II. ENVIRONMENTAL BACKGROUND

A. Physiography

The SR 896 corridor lies at the northern edge of the Coastal Plain physiographic province, the most extensive physiographic zone in the state (Figure 2-1). The Coastal Plain is characterized by unconsolidated sandy and silty sediments and exhibits relatively little topographic relief. The region is subdivided into two segments—the Low and High Coastal Plains. The Low Coastal Plain comprises most of Kent and Sussex Counties and consists of sandy, generally well-drained soils of the early Cretaceous Potomac Formation (Jordan 1964). The region is nearly level, with maximum elevations typically below 10 meters (30 feet) above mean sea level. Most of the streams in the Low Coastal Plain drain eastward toward the Delaware Bay and are tidal for much of their length (Matthews and Lavoie 1970).

The High Coastal Plain, composed of sediment eroded from the Piedmont terraces to the north and northwest, is delineated by the extent of coarse gravel deposits associated with the Columbia Formation (Jordan 1964). The gravels comprising the High Coastal Plain extend horizontally from the Fall Line southward to the Smyrna River. The region displays somewhat greater relief than the Low Coastal Plain, with elevations up to 16 meters (50 feet). As a result, streams are more often incised, and a greater variety of well-drained and poorly drained soils and more diverse environmental habitats are present. Streams typically flow eastward to the Delaware River and are tidal through their low and middle reaches. A few streams at the western edge of the High Coastal Plain flow westward into the Chesapeake Bay. The divide separating the watersheds is referred to as the Mid-Peninsular Drainage Divide. The SR 896 corridor roughly parallels this divide.

Immediately north of the project area lies the Piedmont/Fall Line province, separated from the Coastal Plain along an irregular boundary. The region exhibits substantially greater relief than either segment of the Coastal Plain, with elevations

ranging to 80 meters (260 meters). Stream incision is frequently pronounced. At the Fall Line, streams tend to drop sediment bed loads collected from the Piedmont terraces. While few streams currently carry great sediment loads, glacial outwash at the end of the Pleistocene deposited extensive pebble and cobble beds (the Columbia sediments) containing quartzite, quartz, and chert. These deposits represent valuable secondary lithic sources that were quarried by prehistoric populations (Jordan 1964; Custer and Glasso 1980; Riley et al. 1994a). The zone generally exhibits well-drained soils with few extensive floodplains. The range of habitats represented in areas of moderate relief provide the basis for relatively high natural resource diversity.

B. Geology and Soils

The Columbia Formation sediments consist of unconsolidated quartz and feldspar sands mixed with sandstone, vein quartz, and chert gravels (Jordan 1964). The material was deposited within a braided stream channel that ran roughly north-to-south through the area during the Pleistocene (Spoljaric 1967). Stratigraphically, the sediments exhibit a regional dip toward the south—sediment particle size generally decreases and sorting increases to the south as well. The Columbia Formation sediments are underlain by the Wissahickon Formation, consisting of igneous and metamorphic bedrock including schist, gneiss, and migmatite (Spoljaric 1967; Matthews and Lavoie 1970). Two prominences south of the Fall Line, Iron Hill and Chestnut Hill, are part of the Piedmont bedrock. The hills are composed mainly of igneous rock—gabbro, norite, and pyroxenite (Spoljaric 1967), but siliceous jaspers are also present (Melson 1969). Primary outcrops of jasper occur in many portions of the two hills, and while the quality of the cryptocrystalline material is highly variable, stone suitable for tool manufacture is available and has been exploited by prehistoric populations (Custer and Glasso 1980; Custer et al. 1986a).

Iron Hill is the southernmost outlier of the Piedmont physiographic province in Delaware. In the southwestern part of the Delaware Piedmont, micaceous schists,

gneisses, and migmatites of the Wissahickon Formation predominate (Spoljaric 1972). These crystalline rocks slope to the south and southeast forming a basement that underlies the wedge-shaped mass of sediments of the Coastal Plain. Iron Hill rests on the basement complex and is surrounded by Coastal Plain sediments.

Iron Hill is related geologically to Chestnut Hill, located just to the northwest, and Gray's Hill in Maryland (Blackman 1976). Hypersthene is the main constituent of the gabbro comprising most of Iron Hill, and its composition is about 40 per cent magnesium and iron oxides and 60 per cent silica (Melson 1969). When iron is liberated by the weathering of the hypersthene in the parent gabbroic rock, it combines with oxygen from the air and precipitates as one of the oxides or hyroxides of iron (Melson 1969). In addition to iron oxide, the weathering is also accompanied by the liberation of silica in the form of quartz or limonitic jasper. Through long-term weathering, the gabbro has left in places a thick crust of iron oxide and ferruginous jasper, referred to as a gossan (Leavens 1979). The gossan is a leaching zone, in which water, in the form of springs, redeposits a zone of oxides as secondary minerals as it brings them into contact with oxidizing agents. During weathering, the local hydrology is responsible for the liberation of iron, silica, and magnesium in the gabbro. Rich pockets containing the oxides form where springs occur, accounting for a lateritic accumulation of the material.

The minerals that make up the gossan of Iron Hill vary in chemical composition, the most abundant being amorphous limonite, goethite, and limonitic jasper (Vidal 1988). Goethite on Iron Hill is black, often occurring in veins throughout the gossan, and at times as geodes and concretions. The limonite is yellowish in color and may be classified as a rust (Leavens 1979). Both the goethite and amorphous limonite are sources of iron ore. The limonitic jasper varies considerably in color and texture, but very little chemically (Blackman 1976). The so-called Newark jaspers occurring at Iron Hill are part of a complex referred to as the Delaware Chalcedony Complex (Wilkens 1976). Color variation within the formation is due to submicroscopic inclusions of goethite, producing yellow and brown coloration (Blackman 1976). The limonitic iron oxides

steeply sloped areas in the High Coastal Plain, a chestnut-pine association may occur. Ravines in the High Coastal Plain may contain a mesic chestnut-oak association (Custer 1989). The area supports populations of deer, turkey, small mammals, and reptiles, along with a variety of birds, particularly migratory waterfowl (Shelford 1963).

D. Paleoenvironment

To assess natural resource distribution through time within the project area, it is necessary to consider the changing characteristics of the environment during the approximately 12,000 years of human occupation of the region. In general, it may be stated that the environment of the Middle Atlantic region has remained relatively stable for the past 3,000 years. Prior to that time, two broad trends are noted, both of which were related to the retreat of the last continental glaciers during a period that coincides with the arrival of Native American populations in the Northeast. The trends are characterized as gradual warming accompanied by the replacement of an open boreal forest, typified by conifers, with temperate, mixed deciduous communities (Gaudreau 1988).

At the end of the last glaciation, much of northeastern North America was considerably colder and wetter than at present, covered by open tundra and boreal forest environments. Sea level has been estimated at as much as 130 meters (430 feet) below current levels (Milliman and Emery 1968), with estuary systems such as the Chesapeake and Delaware Bays still consisting of rivers and outwash channels.

Accompanying the retreat of the ice sheets was a gradual warming trend, which saw the replacement of northern forests and their associated faunal communities with varieties more typical of southern temperate zones. By approximately 5000 B.C., an essentially modern climate and environment had become established.

Climatic changes did not occur at a smooth, unvarying rate, but rather consisted of a series of short-term variations within a general trend. The following outline of climatic episodes in the Northeast and Middle Atlantic regions 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, in western Maryland (Maxwell and Davis 1972); Hartstown Bog in Mercer County, in northwest Pennsylvania (Walker and Hartman 1960); the New Paris Sinkhole in Somerset County, in southwestern Pennsylvania (Guilday et al. 1964), and several ponds in central Delaware, including Walter's Puddle (Newby et al. 1994; Webb et al. 1994). The dates presented here approximate those of Dent, who provides a full and detailed sequence based on data closest to the current study area. Carbone's periods are comparable to Dent's, but run 500 to 1,000 years earlier than Dent's prior to the Atlantic period, and 500 to 700 years later following the Atlantic period. Note that the initial episode, the Late Glacial, pre-dates the traditionally accepted entrance of man in the Northeast by at least 1,500 years.

> *Late Glacial* ca. 13,000-11,000 B.C. The Late Glacial was a cold and wet period, with tundra-like vegetation present, particularly near the ice front. Further south lay abundant open parkland, with sedge and grass 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 by approximately 11,500 B.C. (Martin 1958), which suggests the transitional nature of climate and vegetation during the period. Whitehead (1973) has suggested a general displacement of approximately 1,000 kilometers between the glacial front and boreal forests to the south. Northern faunal species and now extinct megafauna ranged freely. Guilday (1982) has noted a distinctly greater variety of faunal species, and in particular large animal species, in Pleistocene and Late Glacial times in comparison with later Holocene periods, suggesting more open forest and grassland capable of supporting greater numbers of grazing animals. In contrast, Custer (1990) has argued that a relatively undifferentiated boreal forest environment was in place in the Middle Atlantic region, and that herds of large game were probably not present by the time of the first documented human occupations.

Pre-Boreal ca. 11,000-8700 B.C. The Pre-Boreal consisted of a colder and wetter period, though with the retreat of the continental ice sheet, regional temperatures began a gradual warming trend. The existing mosaic of tundra, open grasslands, and boreal forest may have continued in some areas, with spruce and pine forest becoming dominant. Swamps and remnant peri-glacial lakes were common (Custer 1984). Less varied plant food availability has been suggested (Raber 1985:9-10), and a decline in both large and small animal species has been reported (Guilday 1982). Both circumstances bear implications for human subsistence practices. Carbone (1976:185), in contrast, 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.

Boreal ca. 8700-7200 B.C. Initially, this period was marked by an increase in warm air masses bring a gradual warming trend. Open grasslands diminished in extent, and spruce woodlands were replaced by pine forest and northern hardwoods, especially oak (Walker and Hartman 1960; Sirkin 1977). Watson and Custer (1989) report the replacement of spruce 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 7000 B.C. He notes an overall decrease in species diversity among browsing and grazing herbivores, from 75 species during the Late Pleistocene to 51 in the Holocene. The proportion of large grazers decreased from 35 percent of the total fauna to 12 percent, suggesting development of a closed, deciduous forest. Webb et al. (1994) note an extended period of dessication in central Delmarva beginning around 9000 B.C. and continuing through the Boreal into the following Atlantic period. Evidence for this is derived from pond sediments suggesting depressed water levels throughout the period.

Atlantic ca. 7200-4600 B.C. The early portion of the Atlantic period was characterized by a warm and increasingly wet conditions, signaling the onset of a fully modern climatic regime with associated floral and faunal communities. Oak-hemlock forests expanded, and "mesic forests mantled the landscape from the floodplain to the ridges" (Carbone 1976:189). An oak-hemlock complex is well-established at the Mitchell Farm site (7NC-A-2), in northern New Castle County by about 5900 B.C. (Custer and DeSantis 1985). Oak dominance over hemlock is noted in Delmarva by 5000 B.C. (Bernabo and Webb 1977). Wetter conditions may have fostered wetland expansion, but a drying trend is noted near the end of the period (Carbone 1976:76). Generalized deciduous forests, producing large

quantities of mast foods, were in place by 4000 B.C., and deer, small mammal, and turkey populations increased (Custer 1989).

Sub-Boreal ca. 4600 B.C.-A.D. 0. The Sub-Boreal consisted of a warm and dry period, with consequent re-expansion of grasslands and dominance of oak-hickory forests and xerophytic species. Pollen analysis at Walter's Puddle, in southern New Castle County, Delaware, suggests the presence of a regional forest dominated by oak by 3870 B.C. (Newby et al. 1994). Environmental stabilization near the end of the period is evidenced by a lack of change in forest components, as suggested by pollen cores taken near St. Mary's City, in southern Maryland (Kraft and Brush 1981). These cores indicate the general dominance of oak, hickory, and pine by around 3400 B.C. 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 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). Increasingly cool and moist conditions prevailed near the end of the Sub-Boreal period.

Sub-Atlantic ca. A.D. 0-present. An general, progressive cooling trend is noted throughout the period. Stratigraphic unconformities associated with both aeolian and alluvial depositional events suggest abrupt shifts in precipitation (Custer 1978, 1989). By ca. A.D. 500 the pattern had 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).

The study of the physical environment of the region and the alterations it has undergone during the time the area has been occupied by human populations furnishes insights into the nature and availability of habitats suitable to prehistoric groups. These environmental changes provide a background or context for cultural change as seen through artifact and settlement pattern variation. The major cultural changes recognized in the Delaware archaeological record are referred to by period and are described in the following section.