SECTION 4.0 REGIONAL SETTING AND GEOLOGIC HISTORY OF THE ST. JONES RIVER VALLEY

To understand the cultural behaviors occurring at Hickory Bluff, it was first necessary to examine the regional setting and the geologic history of the St. Jones River valley. Characteristics of site morphology and agents of environmental change were examined to provide a context to evaluate effects on Native American economy and settlement history. Attention was also placed on the site setting and environmental changes to that setting since these likely influenced archaeological site formation and preservation. The location of Hickory Bluff coincides with the upstream limits of present-day tidal influences in the St. Jones River valley (Figure 4.1). The physiographic setting of the site along the limits of tidal influence, its association with ancient marine transgressions and related geological deposits, and subsequent changes in overall environmental conditions, were all important considerations in understanding the formation history of the river valley, the site landform, and the archaeological record.

PHYSIOGRAPHICAL AND GEOLOGICAL BACKGROUND

Hickory Bluff occurs in the southern outskirts of the City of Dover, Kent County, Delaware. The site lies within the St. Jones River valley, in the Coastal Plain physiographic region of the Delmarva Peninsula (Figures 4.1 and 4.2). The St. Jones River is a relatively small and low discharge stream. It drains an approximate 200-250 km^2 area south of the Leipsic River, west of Route 13, and north of the Murderkill River. The site is situated about 10 kilometers (km) upstream from the present mouth of the St. Jones River at Bowers Beach on the Delaware Bay.

Figure 4.2 Orthophoto Map of the St. Jones River Valley Between Dover and Delaware Bay

Upland topography in eastern Kent County forms a relatively flat surface or plain that slopes gently toward Delaware Bay. Near the bay, this surface is at an altitude of 3-5 meters (m) above sea level (masl), while west of Dover, it rises to 15-18 masl. This plain is mainly Pleistocene in age (Groot and Jordan 1999; Jordan 1964; Pickett and Benson 1983) and has been dissected by a trellised drainage system of east-west and northwest-southeast flowing streams. The upland constitutes the interfluves within this drainage system. The mouths of the dissecting streams have been drowned by the bay (including the St. Jones River), are commonly up to 2 km wide, and today contain extensive, fine-grained, organic-rich tidal marsh deposits (Kraft 1971). These marsh deposits usually extend north-south along the bay behind extensive barrier-bar systems and connect adjacent drainage systems. They are thickest near the bay, and thinnest near the upstream limits of tidal influence. The St. Jones River drainage is typical of such river systems and has a broad, drowned mouth and associated 2 km wide tidal marsh. Although the marsh narrows upstream, it does extend to the Capital Green at Dover (Pickett and Benson 1983). At Hickory Bluff, the tidal marsh extends from one side of the St. Jones River valley to the other and is 200-300 m wide.

UPLAND HISTORY AND MORPHOLOGY

Hickory Bluff occurs along a well-drained, sandy-textured, 7 m high bluff that defines the Pleistocene upland marking the left (east) bank of the St. Jones River (Figure 4.1). Surficial deposits are Pleistocene in age, up to 10 m thick, and rest on semi-to-poorly consolidated Miocene-age, gray, diatomaceous-to-sandy, fossiliferous bedrock of the Calvert Formation (Fm.) (Pickett and Benson 1983). Exposures of Pleistocene deposits at the site indicated relatively thick units of cross-bedded cobbles, gravel and sand that grade upwards to unconsolidated, sandy-silt nearer the surface. Oftentimes, the upper ~80 cm of near-surface deposits exhibited advanced soil formation (pedogenesis). The archaeological component was recovered within the upper mantle of these pedogenically-altered sediments.

During the past decade, the nomenclature, age, and stratigraphic relationships of late-Cenozoic surficial deposits comprising the coastal plain of Delaware have undergone revision (Groot and Jordan 1999). Previously, these mainly coarse-grained, sandy deposits were defined as various depositional facies of the Columbia Fm. and were believed to generally represent only a single phase of late Pleistocene deposition (Jordan 1964, 1974; Kraft 1971). More recent researchers, however, have revisited this and, based primarily on specific indicator plant fossils (mainly pollen) and surficial morphology (presence of erosional scarps), separated the Columbia Fm. in Kent County into the Delaware Bay Group, which is confined to within about 10 km of Delaware Bay. The Delaware Bay Group consists of the Lynch Heights Fm., the Scotts Corners Fm., and the Columbia Fm., which lies mainly west of Dover (Figure 4.3; Groot and Jordan 1999). The Columbia Fm. is reportedly middle Pleistocene in age (>300,000 years B.P.), while the Delaware Bay Group is late Pleistocene in age, mainly Sangamon-to-late-Wisconsinan (<100,000 years B.P.; Groot and Jordan 1999).

Hickory Bluff occurs near the contact between these three formations and because definition of each is based more on indicator fossils than lithological parameters, the actual formation that occurs at the site location is unclear. In fact, only the upper parts of the deposits may relate to Delaware Bay Group sediments and the lower, deeper sediments may be part of the Columbia Fm.

Although details concerning age and stratigraphic nomenclature of surficial deposits near Hickory Bluff may be of little relevance to the archaeology, the texture and distribution of these surficial deposits are important and probably affected both the settlement history and preservation conditions of the site. For example, although Jordan's (1964) conclusions that the Columbia Fm. represented a single phase of fluvial deposition may be disputable, as is the suggested age of the deposits, the textural data supporting those conclusions remain valid (Figure

4.4). Importantly, these indicate the Hickory Bluff substrata consist of relatively coarse-grained deposits. Pebbles (mean size 200 mm) apparently predominate the coarse fraction and are among the coarsest coastal plain deposits in Delaware. Moreover, the fact that Jordan's paleochannel associated with Columbia Fm. deposition (Figure 4.4) generally occurs just west of the contact between the Columbia Fm. and the Delaware Bay Group sediments (Figure 4.3) is probably not coincidental. The "channel-like" texture noted by Jordan (1964, 1974) likely resulted from the periodic winnowing of fine-grained sediments and, therefore, the concentration of coarser-grained sediments (gravels) within ancient fluvial systems that existed during several interglacial transgressions throughout the Middle and Late Pleistocene. Jordan's "channel" is oriented north-south and generally occurs along the contact between the middle Pleistocene Columbia Fm. and late Pleistocene Delaware Bay Group, indicating that during interglacial periods, sea-level rose to about the same altitude (ca. 5-10 m above present level), concentrating gravels within the mouths of tributaries and within beach deposits.

The net result of these processes was the concentration of extraordinary gravel resources within the local area. The abundance of these gravels is amply demonstrated by the fact that they were extensively mined historically for aggregate around Dover (Pickett and Benson 1983; USGS 1993a, 1993c). Abandoned and active gravel pits dot the landscape for several kilometers both east and west of Dover. They are especially concentrated in the upland bordering the St. Jones River, downstream from its confluence with Puncheon Run. Several abandoned pits are concentrated within 1 km of the St. Jones River between Puncheon Run and Isaac Branch (Pickett and Benson 1983). Additional abandoned pits also occur within the vicinity of the Puncheon Run Site. Prehistorically, these coarse-grained deposits likely represented an important lithic material resource. As will be discussed below, ready access to these gravel resources during the prehistoric period may have been linked to a specific phase of riverine development during the Holocene transgression of the Delaware Bay.

RIVER VALLEY HISTORY AND MORPHOLOGY

The modern St. Jones River, including its wide sinuous channel, relatively steep banks, drowned mouth, and associated tidal marshes reflects the culmination of a long and varied formation history (twentieth century straightening and dredging notwithstanding, Appendix A). Significantly, this combination of features indicates that major changes have affected river behavior in the recent geologic past; previously the river was strongly influenced by far different hydraulic conditions (i.e., discharge, gradient, and sediment load). Rising sea levels have overwhelmed and increasingly replaced the preexisting riverine environment with estuarine conditions. As with the original construction of the Delmarva Peninsula and the local uplands discussed previously, the principal controlling factor affecting these processes has been changing sea level. The dramatic fall in sea level associated with extensive continental glaciations, and the subsequent rise in sea level as the ice sheets melted during the late Wisconsinan and early-to-middle Holocene, have fostered important environmental consequences.

During the last major glacial stage (Wisconsinan; 100,000-10,000 years B.P.), a significant percentage of the earth's water supply was contained in continental glaciers. Worldwide sea levels were substantially lower, approaching 100 m below present levels. During this time, most of the continental shelf was exposed and Delaware Bay was an extension of the Delaware River valley (Kraft 1971, Figure 4.5). The St. Jones River was a small tributary of the Delaware drainage system that flowed along the bottom of what is now Delaware Bay. It apparently down-cut a relatively deep valley through the poorly-to-unconsolidated Coastal Plain sediments discussed previously.

At the end of the late Wisconsinan (12,000-10,000 years B.P.), sea level stood near the margin of the continental shelf, leaving Delaware Bay mainly above sea level (Kraft 1971). However, during the inception of the Holocene, sea level rose relatively rapidly, primarily due to influxes of melting continental glaciers. By 4,000 years B.P., sea level stood approximately 5 m below present levels. From this time to the present, sea levels have continued to rise at much reduced rates, due less to influxes of additional meltwater than to continued subsidence of the regional coastal margin. Following the major shift in global climate that triggered ice-sheet reduction, climate has exerted secondary controls affecting sea level (Fairbridge 1992).

As sea level rose, rapidly during the early Holocene and more gradually during the middle and late Holocene, the lower reaches of local river systems were progressively drowned. Rising base level resulted in flatter river gradients, and stream mechanics responded with extensive lateral migration, bank erosion, and the relative lengthening of upstream channel segments. As sea level approached channel elevation, channel migration and incision diminished. Corresponding valley segments shifted from fluvial-riverine to tidal-estuarine environments. Sea encroachment resulted in the accumulation of organic-rich marsh sediments within the reaches of tidal influence, burying older fluvial deposits. This transgression also resulted in the gradual, progressively upstream, replacement of freshwater riparian environments, and associated plant and animal communities with brackish salt marshes. These changes are time- and elevation-transgressive with increased distance from the encroaching sea.

The upland terrace at Hickory Bluff consists of a fining-upward sequence of fluvial and near-shore gravels, sands and silty-sands deposited by alluvial processes that occurred during the

Pleistocene. However, since initial deposition, eolian processes have resulted in the redistribution of surface fine-grained sediments within the Dover area. The identification of extant surface landforms including erosional features (i.e., blowouts) and constructional features (e.g., dunes) provide ample evidence of these processes. As will be discussed, the existence of intervening sand sheets is less obvious but no less probable.

Figure 4.5 Bottom Configuration of Delaware Bay, Drowned Channels, and Tidal Marshes (Kraft 1971)

THE VALLEY/UPLAND DICHOTOMY AND EOLIAN PROCESSES

The possibility that eolian processes have occurred during the Holocene period of human occupation of the Delmarva Peninsula has been addressed from both the standpoint of landform history (Daniels 1995; Denny and Owens 1979; Stolt and Rabenhorst 1987) and archaeological site genesis (Blume 1995; Custer et al. 1996; Kellogg and Custer 1994; Petraglia et al. 1998a; Ward and Bachman 1987). While establishing a definite chronology for eolian activity is somewhat difficult, several distinct periods and preconditions have been suggested. Many upland dune features (Denny et al. 1979) and Carolina Bays (Stolt and Rabenhorst 1987) are often attributed to the late Pleistocene, when strong, dune-building winds originated from the northwest (Denny and Owens 1979). Dunes flanking rivers are thought to differ from upland dunes in both source and age. The common position of these dune features on the east and southeast sides of river valleys has led to speculation that they formed during the Holocene, prior to development of adjacent marsh and swamp conditions related to postglacial rise in sea level (Denny and Owens 1979).

In addition, both Kent and Sussex Counties have a small percentage of mapped eolian soils, and a larger percentage of mapped “possible” eolian soils (USDA-SCS 1971, 1974a). Eolian landform features such as blowouts and dunes are apparent across the upland areas bordering the St. Jones River drainage, and often occur in distinct groups. These are particularly evident on the Dover and Little Creek USGS 7.5' topographic maps, where many of these features exhibit northwest-southeast orientation, with dune features downwind or southeast of blowouts. Blowouts are mapped as round or sub rounded pocket-depressions and are generally less than 2 m deep. Dunes appear arcuate in form and are usually less than 3 m high. Reconnaissance field investigations of several of these features east of Hickory Bluff found all to be presently inactive and stabilized by surface vegetation. A few were mined for sand.

Closer to Dover, several preexisting eolian features have been modified by urbanization. Examination of older topographic maps noted the presence of a possible blowout about 100-200 m north-northeast of Hickory Bluff in an area presently buried with fills. Several additional closed depressions were noted north and west of Puncheon Run.

The presence of visible deflation features such as blowouts and dunes lends credence to the possible presence of intermediary features such as thin “sheet” deposits of eolian sand and silt that periodically reactivated across the upland landscape. However, although blowouts and dunes leave distinctive marks on surface topography, sheet deposits leave little tangible evidence. Unambiguous identification of such relatively thin, laterally extensive deposits is difficult (Section 9.0). Subsequent soil, weathering, and biogenetic influences mask the original sedimentological characteristics of eolian bedding and sorting, and this type of landform (i.e., a sand sheet) does not retain the three-dimensional characteristics of blowouts and dunes.

Significant eolian activity is dependent upon factors of relatively strong wind and the presence of suitable (properly-sized) source material (medium-to-fine-grained sand and silt). Additionally, the ground surface of source areas must be vegetation-free, disturbed or at least generally unstable. Vegetation conditions of deposition areas are less important although windbreaks often reduce wind velocity and prompt eolian deposition (one factor promoting the formation of river dunes). Strong wind conditions are evident from the identification of the aforementioned northwest-southeast trending eolian features identified from local maps and noted across the Delmarva and the greater Coastal Plain (Denny and Owens 1979).

In local upland settings, fine-grained source materials constitute much of the mapped surficial deposits. That previous eolian activity may have deposited and selectively and repeatedly reworked these sediments is possible; each successive eolian landform is only as old as its initial date of stabilization. To this day, vegetation conditions in upland areas remain strongly affected by both climate (especially precipitation and groundwater levels) and cultural activities (such as clearing, burning and cultivation). Late-spring wind conditions presently move fine-grained sediments from locally cultivated fields across the Delmarva.

In local riverine settings, sediment size is primarily dependent upon dominant fluvial conditions that became increasingly affected by sea level rise during the later Holocene. Vegetation conditions in riverine areas are less dependent on climate, but are strongly and locally dependent upon evolving stages of river- and valley-bottom morphology. As examples, gravel bars would prove a poor source for eolian sediment, while mudflats would prove very effective.

Incipient mud flats that formed within river valleys during the late Holocene waning phases of the Delaware Bay transgression probably provided vast open stretches of relatively unvegetated, fine-textured sediments that were an easily eroded source for eolian sediment. As will be proposed below, such environmental conditions within the section of St. Jones River valley adjacent to Hickory Bluff were optimal only during a brief part of the Late Holocene, probably for a few centuries around 1,500 years B.P.

Clear evidence of prior eolian processes was not discernable across Hickory Bluff from examination of surface morphology. However, reworking or burial of the terrace surface by eolian processes would have important implications for archaeological site preservation and context. Morphological characteristics of supporting sediment matrices, and the stratigraphic and chronological disposition of the inclusive archaeological record, have prompted further investigation of this issue in Sections 6.0 and 9.0.

HICKORY BLUFF SITE FORMATION WITHIN A CHANGING ENVIRONMENTAL FRAMEWORK

The Holocene transgression of Delaware Bay, coupled with a unique set of environmental and geological factors that changed over time, greatly affected variables of archaeological site location, formation and preservation. While modern conditions at the site may approximate those of the late prehistoric period, they were apparently much different during earlier occupations. Presently, the valley bottom at the Hickory Bluff site location is broad, flat, and composed mainly of fine-grained, organic-rich marsh deposits. Sediment core data collected a few kilometers downstream from Hickory Bluff, however, indicated that these fine-grained sediments are actually underlain by coarse-grained fluvial deposits of sand and gravel (Rogers and Pizzuto 1994). Radiocarbon-age estimates suggest that these coarse-grained sediments were derived from a pre-transgression, middle-Holocene fluvial environment that represented valley conditions during the Archaic and Early Woodland periods. The transition to overlying finer-grained mud and marsh deposits indicates changing depositional conditions within the valley that may have exerted secondary affects upon the bluff site formation processes, both in net accumulations of natural sediments and archaeological materials.

Rates of sea level change and valley depositional data are synthesized in Figure 4.6. The left side of the diagram indicates the middle-to-late Holocene transgression of Delaware Bay, and a sea level rise to within 5 m of present by 4,000 years B.P. (coinciding with intensive occupation at Hickory Bluff). By 2,000 years B.P., sea level had risen to within about 1 m of modern levels (at the approximate time that site intensity began to decline). The right side of Figure 4.6 outlines the generalized depositional history of the valley, synthesized from multiple cores extracted approximately 1 km downstream from the site (Figure 4.1) (Rogers and Pizzuto 1994). As typically marks such a transgressive sequence, the base consists of sandy and organic-rich fluvial deposits. These fluvial deposits were buried by >3 m of fine-grained organic-rich, tidal-marsh sediments after 2,000 years B.P. Most of the tidal-marsh sequence was deposited by 1,000 years B.P., which suggests that more stable, tidal-marsh conditions were achieved by that time. Interestingly, abundant charcoal was also recovered between 2-3 m (practically no charcoal was recovered from the upper 1.5 m), presumed to mark a very dry period with extensive forest fires within the St. Jones River valley (Rogers and Pizzuto 1994). However, this variability may also reflect intensity of local human activity within the valley (Kellogg and Custer 1994).

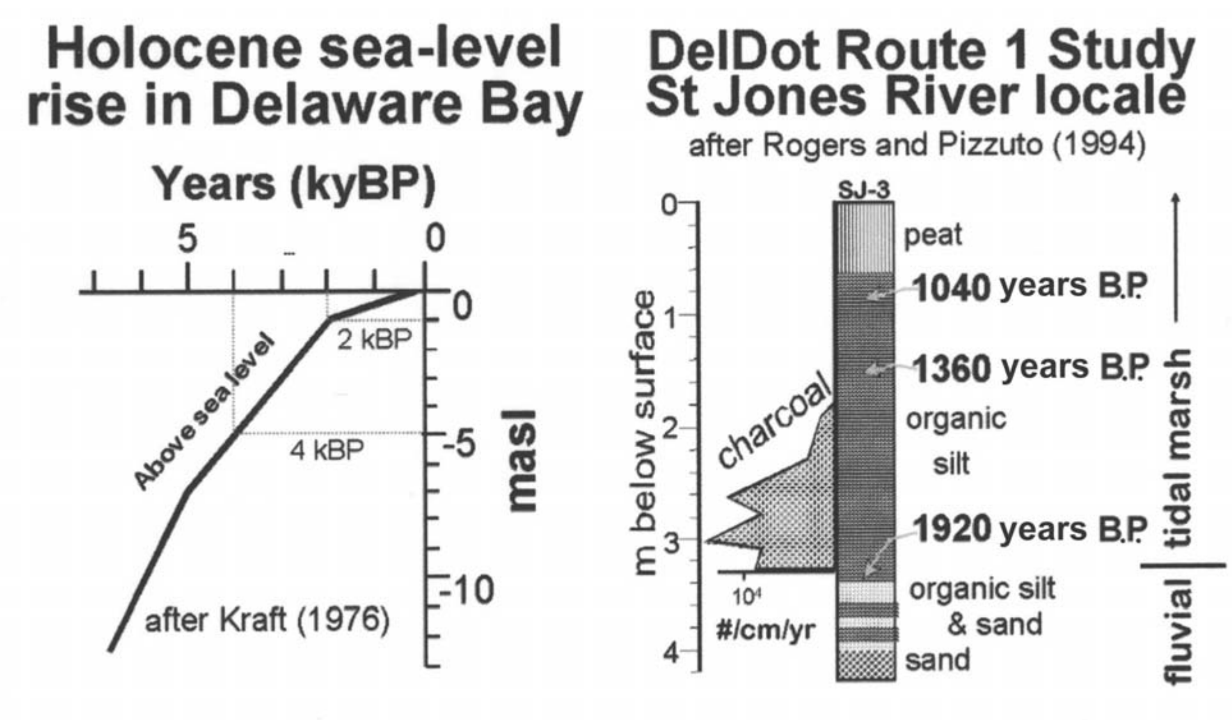

Figure 4.6 Holocene Trangression of Delaware Bay and SR 1 Stratigraphic Column of the St. Jones River Near Hickory Bluff (Sea Level Rise from Kraft 1977; SR 1 Stratigraphic Column Modified from Rodgers and Pizzuto 1994**)**

The timing of the transition from mainly fluvial/palustrine to mainly tidal/estuarine conditions is significant. Prior to this transitional period, gravel and cobbles were probably relatively abundant in the valley. Tidal conditions predominated after about 2,000 years B.P. within the St. Jones River, Leipsic River, and Duck Creek valleys (Pizzuto and Rogers 1992; Rogers and Pizzuto 1994). This is in general agreement with sea level curves synthesized by

Fletcher et al. (1990) and Kraft (1977) based on a host of radiocarbon age determinations collected over the past 40 years from around Delaware Bay (Ramsey and Baxter 1996). Based on supplemental cores collected from the St. Jones River valley near the Carey Farm and Island Farm sites (Custer et al. 1996), it was reported that tidal conditions reached within 4 m of present levels between 3,500 and 1,900 years B.P. (Pizzuto 1996:319), with the earlier date (derived from a single radiocarbon-age estimate) actually reflecting the time of transition from fluvial to tidal *marsh* conditions. Such an early age determination for the onset of *marsh* formation is somewhat at odds with other data collected from the same study, and other nearby valleys (Rogers and Pizzuto 1994). In fact, extensive lateral channel migration and sedimentation in the vicinity of the core transect (Pizzuto 1996) was suggested earlier (Rogers and Pizzuto 1994). It was also reported that this migrating channel was abandoned and drowned “coincident with the transgression of tidal water into the area in approximately 2000 BP” (Rodgers and Pizzuto 1994:73).

Although the older age suggested by Pizzuto (1996) for the influx of tidal water in the upper reaches of the St. Jones River may be disputable, the remainder of the reported lithologic and radiometric sequence is in agreement with the more traditional timing of tidal incursion. The majority of age determinations from tidal-marsh deposits (i.e., peat and organic-rich muds) fall in the 1,000-2,000 years B.P. range; little if any tidal sediment was deposited before 2,000 years B.P. This lack of tidal-marsh deposition again attests to the probable exposure of coarse-grained fluvial sediments within the valley prior to 2,000 years B.P.

In consideration of the data presented in Figure 4.6 and discussed above, changes in the Hickory Bluff archaeological record may be correlative with dynamic shifts in the St. Jones River related to rising sea level. For example, the period of most intensive occupation, as well as prolific tool production, appears related to the period of fluvial conditions within the valley when gravels were easily available. With the onset of extensive fine-grained marsh infilling of the valley, site function, as well as occupational intensity, apparently changed. Evolving valley conditions are summarized below and modeled in Figure 4.7.

Prior to sea level transgression, and during most of the past 100,000 years, Delaware Bay and much of the continental shelf was subaerially exposed. As a consequence, streams draining into the Bay, such as the St. Jones River, eroded deep valleys through most of the unconsolidated Columbia Fm. and parts of the Delaware Bay Group sediments. As is true with most down-cutting systems, this river channel was probably relatively straight, with few meanders (Figure 4.7A). As it eroded the Columbia Fm, gravels may have been periodically exposed but were probably not aerially extensive. Additionally, valley walls likely were also quickly slumped and vegetated. Consequently, outcrops of gravel in the Columbia Fm. were probably largely hidden under soil and vegetation.

As sea level rose during the early and middle Holocene, the St. Jones River valley began to back-flood (Figure 4.7B). First the “submarine” channels were flooded under present-day Delaware Bay. By 4,000 years B.P., the surface of Delaware Bay was within 5 m of modern levels and probably began to affect the upstream portions of the river near Hickory Bluff (Figure 4.6). Rising seas, acting as a rising base level for the river, resulted in a reduced channel gradient- a flatter, less inclined channel. This caused the river to meander and form a relatively longer channel. This laterally shifting channel reworked preexisting valley-bottom landforms such as alluvial fans and strath terraces, and cut into the valley walls and thereby widened the valley bottom (any pre-existing archaeological site locations within the bluff edge and valley bottom were probably buried or destroyed). Meander undercutting also caused extensive slumping and scarring of gravel-rich valley walls; fine sediments were subsequently washed away from slumps and slides leaving coarser sediments behind. Within the river bottom, sizable point bars formed that further winnowed the gravel. Continued transgression amplified the process and meandering accelerated as channel gradient continued to decline. More extensive point bars developed and continuously reworked older sequences. The valley bottom aggraded (filled) with coarse-grained fluvial (channel) deposits. By 2,500 years B.P., the valley bottom probably looked more like a braided-stream sand plain than a meandering-channel flood plain. This period of active channel migration probably resulted in formation of extensive, continually replenished and reworked, gravel deposits within the valley bottom, as well as outcrop exposures of gravel in the valley walls. The timing and relative intensity of site occupation may relate to gravel availability and abundance.

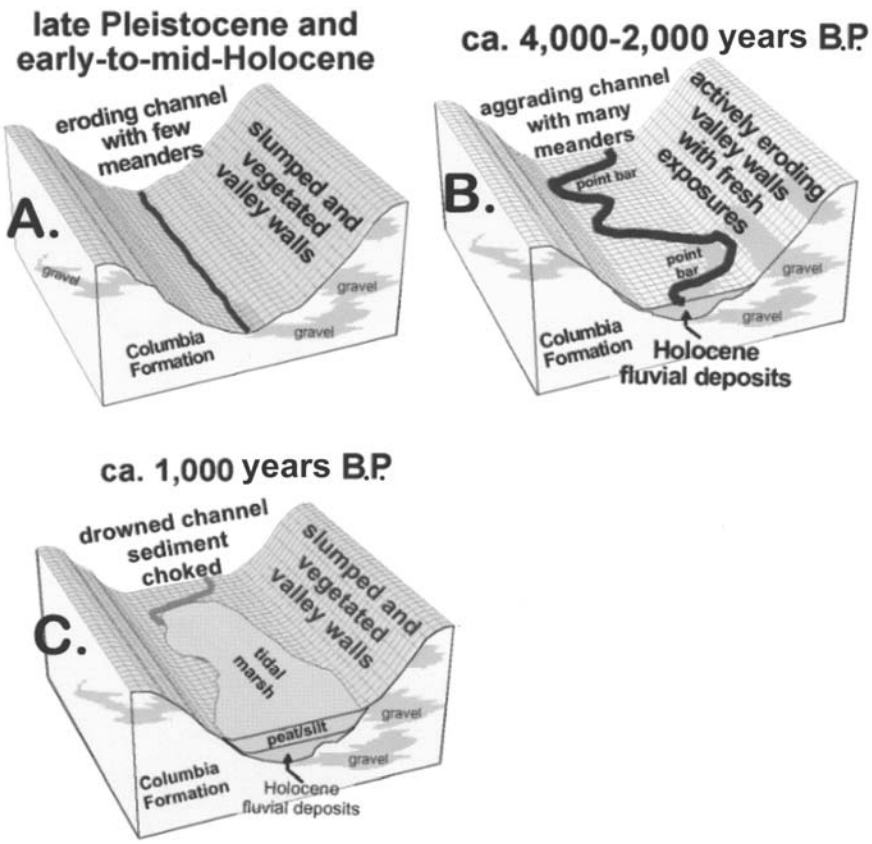

Figure 4.7 Model of the Middle-to-late Holocene Evolution of the St. Jones River Valley Near Hickory Bluff

After 2,000 years B.P., tidal influences resulted in net deposition of extensive fine-grained and organic-rich sediments within the valley bottom (Figures 4.6 and 4.7C). As the river channel became drowned progressively upstream, stream competency changed and it could no longer carry coarse sediment. Rates of point bar replenishment slowed. Lateral channel migration ceased, and the broad arcuate meander scars stopped developing. Valley walls began to stabilize with soil and vegetation cover. By 1,500-1,000 years B.P., early and immature wetland environments formed within the valley bottom bordering the site as sea level neared its Holocene maximum.

These transitional conditions–characterized by mud flat formation--may have provided a sediment source for eolian processes to partly mantle the vegetated, upland valley margins south and east of the river. An extensive plain of easily eroded, sandy-to-silty sediment likely developed across the valley bottom. Dominant west-northwest winds may have had adequate competency to erode these flats and deposit incremental additions of deflated sediment upon the vegetated bluff crest. As transgression progressed and the valley bottom stabilized with marsh vegetation, availability of this sediment source would diminish, and correspondingly, net accumulation of eolian deposition across the upland site. Features and artifacts attributable to the Archaic through Middle Woodland time periods appeared buried under 10-20 cm of sediment. The depositional conditions of the archaeological record and supporting sediment matrices prompted further investigation of the eolian burial issue (Section 9.0).