3.0 ENVIRONMENTAL SETTING

3.1 Paleoenvironment

Understanding long-term variation in the characteristics of the natural environment is essential to assessing American Indian use of resources distributed across the project area during the approximately 12,000 or more years that people lived in this part of Delaware. While the environment of the Middle Atlantic region has remained relatively stable for the past 5,000 years, substantial change has been recorded in geological and biological records prior to that time. Two broad trends shaped the region's environment during this period: a general warming of the climate that marked the end of the Pleistocene Ice Age; and, ongoing sea-level rise.

The continental ice sheet reached what is now central Pennsylvania and New Jersey, and much of the Middle Atlantic ahead of the ice front was covered by open tundra or boreal forest typified by conifers. Evidence has also been recorded of permafrost in areas as far south as southern Delaware (French et al. 2009). Holocene warming resulted in the replacement of boreal forests with mixed deciduous communities typical of southern temperate zones. Relative sea level, at the end of the last glaciation, is estimated to have been as much as 100 m below current levels (Kraft 1971). Large areas of the continental shelf were exposed, and the present Chesapeake and Delaware Bays consisted of freshwater rivers and outwash channels. Melt water from the retreating glaciers rapidly raised sea levels, resulting in the inundation of coastal streams and, ultimately, the creation of modern estuary systems. Rising sea levels resulted in the transformation of many rivers on the Coastal Plain from systems flowing in entrenched valleys to the sluggish, meandering courses seen today.

Sea level rise also encouraged the expansion of interior wetlands. Dent (1995) summarizes a large body of data specific to the Chesapeake region, indicating that the development of the Bay estuary system was well underway by 5500 years BP and was largely complete by 2000 years BP. The onset of tidal conditions was a key indicator for the estuarine development. Rivers in the interior areas of Delmarva became tidal later than the main bodies of the Delaware and Chesapeake bays (Kellogg and Custer 1994). Paleoenvironmental studies specific to the SR1 corridor suggest the freshwater tidal conditions arose on the St. Jones River near Dover around 2,000 years ago (Rogers and Pizzuto 1994:75), but did not reach the portions of Duck Creek and the Leipsic River, north of Frederick Lodge, until approximately 500 years ago (Rogers and Pizzuto 1994:72,79).

Climatic changes occurred as a series of short-term variations within a general trend. In the Northeast and Middle Atlantic, the major climatic episodes are known as the Late Glacial, Pre-Boreal, Boreal, and Atlantic and the primary characteristics of these periods are summarized below. The following outline is based on the work of Carbone in the Shenandoah Valley (Carbone 1976); Rippeteau in the Upper Susquehanna Valley of New York (Rippeteau 1977); Vento and Rollins (1990) in the Susquehanna and Delaware Valleys; Dent's research from the Upper Delaware Valley (Dent 1979); Delcourt and Delcourt's regional synthesis (Delcourt and Delcourt 1981); and several site-specific studies, such as at Buckles Bog in Garrett County, western Maryland (Maxwell and Davis 1972); Hartstown

Bog in Mercer County, northwest Pennsylvania (Walker and Hartman 1960); the New Paris Sinkhole in Somerset County, southwestern Pennsylvania (Guilday et al. 1964), Prince Georges County, Maryland (LeeDecker et al. 1991); and several locations in central Delaware, including Walter's Puddle, in southern New Castle County (Newby et al. 1994; Webb et al. 1994), and the floodplain of St. Jones River at Blueberry Hill, in central Kent County (Brush 1995). The initial episode, the Late Glacial, pre-dates the traditionally accepted arrival of human populations in the Northeast by at least 1,500 years, but is included as a backdrop for human occupation of the region.

3.1.1 Late Glacial ca. 15,000-13,000 years BP

The climate of the Late Glacial period was cold and wet, with tundra-like vegetation present, particularly near the ice front. Abundant open parkland occurred further south, with sedges and grasses interspersed with stands of spruce and fir (Maxwell and Davis 1972; Wright 1981). Pollen records at Marsh Creek in Chester County, Pennsylvania, indicate a changing mixture of grasses, sedges, and boreal species at approximately 13,500 years BP, suggesting the transitional nature of the period (Martin 1958). Whitehead (1973) has proposed a general displacement of approximately 1,000 kilometers (km) between the glacial front and boreal forests to the south. These open areas, which would have included all of the Delmarva Peninsula, may have supported a wide variety of northern faunal species and Pleistocene megafauna. More recently, it has been argued that a relatively undifferentiated boreal forest environment was in place in the Middle Atlantic region during the Late Glacial, and that herds of large game were probably not present by the time of the first documented human incursion (Custer 1990).

3.1.2 Pre-Boreal ca. 13,000-10,700 years BP

The Pre-Boreal period remained cold and wet, though it was marked by a general warming trend. The existing mosaic of tundra, open grasslands, and boreal forest continued relatively unchanged in many areas, with spruce and pine forest becoming dominant in most locations. Swamps and remnant peri-glacial lakes were common (Custer 1984). A decline in species diversity in both flora and fauna has been suggested, leading to less varied plant food availability (Raber 1985:9-10) and a reduction in both large and small animal species (Guilday 1982). Alternatively, Carbone (1976:185) suggests a fairly compressed mix of "boreal and austral species side by side," including deer, elk, moose, possibly remnant mastodon, horse, bison, and smaller game.

3.1.3 Boreal ca. 10,700-9200 years BP

Initially, this period was marked by an increase in the development and spread of warm air masses across the region. Open grasslands diminished in extent, while spruce woodlands were replaced by pine forest and northern hardwoods, especially oak (Walker and Hartman 1960; Sirkin 1977). Watson and Custer (1989) cite evidence for the replacement of spruce forests by hemlock in the Middle Atlantic Coastal Plain. Less varied habitats may have resulted in lower carrying capacity (LeeDecker et al. 1991). Guilday (1982) has indicated that modern faunal species were in place in western Pennsylvania in a mixed, oak/chestnut-dominated forest by at least 9000 years BP.

3.1.4 Atlantic ca. 9200-6600 years BP

The early portion of the Atlantic period was characterized by warm and increasingly wet conditions, signaling the onset of a fully modern climatic regime and essentially modern floral and faunal communities. Oak-hemlock forests expanded, and "mesic forests mantled the landscape from the floodplain to the ridges" (Carbone 1976:189). Evidence that an oak-hemlock complex was well established by about 7900 years BP was recorded at the Mitchell Farm site (7NC-A-2), in northern New Castle County (Custer and DeSantis 1985). Oak dominance over hemlock is identified in Delmarva by 7000 years BP (Bernabo and Webb 1977). Wetter conditions fostered the expansion of wetlands, but a drying trend occurred near the end of the period (Carbone 1976:76). Regionally, pollen profiles at Walter's Puddle, approximately two miles north of the present project area, indicate that at an oak-dominated forest was well established by 5800 years BP (Newby et al. 1994:35). The dominance of mast producing tree species likely encouraged an increase in deer, turkey, and small mammal populations (Custer 1989).

3.1.5 Sub-Boreal ca. 6600-2000 years BP

The Sub-Boreal period was warm and dry, characterized by a re-expansion of grasslands and the dominance of oak-hickory forests and xerophytic floral species. Environmental stabilization near the end of the period is evidenced by a lack of change in forest components, as suggested by pollen cores from southern Maryland, near St. Mary's City (Kraft and Brush 1981). These cores indicate the general dominance of oak, hickory, and pine by around 3400 years BP. Additional pollen profiles from Delmarva suggest that hickory was the dominant species in the northern part of the peninsula, and pine in the southern part (Bernabo and Webb 1977). The decrease in hemlock during the Sub-Boreal was widespread in eastern North America during the middle Holocene, but in Delmarva, it may have been as much a result of edaphic conditions—specifically the predominance of dry, sandy soils—as it was of climate change (Custer 1989). The burial of landscapes through aeolian, or windblown, deposition has also been observed throughout the peninsula, and is presumably associated with a combination of xeric soils and drying climatic conditions (Curry 1980, 1992; Ward and Bachman 1987; Curry and Ebright 1989; Daniels 1993). An increasingly cool and moist climate prevailed near the end of the Sub-Boreal period.

3.1.6 Sub-Atlantic ca. 2000 years BP -present

A general and progressive cooling trend is noted throughout the Sub-Atlantic period to the present day. A rise in the incidence of organic debris in sediments along the St. Jones River in central Delaware suggests increased precipitation (Daniels 1993). Stratigraphic non-conformities associated with both aeolian and alluvial depositional events suggest abrupt shifts in precipitation (Custer 1978, 1989). Since the last 500 years ago, the climatic pattern appears to have stabilized. Modern oak-chestnut forests were well established in the Piedmont and Fall Line Zones, while chestnut-pine communities were common in the High Coastal Plain, particularly in sloping locales (Braun 1950).

3.2 Present Environment

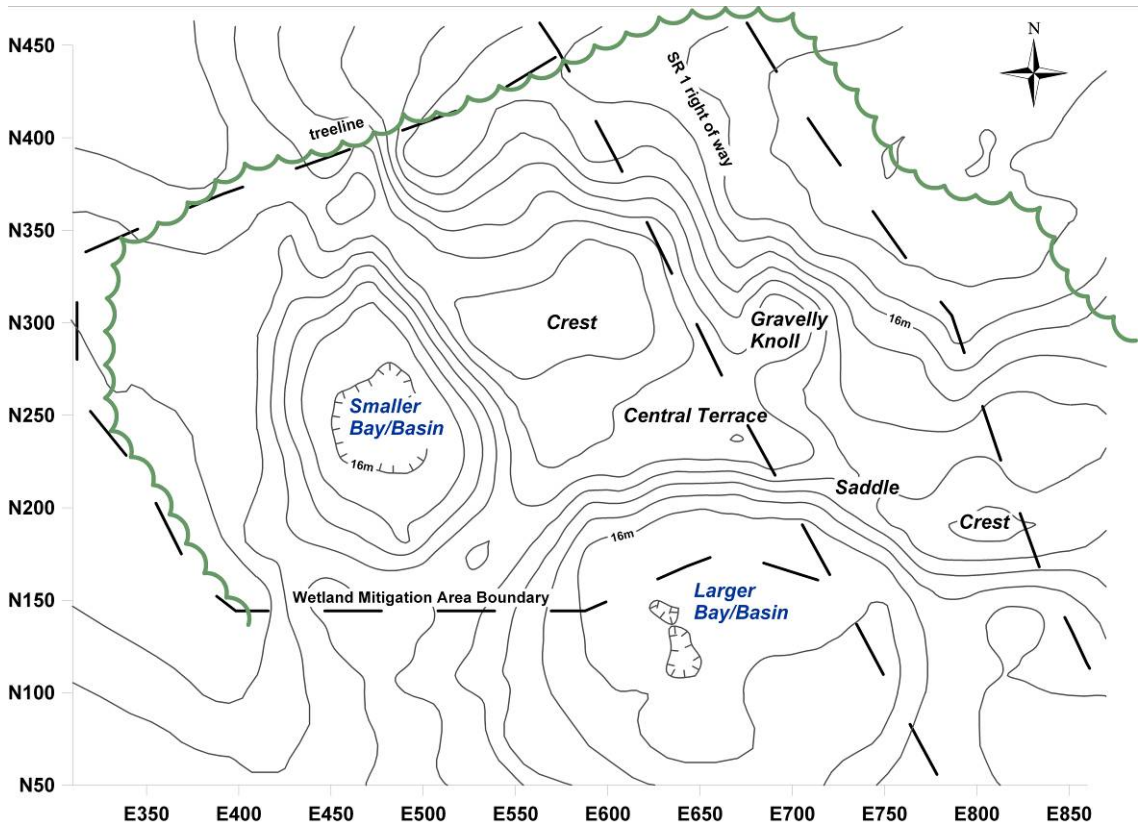
3.2.1 Site Location and Setting

The Frederick Lodge Site Complex was situated approximately 7 km north of the town of Smyrna, in New Castle County, Delaware. The site complex takes its name from the nearby Frederick Lodge, a historic manor house and presently the location of a mobile home park. The Frederick Lodge Site Complex was centered in an agricultural field approximately 500 m west of the manor house. The SR1 right-of-way corridor extended southeast-to-northwest across the eastern limits of the archaeological site (Figure 3-1). The bulk of the site, however, fell within an adjoining wetland replacement area that was roughly rectangular in shape. Together, the right-of-way and wetlands replacement area encompassed 11.5 hectares (28.4 acres).

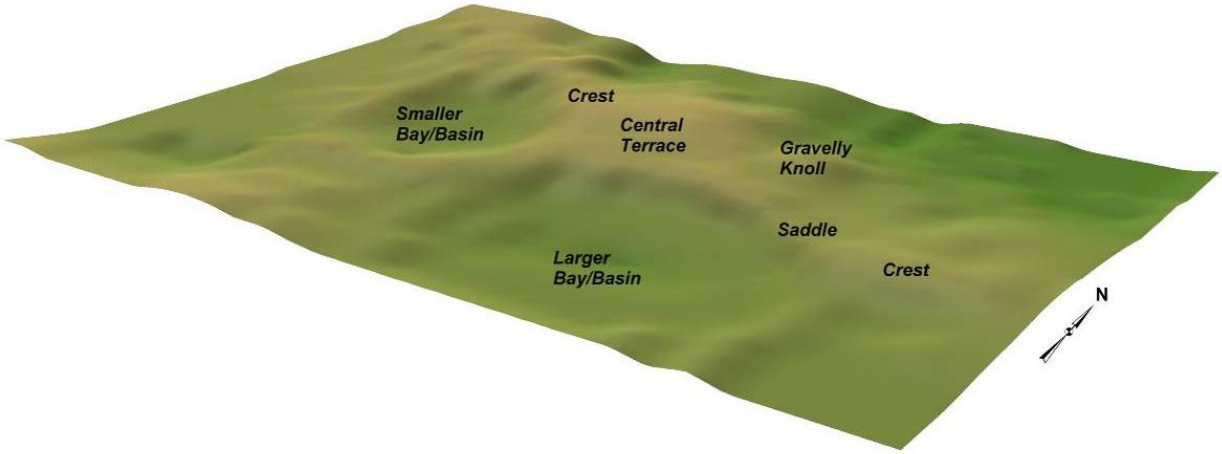
The most prominent topographic features within the Frederick Lodge area were two large bay/basins, broad, circular-to-oval depressions that are common throughout surrounding portions of New Castle County. Wide terraces capped by low, dune-like knolls bordered the depressions, giving the terrain an undulating character. To facilitate discussion of the archaeological findings in relation to the landscape features, several of the latter were given specific designations. One of the bay/basins, for example, fronted the southern portion of the proposed wetland replacement area. The feature measured approximately 300 m in diameter, and is hereafter referred to as the *larger bay/basin* (Figure 3-1). The difference in elevation between the rim and bottom of the bay/basin was approximately 2.4 m. The northern edge of the feature, including the full extent of the slope, fell within the project area limits and had until recently been in agricultural use. The bottom of the bay/basin was dry, although a modern, excavated pond was located at its base (Plates 3-1, 3-2).

The second bay/basin feature was situated entirely within the western portion of the proposed wetland replacement tract. The depression measured approximately 160 m in diameter, and is hereafter referred to as the *smaller bay/basin*. The bottom of the feature was dry and, like the rest of Frederick Lodge area, had been under recent cultivation. The difference in elevation between the rim and base of the depression was approximately 2.8 m.

A broad terrace was situated east of the smaller bay/basin and north of the larger feature. This landform occupied roughly the center of the project area tract and is hereafter referred to as the *central terrace*. A low, dune-like knoll, referred to as the *crest* or *landform crest*, was present along the northern end of the terrace, centered on the northeast side of the smaller bay/basin. A similar *crest* was present along the northeast side of the larger bay/basin, separated from the central terrace by a broad *saddle*. North of the central terrace, the landform sloped steadily to the northeast. An anomalous area on the northern edge of the terrace was capped with Columbia Formation gravels and small cobbles exposed on the surface, and; the area is referred to here as the *gravelly knoll*.



a) topographic relief (grid scale in meters, elevation contour interval 40 cm)



b) surface rendering (vertical exaggeration ca. 5x)

Figure 3-1. Major Landforms Associated with the Frederick Lodge Site Complex.

3.2.2 Regional Physiographic Setting

The Frederick Lodge Site Complex was located within the High Coastal Plain physiographic province, which extends from the Smyrna River north to the Fall Line (Custer 1989). This zone is typified by rolling topography and displays sufficient relief to influence seasonal differences in plant communities. The High Coastal Plain of Delaware can be sub-divided into three zones: Bay Coast, Mid-Drainage, and Drainage Divide (Custer 1989). The Frederick Lodge Site Complex was located along the boundary between the Mid-Drainage and Drainage Divide zones. Both of these zones are rich in a variety of resources, since they include the varied ecological elements contained in freshwater and brackish streams, freshwater swamps, and a range of soil types and associated vegetative communities, all within closely bounded areas.

An important factor contributing to the productivity of the Delaware Coastal Plain is the occurrence of a variety of environmental zones within a relatively small geographic area. Thomas et al. (1975) effectively summarized these zones and the resource bases they represented as follows: 1) Saltwater Bays/Ocean, 2) Tidal Marsh and Estuarine Environments, 3) Well Drained Woodlands, 4) Poorly Drained Woods and Swamp, and 5) Permanent Freshwater (rivers/streams). Each zone would have offered a distinctive set of game, plant food, and raw material resources. With the exception of the Delaware Bay shore, which is located approximately 9 km distant, all of the zones occur within the immediate vicinity of the Frederick Lodge Site Complex, emphasizing again the resource diversity of this upland locale.

The High Coastal Plain is underlain by the southeastern extension of the Columbia Formation, a deposit of continental rather than marine sediment (Custer 1989). Specifically, the Columbia Formation consists of unconsolidated and heavily reworked sands and gravels of Pleistocene age deposited as glacial outwash and originating from the Piedmont uplands (Groot and Jordan 1999). This deposit contains a wide variety of stone types, including quartz, quartzite, chert, and jasper, ranging in size from sorted sands, to gravels, cobbles, and boulders. A high percentage of coarse material that resists weathering occurs in the formation, which has contributed to the rolling topography characteristic of this physiographic zone. Portions of the underlying Columbia Formation are often found exposed along stream banks, within eroded gullies, in large tree-throw depressions, and in eroded surface features, such as the gravelly knoll near the center of the Frederick Lodge Site Complex. The deposits were important for local prehistoric populations as a source of raw material for stone tool manufacture.

3.2.3 Soils

Surface soils along the central terrace and other elevated portions of the Frederick Lodge Site Complex consist of Sassafras Series sandy loam. The adjacent bay/basin soils are classified as Fallingston Series Sandy Loam (Matthews and Lavoie 1970). Sassafrass Series soils are characterized as well-drained or exceedingly well-drained. On level ground they are generally fertile and would have constituted good soils for primitive horticulture (Thomas et al. 1975:41). Well-drained soils such as the Sassafrass Series favor mast-producing trees, such as oaks and hickories, as well as other species of potential economic importance, such as persimmon. In contrast, Fallingston Series soils are generally poorly drained and often

contain seasonally or perennially high water tables. Vegetation in areas of Fallingston Series soils prior to historic land clearing would likely have been limited to water-tolerant or wetland species. Areas such as these were likely to have had dense understories and would have provided good forage and game cover (Thomas et al. 1975:41).

3.2.4 Hydrology and Topography

The Frederick Lodge Site Complex straddled the divide between two Delaware Bay watersheds. Areas south and east of this location are drained by the headwaters of Sawmill Branch, a tributary of the Smyrna River. This river flows into the Delaware Bay directly east of the town of Smyrna. Areas to the north are drained by Sandom Branch, a first-order tributary of Blackbird Creek, which also flows eastward to the Delaware Bay. The lower reaches of both the Smyrna River and Blackbird Creek are tidal and broadly embayed. Extensive fresh/brackish water wetlands flank the lower portions of both waterways, as well as the adjacent Delaware Bay shoreline.

Broad, level upland terraces characterize the Sawmill Branch headwater areas east of the site. These upland areas are poorly drained and remain largely wooded. Elevations range from 14-20 m above mean sea level. A large number of bay/basin features are present north and west of the site. These features are particularly numerous in the area of Blackbird State Forest. Like the two bay/basins on the Frederick Lodge Site Complex, most are dry. Northeast of the site, elevations drop and the landform surface is more irregular. Shallow gullies and minor scarp-like rises, reminiscent of relic stream channels and terraces, are evident. Standing water may be present in these low areas, even throughout the seasonally dry fall months.

3.2.5 Modern Climate

The climate of northern Delaware is temperate and humid. The proximity of the Chesapeake Bay, Delaware Bay, and the Atlantic Ocean serve to moderate temperature extremes. The following climate information for New Castle County is derived from long-term National Oceanic and Atmospheric Administration records for Wilmington, Delaware, posted on the Northeast Regional Climate Center website, *Comparative Climate Data for the United States* (NRCC n.d.). July average high and low temperatures are 85.6 degrees Fahrenheit (F) and 67.1 degrees F. January highs and lows are 38.7 degrees F and 22.4 degrees F. The area experiences significant temperature swings, particularly outside the summer months. In the winter, these changes are typically brought on by the arrival of continental cold fronts. On average, there are 20 days a year in which the temperature reaches or exceeds 90 degrees F, while freezing temperatures occur 99 days of the year. Average annual precipitation is 40.8 inches. Although this total is spread evenly throughout the 12 months, the greatest rainfall is in July, most falling quickly as a result of thunderstorms. Tropical storms occasionally reach as far north as Delaware, occurring from June to October, with the months of August and September bringing the greatest threat of tropical weather. Precipitation during cool weather months is the result of cyclonic low pressure systems. In the winter months, average snowfall is 20.7 inches.

3.2.6 Flora and Fauna

The Delaware Coastal Plain is a rich environment that supports a variety of plant and animal species. The relatively mild coastal climate provides for short winters. Fertile soil and a long growing season are considerations that are equally important to modern agriculture as to the productivity of wild plant species for people living in the region prior to European settlement. The northern half of the Delaware Coastal Plain falls within the oak-hickory climax forest type (Thomas et al. 1975:37). Oak species as well as hickories have been an important component of the local forest cover since approximately 4000 BC (Kellogg and Custer 1994:96). The Holocene pollen stratigraphy of the nearby Walter's Puddle bay/basin records a regional oak-dominated forest with the additional presence of vegetation characteristic of bog habitats (Newby et al. 1994:35). The oak-hickory forest, with its extensive mast production, represents a particularly rich environment (Sutton and Sutton 1985: 21-31). Nuts and acorns are primary seasonal forage for game species, such as deer, turkey and squirrel. These animal species along with the forest mast itself were key elements in Native American economies.

Most of the bay/basin depressions in the region contain wetland soils, suggesting that while many are dry today, most of them probably held surface water in the past. The features would have represented a distinctive set of micro-environmental features supporting a variety of plant and animal types beyond the typical forest communities. In the Carolinas, ecological research into ponded bay/basin has shown these environments to have very high bio-diversity (Krajick 1997:50). Ponded features in the Delmarva uplands likely comprised similarly unique settings within an already diverse and productive local environment. Freshwater pond habitats support a variety of aquatic and amphibious animals. A number of mammalian species, notably beaver, muskrat, mink, otter, and weasel, live or feed around ponds and wetland fringes. Open water would have also attracted water fowl. In terms of vegetation, cattail species and other emergent wetland plants would have offered human populations both food resources and useful raw material. The adjacent slopes of the depressions would have supported forest fringe species, most importantly Black Cherry (*Prunus serotina*), Wild Plum (*Prunus americana*), and Persimmon (*Diospyros virginiana*) (Taber 1995). High, well-drained ground such as the sandy knolls bordering the bay/basins are the preferred habitat for sweetmeat hickories, such as Pignut (*Carya glabra*) and Mockernut (*Carya alba*) (Taber 1995).

Bay/basins without ponded surface water would also have represented productive resource locations. As closed drainage areas, the basin soils would have been moister and more organically enriched than the surrounding uplands. Rich, moist woodlands are the preferred habitat for a variety of important understory and ground cover plant species, such as Paw Paw (*Asimna triloba*), Hackberry (*Celtis occidentalis*), and Shadbush (*Amelanchier aborea*) (Taber 1995; Sutton and Sutton 1985). Other edible plants that thrive in these settings include Jack in the Pulpit (*Arisaema species)* (Fernald and Kinsey 1958), as well as fern species and a variety of mushrooms and fungi.

3.2.7 Historical Landscape Impact

The Frederick Lodge Site Complex was located in an open agricultural field. At the time of investigations, ground surface visibility was good, as the field had been plowed and disked as

part of the Phase II archaeological evaluation. The property that contained the Frederick Lodge Site Complex had been in agricultural use throughout the historical period to the modern day. Archival research, Phase II artifact data, and field inspections suggested that the site complex had not been subject to historical construction or related activities. Historical structures were documented along US Highway 13, well east of the site, but no evidence was found of structures within the delineated site boundaries (Appendix C contains a detailed description and analysis of the Historical Component). Physical impacts to the small bay/basin are limited to those associated with plowing. A ditch extended out the south side the larger bay/basin. This excavation had likely been designed to facilitate drainage to claim the bottom of the depression for agricultural use. In addition, an artificial pond and been excavated near the center of the feature. The perennial water table within this pond was approximately 60 centimeters (cm) below grade. The ditch and pond represented minimal landscape impacts localized in areas immediately outside the boundaries of the archaeological site.