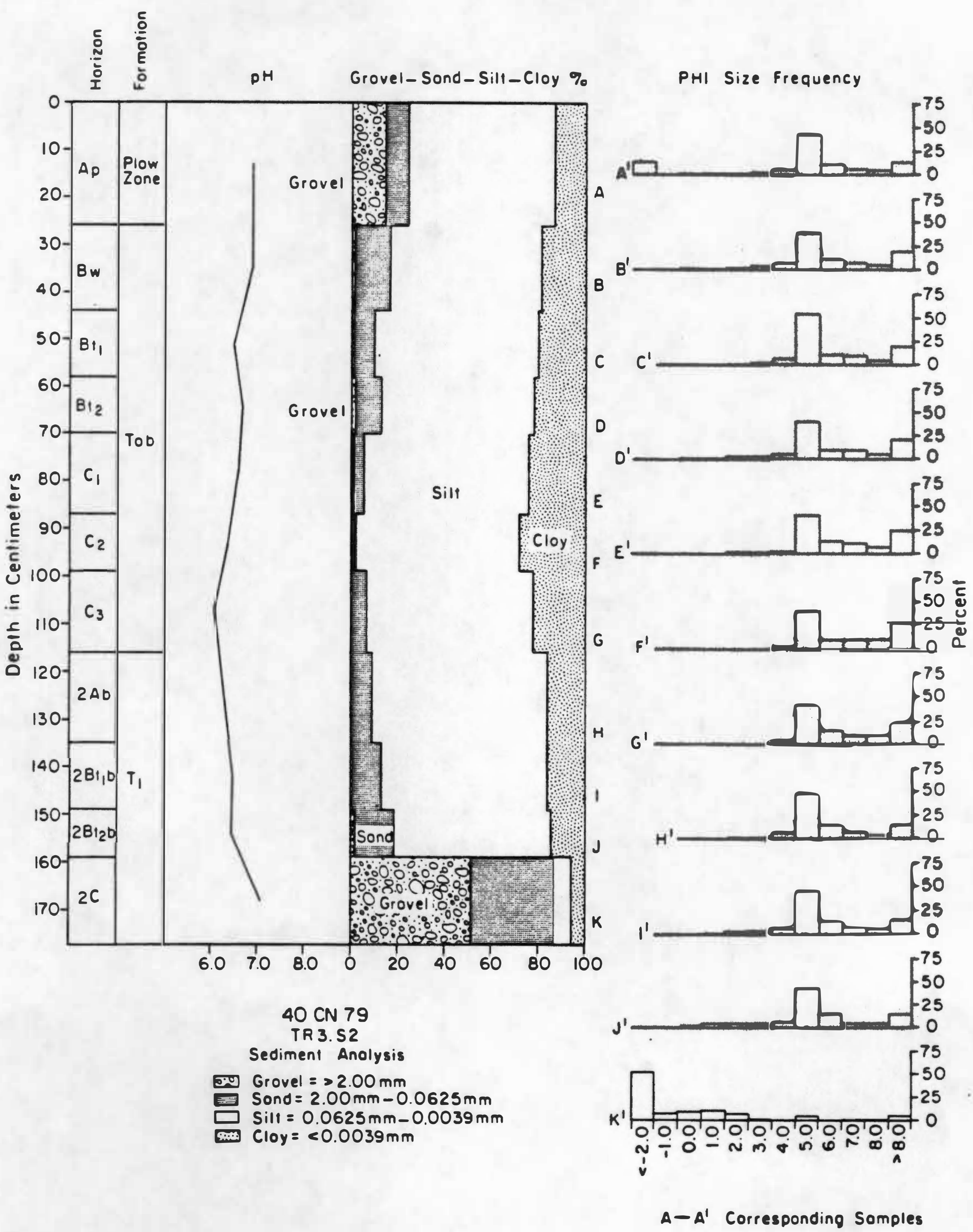


Figure 19. Sediment Analysis of Trench 3. Section 2.

The textural analysis tends to confirm the bisequel nature of the sediment profile (Figure 20). With the exception of the Ap horizon, the means of the T0b formation show these samples are finer than those of the T1 formation. The means in the T0b range from 5.90 Ø to 6.90 Ø while the means in the T1 formation range from 5.28 Ø to 5.66 Ø. This is a reversal of the situation in TR1.S2 and TR2.S2 where the T1 formation samples are finer than the overlying T0b samples. This may be indicative of a hydrologic regime of lower water velocities than the samples downstream, and may indicate a relatively gentle pool or eddy that would deposit finer materials than those downstream. Standard deviation values in the T1 are lower, ranging from 2.30 Ø to 2.74 Ø, than the values in the T0b which range from 2.75 Ø to 3.62 Ø. These values indicate that the sediments of the T1 are better sorted than those of the T0b. All of the samples, with the exception of the Ap horizon, exhibit a very positively skewed distribution due to the high clay content in all of the samples. The kurtosis values of the T1 are higher, with ranges of 1.77 Ø to 2.62 Ø, in comparison to the T0b kurtosis values which range from 1.03 Ø to 1.64 Ø. The Ap horizon is an exception with an extremely high kurtosis value of 3.35 Ø. A high kurtosis value represents a distribution that is more well sorted in the central part of the distribution in comparison to the tails of the distribution.

The auxilliary laboratory analyses tend to confirm the bisequel nature of this sediment profile (Figure 21). The greatest accumulation of carbon is 1.42% in the Ap horizon. There is a steady decrease in carbon through the T0b to 0.90% in the C_1 horizon with a carbon peak in the Bt_1 horizon at 0.99%. The carbon then increases to 0.90% in the C_2 horizon and to 1.23% in the C_3 horizon. The carbon increases to 1.26% in the 2Ab horizon of the T1 formation with a peak carbon percentage of 1.35% in the $2Bt_1b$ horizon. The carbon then decreases to 1.10% in the gravel bar (2C horizon) at the base of the unit. The carbon percentages in the T1 rival that of the Ap horizon and indicate a buried surface in the T1 formation. The phosphorus analysis shows a maximum distribution of phosphorus in the Ap, Bw and Bt_1 horizons of 300 ppm. The phosphorus content sharply decreases to 75 ppm in the C_2 horizon of the T0b formation. A sharp peak is

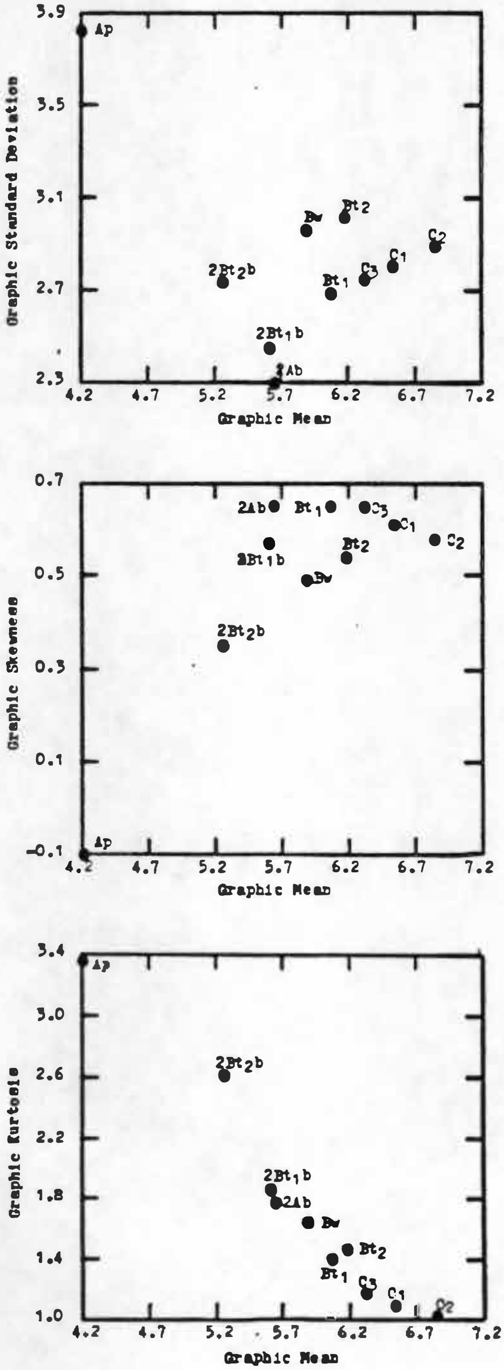
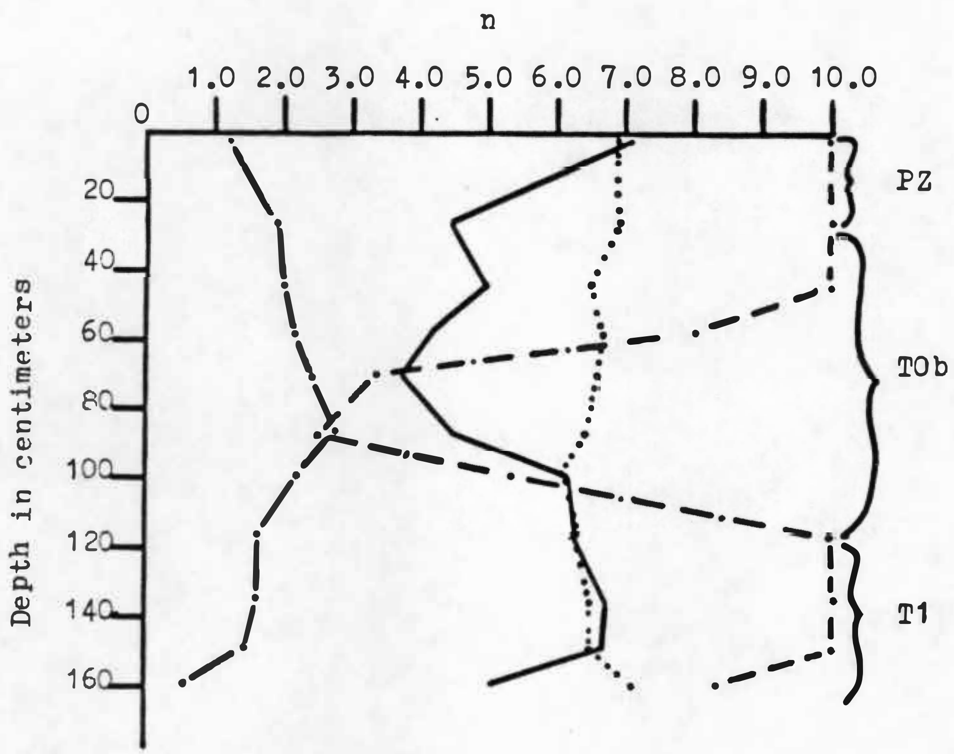


Figure 20. Textural Analysis of Trench 3. Section 2; Graphic Standard Deviation vs. Graphic Mean, Graphic Skewness vs. Graphic Mean, Graphic Kurtosis vs. Graphic Mean.



.—.—. = n x 30 ppm Extractable Phosphorus

——— = n x 0.20 % Total Carbon

.—.—. = n x 10.00 % Clay

.... = n x 1.0 pH

Figure 21. Chemical Analysis of Trench 3. Section 2.

observed in the 2Ab horizon of the T1 formation at 300 ppm and remains so until it drops to 250 ppm in the gravel bar. The sharp increase in phosphorus content at the T1 surface tends to indicate the T1 was a true buried surface with phosphorus contents attributed to additions of organic matter and refuse. The pH's, which range from 6.1 to 7.1 pH, are relatively high.

Trench 4. Section 2

Trench 4. Section 2 is located on the floodplain and is situated between the T2 escarpment and the slough. The effects of the slough, as seen in TR1.S2, TR2.S2, and TR3.S2, were not evident in this trench section. The sediments are comprised of Late Holocene-Historic age alluvial deposits of the T0a formation. The sediment textures indicate the profile has a silt loam upper matrix that gradually grades into a lag channel deposit composed of rounded chert gravels and cobbles (Figure 22). Colors are in the range of 10YR 4/3 to 10YR 4/4 and some pedogenic development is observed in the presence of thin discontinuous clay coatings (Table 5). The field observations of this profile indicated a single sequum; however, laboratory analysis suggests a possible besequel soil. A clay peak of 18.50% is observed in the Bw_1 and Bw_2 samples and another clay peak is observed in the Bw_5 horizon at 16.00%. If this is a bisequel sediment, it is likely that the T0b formation overlies the T0a formation in this profile (Figure 23).

Textural analysis confirms a silty upper mantle grading into a gravel bar (Figure 24). Mean distributions in this profile range from 4.46 Ø to 5.88 Ø. Gravel bar means range from -1.51 Ø to 1.06 Ø reflecting the coarse nature of the sediments. Standard deviation values reflect a relatively poorly sorted upper mantle comprising the Ap, Bw_1, Bw_2, and Bw_3 horizons with distributional ranges of 2.69 Ø to 3.02 Ø. The Bw_4 and Bw_5 horizons are better sorted with standard deviation values of 2.29 Ø to 3.65 Ø. The skewness values for the upper silty matrix shows little variation with values ranging from 0.49 Ø to 0.60 Ø indicating these sediments are very positively skewed. The gravel bar deposits exhibit skewness values which range from nearly symmetrical distributions (0.09

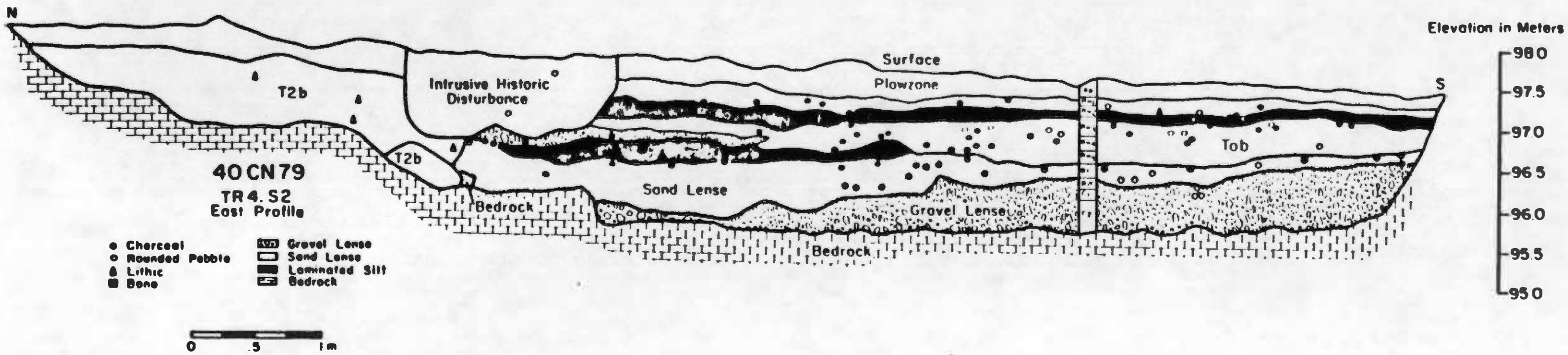


Figure 22. East Profile of Trench 4. Section 2.

Table 5. Soil Horizon Descriptions of Trench 4. Section 2.

Horizon	Depth (cm)	Color	Structure	Texture	Boundary
Ap	0- 14	10YR 4/3	2mgr	sil	
Bw_1	14- 30	10YR 4/3	1msbk	sil	cs
Bw_2	30- 44	10YR 4/3	1msbk	sil	gs
Bw_3	44- 64	10YR 4/3	1msbk	sil	gs
Bw_4	64- 81	10YR 4/3	1msbk	sil	gs
Bw_5	81- 98	10YR 4/3	1csbk	sil	gs
Bw_6	98-115	10YR 3/3	2msbk	sil	gs
B/C	115-129	10YR 3/3	2mgr	ls	cs
C_1	129-141	10YR 4/4	0gr	gs	gs
C_2	141-163	10YR 4/3	0gr	gs	gs

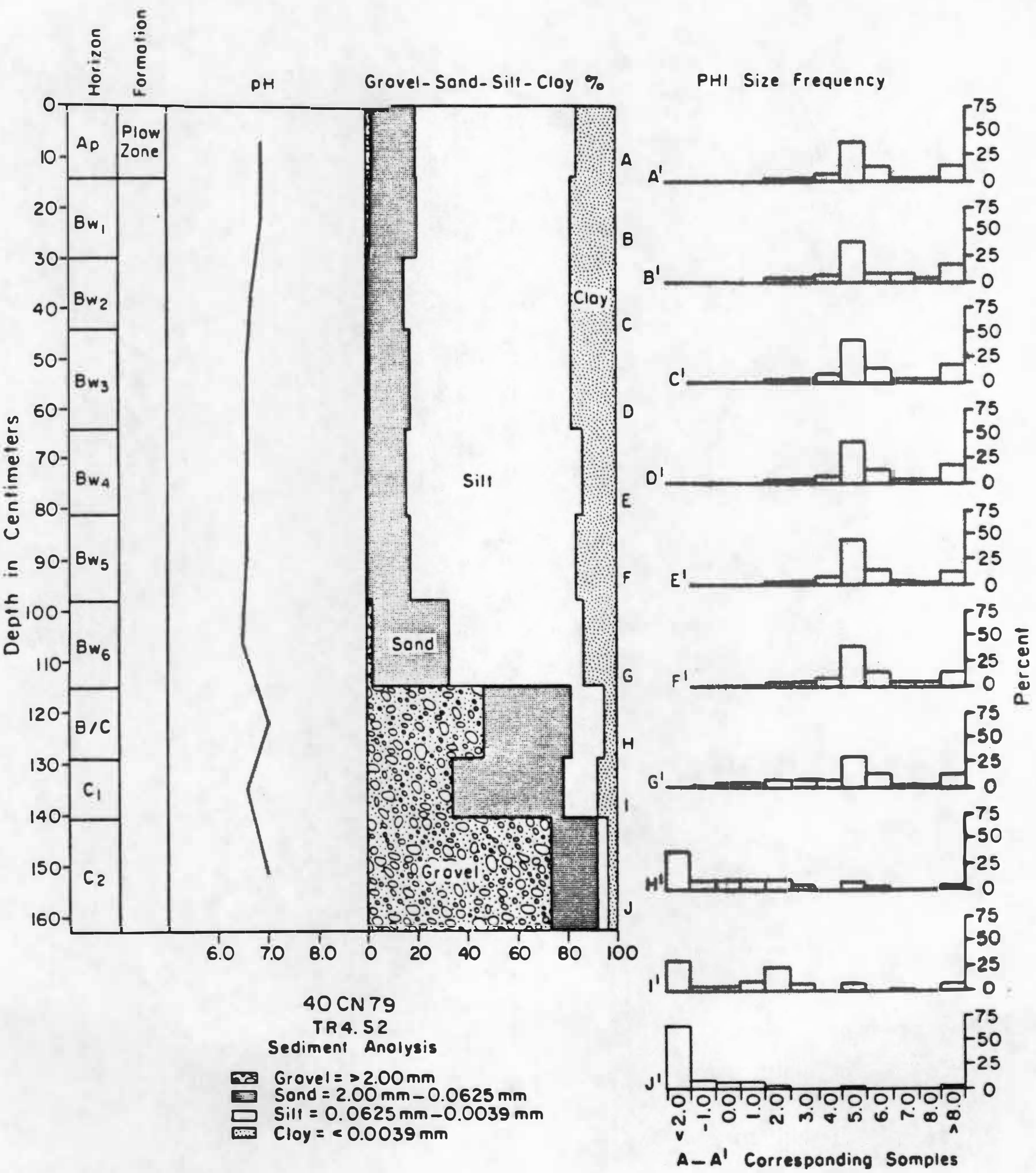


Figure 23. Sediment Analysis of Trench 4. Section 2.

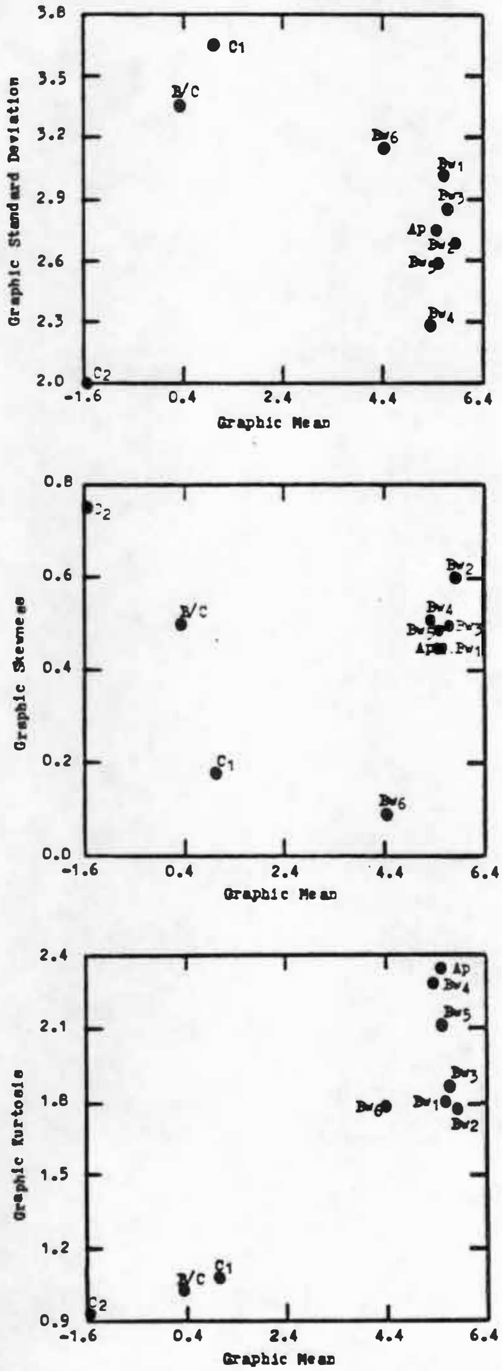


Figure 24. Textural Analysis of Trench 4. Section 2; Graphic Standard Deviation vs. Graphic Mean, Graphic Skewness vs. Graphic Mean, Graphic Standard Deviation vs. Graphic Mean.

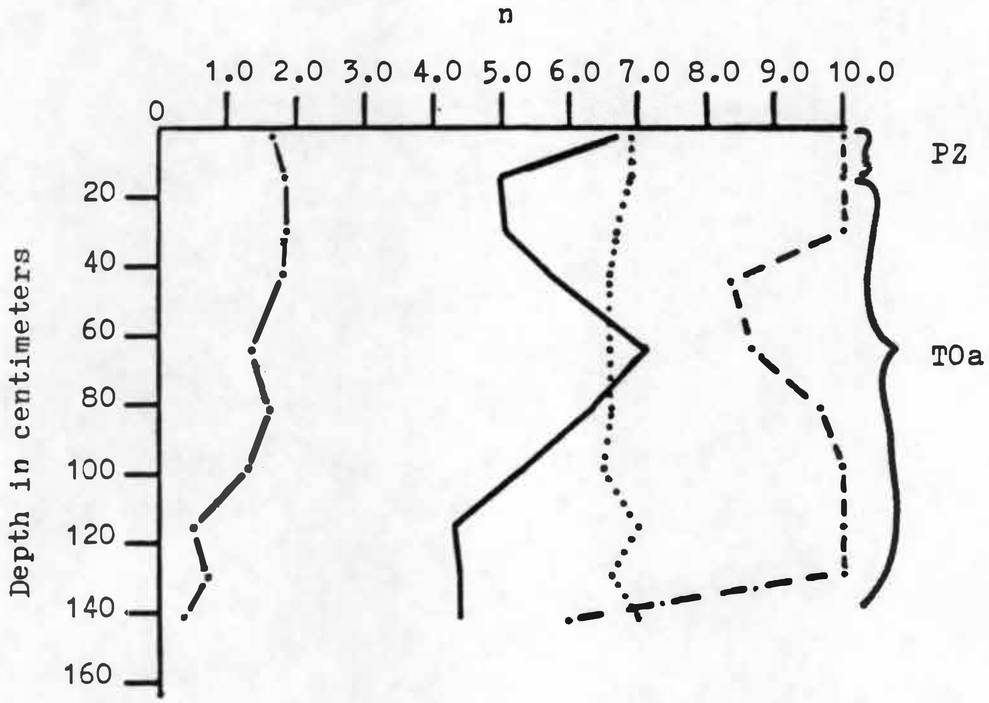
Ø) to very positively skewed distributions (0.75 Ø). Kurtosis values reveal the silty upper mantle has distributions that are very leptokurtic while the gravel bar deposits exhibit leptokurtic distributions.

Carbon and phosphorus analyses in this profile reflect the possible bisequel nature of this landform (Figure 25). The total carbon analysis exhibits a high in the Ap horizon of 1.14% that decreases to 1.01% in the Bw_2 horizon. A sharp peak is then observed in the Bw_4 horizon of 1.42% possibly indicating a buried surface. The distribution then decreases to 0.88% in the gravel bar at the base of the unit. Phosphorus analysis shows a maximum of 300 ppm in the Ap, Bw_1, and Bw_2 horizons. A sharp decrease is noted in the Bw_3 horizon to 250 ppm and gradually increases to 300 ppm in the Bw_6 horizon, with a drop of 180 ppm observed at the bottom of the lag channel deposit. The decrease in phosphate in the silty upper mantle may be indicative of a leaching profile from a former buried surface. Phosphorus may have been translocated through the profile into the lower silty mantle. The relatively high amounts of phosphorus in this profile may indicate that phosphorus is sedimentary in origin rather than pedogenic. Phosphorus would enter the profile as a component of the parent material of the sedimentary matrix. The pH's in this profile are relatively high, ranging from 6.5 to 7.0 pH.

Trench 2. Section 1.5

Trench 2. Section 1.5 is located between the slough and the levee on the floodplain. The sediments in this trench are composed of a silt loam upper mantle that grades into a lag channel deposit at the base (Figure 26). The T0a formation is represented in this trench section. Colors are generally 10YR 4/3 to 10YR 4/4 with some soil development indicated by the moderate soil structure and discontinuous clay coatings (Table 6). Clay percentages are relatively homogeneous with 16.50% clay content in the upper silty mantle which grades to 2.00% clay in the gravel bar (Figure 27). There is only one soil sequum represented in this profile.

The textural analysis performed on these samples reflect a natural alluvial distribution of a single sequence in a profile. Mean values in the sediment show a gradual decrease in mean size



.—.—. = n x 30 ppm Extractable Phosphorus

——— = n x 0.20 % Total Carbon

.—.—. = n x 10.00 % Clay

.... = n x 1.0 pH

Figure 25. Chemical Analysis of Trench 4. Section 2.

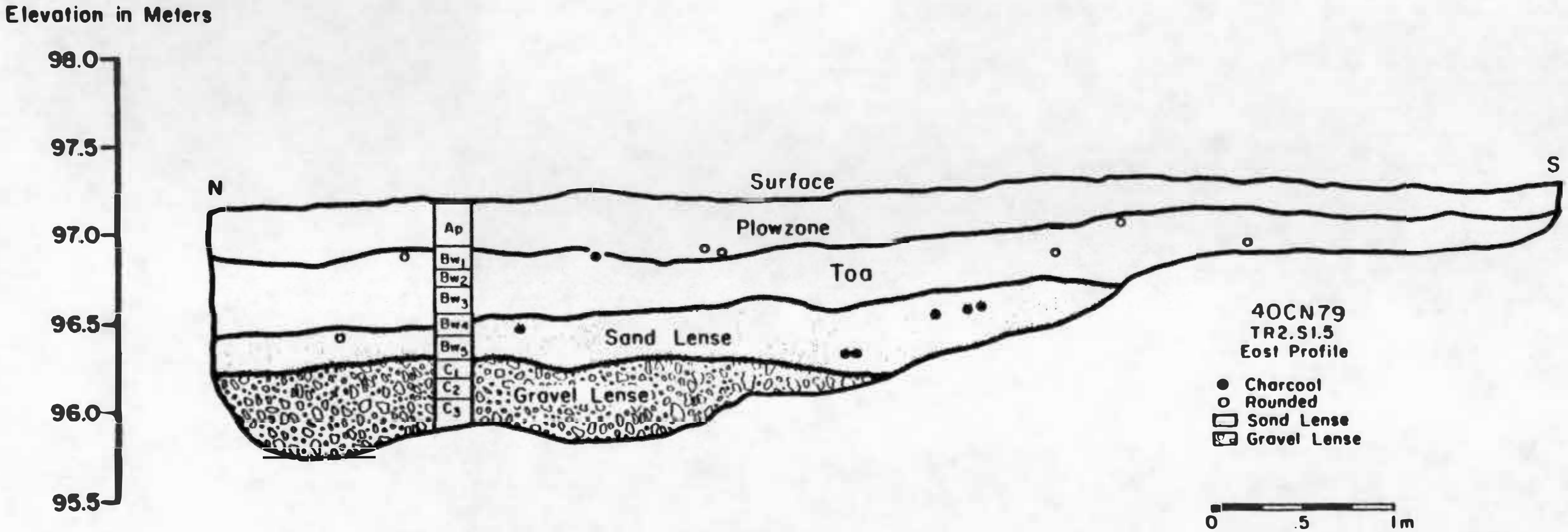


Figure 26. East Profile of Trench 2. Section 1.5.

Table 6. Soil Horizon Descriptions of Trench 2. Section 1.5.

Horizon	Depth (cm)	Color	Structure	Texture	Boundary
Ap	0- 25	10YR 4/3	2mgr	sil	
Bw_1	25- 37	10YR 4/3	2msbk	sil	cs
Bw_2	37- 48	10YR 4/3	2msbk	sil	gs
Bw_3	48- 63	10YR 4/3	2msbk	sil	gs
Bw_4	63- 76	10YR 4/3	1csbk	l	gs
Bw_5	76- 89	10YR 4/4	1csbk	gs	gs
C_1	89-100	10YR 5/6	0gr	gs	cs
C_2	100-111	10YR 5/6	0gr	gs	gs
C_3	111-130	10YR 6/6	0gr	gs	gs

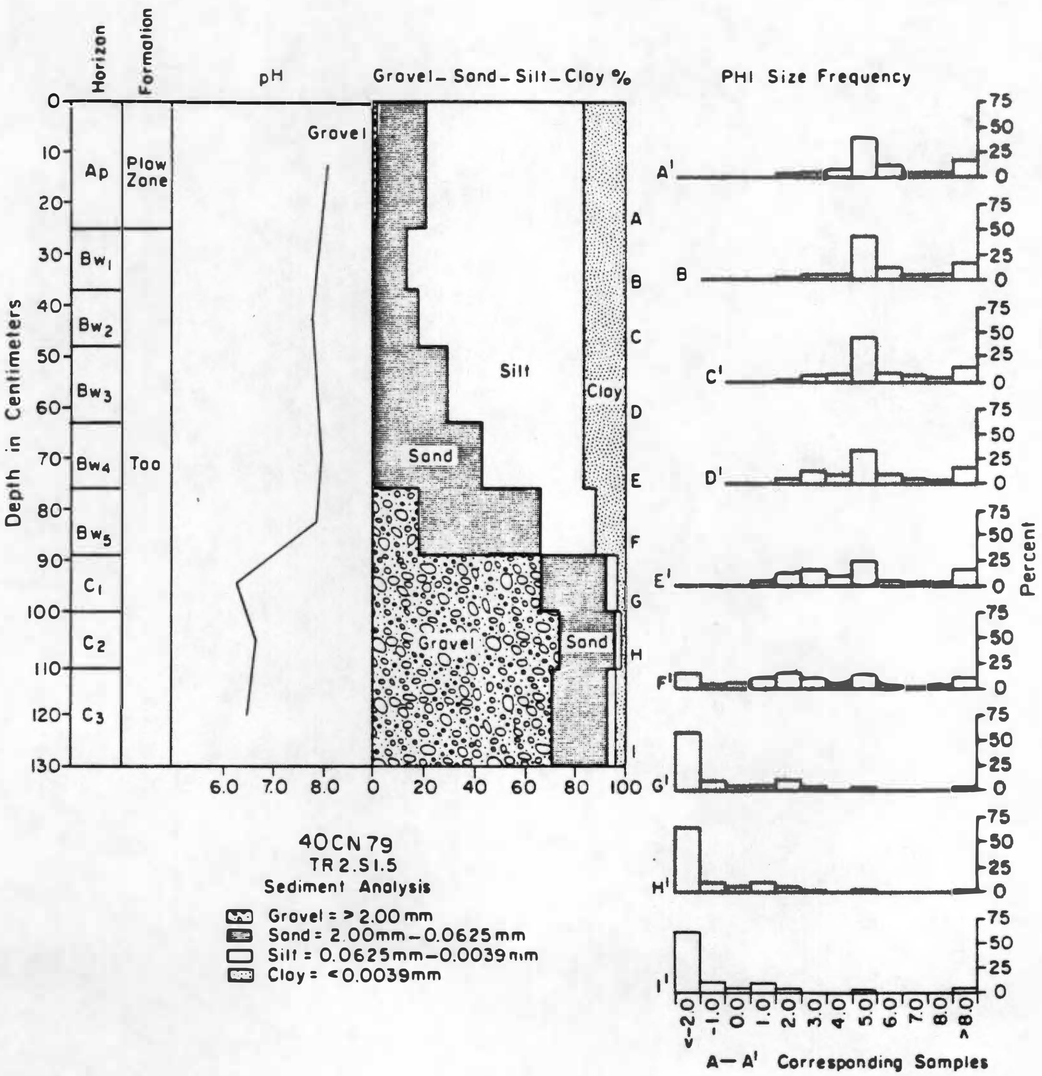


Figure 27. Sediment Analysis of Trench 2. Section 1.5.

from the top of the silty mantle (5.69 Ø) to the base of the lag channel deposit (-1.46 Ø) (Figure 28). This shows a gradual change from a fine silty matrix that grades into a coarser gravelly matrix. The sediments exhibit a gradually increasing standard deviation value from the surface (2.49 Ø) to the base of the silty mantle (4.04 Ø). This indicates the profile becomes increasingly poorly sorted with depth as the sediments become coarser approaching the gravel bar. The gravel bar is relatively well sorted with standard deviation values ranging from 1.55 Ø to 2.03 Ø. From the surface to the base of the silty upper mantle there is a steady decrease in skewness values from 0.57 Ø to 0.20 Ø indicating the rise in coarse sediment textures as the sediments approach the gravel bar. The gravel bar reflects very positively skewed distributions ranging from 0.69 Ø to 0.76 Ø values. The kurtosis values decrease from the surface to the base of the silty upper mantle with ranges from 1.80 Ø to 1.29 Ø. The gravel bar exhibits very leptokurtic distributions ranging from 1.09 Ø to 1.39 Ø. The nature of these sediment distributions are represented by the gradual increase in the sand and gravel fraction with increasing depth in the profile.

The auxiliary laboratory analyses reflect the single sequum of soil development within this profile (Figure 29). Total carbon analyses show a maximum of 1.32% at the surface in the Ap horizon with decreasing values with depth to a low of 0.64% in the C_2 horizon. An increase of 0.82% is noted at the base of the gravel bar in the C_3 horizon. The phosphorus analysis is more variable with a concentration of phosphorus in the surface (290 ppm) and in the silty matrix overlying the gravel bar (300 ppm). The relatively high amounts of phosphorus in this profile indicate the phosphorus is sedimentary rather than pedogenic in origin. The pH's in the silty upper mantle range from 6.9 to 7.1 pH and pH's in the gravel bar deposits range from 5.3 to 5.7 pH. The decrease in pH's in the gravel bar deposits reflect the less reactive nature of coarser sediments.

Trench 2. Section 1

Trench 2. Section 1 is located on the levee at the river bank. This profile represents bisequel alluvial sediments with the T0b and T0a formations represented (Figure 30). The T0b

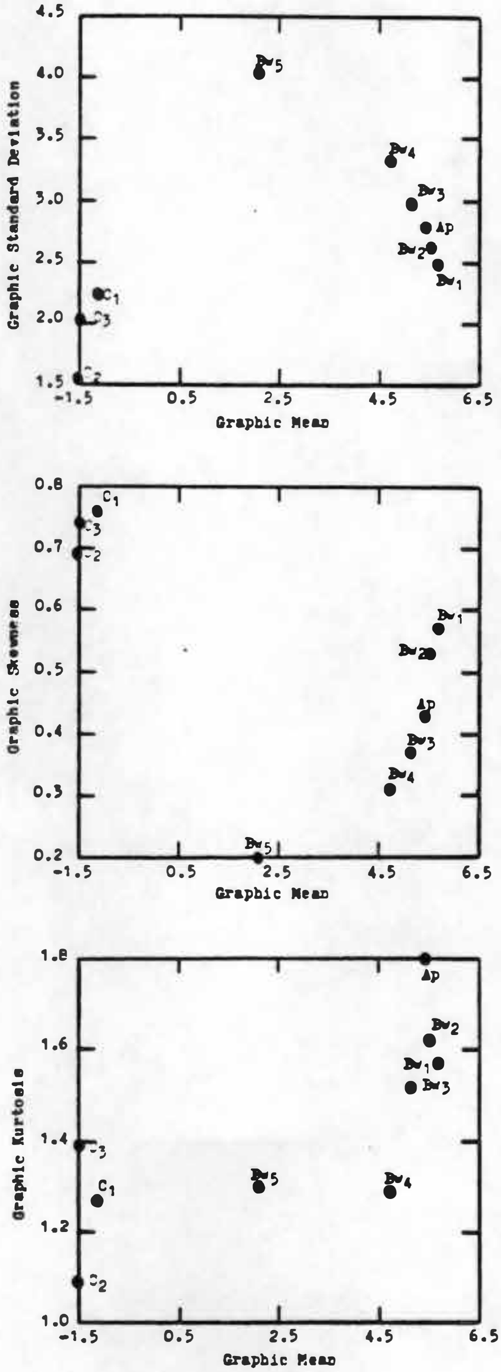


Figure 28. Textural Analysis of Trench 2. Section 1.5; Graphic Standard Deviation vs. Graphic Mean, Graphic Kurtosis vs. Graphic Mean, Graphic Kurtosis vs. Graphic Mean.

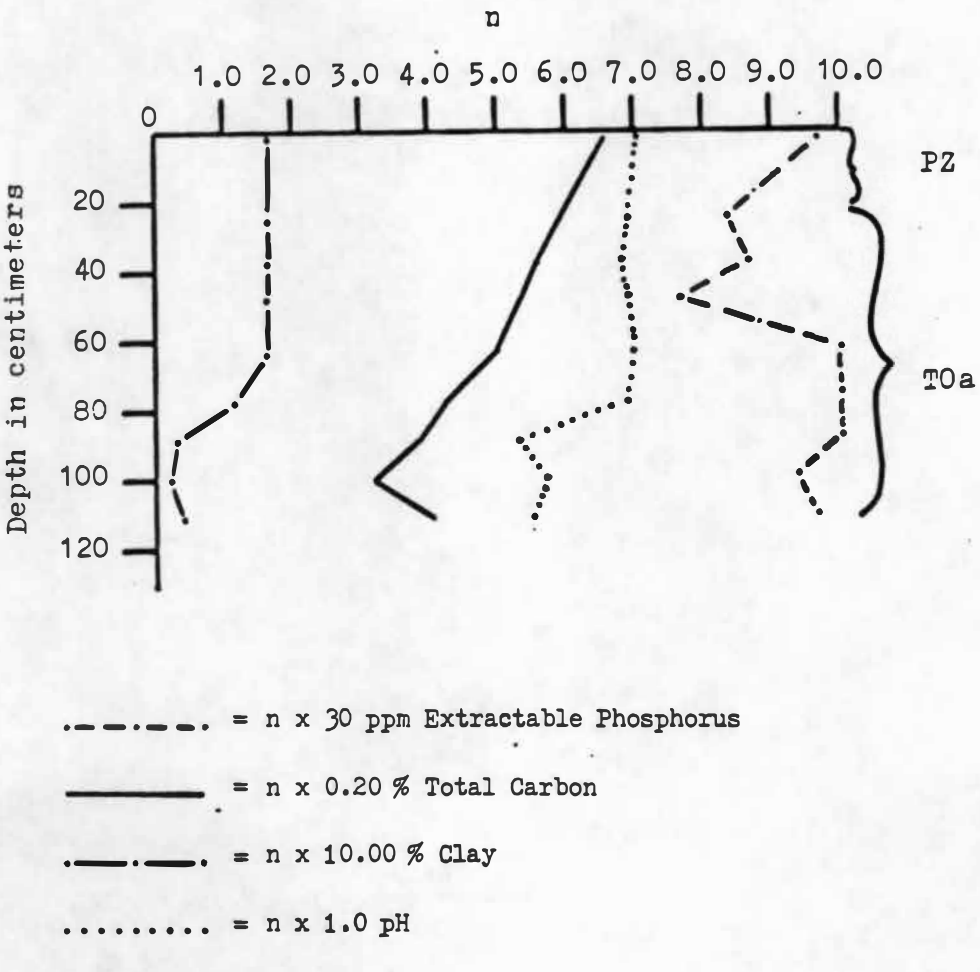


Figure 29. Chemical Analysis of Trench 2. Section 1.5.

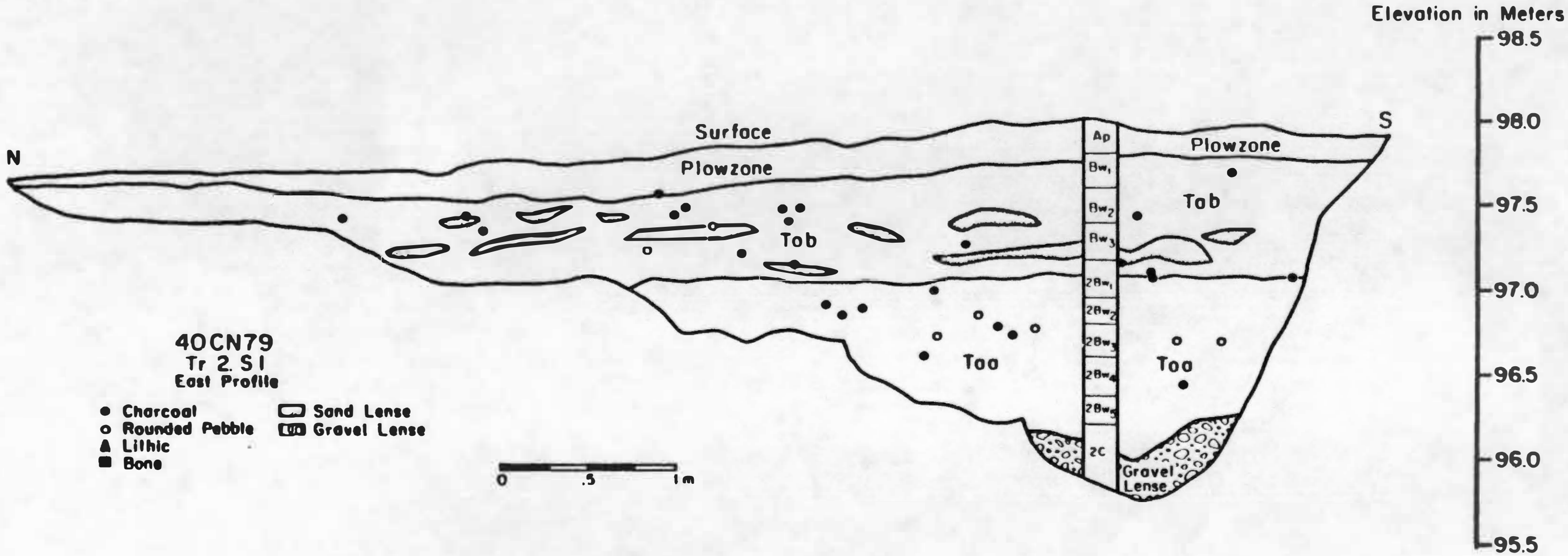


Figure 30. East Profile of Trench 2. Section 1.

formation overlies the T0a formation and has a sandier nature with loam textures in comparison to the silt loam texture of the T0a formation (Table 7). The entire profile exhibits weakly developed structure with thin discontinuous clay coatings in the T0a sediments. The T0a formation grades into a gravel lag channel deposit at its' base (Figure 31). The sandier nature of the T0b sediments is regraded as increased sediment load in the river may be due to landform instability from historic age land clearance practices.

The textural analysis of the sediments in this profile reflects the bisequel nature of the profile (Figure 32). The means of the T0b formation range from 4.37 ∅ at the surface (Ap horizon) and increases gradually to 5.04 ∅ in the Bw_3 horizon, gradually getting finer with depth. The T0a formation has even finer sediments within the 4.97 ∅ to 5.60 ∅ range. The standard deviations of the entire profile are relatively similar with ranges in the T0b sediments of 2.65 ∅ to 2.96 ∅ and ranges in the Toa sediments of 2.87 ∅ to 3.11 ∅. The $2Bw_5$ sample has a standard deviation value of 3.72 ∅ reflecting its sandier, poorly sorted nature because of its juxtaposition with the gravel bar. The skewness values of the profile show the T0a samples are slightly more positively skewed (0.38 ∅ to 0.49 ∅) than the T0b samples (0.23 ∅ to 0.35 ∅). The T0a samples are also more leptokurtic (1.62 ∅ to 1.82 ∅) than the T0b samples (1.48 ∅ to 1.58 ∅).

The carbon and phosphorus analyses aid in confirming the bisequel nature of this profile. The total carbon percentage is greatest in the Ap horizon at 1.78% and drops steadily to the $2Bw_1$ horizon to 0.93% (Figure 33). A carbon peak is observed at the $2Bw_2$ horizon of 1.08% and drops steadily again to 0.83% in the $2Bw_4$ horizon. This indicates a buried surface confirmed by the lithologic discontinuity between the T0b and T0a formations. The carbon percentage increases again to the base of the gravel bar at 1.47%. Because only the fine material was extracted from the gravel bar for carbon analysis, it appears that organic carbon is a major component of the fine material in the gravel bar. The phosphate analysis may also reflect the bisequel nature of the profile. The lowest phosphorus content of 90 ppm is observed at the surface in the Ap horizon. The phosphorus

Table 7. Soil Horizon Descriptions of Trench 2. Section 1.

Horizon	Depth (cm)	Color	Structure	Texture	Boundary
Ap	0- 17	10YR 3/3	2mgr	sl	
Bw_1	17- 38	10YR 3/3	1msbk	l	cs
Bw_2	38- 60	10YR 4/3	1msbk	l	gs
Bw_3	60- 81	10YR 4/3	1msbk	l	gs
$2Bw_1$	81-103	10YR 4/3	1msbk	sil	cs
$2Bw_2$	103-119	10YR 4/3	1msbk	sil	gs
$2Bw_3$	119-138	10YR 4/3	1csbk	sil	gs
$2Bw_4$	138-162	10YR 4/3	1csbk	sil	gs
$2Bw_5$	162-179	10YR 4/3	2msbk	sil	gs
2C	179-199	10YR 4/3	0gr	gls	as

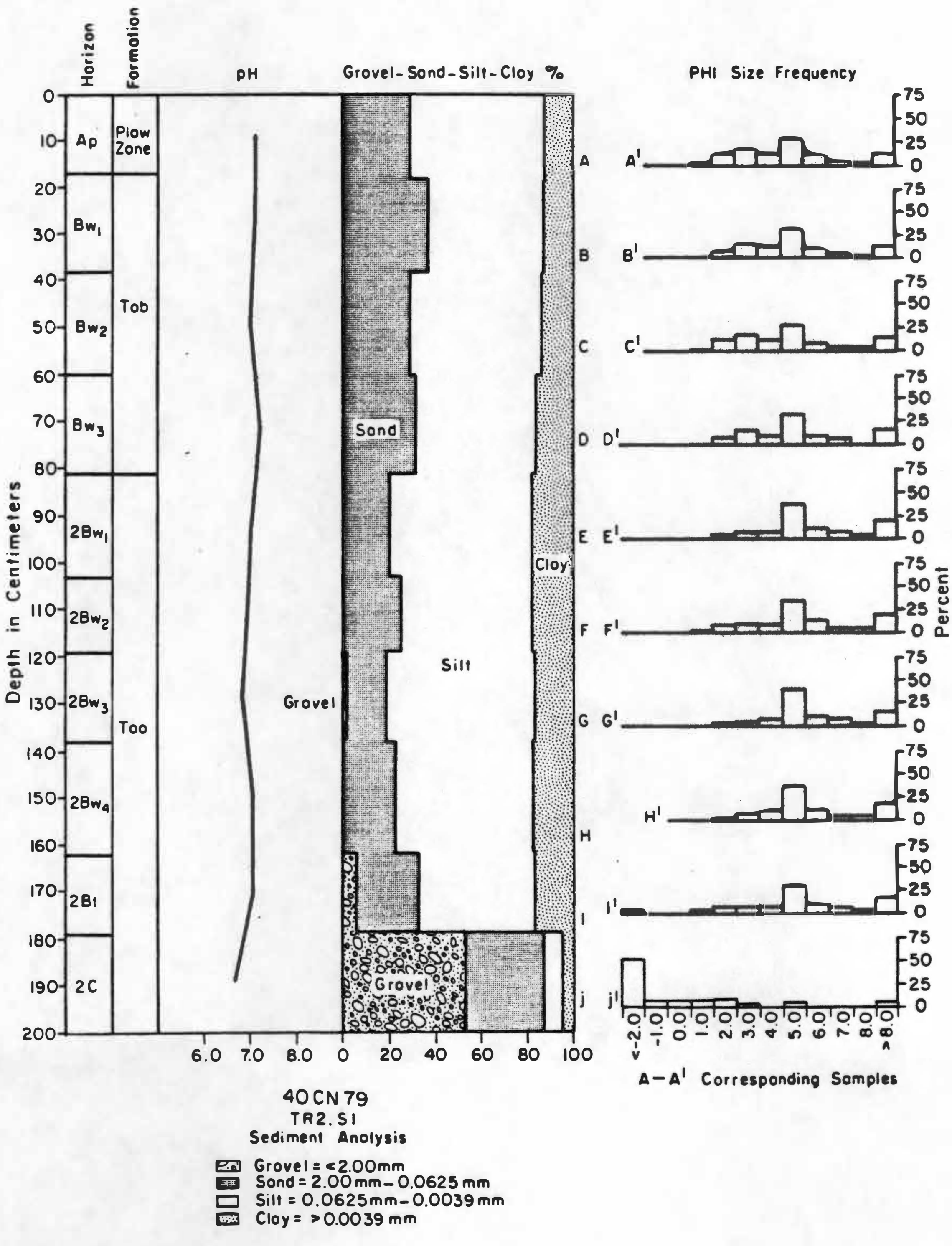


Figure 31. Sediment Analysis of Trench 2. Section 1.

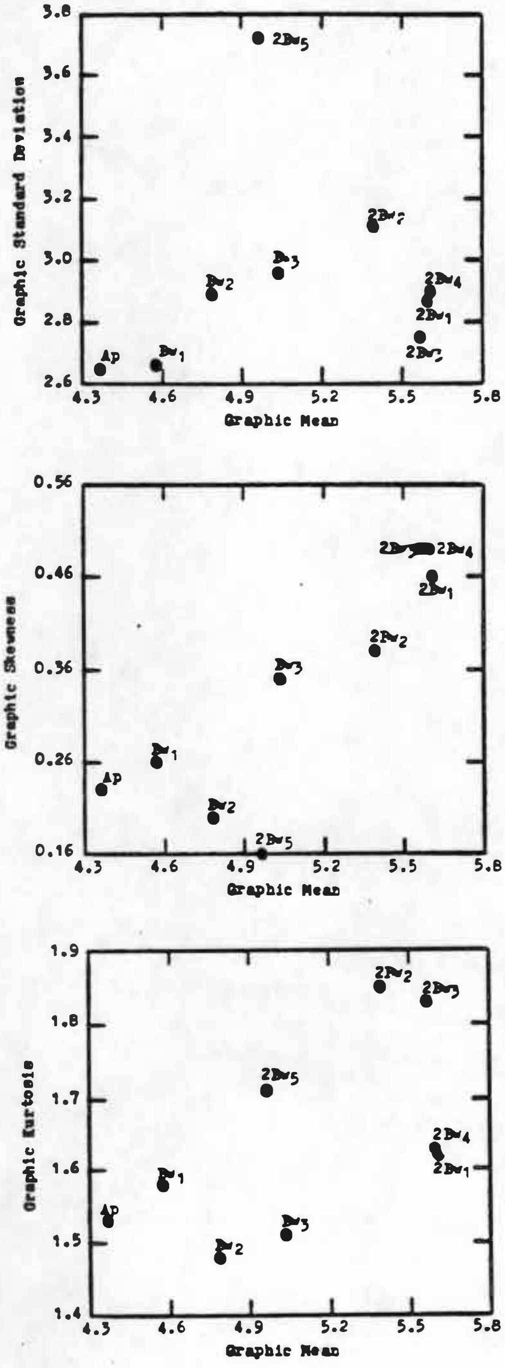


Figure 32. Textural Analysis of Trench 2. Section 1; Graphic Standard Deviation vs. Graphic Mean, Graphic Skewness vs. Graphic Mean, Graphic Kurtosis vs. Graphic Mean.

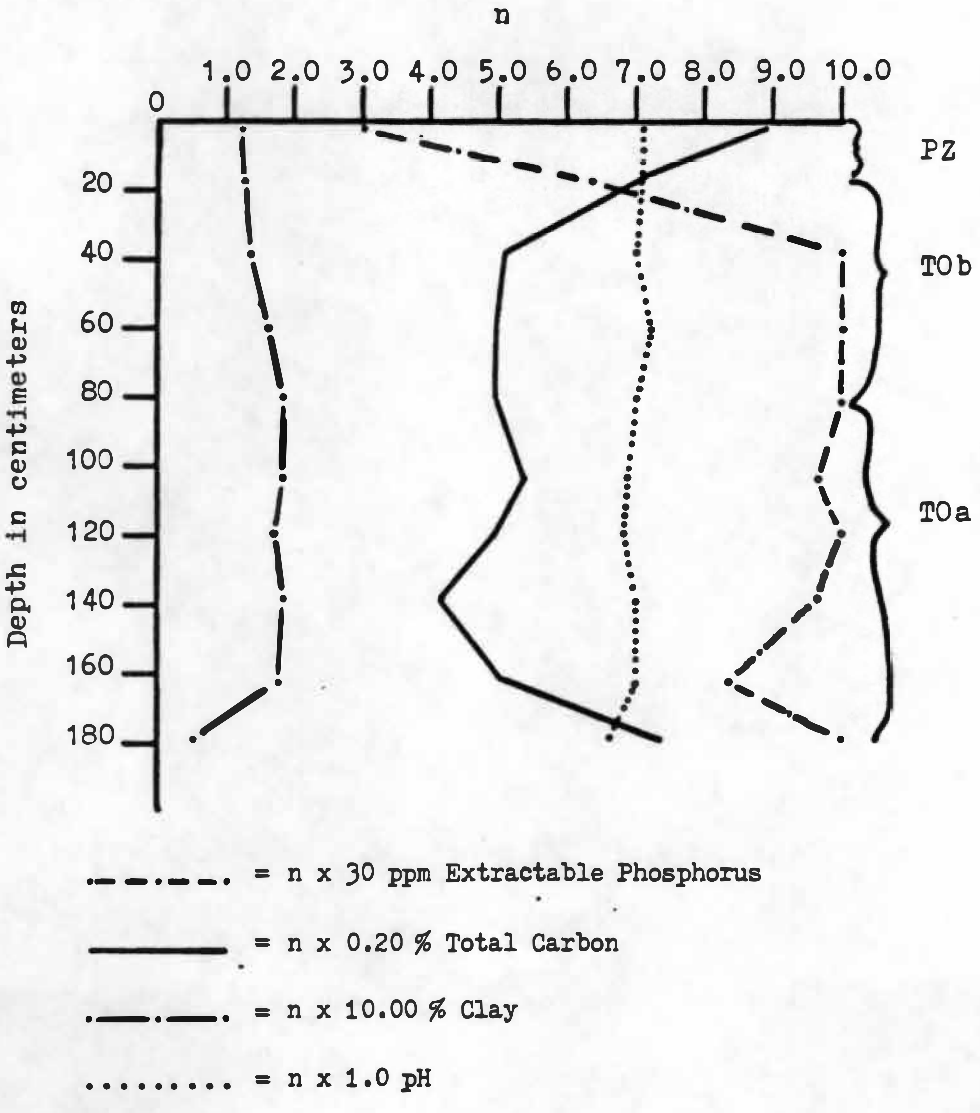


Figure 33. Chemical Analysis of Trench 2. Section 1.

content increases to 300 ppm in the Bw_2 horizon, perhaps denoting some leaching of phosphorus or use by plants. The phosphorus content also drops to 290 ppm in the $2Bw_2$ horizon of the T0a formation, possibly reflecting a minor amount of leaching or translocation of phosphorus from the buried surface. The phosphorus content drops to 250 ppm in the $2Bw_5$ horizon and increases again to 300 ppm in the gravel bar. The high content of phosphorus in the profile suggests the phosphorus is sedimentary rather than pedogenic in origin. The loam to silt loam texture of the profile would allow for good permeability and phosphorus could be added to the system by floodwaters. The pH's for this profile are relatively high ranging from 6.6 to 7.2 pH.

Trench 4. Section 1

Trench 4. Section 1 is located on the levee near the river bank. Field descriptions and observations denoted a single alluvial sequence with a silty upper mantle grading into a lag channel deposit at the base (Figure 34). There is evidence of weakly developed soil structure with thin discontinuous clay coatings. Colors are generally a 10YR 4/3 (Table 8). This trench represents a single alluvial sequence of T0a formation deposits (Figure 35).

The textural analysis of this profile tends to divide the sediments into two groups; a silty upper mantle and a lag channel deposit (Figure 36). The means of the silty upper mantle range from 4.73 Ø to 5.62 Ø, and the lag channel deposits exhibit means of 1.34 Ø and 0.65 Ø. The upper mantle is better sorted with standard deviation values of 2.48 Ø to 3.07 Ø, than the lag channel deposits which have standard deviation values of 3.71 Ø and 3.90 Ø. The silty upper mantle is more positively skewed than the lag channel deposits. The silty upper mantle is also more leptokurtic.

The auxiliary laboratory analysis in this profile demonstrates the possibility of a bisequel profile rather than a single alluvial sequence (Figure 37). Total carbon percentages start high in the Ap horizon with a content of 1.57%. The content drops in the Bw_1 horizon to 1.09%. A sharp carbon peak is observed in the Bw_3 horizon of 1.30% suggesting a buried surface may be present here. The carbon percentage drops to 0.84% in the underlying horizon (Bw_4) and increases again

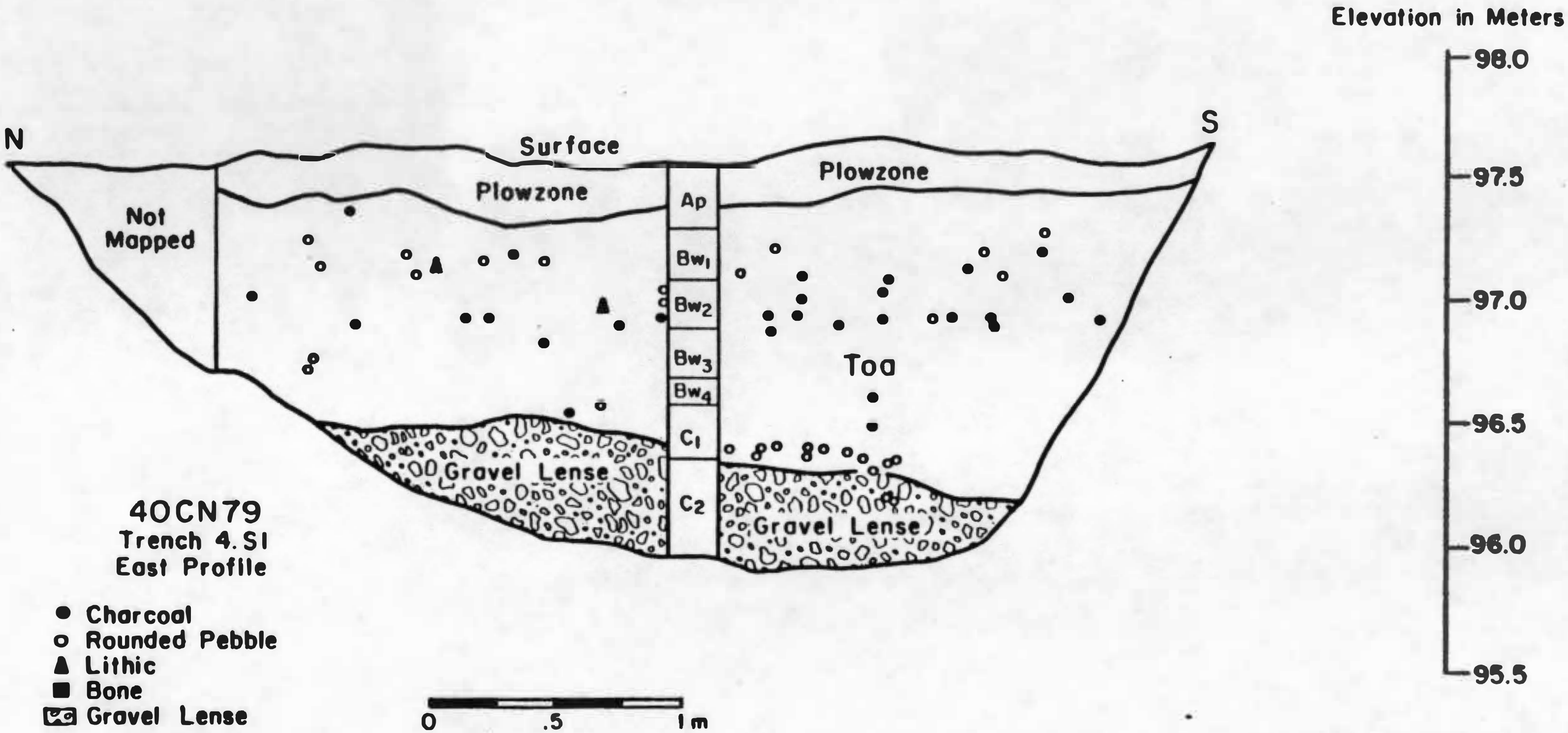


Figure 34. East Profile of Trench 4. Section 1.

Table 8. Soil Horizon Descriptions of Trench 4. Section 1.

Horizon	Depth (cm)	Color	Structure	Texture	Boundary
Ap	0- 24	10YR 4/3	2mgr	sil	
Bw_1	24- 45	10YR 4/3	2msbk	sil	cs
Bw_2	45- 65	10YR 4/3	1msbk	sil	gs
Bw_3	65- 85	10YR 4/3	1msbk	sil	gs
Bw_4	85- 96	10YR 4/3	1csbk	l	gs
C_1	96-118	10YR 4/3	0gr	sl	cs
C_2	118-144	10YR 4/2	0gr	gs	cs

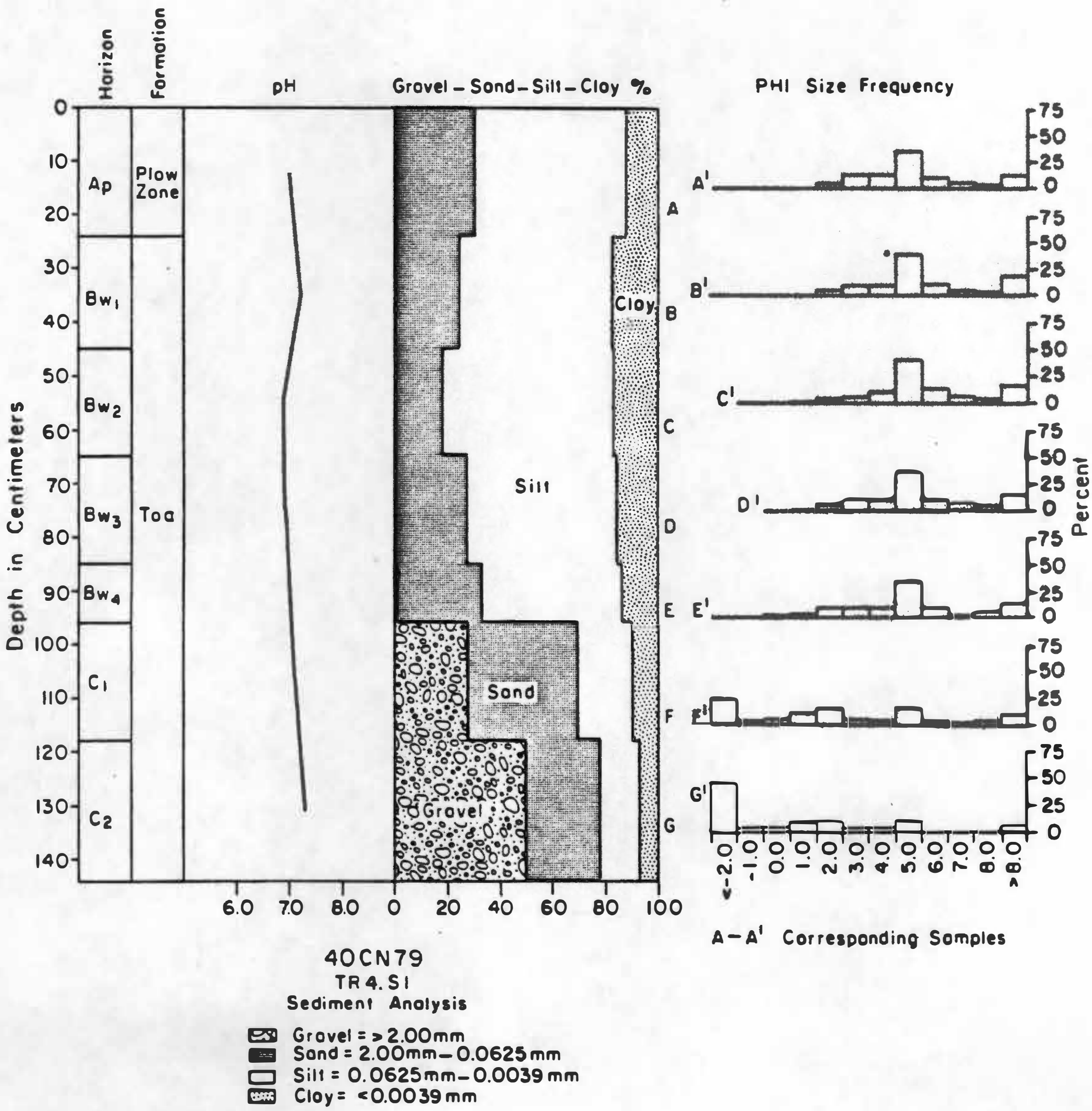


Figure 35. Sediment Analysis of Trench 4. Section 1.

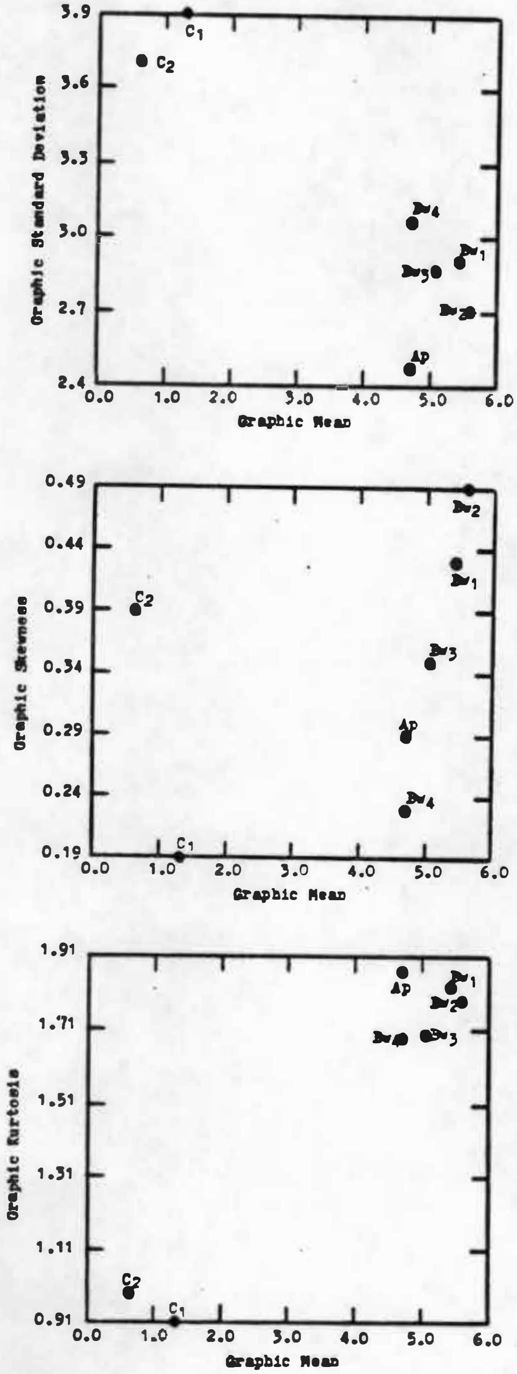
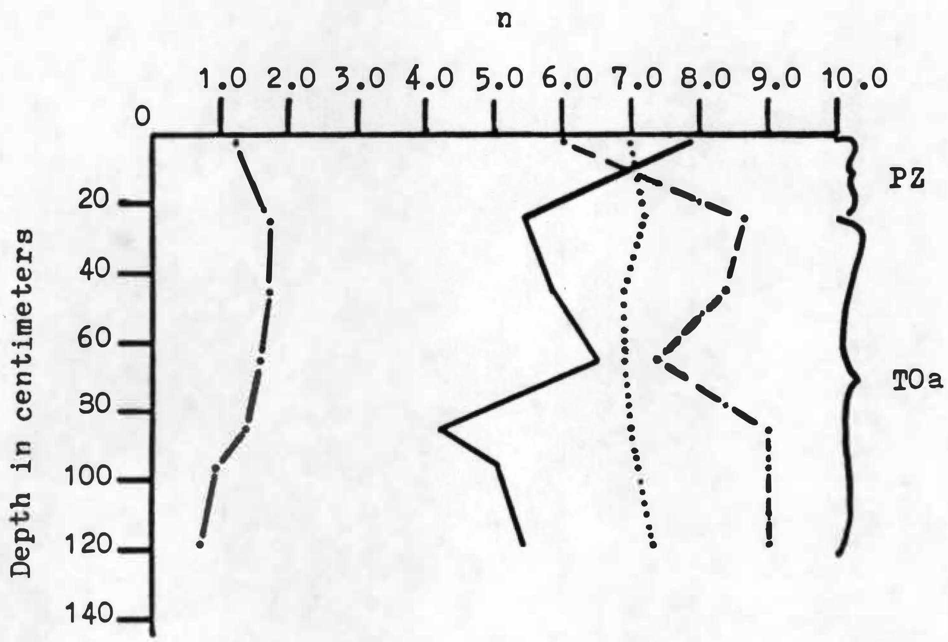


Figure 36. Textural Analysis of Trench 4. Section 1; Graphic Standard Deviation vs. Graphic Mean, Graphic Skewness vs. Graphic Mean, Graphic Kurtosis vs. Graphic Mean.



.— — .— — . = n x 30 ppm Extractable Phosphorus

——— = n x 0.20 % Total Carbon

.——.——. = n x 10.00 % Clay

.... = n x 1.0 pH

Figure 37. Chemical Analysis of Trench 4. Section 1.

to 1.09% at the base of the lag channel deposit. Phosphorus analysis exhibits a relatively low concentration on the surface of the profile (180 ppm) that increases in the Bw_1 horizon (260 ppm). A steady decrease to 220 ppm is observed in the Bw_3 horizon which may indicate leaching or translocation due to a possible buried surface. The phosphorus content increases to 300 ppm into the lag channel deposit.

Multivariate Analysis

A multivariate discriminant analysis was performed on soil samples from the Rush Creek site to determine if these sediments would discriminate in accordance to relative age. The samples were placed into one of five groups representing the T2a, T2b, T1, T0a, and T0b formations. Four variables, graphic mean, graphic standard deviation, graphic skewness, and graphic kurtosis were used in this study. All samples, with the exception of those representing lag channel or gravel bar remanants, were utilized. A total of 69 samples representing the finer upper mantles of the sediment profiles was subjected to the analysis.

The discriminant analysis performed on the sediment samples yielded four discriminant functions (Table 9). The first discriminant function explains 79.56% of the relative variation with a significance level of 0.00 (Table 10). Standardized discriminant function coefficients revealed that the major components of the first discriminant function were the graphic standard deviation and the graphic mean (Table 11) indicating that mean grain size, and relative soring of the sediments were the most important in explaining the variability between formations. The second discriminant function explained 16.18% of the variation and was significant to the 0.05 level (Table 10). The graphic skewness is the major discriminant coefficient for the second discriminant function (Table 10). This is interpreted as the skewness of the distribution from the mean is important, especially in regard the skewness of the distribution curve toward the fine or positive end of the phi scale. The remaining two discriminant functions derived explain 4.26% of the variation and are not significant to any level. The discriminant function coefficient for kurtosis is an important component in the

Table 9. Discriminant Analysis for Sediment Samples from the Rush Creek Site.

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Corr
1	1.2578178	79.56	0.74639
2	0.2558469	16.18	0.45136
3	0.0665413	4.21	0.24978
4	0.0007725	0.05	0.02778

Table 10. Discriminant Functions Derived for Sediment Samples from the Rush Creek Site.

Functions Derived	Wilks Lambda	Chi-Square	DF	Sig. Level
0	0.3304162	70.320036	16	0.00000
1	0.7460196	18.605715	9	0.02876
2	0.9368864	4.139768	4	0.38742
3	0.9992281	0.049035	1	0.82475

Table 11. Standardized Discriminant Function Coefficients for Sediment Samples from the Rush Creek Site.

	1	2	3	4
M_z	0.87026	0.03318	-2.08770	-0.12977
o'_i	1.02835	0.33140	1.23671	0.60182
Sk_i	-0.18475	1.31045	2.67658	0.68693
K_G	-0.26378	0.33891	-0.18243	1.02304

fourth discriminant function derived and indicates that kurtosis is but a minor indicator of variability between formations in this study.

The classification results for the multivariate discriminant analysis were determined (Tables 12 and 13). Sediment samples were grouped in accordance to relative age from the oldest (T2a) to the youngest (T0b). The classification results show that the T2a and T2b formations discriminated well with only one sample from the T2b formation misclassified. The T2a and T2b formations exhibit strong argillic horizons and higher clay contents than the remaining floodplain samples. The high clay content is deemed as pedogenic in origin from the breakdown of primary minerals into secondary minerals. This is a weathering situation that takes a relatively long period of time to develop and explains the good discrimination represented. The T1 formation, or the buried "A" (cultural midden) was only predicted correctly 20% of the time. Forty percent of the T1 samples were misclassified with the T2 formations and 40% were misclassified as T0 formation samples. Samples from the T1 formation which exhibited higher clay contents and lower standard deviations (well sorted) were classified with the Pleistocene age formations. T1 samples in close proximity to the lag channel deposits and exhibiting lower mean sizes from the inclusion of sand and gravel in the distribution were classified in the Late Holocene-Historic formations. The T1 formation exhibits pedogenic alteration and the higher clay contents of the argillic horizons in the T1 tend to lead to an association with Pleistocene age deposits, while samples collected in proximity to the lag channel deposits are more poorly sorted which may explain its misclassification with the T0 deposits. Samples representative of the T0a formation were classified correctly 72.73% of the time. Four samples of the T0a which exhibited some soil development in the form of thin clay coatings were misclassified as T1 formation samples, and 2 samples which were sandier in nature with lower mean grain sizes were misclassified with T0b samples. Samples representative of the T0b formation were correctly classified 48.15% of the time. Four samples were misclassified as T2b formation samples. These samples were located in the varve deposits overlying the T1 formation in Trench 3. Section

Table 12. Classification Results for Sediment Samples from the Rush Creek Site; Predicted Group Counts.

Actual Group	T2a	T2b	T1	T0a	T0b	Total
T2a	5	0	0	0	0	5
T2b	0	4	1	0	0	5
T1	1	3	2	3	1	10
T0a	0	0	4	16	2	22
T0b	0	4	4	6	13	27

Table 13. Classification Results for Sediment Samples from the Rush Creek Site; Predicted Group Percentages.

Actual Group	T2a	T2b	T1	T0a	T0b	Total
T2a	100.00	0.00	0.00	0.00	0.00	100.00
T2b	0.00	80.00	20.00	0.00	0.00	100.00
T1	10.00	30.00	20.00	30.00	10.00	100.00
T0a	0.00	0.00	18.18	72.73	9.09	100.00
T0b	0.00	14.81	14.81	22.22	48.15	100.00

2. These samples exhibited the highest clay contents in the floodplain; however, the massive, laminated nature of the samples suggest the clay content is inherited or sedimentary in nature rather than pedogenic in nature. Four samples of the T0b formation which were misclassified as T1 formation samples were located directly below the plow zone where some soil development in the form of thin clay coatings were noted. In general, the T0b formation samples are sandier in nature and have lower mean grain sizes than the samples from the remaining formations.

The results of the multivariate discriminant analysis were successful in discriminating landforms by relative ages with some reservations. This classification results tend to lead to the conclusion that the development of pedogenic clay is an extremely important factor in discriminating between these landforms. Older landforms with a greater development of pedogenic clay discriminates well because of higher mean sizes, good sorting, and highly positive skewnesses. Younger samples exhibit less pedogenically derived clay, as well as high sand contents due to Late Holocene-Historic Period land clearing practices. Land clearing increases the erosional potential of the landform and the grain size distributions from runoff is increased. As long as the depositional agent has a high critical power threshold, the result is deposition of coarser grained sediments on the floodplain. The formation of primary interest (T1) has a well enough developed argillic horizon with pedogenically derived clay to classify it as a formation older than the T0b and T0a, but not high enough to be Pleistocene in age.

Thermodynamics may play a part in the classification of these formations. The Pleistocene age formations exhibit well developed pedogenic profiles because the energy of the system has had sufficient time to order the profile, decreasing the entropy of the system. More recent sediments exhibit a higher entropy because the profiles have not experienced the longer time factor for the the relative energy of the system to order the profile. Therefore, as time increases, the energy quotient increases, and the profile becomes more ordered through time, and discriminates much better. An older profile therefore exhibits less variability between horizons than a younger profile.

CHAPTER 7

DISCUSSION

When dealing with depositional histories of landforms, especially those as complex as the Rush Creek site, no singular analysis is adequate. It takes a battery of investigative techniques to discern the various factors operating on the system. The compilation of these analyses, both field and laboratory oriented, aid in the interpretation of these depositional histories and postdepositional processes.

The T2a and T2b formations (Cheek Bend) were alluvial in origin and formed during the Late Pleistocene. The postdepositional development of these landforms are evidenced by the strong argillic horizons that were developed as well as the brighter red and yellow colors from the expression of oxidized iron. These landforms exhibit relatively low carbon and phosphate contents in comparison to the floodplain landforms due to weathering processes over time. The high clay content is due to the weathering of primary into secondary minerals over time. The discontinuity between the T2a and the T2b formations is marked by a line of alluvial gravel and a small carbon increase denoting a buried surface. The T2a and T2b landforms represent former active floodplains that were abandoned when the East Fork Stones River entrenched itself below these formations sometime around the Early Holocene period.

The T1 formation (Leftwich) was developed after the East Fork Stones River entrenched itself below the T2 formations. It was formed by alluvial overbank deposits over the former lag channel deposit. The landform aggraded until it stabilized around 5,000 yr. B.P. when a soil was developed on its surface. This stabilization was due to a mid-Holocene warming and drying trend known as the Hypsithermal Interval. Radiocarbon dates from the T1 paleosol most closely correlates with the T1b1 paleosols recorded along the Duck River by Brackenridge (1982, 1984). Archaeological materials were deposited on this surface including lithic debitage and organic refuse.

The archaeological component is unknown, but the chronometric dating of this landform suggests a Late Archaic association.

The postdepositional processes on the T1 formation has developed an argillic horizon. The alteration of primary into secondary minerals has not been as complete as with the T2 formations. The stickiness of the consistency of this landform suggests the presence of three layered phylosilicate clays may be possible. The wetting and drying processes have left vertical cracks in this formation denoting shrink-swell activities. Other profiles in the Nashville Basin have exhibited some slight slickenside development in Leftwich formation sediments (Morris 1985). There has also been evidence of artifact movement through Leftwich formation sediments in the Nashville Basin due to shrink-swell activities (Hofman 1986). At the Rush Creek site, these artifacts were deposited on the T1 surface and may have been translocated down through the profile over time. Lithic analysis performed on artifacts from this landform reveal a random distribution of lithics vertically and horizontally through the profile. The high carbon and phosphate contents in this landform suggest deposition of organic refuse along with lithic debitage. The darker color, good structure, and firm sticky consistency demarcate the T1 formation from other floodplain formations at the Rush Creek site.

The T1 formation was buried by a Late Holocene alluvial overbank deposit, the T0a (Cannon Bend) formation. The T0a formation is a silty alluvial overbank deposit that aggraded over the former T1 formation channel. There is some soil development present on the T0a surface in the form of thin discontinuous clay coatings, but not enough to develop argillic horizons. There is evidence of organic accumulation of plant materials on the surface of the T0a and also evidence of leaching of soluble phosphorus. The T0a has a lower mean grain size than the T1 formation suggesting some influence from aboriginal land clearance practices resulting from landform destabilization upstream.

During the Historic Period, an important episode transpired at the Rush Creek site. A slough was developed across the site originating at Rush Creek and running across the site at the base of the T2 scarp to some 200 meters where it joins the East Fork Stones River. It was speculated that a mill may have existed downstream and the slough was evidence of a former mill race. Historic research could not pin down a mill in this relative locale. It has been noted that corn mills were located all along the Stones River at the heads of streams where there was drop enough to turn an overshot wheel (Mason 1982: 91). A map drawn in 1865 by Confederate Col. W.E. Merril (1865) locates mills at the Stones River near the Woodbury vicinity. No mill was located at the Rush Creek site at that time, but a line is drawn across the landform at the particular bend where Rush Creek is located. The exact meaning is not known as to whether Col. Merril was portraying a mill race, stream, or road bed, but there is something noted here. However, Col. Merril did not locate Rush Creek on the map, so a valuable landmark is missing. Goodspeed (1972: 856) notes two early mills dating to 1813 in the Woodbury area and it is possible that the Rush Creek mill predated the 1865 map. There is also some mention of a road bed which may have crossed the Stones River somewhere near the Rush Creek vicinity (Mason 1982: 10). Whatever the disturbance, it truncated the Rush Creek site along the T2 scarp and eroded the T0a formation.

It is believed that the disturbance or slough was formed by running water. The erosional processes stripped the T0a formation sediments at the base of the T2 scarp and eroded the landform down to the surface of the T1 formation. Because of its high clay content and its firm consistence, the T1 formation was not affectively eroded. The clay content made the T1 matrix more cohesive than the overlying T0a formation. This characteristic of the T1 sediments was noted in the relative difficulty of waterscreening this sediment in comparison to the T0a and T0b formation sediments. Eventually, erosional processes stripped the T0a formation, and the surface of the T1 formation was reexposed. The T1 formation then became an exhumed paleosol and historic period artifacts, including domesticated faunal remains, and historic age stoneware were deposited on the surface of

the T1 formation after the slough was abandoned. Charcoal samples extracted from the surface of this exhumed soil revealed an historic date of around 150 yr. B.P. This is believed to demarcate the abandonment of the slough. A small section of the T1 that was located farther up slope from the slough represents the only undisturbed portion of the T1 formation. A mid-Holocene date from charcoal extracted from this paleosol confirmed this suspicion.

Following the abandonment of the slough, the infilling process began. The fill of the slough consisted of alternating sand and silt lenses comprising the T0b formation. This represents the sterile overburden which buried the T1 formation. These alternating sand and silt lenses also represent a series of varve deposits from alluvial activity. It is believed that the fine, well sorted silty to clayey sediments were deposited by a damming action downstream which ponded the slough. The water became still enough for the deposition of fine silt and clay sized particles. The sand lenses are believed to represent higher velocity hydrologic regimes resultant from the release of water downstream. There is some evidence of pedogenesis in the upper mantle of the T0b slough deposits suggesting the ponding process had ceased. The pedogenic development is in the form of thin discontinuous clay coatings and some development of soil structure.

The T0b sediments which occupy the floodplain, outside the realm of the slough, form a sandy upper mantle which overlays the T0a formation. This is especially noted in the areas of the levee where a bisequel soil is evident. The T0b formation is high in phosphate and pH values, due to the addition of soluble cations from floodwaters which occasionally inundate the Rush Creek site floodplain. The T0b formation is the highest in sand content of all the formations at the site, and this is interpreted as the result of landform destabilization upstream due to historic land clearance practices. The evidence also suggests this landform continues to aggrade depositing T0b sediments across the floodplain to the present.

CHAPTER 8

CONCLUSION

The geoarchaeological investigations at the Rush Creek Site was a study in the determination of depositional and post-depositional processes which effect an archaeolgocial site. Through field observations, laboratory analyses and quantitative assessments, the history of the site's sediment systems can be addressed. Once the sediment system has been assessed, determination of archaeological context is possible.

The primary conclusion concerning the Rush Creek Site is that the T1 formation represents a legitimate prehistoric archaeological context. The dark color, good soil structure, high clay content, high phosphate and carbon content distinguishes this formation from the surrounding landforms. The soil development on top of the formation suggests its stabilization around 5,000 yr. B.P. It is believed lithic artifacts, probably of a Late Archaic component, were deposited on this surface and were translocated down through the profile through time due to argilliturbation. It is also believed that historic erosional processes truncated the surface of the T1 formation, reexposing its surface. The high clay content of the T1 created a cohesive matrix that was erosion resistant and disturbance affected only the surface of the formation. Historic age artifacts were deposited on the surface of the reexposed T1 during and shortly after slough abandonement. Following slough abandonement, the T1 surface was buried and sealed by sterile overburden comprised of T0b formation deposits.

The secondary conclusion of this investigation is that altered landforms at the Rush Creek Site can be discriminated according to age. The primary discriminating variable in assessing landform age is the development of pedogenic clay minerals. The older the landform the higher the pedogenic clay content. More recent sediments can be discriminated not only by a lower pedogenic clay content, but also by its higher sand content through time. Increasing sediment load transported by the Stones River was influenced by aboriginal and historic period land clearance practices. The

determination of carbon and phosphorus contents within the profiles of these landforms demarcated sedimentary breaks and aided in the location of former stable land surfaces.

The results of this geoarchaeological survey have yielded more than archaeological context assessments. The development of landforms and their impact by the associated environment is useful for more than simply archaeological site assessment. It is encouraged that future investigators of archaeological sites utilize interdisciplinary approaches in solving archaeological problems. The yield of information is much more profound than the effort expended.

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APPENDICES

APPENDIX A

SOIL PROFILE DESCRIPTIONS

Appendix A-1. Soil Profile Descriptions of Trench 2. Section 4.

SITE: 40CN79
LOCATION: Cannon County, Tennessee
VEGETATION: Pasture, forage
PARENT MATERIAL: Old alluvium
PHYSIOGRAPHY: Top of T2, Pleistocene terrace
RELIEF: Nearly level
ELEVATION: About 200 m AMSL
SLOPE: Less that 2%
ASPECT: South
EROSION: Slight
PERMEABILITY: Moderate
DRAINAGE: Well drained
GROUNDWATER: Not evident
MOISTURE: Moderately dry
ROOT DISTRIBUTION: 0-107 cm
SALT OR ALKALI: Not evident
STONINESS: Some alluvial gravel at 123 cm

PZ Formation

Ap — 0-22 cm; moist color 10YR 4/3, dry color 10YR 6/4; silt loam texture; moderate, medium, granular (crumb) structure; friable, moist, nonsticky consistence; no visible clay coatings; many fine and medium roots; many fine and medium pores and tunnels; no noticeable coarse fragments.

T2b Formation

Bt_1 — 22-40 cm; moist color 7.5YR 4/4, dry color 10YR 6/4; silty clay loam texture; moderate, medium, subangular blocky structure; friable, moist, nonsticky consistence; thin, discontinuous clay coatings; clear, smooth boundary; many fine and medium roots; many fine and medium pores and tunnels; no noticeable coarse fragments.

Bt_2 — 40-60 cm; moist color 7.5YR 4/6 with clay coatings of 7.5YR 4/4, dry color 10YR 6/4; silty clay loam texture; moderate, medium, subangular blocky structure; friable, moist, sticky consistence; thin, continuous clay coatings; clear, smooth boundary; common fine and medium roots; common fine and medium pores and tunnels; no noticeable coarse fragments.

Bt_3 — 60-82 cm; moist color 7.5YR 5/4 with clay coatings of 7.5YR 4/4, dry color 10YR 6/4; silty clay loam texture; moderate, medium, subangular blocky structure with some fine laminations present; firm, moist, sticky consistence; thin, continuous clay coatings; common medium pores and tunnels; no noticeable coarse fragments.

Bt_4 — 82-107 cm; moist color 7.5YR 5/6, dry color 10YR 7/4; silty clay loam texture; moderate, medium, subangular blocky structure with some fine laminations present; firm, moist, sticky consistence; thin continuous clay coatings; few fine manganese nodules comprising about 2% of the matrix; gradual, smooth boundary; few fine roots; common fine pores and tunnels; no noticeable coarse fragments.

T2a Formation

$2Bt_1$ — 107-123 cm; moist color 7.5YR 5/6, dry color 10YR 7/4; silty clay loam texture; moderate, fine, subangular blocky structure; firm, moist, sticky consistence; thin, continuous clay coatings; common fine manganese nodules and coatings comprising about 10% of the matrix; clear, smooth boundary; common medium rounded chert gravels comprising about 10% of the matrix; few fine pores and tunnels.

$2Bt_2$ — 123-145 cm; moist color 7.5YR 5/6, iron oxide coatings 7.5YR 4/6 comprising about 10% of matrix, manganese oxide coatings 7.5YR 3/0 comprising about 10% of matrix, dry color 10YR 7/4; clay loam texture; moderate, medium subangular blocky structure; firm, moist, sticky consistence; thin, continuous clay coatings; common fine manganese nodules comprising about 10% of matrix; clear, smooth boundary; common medium rounded chert gravels comprising about 10% of matrix; few fine pores and tunnels; no noticeable roots.

$2Bt_3$ — 145-167 cm; moist color 10YR 5/4, iron oxide coatings 10YR 5/6, manganese oxide coatings 10YR 2/1, dry color 10YR 7/4; clay loam texture; moderate, medium, subangular blocky structure with some fine laminations present; firm, moist, sticky consistence; thin, continuous clay coatings; common fine manganese nodules comprising about 10% of matrix; gradual, smooth boundary; common medium rounded chert gravels comprising about 10% of matrix; few fine pores and tunnels; no noticeable roots.

$2Bt_4$ — 167-189 cm; moist color 10YR 5/4, iron oxide coatings 7.5YR 5/6, manganese oxide coatings 7.5YR 3/0, dry color 10YR 7/4; clay texture; moderate, medium, subangular blocky structure; firm, moist, sticky consistence; thin discontinuous clay coatings; common fine manganese nodules and coatings comprising about 20% of matrix, iron oxide coatings comprise about 20% of matrix; common rounded chert gravels comprising about 10% of matrix; few fine pores and tunnels; no noticeable roots.

$2Bt_5$ — 189-208 cm; moist color 10YR 6/6, iron oxide coatings 7.5YR 5/6, manganese oxide coatings 7.5YR 3/0, dry color 10YR 7/4; clay texture; moderate, medium, subangular blocky structure; firm, moist, sticky consistence; thin, continuous clay coatings; common fine manganese nodules and coatings comprising about 20% of matrix; iron oxide coatings comprise about 20% of matrix; gradual smooth boundary; common medium rounded chert gravels comprising about 10% of matrix; no noticeable roots or pores.

Appendix A-2. Soil Profile Descriptions of Trench 1. Section 2.

SITE: 40CN79
LOCATION: Cannon County, Tennessee
VEGETATION: Pasture, forage
PARENT MATERIAL: Alluvium
PHYSIOGRAPHY: Floodplain, footslope of T2
RELIEF: Nearly level, to slightly rolling
ELEVATION: About 200 m AMSL
SLOPE: 10%
ASPECT: South
EROSION: Evident
PERMEABILITY: Moderately Rapid
DRAINAGE: Well drained
GROUNDWATER: 171 cm below surface
MOISTURE: Moist
ROOT DISTRIBUTION: 0-122 cm
SALT OR ALKALI: Not evident
STONINESS: Alluvial gravel bar noted at bottom of unit

PZ Formation

Ap — 0-29 cm; moist color 10YR 4/3; silt loam texture; moderate, medium, subangular structure; friable, moist, nonsticky consistence; no visible clay coatings; few fine manganese nodules comprising about 5% of matrix; many fine roots; common medium rounded chert gravels comprising about 10% of matrix; common fine and medium pores and tunnels.

T0b Formation

Bw_1 — 29-55 cm; moist color 10YR 4/3; silty clay loam texture; weak, coarse, subangular structure; friable, moist, nonsticky consistence; thin, discontinuous clay coatings; few fine manganese nodules comprising about 2% of matrix; clear, smooth boundary; few charcoal fragments comprising about 2% of matrix; few medium rounded chert pebbles comprising about 5% of matrix; common fine and medium pores and tunnels; common fine roots.

Bw_2 — 55-59 cm; moist color 10YR 4/3; sandy loam texture; fine, granular structure; loose, dry, nonsticky consistence; thin, discontinuous clay coatings; few fine manganese nodules comprising about 2% of matrix; clear, smooth boundary; few fine roots; no noticable coarse fragments or pores.

T1 Formation

2Ab	59-68 cm; moist color 10YR 3/2; clay loam texture; weak, coarse, prismatic structure; friable, moist, sticky consistence; thin, discontinuous clay coatings; few fine manganese nodules comprising about 2% of matrix; clear, smooth boundary; few fine roots; common medium rounded chert gravels comprising about 10% of matrix; few charcoal fragments comprising about 2% of matrix; few fine and medium pores and tunnels.
$2Bt_1b$	68-95 cm; moist color 10YR 3/2; clay loam texture; moderate, medium, subangular blocky structure; firm, moist, sticky consistence; thin continuous clay coatings; gradual, smooth boundary; few fine roots; few medium rounded chert gravels comprising about 5% of matrix; few charcoal fragments comprising about 2% of matrix; few fine pores and tunnels.
$2Bt_2b$	95-122 cm; moist color 10YR 3/3; clay loam texture; strong, medium, subangular blocky structure; firm, moist, sticky consistence; thin continuous clay coatings; gradual, smooth boundary; few fine roots; common rounded chert gravels comprising about 10% of matrix; few fine pores and tunnels.
$2Bt_3b$	122-144 cm; moist color 10YR 3/3; gravelly medium sandy clay loam texture; weak, moderate, subangular blocky structure; friable, moist, sticky consistence; thin continuous clay coatings; gradual, smooth boundary; many medium rounded chert gravels comprising about 2% of matrix; few fine pores and tunnels; no noticable roots.
2Bgb	144-185 cm; moist color 10YR 4/3, gleyed coatings 5YR 5/1 comprising about 30% of matrix, iron oxide coatings 7.5YR 5/6 comprising about 20% of matrix; gravelly medium sandy clay loam; massive structure; firm, moist, sticky consistence; no visible clay coatings; clear, smooth boundary; many medium and coarse rounded chert gravels comprising about 20% of matrix; no noticable roots or pores.
R	185 cm.

Additional Field Notes:

Buried "A" very prominent in this trench. Most coarse fragments are rounded chert gravels. No lithic debitage noted; however, lithics found when overburden was stripped to the surface of the buried "A". Buried "A" runs along the length of the trench. Bedrock lies directly below 2Bgb horizon. Water table lowered after long drought, it could be much higher.

Appendix A-3. Soil Profile Descriptions of Trench 2. Section 2.

SITE: 40CN79
LOCATION: Cannon County, Tennessee
VEGETATION: Pasture, forage
PARENT MATERIAL: Alluvium, some colluvium
PHYSIOGRAPHY: Footslope of T2
RELIEF: Nearly level, to slightly rolling
ELEVATION: About 200 m AMSL
SLOPE: Less than 5%
ASPECT: South
EROSION: Slight
PERMEABILITY: Moderately rapid
DRAINAGE: Well drained
GROUNDWATER: Highest level noted at 2 m below surface
MOISTURE: Moist
ROOT DISTRIBUTION: 0-70 cm
SALT OR ALKALI: $CaCO_3$ coatings noted on some limestone fragments
STONINESS: Alluvial gravel lense noted at bottom of unit overlying bedrock

PZ Formation

Ap — 0-32 cm; moist color 10YR 4/4; gravely silt loam texture; moderate, medium, granular structure; loose, friable, nonsticky consistence; no visible clay coatings; common medium and fine roots; common coarse, medium, and fine angular and rounded limestone and chert fragments comprising about 20% of the matrix; common medium and fine pores and tunnels.

T0b Formation

Bw_1 — 32-48 cm; moist color 10YR 4/3; silt loam texture; weak, moderate, subangular blocky structure; friable, moist, nonsticky consistence; thin, discontinuous clay coatings; few fine manganese nodules comprising about 2% of the matrix; clear; smooth boundary; common fine roots; few angular limestone fragments comprising about 5% of matrix; common fine and medium pores and tunnels.

Bw_2 — 48-63 cm; moist color 10YR 4/3; silt loam texture; weak, moderate, subangular blocky structure; friable, moist, nonsticky consistence; thin discontinuous clay coatings, few fine manganese nodules comprising about 2% of matrix; gradual, smooth boundary; few fine roots; common rounded and angular chert pebbles comprising about 10% of matrix; common fine pores and tunnels.

Bw_3 — 63-70 cm; moist color 10YR 4/3; sandy loam texture; moderate, medium, granular, structure; loose, moist, nonsticky consistence; no visible clay coatings; common fine manganese nodules comprising about 5% of matrix; clear, irregular boundary; few fine roots; few rounded chert pebbles comprising about 5% of matrix; few fine pores and tunnels.

Bw_4	70-83 cm; moist color 10YR 4/3 with fine laminae of 10YR 7/4; silt loam texture; weak, coarse, subangular blocky structure; friable, moist, nonsticky consistence; no visible clay coatings; abrupt, smooth boundary; few medium pores and tunnels.
C_1	83-88 cm; moist color 10YR 4/3; sandy loam texture; weak, fine, granular structure primarily consisting of chert grains; no visible clay coatings; common fine manganese nodules comprising about 5% of matrix; abrupt, irregular boundary; no noticeable roots, pores, or coarse fragments.
C_2	88-95 cm; moist color 10YR 4/4 with fine laminae of 10YR 7/3; silt loam texture; massive, laminated structure; friable, moist, nonsticky consistence; no visible clay coatings; abrupt, irregular boundary; no noticeable roots, pores, or coarse fragments.
C_3	95-100 cm; moist color 10YR 4/4; sandy loam texture; weak, fine, granular structure primarily consisting of chert grains; loose, moist, nonsticky consistence; no visible clay coatings; common fine manganese nodules comprising about 5% of matrix; abrupt, irregular boundary; no noticeable roots, pores, or coarse fragments.
C_4	100-102 cm; moist color 10YR 4/4 with fine laminae of 10YR 7/4; silt loam texture; massive, laminated structure; friable, moist, nonsticky consistence; no visible clay coatings; abrupt, irregular boundary; no noticeable roots, pores, or coarse fragments.
C_5	102-109 cm; moist color 10YR 4/4; sandy loam texture; weak, fine, granular structure consisting primarily of chert grains; loose, moist, nonsticky consistence; no visible clay coatings; common fine manganese nodules comprising about 5% of matrix; abrupt, irregular boundary; few medium rounded chert gravels comprising about 5% of matrix; no noticeable roots or pores.
C_6	109-112 cm; moist color 10YR 4/4 with fine laminae of 10YR 7/4; silt loam texture; massive, laminated structure; friable, moist nonsticky consistence; no visible clay coatings; abrupt, irregular boundary; no noticeable roots, pores, or coarse fragments.
C_7	112-120 cm; moist color 10YR 4/3; sandy loam texture; weak, fine, granular structure, primarily chert grains; loose, moist, nonsticky consistence; no visible clay coatings; common fine manganese nodules comprising about 10% of matrix; abrupt, irregular boundary; common medium, rounded chert gravels; no noticeable roots or pores.
C_8	120-133 cm; moist color 10YR 4/4 with fine laminae of 10YR 7/4; silt loam texture; massive, laminated structure; friable, moist, nonsticky consistence; no visible clay coatings; abrupt, smooth boundary; common medium pores; no visible roots or coarse fragments.

<u>T1 Formation</u>

2Ab	133-152 cm; moist color 10YR 3/3 with fine laminae of 10YR 7/4; silty clay loam texture; moderate, medium, subangular blocky structure; friable, moist, slightly sticky consistence; thin discontinuous clay coatings; few fine manganese nodules comprising about 5% of matrix; abrupt, smooth boundary; few medium rounded chert pebbles, lithic debris, and charcoal fragments comprising about 5% of matrix; common medium and fine pores and tunnels; no noticeable roots.

$2Bt_1b$	152-165 cm; moist color 10YR 3/3 with fine laminae of 10YR 7/4; clay loam texture; moderate, medium, subangular blocky structure; friable, moist, sticky consistence; thin continuous clay coatings; common fine manganese nodules with manganese coatings comprising about 10% of matrix; gradual, smooth boundary; common, medium, rounded chert pebbles, with lithic debris, and charcoal comprising about 10% of matrix; few fine pores and tunnels; no noticeable roots.
$2Bt_2b$	165-176 cm; moist color 10YR 3/3; clay loam texture; moderate, coarse, subangular structure; firm, moist, sticky consistence; thin, continuous clay coatings; few fine manganese nodules comprising about 5% of matrix; gradual, smooth boundary; common, medium, rounded chert pebbles, with lithic debris, and charcoal comprising about 10% of matrix; few fine pores and tunnels; no noticeable roots.
2Bgb	176-180 cm; moist color 10YR 3/3 with manganese oxide coatings of 10YR 2/2 comprising about 10% of matrix, and iron oxide coatings of 7.5YR 5/6 comprising about 10% of matrix; gravelly clay loam texture; massive structure with extensive gleying; firm, moist, sticky consistence; clear, smooth boundary; common coarse rounded chert pebbles comprising about 30% of matrix; no noticeable roots or pores.
R	180 cm.

Additional Field Notes:

Soil unit consists of historic alluvium overlying a buried "A" horizon. Sand lenses are primarily rounded chert grains with pieces of limestone found in the plowzone and on the surface of the 2Ab horizon. Lithic debris noted in buried soil with noticeable waterwear in the lower gravelly horizon. Charcoal is found throughout the profile, but predominates near the surface of the buried "A". Limestone bedrock lies directly beneath 2Bgb horizon.

Appendix A-4. Soil Profile Descriptions of Trench 3. Section 2.

SITE: 40CN79
LOCATION: Cannon County, Tennessee
VEGETATION: Pature, forage
PARENT MATERIAL: Alluvium
PHYSIOGRAPHY: Footslope of T2
RELIEF: Nearly level to slightly rolling
ELEVATION: About 200 m AMSL
SLOPE: Less than 5%
ASPECT: South
EROSION: Slight
PERMEABILITY: Moderately rapid
DRAINAGE: Well drained
GROUNDWATER: Evident at 179 cm below surface
MOISTURE: Moist
ROOT DISTRIBUTION: 0-99 cm
SALT OR ALKALI: Not evident
STONINESS: Gravel lense at bottom of unit

PZ Formation

Ap — 0-26 cm; moist color 10YR 4/3; silt loam texture; moderate, medium, granular (crumb) structure; friable, moist, nonsticky consistence; thin, discontinuous clay coatings; common fine and medium roots; common angular limestone and chert fragments comprising about 10% of matrix; common fine and medium pores and tunnels.

T0b Formation

Bw — 26-44 cm; moist color 10YR 4/3; silt loam texture; weak, medium, subangular blocky structure; friable, moist, nonsticky consistence; thin discontinuous clay coatings; gradual smooth boundary; common fine and medium roots; few medium angular limestone and chert fragments comprising about 5% of matrix; common fine and medium pores and tunnels.

Bt_1 — 44-58 cm; moist color 10YR 4/3; silty clay loam texture; weak, coarse, subangular blocky structure; firm, moist, slightly sticky consistence; thin, discontinuous clay coatings; gradual, smooth boundary; few fine roots; few fine pores and tunnels; no noticeable coarse fragments.

Bt_2 — 58-70 cm; moist color 10YR 4/4; silty clay loam texture; moderate, medium subangular structure; friable, moist, slightly sticky consistence; thin discontinuous clay coatings; gradual, smooth boundary; few fine roots; few fine pores and tunnels; no noticeable coarse fragments.

C_1	70-87 cm; moist color 10YR 4/4 with laminae 10YR 5/4 comprising about 40% of matrix; silt loam texture; massive, laminated structure; friable, moist, nonsticky consistence; no visible clay coatings; clear, smooth boundary; few fine roots; few fine and medium pores and tunnels.
C_2	87-99 cm; moist color 10YR 4/3 with laminae 10YR 7/4 comprising about 40% of matrix; silt loam texture; massive, laminated structure; friable, moist, nonsticky consistence; no visible clay coatings; gradual, smooth boundary; few fine roots; few fine pores and tunnels; no noticeable coarse fragments.
C_3	99-116 cm; moist color 10YR 4/3 with laminae 10YR 7/4 comprising about 40% of matrix; silt loam texture; massive, laminated structure; friable, moist, nonsticky consistence; no visible clay coatings; manganese oxide coatings comprise about 30% of matrix; gradual, smooth boundary; few fine pores and tunnels; no noticeable roots or coarse fragments.

<u>T1 Formation</u>

2Ab	116-135 cm; moist color 10YR 3/3 with manganese oxide coatings 10YR 2/1 comprising about 30% of matrix; silty clay loam texture; moderate, medium, subangular blocky structure; friable, moist, sticky consistence; thin, continuous clay coatings; clear, smooth boundary; few charcoal fragments comprising about 5% of matrix; few fine pores and tunnels; no noticeable roots.
$2Bt_1b$	135-149 cm; moist color 10YR 3/3 with manganese oxide coatings of 10YR 2/1 comprising about 10% of matrix; clay loam texture; moderate, medium, subangular blocky structure; friable, moist sticky consistence; thin, continuous clay coatings; gradual, smooth boundary; few fine pores and tunnels; no noticeable roots or coarse fragments.
$2Bt_2b$	149-159 cm; moist color 10YR 3/3 with manganese oxide coatings of 10YR 2/1 comprising about 10% of matrix, and gleyed coatings of 2.5YR 5/2 comprising about 10% of matrix; clay loam texture; moderate, medium subangular blocky structure; friable, moist, sticky consistence; thin continuous clay coatings; gradual, smooth boundary; few fine pores and tunnels; no noticeable roots or coarse fragments.
2C	159-177 cm; moist color 10YR 4/4; gravelly medium sand texture; granular structure; loose, wet, sticky consistence; no visible clay coatings; manganese nodules comprise about 20% of matrix; clear, smooth boundary; many medium and coarse rounded chert gravels comprising about 50% of matrix; no noticeable roots or pores.
R	177 cm.

Additional Field Notes:

Silt lenses above buried "A" reminiscent of silt lenses in TR2.S2. Argillic horizon present with much more manganese coatings in the buried "A". A very distinctive gravel bar represented here. Historic charcoal lense noted on top of buried "A" but no artifacts were observed in the profile unit.

Appendix A-5. Soil Profile Descriptions of Trench 4. Section 2.

SITE: 40CN79
LOCATION: Cannon County, Tennessee
VEGETATION: Pasture, forage
PARENT MATERIAL: Alluvium
PHYSIOGRAPHY: Floodplain, footslope of T2
RELIEF: Nearly level to slightly rolling
ELEVATION: About 200 m AMSL
SLOPE: Less than 2%
ASPECT: South
EROSION: Slight
PERMEABILITY: Moderately rapid
DRAINAGE: Well drained
GROUNDWATER: Evident at 129 cm
MOISTURE: Moist
ROOT DISTRIBUTION: 0-115 cm
SALT OR ALKALI: Not evident
STONINESS: Alluvial gravel at bottom of unit

<u>PZ Formation</u>

Ap 0-14 cm; moist color 10YR 4/3, dry color 10YR 6/3; silt loam texture; moderate, medium, granular (crumb) structure; friable, moist, nonsticky consistence; no visible clay coatings; common fine and medium roots; common medium angular limestone fragments and rounded chert gravels comprising about 10% of matrix; common fine and medium pores and tunnels.

<u>T0a Formation</u>

Bw_1 14-30 cm; moist color 10YR 4/3, dry color 10YR 6/3; silt loam texture; weak, moderate, subangular blocky structure; friable, moist, slightly sticky consistence; thin, discontinuous clay coatings; clear, smooth boundary; common fine roots; few medium angular limestone fragments comprising about 5% of matrix; common fine and medium pores and tunnels.

Bw_2 30-44 cm; moist color 10YR 4/3, dry color 10YR 6/3; silt loam texture; weak, moderate subangular blocky structure; friable, moist slightly sticky consistence; thin, discontinuous clay coatings; gradual, smooth boundary; common fine roots; few fragments of charcoal comprising about 2% of matrix; common fine and medium pores and tunnels.

Bw_3 44-64 cm; moist color 10YR 4/3, dry color 10YR 5/3; silt loam texture; weak, moderate, subangular blocky structure; friable, moist, slightly sticky consistence; thin discontinuous clay coatings; gradual smooth boundary; few fine roots; few fragments of charcoal comprising about 2% of matrix; common fine and medium pores and tunnels.

Bw_4 64-81 cm; moist color 10YR 4/3, dry color 10YR 5/3; silt loam texture; weak, moderate, subangular blocky structure, friable, moist, slightly sticky consistence; thin, discontinuous clay coatings; gradual, smooth boundary; few fine roots; few fragments of charcoal comprising about 2% of matrix; common fine pores and tunnels.

Bw_5 81-98 cm; moist color 10YR 4/3, dry color 10YR 5/3; silt loam texture; weak, coarse, subangular blocky structure; friable, moist, slightly sticky consistence; thin, discontinuous clay coatings; gradual, smooth boundary; few fine roots; few fragments of charcoal comprising about 2% of matrix; common fine pores and tunnels.

Bw_6 98-115 cm; moist color 10YR 3/3, dry color 10YR 5/3; silt loam texture; moderate, medium subangular blocky structure; friable, moist, slightly sticky consistence; thin discontinuous clay coatings; gradual, smooth boundary; few fine roots; few medium rounded chert gravels comprising about 5% of matrix; few fine pores and tunnels.

B/C 115-129 cm; moist color 10YR 3/3, dry color 10YR 5/3; gravelly, loamy medium sand texture; moderate, medium, granular structure; friable, moist, slightly sticky consistence; no visible clay coatings; clear, smooth boundary; many medium rounded chert gravels comprising about 30% of matrix; few fine pores and tunnels; no noticeable roots; common fine manganese nodules comprising about 10% of matrix.

C_1 129-141 cm; moist color 10YR 4/4, dry color 10YR 5/3; gravelly sand texture; granular structure; loose, moist, nonsticky consistence; no visible clay coatings; gradual, smooth boundary; many medium and coarse rounded chert gravels comprising about 50% of the matrix; no noticeable roots or pores; common manganese nodules comprising about 10% of matrix.

C_2 141-163 cm; moist color 10YR 4/3, dry color 10YR 5/3; gravelly sand texture; granular structure; loose, moist, nonsticky consistence; common fine manganese nodules comprising about 10% of matrix; gradual smooth boundary; many medium and coarse rounded chert gravels comprising about 70% of matrix; no noticeable roots or pores.

R 163 cm.

Appendix A-6. Soil Profile Descriptions of Trench 2. Section 1.5.

SITE: 40CN79
LOCATION: Cannon County, Tennessee
VEGETATION: Pasture, forage
PARENT MATERIAL: Alluvium
PHYSIOGRAPHY: Floodplain
RELIEF: Nearly level
ELEVATION: About 200 m AMSL
SLOPE: Less than 2%
ASPECT: North
EROSION: Not evident
PERMEABILITY: Moderately rapid
DRAINAGE: Well drained
GROUNDWATER: Evident at 135 cm
MOISTURE: Moist
ROOT DISTRIBUTION: 0-111 cm
SALT OR ALKALI: Not evident
STONINESS: Gravel bar noted in base of unit

PZ Formation

Ap — 0-25 cm; moist color 10YR 4/3; silt loam texture; moderate, medium, granular structure (crumb); loose, moist, nonsticky consistence; many fine and medium roots; common medium angular limestone and rounded chert fragments comprising about 10% of matrix; many fine and medium pores and tunnels.

T0a Formation

Bw_1 — 25-37 cm; moist color 10YR 4/3; silt loam texture; moderate, medium, subangular blocky structure; friable, moist, nonsticky consistence; thin, discontinuous clay coatings; clear, smooth boundary; common, fine roots; common fine and medium pores and tunnels; no noticeable coarse fragments.

Bw_2 — 37-48 cm; moist color 10YR 4/3; silt loam texture; moderate, medium, subangular blocky structure; friable, moist, nonsticky consistence; thin, discontinuous clay coatings; gradual, smooth boundary; common, fine roots; common fine and medium pores and tunnels; no noticeable coarse fragments.

Bw_3 — 48-63 cm; moist color 10YR 4/3; silt loam texture; moderate, medium, subangular blocky structure; firm, moist, nonsticky consistence; thin, discontinuous clay coatings; gradual, smooth boundary; few fine roots; common fine and medium pores and tunnels; no noticeable coarse fragments.

Bw_4 — 63-76 cm; moist color 10YR 4/3; loam texture; weak, coarse, subangular blocky structure; friable, moist, nonsticky consistence; no visible clay coatings; gradual, smooth boundary; few fine roots; few fine and medium pores and tunnels; no noticeable coarse fragments.

Bw_5 76-89 cm; moist color 10YR 4/4; sandy loam texture; weak, coarse subangular structure; friable, moist, nonsticky consistence; no visible clay coatings; gradual, smooth boundary; few fine roots; common rounded chert gravels comprising about 10% of the matrix; few fine and medium pores and tunnels.

C_1 89-100 cm; moist color 10YR 5/6; gravelly sand texture; granular structure; loose, moist, nonsticky consistence; no visible clay coatings; few fine manganese nodules comprising about 2% of matrix; clear, smooth boundary; few fine roots; many rounded chert gravels and cobbles comprising about 60% of matrix; no noticeable pores or tunnels.

C_2 100-111 cm; moist color 10YR 5/6; gravelly sand texture; granular structure; loose, moist, nonsticky consistence; no visible clay coatings; few fine manganese nodules comprising about 2% of matrix; gradual, smooth boundary; few fine roots; many rounded chert gravels and cobbles comprising about 60% of the matrix; no visible pores or tunnels.

C_3 111-130 cm; moist color 10YR 6/6; gravelly sand texture; granular structure; loose, wet, nonsticky consistence; no visible clay coatings; few fine manganese nodules comprising about 2% of matrix; gradual, smooth boundary; many rounded chert gravels and cobbles comprising about 80% of the matrix; no noticeable roots or pores.

Additional Field Notes:

Represents good alluvial sequence of graded sediment, probably historic in age. Well developed gravel bar, relatively clean of oxides with a few scattered charcoal fragments. No cultural material was noted within this sequence.

Appendix A-7. Soil Profile Descriptions of Trench 2. Section 1.

SITE: 40CN79
LOCATION: Cannon County, Tennessee
VEGETATION: Pasture, forage
PARENT MATERIAL: Alluvium
PHYSIOGRAPHY: Floodplain, levee bank
RELIEF: Nearly level
ELEVATION: About 200 m AMSL
SLOPE: Less than 2%
ASPECT: North
EROSION: None
PERMEABILITY: Moderately rapid
DRAINAGE: Well drained
GROUNDWATER: Not evident
MOISTURE: Moist
ROOT DISTRIBUTION: 0-138 cm
SALT OR ALKALI: None
STONINESS: Alluvial gravel at bottom of unit

PZ Formation

Ap — 0-17 cm; moist color 10YR 3/3, dry color 10YR 5/3; sandy loam texture; moderate, medium, granular structure; friable, moist, nonsticky consistence; no visible clay coatings; common fine and medium roots; common fine and medium pores and tunnels; no noticeable coarse fragments.

T0b Formation

Bw_1 — 17-38 cm; moist color 10YR 3/3, dry color 10YR 5/3; loam texture; weak, medium, subangular structure; friable, moist, nonsticky consistence; no visible clay coatings; clear, smooth boundary; common fine roots; common fine and medium pores and tunnels; no noticeable coarse fragments.

Bw_2 — 38-60 cm; moist color 10YR 4/3, dry color 10YR 5/3; loam texture; weak, moderate, subangular blocky structure; friable, moist, nonsticky consistence; no visible clay coatings; gradual, smooth boundary; common fine roots; common fine and medium pores and tunnels.

Bw_3 — 60-81 cm; moist color 10YR 4/3, dry color 10YR 6/3, loam texture; weak, medium, subangular blocky structure; friable, moist, nonsticky consistence; no visible clay coatings; gradual, smooth boundary; common fine roots; few medium rounded chert gravels comprising about 5% of the matrix; common fine and medium pores and tunnels.

T0a Formation

$2Bw_1$ 81-103 cm; moist color 10YR 4/3, dry color 10YR 6/3; silt loam texture; weak, medium, subangular blocky structure; friable, moist, nonsticky consistence; thin, discontinuous clay coatings; clear, smooth boundary; few fine roots; few fine pores and tunnels; no noticeable coarse fragments.

$2Bw_2$ 103-119 cm; moist color 10YR 4/3, dry color 10YR 5/4; silt loam texture; weak, medium, subangular blocky structure; friable, moist, nonsticky consistence; thin, discontinuous clay coatings; gradual, smooth boundary; few fine roots; few medium blocky limestone fragments comprising about 2% of matrix; few fine pores and tunnels.

$2Bw_3$ 119-138 cm; moist color 10YR 4/3, dry color 10YR 5/3; silt loam texture; weak, coarse, subangular blocky structure; friable, moist, nonsticky consistence; thin, discontinuous clay coatings; gradual, smooth boundary; few fine roots; few fine pores and tunnels; no noticeable coarse fragments.

$2Bw_4$ 138-162 cm; moist color 10YR 4/3, dry color 10YR 5/3; silt loam texture; weak, coarse, subangular blocky structure; friable, moist, slightly sticky consistence; thin, discontinuous clay coatings; gradual, smooth boundary; few fine roots; few fine pores and tunnels; no noticeable coarse fragments.

$2Bw_5$ 162-179 cm; moist color 10YR 4/3, dry color 10YR 5/3; silt loam texture; moderate, medium, subangular structure; loose, moist, slightly sticky consistence; thin, continuous clay coatings; gradual, smooth boundary; few rounded chert gravels comprising about 5% of the matrix; few fine pores and tunnels; no noticeable roots.

2C 179-199 cm; moist color 10YR 4/3, dry color 10YR 5/3; gravelly loamy sand texture; granular structure; loose, moist, nonsticky consistence; no visible clay coatings; abrupt smooth boundary; many medium and coarse rounded chert gravels comprising about 50% of the matrix; no noticeable roots or pores.

Appendix A-8. Soil Profile Descriptions of Trench 4. Section 1.

SITE: 40CN79
LOCATION: Cannon County, Tennessee
VEGETATION: Pasture, forage
PARENT MATERIAL: Alluvium
PHYSIOGRAPHY: Floodplain, backslope of levee
RELIEF: Nearly level
ELEVATION: About 200 m AMSL
SLOPE: Less than 2%
ASPECT: North
EROSION: Not evident
PERMEABILITY: Moderately rapid
DRAINAGE: Well drained
GROUNDWATER: Not evident
MOISTURE: Moist
ROOT DISTRIBUTION: 0-96 cm
SALT OR ALKALI: Not evident
STONINESS: Alluvial gravel bar at base of unit

<u>PZ Formation</u>

Ap — 0-24 cm; moist color 10YR 4/3, dry color 10YR 5/3; silt loam texture; moderate, medium granular structure; moist, friable, nonsticky consistence; thin discontinuous clay coatings; common fine roots; few medium, angular limestone fragments comprising about 10% of matrix; common fine and medium pores and tunnels.

<u>T0a Formation</u>

Bw_1 — 24-45 cm; moist color 10YR 4/3, dry color 10YR 5/3; silt loam texture; moderate, medium, subangular blocky structure; moist, friable, nonsticky consistence; thin, discontinuous clay coatings; clear, smooth boundary; common fine roots; common fine and medium pores and tunnels; no noticeable coarse fragments.

Bw_2 — 45-65 cm; moist color 10YR 4/3, dry color 10YR 5/3; silt loam texture; weak, medium, subangular blocky structure; moist, friable, nonsticky consistence; thin discontinuous clay coatings; gradual, smooth boundary; few fine roots; common fine and medium pores and tunnels; no noticeable coarse fragments.

Bw_3 — 65-85 cm; moist color 10YR 4/3, dry color 10YR 5/3; silt loam texture; weak, medium subangular blocky structure; moist, friable, nonsticky consistence; thin, discontinuous clay coatings; gradual, smooth boundary; few fine roots; few fine and medium pores and tunnels; no noticeable coarse fragments.

Bw_4 — 85-96 cm; moist color 10YR 4/3, dry color 10YR 5/3; loam texture; weak, coarse, subangular blocky structure; moist, friable, nonsticky consistence; no visible clay coatings; gradual, smooth boundary; few fine roots; few fine pores and tunnels; no noticeable coarse fragments.

C_1 96-118 cm; moist color 10YR 4/3, dry color 10YR 5/3; gravelly medium sandy loam texture; weak, fine, granular structure; loose, moist, nonsticky consistence; no visible clay coatings; few fine manganese nodules comprising about 2% of the matrix; clear, smooth boundary; rounded chert gravels comprise about 30% of the matrix; few fine pores and tunnels.

C_2 118-144 cm; moist color 10YR 4/2, dry color 10YR 5/3; gravelly sand texture; weak, fine, granular structure; loose, moist, nonsticky consistence; no visible clay coatings; few fine manganese nodules comprising about 5% of matrix; common medium pores and tunnels.

APPENDIX B

SEDIMENT ANALYSIS RESULTS

Appendix B-1. Sediment Analysis of Trench 2. Section 4.

		PHI SIZE %											
		Gravel		Sand					Silt				Clay
Horizon	pH	-2.0	-1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	>8.0
Ap	5.8	0.64	0.60	0.60	1.40	2.03	1.73	2.05	43.95	17.00	9.00	3.50	17.50
Bt_1	5.7	0.57	0.35	0.48	1.60	2.05	1.53	1.90	49.52	7.00	10.00	5.00	20.00
Bt_2	5.0	0.00	0.10	0.13	0.70	1.50	1.15	1.28	41.14	16.00	7.00	6.50	24.50
Bt_3	5.1	0.38	0.22	0.25	1.60	2.13	1.43	1.60	48.39	7.00	6.50	7.00	23.50
Bt_4	5.1	0.47	0.59	1.35	3.00	2.83	1.85	1.98	44.43	13.50	6.00	3.50	20.50
$2Bt_1$	4.8	3.03	5.72	5.88	4.73	3.15	1.93	1.95	30.11	15.00	3.00	4.00	21.50
$2Bt_2$	4.5	3.45	3.60	3.80	4.53	3.35	2.05	2.15	31.07	11.50	7.00	4.50	23.00
$2Bt_3$	4.7	2.08	2.77	3.20	3.80	3.20	2.33	2.65	34.97	8.00	5.50	6.50	25.00
$2Bt_4$	4.6	1.02	1.74	1.23	1.85	2.33	2.05	2.48	35.30	9.00	5.00	4.50	33.50
2C	4.6	1.57	2.31	1.23	1.58	1.80	1.68	2.08	37.25	7.00	4.50	4.50	34.50

Appendix B-2. Sediment Analysis of Trench 1. Section 2.

		PHI SIZE %											
		Gravel		Sand					Silt				Clay
Horizon	pH	-2.0	-1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	8.0
Ap	7.0	2.13	1.94	1.28	2.05	2.73	2.93	6.00	40.44	13.00	6.00	6.00	15.50
Bw_1	6.8	1.63	0.78	0.83	1.40	2.33	3.10	6.15	39.78	13.00	7.50	5.00	18.50
Bw_2	7.0	4.93	2.63	1.28	3.33	5.60	5.08	6.05	34.10	12.00	6.50	4.00	14.50
2Ab	6.7	0.02	0.22	0.43	0.78	1.70	2.33	4.60	43.42	15.50	6.50	6.00	18.50
$2Bt_1b$	6.6	1.36	0.53	0.70	0.85	1.28	0.93	2.13	46.72	9.00	7.50	6.00	23.00
$2Bt_2b$	6.6	1.02	0.44	0.63	1.15	1.98	0.98	1.83	46.47	10.50	4.50	7.50	23.00
$2Bt_3b$	7.0	1.96	1.82	1.93	2.78	3.68	1.73	2.38	35.22	12.00	6.00	6.50	24.00
2Bgb	7.0	17.09	3.86	3.15	4.50	5.63	2.68	2.83	27.76	5.00	4.50	4.00	19.00

Appendix B-3. Sediment Analysis of Trench 2. Section 2.

Horizon	pH	PH SIZE %											
		Gravel		Sand					Silt				Clay
		-2.0	-1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	>8.0
Ap	6.6	2.68	1.44	0.30	1.15	2.78	3.28	5.83	39.54	16.00	6.50	5.00	15.50
Bw_1	6.6	3.98	1.05	0.93	1.83	3.38	2.85	4.88	36.60	15.00	7.00	5.00	17.50
Bw_2	6.1	7.78	2.78	2.03	2.70	3.88	4.15	6.25	33.43	12.50	4.50	5.50	14.50
Bw_3	6.6	3.98	3.25	3.45	6.55	7.60	6.45	7.20	29.02	10.00	4.00	3.00	15.50
Bw_4	6.5	0.08	0.45	0.53	1.43	2.63	2.45	3.68	40.75	17.50	10.00	5.00	15.50
C_1	6.6	0.35	2.33	4.08	8.53	9.25	6.03	5.18	31.75	9.00	3.00	4.50	16.00
C_2	6.3	0.05	0.29	0.10	0.83	2.40	2.25	4.23	49.35	13.00	6.50	4.00	17.00
C_3	6.7	5.70	2.24	1.70	3.73	5.35	3.58	5.08	38.62	9.00	5.50	3.00	16.50
C_4	6.7	0.23	1.40	0.53	2.10	3.38	3.08	6.73	45.55	9.50	6.50	3.00	18.00
C_5	6.5	1.06	3.04	3.00	4.98	5.33	4.83	8.25	35.01	11.00	3.00	4.50	16.00
C_6	6.4	2.03	0.91	0.85	2.30	3.68	3.33	6.75	42.15	13.00	5.00	2.50	17.50
C_7	6.7	3.37	3.97	4.55	6.30	8.38	6.78	7.23	28.42	8.00	4.50	3.00	15.50
C_8	6.5	0.04	0.22	0.38	1.13	1.63	1.13	2.40	45.07	17.00	7.50	6.00	17.50
2Ab	6.1	2.28	1.02	0.85	2.13	2.88	2.00	3.33	39.51	10.00	11.00	6.00	19.00
$2Bt_1b$	6.3	0.13	0.38	0.50	0.93	1.20	1.58	4.50	44.78	12.00	7.50	7.50	19.00
$2Bt_2b$	6.5	10.07	0.42	0.53	0.85	1.08	1.30	3.85	39.90	11.00	7.50	7.00	16.50
2Bgb	6.8	25.37	3.20	2.48	2.03	1.45	1.30	2.85	30.32	6.00	5.00	4.50	15.50

Appendix B-4. Sediment Analysis of Trench 3. Section 2.

		PHI SIZE %											
		Gravel		Sand					Silt				Clay
Horizon	pH	-2.0	-1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	>8.0
Ap	6.9	13.44	0.74	0.98	1.13	1.43	1.95	4.68	41.65	11.50	5.50	3.50	13.50
Bw	6.9	0.37	0.59	1.18	2.10	2.95	3.25	6.28	38.78	12.00	7.50	6.00	19.00
Bt_1	6.5	0.00	0.29	0.13	0.43	1.25	2.18	5.90	43.32	12.00	9.00	5.50	20.00
Bt_2	6.7	0.60	0.62	1.00	1.33	2.28	2.93	4.13	39.11	11.00	10.00	5.50	21.50
C_1	6.6	0.18	0.36	0.18	0.55	1.23	1.33	1.80	39.37	12.50	10.50	7.50	24.00
C_2	6.4	0.00	0.05	0.13	0.18	0.40	0.65	1.10	40.49	9.50	10.00	10.00	27.50
C_3	6.1	0.00	0.07	0.33	0.45	0.93	1.73	3.30	41.19	14.50	7.50	8.00	22.00
2Ab	6.3	0.00	0.00	0.05	0.20	0.85	1.88	6.25	48.77	14.50	6.50	5.00	16.00
$2Bt_1b$	6.5	0.00	0.04	0.10	0.95	2.33	3.33	6.73	45.52	13.50	6.50	5.00	16.00
$2Bt_2b$	6.5	0.90	0.57	1.35	3.20	3.78	3.38	5.60	43.22	14.50	5.00	4.00	14.50
2C	7.1	51.76	7.67	8.83	10.40	6.63	1.13	0.68	4.90	0.50	1.00	1.00	5.50

Appendix B-5. Sediment Analysis of Trench 4. Section 2.

		PHI SIZE %											
		Gravel		Sand					Silt				Clay
Horizon	pH	-2.0	-1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	>8.0
Ap	6.9	1.09	0.50	0.53	1.18	3.05	4.70	8.23	40.22	15.50	4.50	4.00	16.50
Bw_1	6.9	0.40	0.50	0.53	1.90	4.35	4.78	7.33	41.35	8.50	8.00	3.50	18.50
Bw_2	6.7	0.00	0.14	0.18	0.60	2.13	3.75	8.40	42.30	15.00	5.00	4.00	18.50
Bw_3	6.6	0.12	0.45	0.73	1.45	3.33	4.53	7.25	41.15	13.50	5.00	4.50	18.00
Bw_4	6.6	0.00	0.03	0.23	0.68	2.68	4.88	7.78	44.22	16.00	6.00	4.00	13.50
Bw_5	6.6	0.00	0.05	0.43	1.53	3.23	4.40	7.73	40:65	16.00	6.00	4.00	16.00
Bw_6	6.5	0.81	1.56	3.18	4.85	7.85	7.35	7.53	32.90	14.00	3.50	3.50	13.00
B/C	7.0	38.22	8.30	8.55	9.90	10.23	5.00	1.83	7.97	3.50	0.50	1.00	5.00
C_1	6.6	29.85	4.53	2.63	10.75	23.25	6.93	1.58	8.48	2.00	1.00	2.00	7.00
C_2	7.0	64.93	9.26	6.93	6.48	3.55	0.78	0.30	2.77	0.50	1.00	0.50	3.50

Appendix B-6. Sediment Analysis of Trench 2. Section 1.5.

		PHI SIZE %											
		Gravel		Sand					Silt				Clay
Horizon	pH	-2.0	-1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	>8.0
Ap	7.1	0.37	0.34	0.10	1.10	4.73	6.00	8.35	39.01	12.50	5.00	6.00	16.50
Bw_1	6.9	0.00	0.03	0.03	0.30	2.08	4.78	6.40	43.88	12.50	6.50	7.00	16.50
Bw_2	6.8	0.00	0.00	0.05	0.25	2.75	7.33	7.83	43.29	8.50	7.50	6.00	16.50
Bw_3	6.9	0.00	0.00	0.13	0.88	6.18	12.58	9.60	33.13	10.00	6.50	4.50	16.50
Bw_4	7.0	0.14	0.53	1.08	3.98	13.03	16.23	8.78	25.23	6.00	4.50	4.00	16.50
Bw_5	6.9	14.80	3.29	5.38	10.45	16.48	10.78	5.20	14.62	3.00	2.00	2.50	11.50
C_1	5.3	56.42	9.37	4.93	6.75	10.10	3.13	0.95	2.85	0.50	0.50	0.50	3.00
C_2	5.7	63.30	9.98	6.48	9.73	5.45	0.95	0.25	1.36	0.00	0.00	0.50	2.00
C_3	5.5	60.20	10.08	6.78	9.85	4.83	0.90	0.38	2.48	0.00	0.50	0.00	4.00

Appendix B-7. Sediment Analysis of Trench 2. Section 1.

		PHI SIZE %											
		Gravel		Sand					Silt				Clay
Horizon	pH	-2.0	-1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	>8.0
Ap	7.1	0.00	0.12	0.08	1.05	11.78	16.83	12.08	28.06	11.50	4.00	2.50	12.00
Bw_1	7.1	0.00	0.04	0.23	1.03	8.28	15.65	12.15	31.12	10.50	5.50	3.00	12.50
Bw_2	7.0	0.00	0.07	0.15	0.98	10.98	17.30	11.18	29.34	8.00	4.00	4.50	13.50
Bw_3	7.2	0.04	0.09	0.05	0.48	7.40	14.10	9.03	32.01	10.00	6.50	3.50	16.00
$2Bw_1$	7.0	0.11	0.08	0.03	0.40	4.75	7.08	7.28	36.87	11.50	8.00	5.00	18.00
$2Bw_2$	6.9	0.15	0.11	0.43	1.08	6.68	9.23	7.33	34.99	13.00	5.00	4.00	18.00
$2Bw_3$	6.8	0.37	0.19	0.15	0.83	3.65	5.95	8.05	40.81	11.50	8.00	3.50	17.00
$2Bw_4$	7.0	0.00	0.00	0.13	0.75	3.38	7.45	10.58	37.71	11.50	5.50	5.00	18.00
$2Bw_5$	7.0	4.68	0.39	0.83	3.63	8.10	6.73	7.90	30.24	10.50	6.50	3.00	17.50
2C	6.6	52.91	7.11	6.45	7.70	8.90	2.58	1.15	5.20	1.00	1.00	1.00	5.00

Appendix B-8. Sediment Analysis of Trench 4. Section 1.

		PHI SIZE %											
		Gravel		Sand					Silt				Clay
Horizon	pH	-2.0	-1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	>8.0
Ap	7.0	0.05	0.06	0.15	0.50	5.30	12.13	12.33	36.98	11.00	6.50	3.00	12.00
Bw_1	7.2	0.25	0.14	0.15	0.55	4.20	9.28	9.98	37.45	11.00	6.00	3.50	17.50
Bw_2	6.9	0.00	0.10	0.18	0.85	3.58	5.58	8.15	39.56	13.50	7.00	4.50	17.00
Bw_3	6.9	0.00	0.00	0.03	0.95	6.93	10.60	9.38	35.61	10.00	7.00	4.00	15.50
Bw_4	7.0	0.32	0.27	1.33	4.33	8.95	9.33	9.15	33.82	10.00	2.50	6.50	13.50
C_1	7.1	24.20	3.53	5.98	11.18	14.50	6.10	4.00	14.51	2.50	1.50	2.50	9.50
C_2	7.3	46.04	3.66	4.35	8.20	9.93	3.63	2.30	10.89	1.50	1.50	1.00	7.00

APPENDIX C

SEDIMENT PARAMETERS

Appendix C-1. Sediment Parameters of Trench 2. Section 4

Horizon	M_z	o'_i	Sk_i	K_G
Ap	6.27	2.97	0.57	1.94
Bt_1	6.06	2.86	0.59	1.61
Bt_2	6.70	2.78	0.55	1.06
Bt_3	6.32	3.02	0.63	1.25
Bt_4	6.09	3.08	0.51	1.88
$2Bt_1$	4.87	4.31	0.03	1.41
$2Bt_2$	5.19	4.32	0.18	1.68
$2Bt_3$	5.81	4.02	0.26	1.46
$2Bt_4$	6.81	3.66	0.47	0.99
$2Bt_5$	6.80	3.78	0.47	1.02

Appendix C-2. Sediment Parameters of Trench 1. Section 2

Horizon	M_z	σ'_i	Sk_i	K_G
Ap	5.39	2.98	0.31	2.23
Bw_1	5.87	2.42	0.35	1.27
Bw_2	4.64	3.59	0.03	2.16
2Ab	5.96	2.62	0.61	1.52
$2Bt_1b$	6.30	2.99	0.62	1.29
$2Bt_2b$	6.30	2.75	0.63	1.07
$2Bt_3b$	6.28	3.52	0.42	1.49
2Bgb	3.75	5.04	-0.05	0.97

Appendix C-3. Sediment Parameters of Trench 2. Section 2.

Horizon	M_z	σ'_i	Sk_i	K_G
Ap	5.49	2.79	0.37	2.23
Bw_1	5.59	3.29	0.28	2.21
Bw_2	4.51	3.80	-0.01	2.16
Bw_3	4.35	3.84	0.05	1.51
Bw_4	5.66	2.48	0.48	1.87
C_1	4.51	3.63	0.12	1.37
C_2	5.76	2.52	0.61	1.90
C_3	4.75	3.84	0.07	2.37
C_4	5.72	2.91	0.50	2.06
C_5	4.73	3.51	0.17	2.08
C_6	5.55	3.05	0.39	2.57
C_7	4.60	3.61	0.13	1.42
C_8	5.89	2.45	0.63	1.55
2Ab	5.96	3.05	0.45	1.80
$2Bt_1b$	6.00	2.62	0.64	1.35
$2Bt_2b$	5.48	3.41	0.22	2.29
2Bgb	3.30	4.82	-0.14	0.76

Appendix C-4. Sediment Parameters of Trench 3. Section 2.

Horizon	M_z	o'_i	Sk_i	K_G
Ap	4.22	3.82	-0.10	3.35
Bw	5.90	2.96	0.49	1.64
Bt_1	6.08	2.69	0.65	1.40
Bt_2	6.19	3.02	0.54	1.47
C_1	6.55	2.81	0.61	1.10
C_2	6.86	2.89	0.58	1.03
C_3	6.33	2.75	0.65	1.18
2Ab	5.66	2.30	0.65	1.77
$2Bt_1b$	5.62	2.45	0.57	1.86
$2Bt_2b$	5.28	2.74	0.35	2.62
2C	-0.97	2.86	0.78	1.48

Appendix C-5. Sediment Parameters of Trench 4. Section 2.

Horizon	M_z	o'_i	Sk_i	K_G
Ap	5.51	2.75	0.45	2.34
Bw_1	5.65	3.02	0.45	1.81
Bw_2	5.88	2.69	0.60	1.78
Bw_3	5.73	2.85	0.50	1.87
Bw_4	5.37	2.29	0.51	2.28
Bw_5	5.54	2.59	0.49	2.11
Bw_6	4.46	3.15	0.09	1.79
B/C	0.36	3.35	0.50	1.03
C_1	1.06	3.65	0.18	1.08
C_2	-1.51	2.00	0.75	0.93

Appendix C-6. Sediment Parameters of Trench 2. Section 1.5.

Horizon	M_z	σ'_i	Sk_i	K_G
Ap	5.44	2.79	0.43	1.80
Bw_1	5.69	2.49	0.57	1.57
Bw_2	5.54	2.62	0.53	1.62
Bw_3	5.17	2.97	0.37	1.52
Bw_4	4.74	3.32	0.31	1.29
Bw_5	2.12	4.04	0.20	1.30
C_1	-1.10	2.24	0.76	1.27
C_2	-1.50	1.55	0.69	1.09
C_3	-1.46	2.03	0.74	1.39

Appendix C-7. Sediment Parameters of Trench 2. Section 1.

Horizon	M_z	σ'_i	Sk_i	K_G
Ap	4.37	2.65	0.23	1.53
Bw_1	4.58	2.66	0.26	1.58
Bw_2	4.79	2.89	0.20	1.48
Bw_3	5.04	2.96	0.35	1.51
$2Bw_1$	5.61	2.90	0.46	1.62
$2Bw_2$	5.40	3.11	0.38	1.85
$2Bw_3$	5.57	2.75	0.49	1.83
$2Bw_4$	5.60	2.87	0.49	1.63
$2Bw_5$	4.97	3.72	0.16	1.71
2C	-0.80	2.92	0.79	1.24

Appendix C-8. Sediment Parameters of Trench 4. Section 1.

Horizon	M_z	σ'_i	Sk_i	K_G
Ap	4.73	2.48	0.29	1.87
Bw_1	5.44	2.91	0.43	1.83
Bw_2	5.62	2.71	0.49	1.79
Bw_3	5.09	2.87	0.35	1.70
Bw_4	4.73	3.07	0.23	1.69
C_1	1.34	3.90	0.19	0.91
C_2	0.65	3.71	0.39	0.99

APPENDIX D

CHEMICAL ANALYSIS RESULTS

Appendix D-1. Chemical Analysis of Trench 2. Section 4.

Horizon	Total Carbon (%)	Extractable Phosphorus (ppm)	pH
Ap	1.20	22	5.8
Bt_1	0.80	12	5.7
Bt_2	0.39	20	5.0
Bt_3	0.23	36	5.1
Bt_4	0.17	34	5.1
$2Bt_1$	0.20	25	4.8
$2Bt_2$	0.20	20	4.5
$2Bt_3$	0.18	16	4.7
$2Bt_4$	0.18	14	4.6
$2Bt_5$	0.16	12	4.6

Appendix D-2. Chemical Analysis of Trench 1. Section 2.

Horizon	Total Carbon (%)	Extractable Phosphorus (ppm)	pH
Ap	1.28	300	7.0
Bw_1	0.99	220	6.8
Bw_2	0.96	60	7.0
2Ab	1.00	130	6.7
$2Bt_1b$	1.08	75	6.6
$2Bt_2b$	1.25	120	6.6
$2Bt_3b$	0.96	210	7.0
2Bgb	0.65	300	7.0

Appendix D-3. Chemical Analysis of Trench 2. Section 2.

Horizon	Total Carbon (%)	Extractable Phosphorus (ppm)	pH
Ap	1.30	260	6.6
Bw_1	0.80	250	6.6
Bw_2	0.78	210	6.1
Bw_3	0.54	100	6.6
Bw_4	0.51	70	6.5
C_1	0.42	70	6.6
C_2	0.41	56	6.3
C_3	0.39	70	6.7
C_4	0.35	46	6.7
C_5	0.37	56	6.5
C_6	0.34	54	6.4
C_7	0.39	75	6.7
C_8	0.54	75	6.5
2Ab	0.84	110	6.1
$2Bt_1b$	1.18	260	6.3
$2Bt_2b$	1.20	260	6.5
2Bgb	1.21	90	6.8

Appendix D-4. Chemical Analysis of Trench 3. Section 2.

Horizon	Total Carbon (%)	Extractable Phosphorus (ppm)	pH
Ap	1.42	300	6.9
Bw	0.90	300	6.9
Bt_1	0.99	300	6.5
Bt_2	0.84	240	6.7
C_1	0.75	100	6.6
C_2	0.90	75	6.4
C_3	1.23	160	6.1
2Ab	1.26	300	6.3
$2Bt_1b$	1.35	300	6.5
$2Bt_2b$	1.34	300	6.5
2C	1.10	250	7.1

Appendix D-5. Chemical Analysis of Trench 4. Section 2.

Horizon	Total Carbon (%)	Extractable Phosphorus (ppm)	pH
Ap	1.14	300	6.9
Bw_1	0.99	300	6.9
Bw_2	1.01	300	6.7
Bw_3	1.14	250	6.6
Bw_4	1.42	260	6.6
Bw_5	1.27	290	6.6
Bw_6	1.07	300	6.5
B/C	0.86	300	7.0
C_1	0.88	300	6.6
C_2	0.88	180	7.0

Appendix D-6. Chemical Analysis of Trench 2. Section 1.5.

Horizon	Total Carbon (%)	Extractable Phosphorus (ppm)	pH
Ap	1.32	290	7.1
Bw_1	1.19	250	6.9
Bw_2	1.11	260	6.8
Bw_3	1.07	230	6.9
Bw_4	1.00	300	7.0
Bw_5	0.85	300	6.9
C_1	0.77	300	5.3
C_2	0.64	280	5.7
C_3	0.82	290	5.5

Appendix D-7. Chemical Analysis of Trench 2. Section 1.

Horizon	Total Carbon (%)	Extractable Phosphorus (ppm)	pH
Ap	1.78	90	7.1
Bw_1	1.40	190	7.1
Bw_2	1.09	300	7.0
Bw_3	0.97	300	7.2
$2Bw_1$	0.93	300	7.0
$2Bw_2$	1.08	290	6.9
$2Bw_3$	0.93	300	6.8
$2Bw_4$	0.83	280	7.0
$2Bw_5$	1.16	250	7.0
2C	1.47	300	6.6

Appendix D-8. Chemical Analysis of Trench 4. Section 1.

Horizon	Total Carbon (%)	Extractable Phosphorus (ppm)	pH
Ap	1.57	180	7.0
Bw_1	1.09	260	7.2
Bw_2	1.18	250	6.9
Bw_3	1.30	220	6.9
Bw_4	0.84	300	7.0
C_1	1.01	300	7.1
C_2	1.09	300	7.3

VITA

Michael Wayne Morris was born in Winchester, Virginia on March 23, 1959. He attended the Frederick County School system until 1968 when he moved to Culpeper, Virginia. He attended the public school system there and graduated from Culpeper County High School in June 1977. In the fall of 1977, he entered the College of William and Mary in Williamsburg, Virginia. He began his archaeological experience as a volunteer for the Governor's Land Project in Jamestown, Virginia and the Shirley Plantation Project in Charles City County, Virginia. He became interested in soils work as a laborer for a land development company in Manassas, Virginia where he dug ditches and helped locate drain field sites. He received his Bachelor of Arts degree in Anthropology in May 1981.

He entered the University of Tennessee, Knoxville in September 1981 to pursue a Master's degree in Anthropology. While in attendance, he worked for several archaeological projects including the Big South Fork Archaeological Project of the Big South Fork National River and Recreation Area in Tennessee and Kentucky, the Shelby Bend Archaeological project in Maury County, Tennessee, and numerous smaller projects. His primary research interest is in the integration of archaeology and soil science. He is holding or has held memberships in the American Quaternary Association, the Society for American Archaeology, and the Archaeological Society of Virginia.