VIII. CONCLUSIONS

The archaeological investigations performed at the Lums Pond site provided the opportunity to consider a number of questions concerning Delaware regional prehistory. After survey and evaluative testing at the site, a series of specific research questions were formulated, centering on issues relating to prehistoric chronology, settlement, subsistence, and technology. These questions were posed individually in Chapter V, the Research Design, and the information recovered at the site that addresses each issue is presented in the pages that follow.

Chronology

After the initial phases of investigation at Lums Pond, our impression was that site occupation had spanned a lengthy period of time, potentially ranging from the Archaic to the Woodland II. The data recovery excavations were geared towards a more refined understanding of the timing of site occupations. Resolving site chronology was considered critical, since it would provide the basic framework for all of the comparative studies of aboriginal activities at the site. Two main methods were employed in determining site chronology: radiocarbon samples were submitted for dating, and artifact styles were examined.

Radiocarbon Dates

The radiocarbon dating conducted at Lums Pond provided the most secure chronological data by placing the prehistoric occupations in absolute context. Figure 48 shows the combined dates from the site. The Area 2 pits and the Area 3 deposits provided reliable indicators of the timing of human occupation (Plates 28 and 29). The vertical bars suggest the periods of most intensive site use as indicated by the data. In Area 2, carbon samples from pit features returned dates ranging from 2660 to 2960 BP. Several studies indicated that the features were probably contemporary, and an average date of 2802 BP was calculated for the group. In Area 3, buried prehistoric deposits were identified, and were considered to be stratigraphically ordered. Radiocarbon samples analyzed from Stratum C, a buried surface horizon, produced dates of 700, 400, 380, and 330 BP, with an average date calculated as 431 BP. A cluster of three dates was returned from Stratum D, the lower occupation zone, 3440, 3320, 3240 BP, with a mean calculated as 3331 BP. As a consequence, it was inferred that Stratum C dated to the later portion of the Woodland II and Stratum D dated to the middle part of the Woodland I, showing clear separation of the occupations and an ordered stratigraphic succession. Although the Area

2 and 3 deposits dated to the middle portion of the Woodland I, they were not strictly contemporaneous, separated by some 500 years.

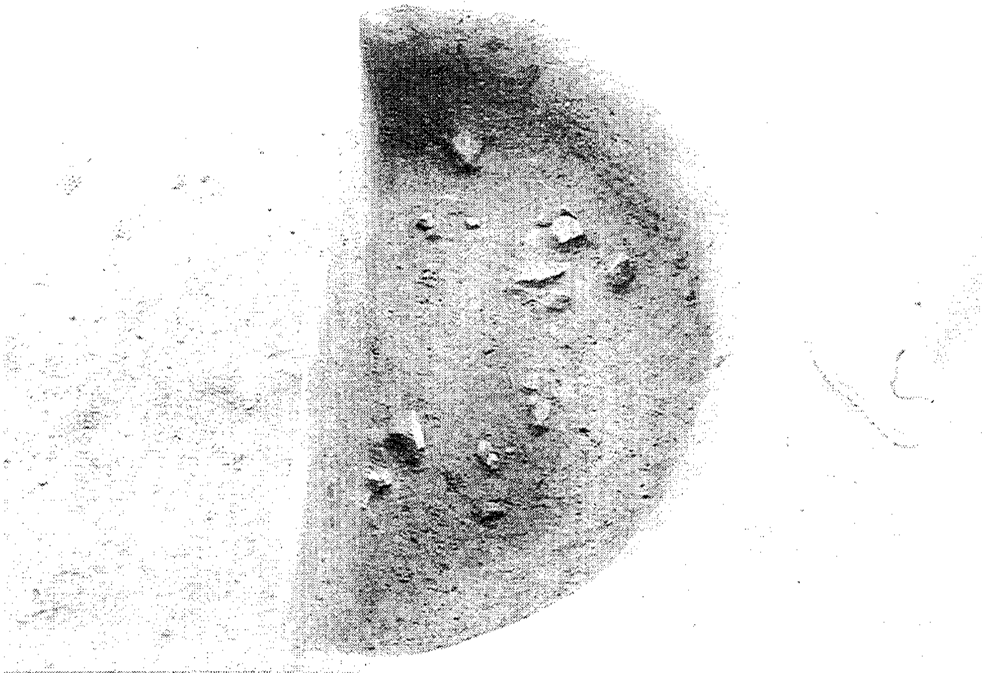

Plate 28. Area 2 Pit with Fire-Cracked Rock and Charcoal for Radiocarbon Dating

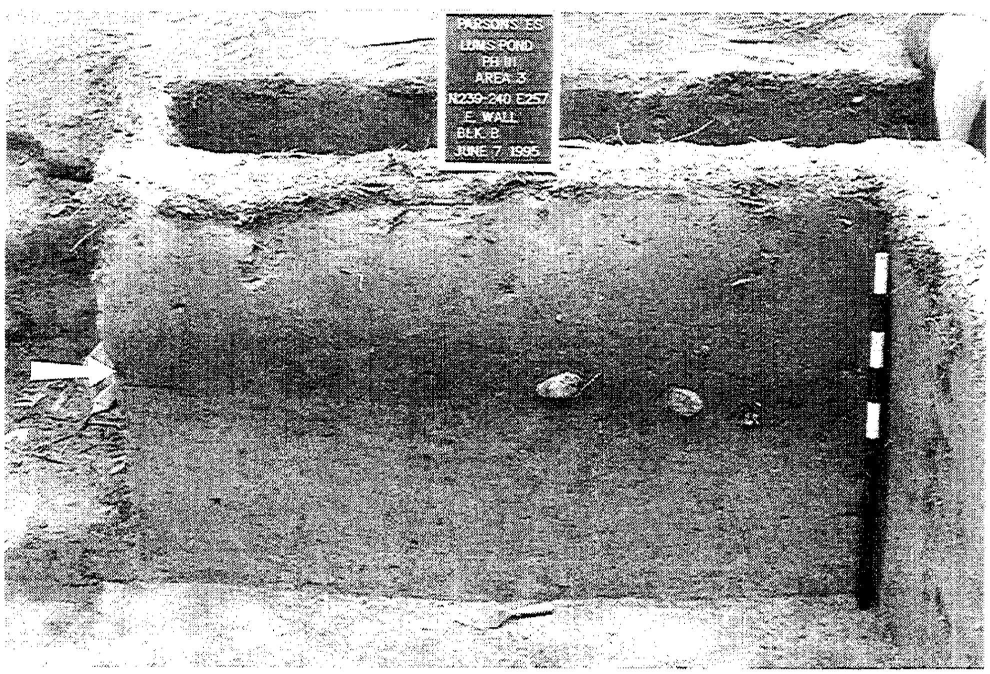

Plate 29. Area 3, Block B Wall Profile, with Charcoal-rich Horizon (Stratum C) for Radiocarbon Dating

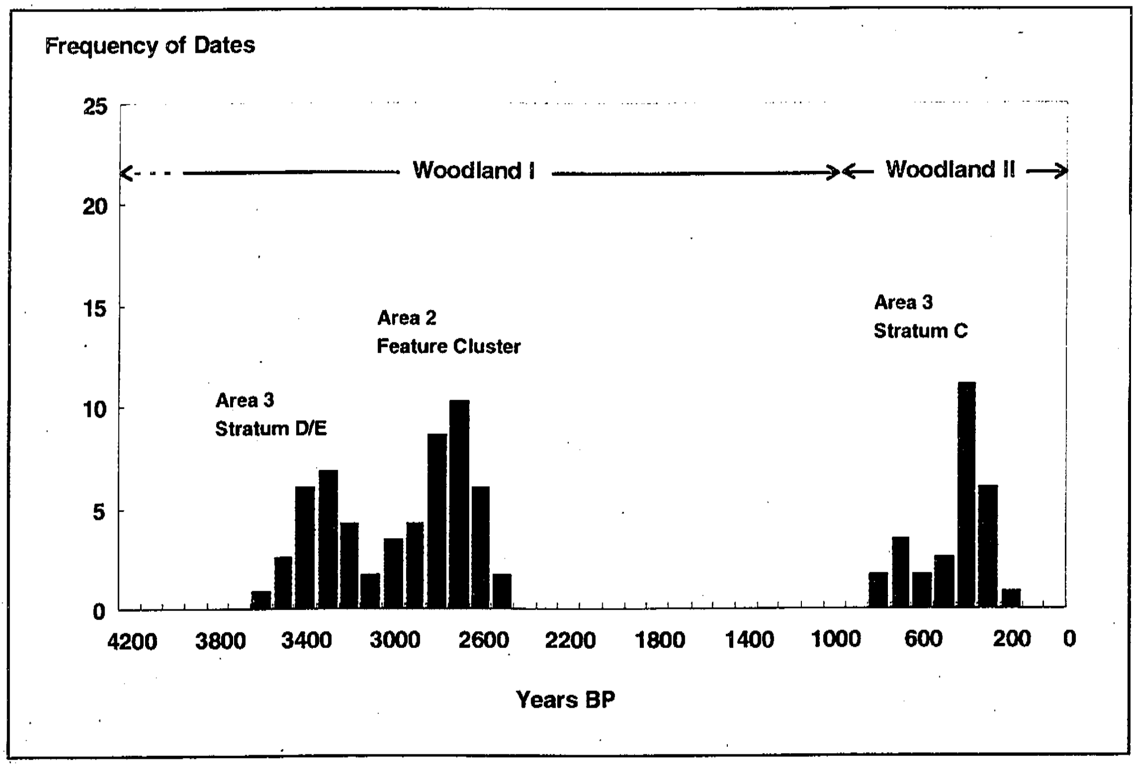

Figure 48. Occupation Episodes Indicated by Radiocarbon Dates from Areas 2 and 3

Relative Dating Methods

Archaeologists working in the Middle Atlantic region commonly place emphasis on changes observed in artifact styles and traits as a means of dating prehistoric sites. This process continues to have utility and was of use in estimating the age of the Lums Pond habitations. The most useful indicators of the potential age of the prehistoric deposits at Lums Pond were projectile points and ceramics. Additionally, the relative values of geochemical indications played a key role in inferring and supporting age determinations.

Projectile Points

A number of temporally diagnostic projectile points were recovered from the Lums Pond Site. Based on age estimates from other archaeological sites in Delaware and the Northeast, the projectile points were representative of Archaic, Woodland I, and Woodland II period styles.

Evidence from the Archaic period was relatively limited, and none occurred in contexts securely dated to that period. In a several cases, Archaic period artifacts were found in disturbed, plow zone contexts. In the sub-plow zone contexts of Area 3, Archaic points were found in levels that were dated radiometrically to the Woodland I period. These artifacts were considered to be reworked or scavenged items, introduced into the deposits by later groups.

The Woodland I projectile point evidence was the most abundant and most convincing of all temporally diagnostic data recovered from the Lums Pond site. Many of the types were narrow-bladed, stemmed varieties that shared similar characteristics with Custer's Types E and B of the Woodland I period (Figure 49). The round based stems on the Lums Pond points were characteristic of the traditional Poplar Island, Lackawaxen, or Bare Island varieties. All three are types originally defined in eastern Pennsylvania, at sites in the Delaware and lower Susquehanna valleys. Their distributions outside of those regions are variable. The points display a variety of stem and base configurations and the ambiguity inherent in their morphology is one of the factors that led Custer to reconsider Woodland I projectile point typology and chronology. He notes that few of these point types have good contextual data associated with them. Radiocarbon dates have placed narrow-bladed, stemmed points of the Poplar Island/Lackawaxen styles in a wide temporal range, spanning a period from 4560 to 2650 BP. Two sets of dates were associated with the points at Lums Pond: 2802 BP (852 BC), a mean date calculated from the pit feature cluster in Area 2; and 3331 BP (1381 BC), also a mean date, calculated from the stratigraphic sequence in Area 3.

A second point type recovered frequently in Areas 2 and 3 was the Teardrop point (Figure 49). These points have been reported throughout the Middle Atlantic in contexts spanning the entire Woodland I period, although published radiometric dates range from 3400 to 2200 BP. Teardrop points were found in association with the narrow-bladed, stemmed points in both Area 2 and 3 at Lums Pond. Radiocarbon dates from the two areas appear to place the Teardrop along with the Poplar Island/Lackawaxen forms late in the Clyde Farm Complex of the Woodland I (Clyde Farm III).

Woodland II projectile points were also recovered from the site, most of them examples of a relatively large triangular point referred to as Levanna. The artifacts were all recovered from plow zone contexts, none from intact stratigraphic deposits. Nevertheless, the location of these chronologically late points in the plow zone was consistent with temporal evidence implying that the youngest deposits across the entire site had been reworked in uppermost horizons. The evidence from projectile point distributions therefore demonstrated that Woodland II groups did inhabit the site. Most of the triangular points were recovered from Area 3, suggesting more use of the floodplain than the midslope (Area 2) during the period, yet the evidence was not secure enough to allow substantial statements concerning details of the occupations.

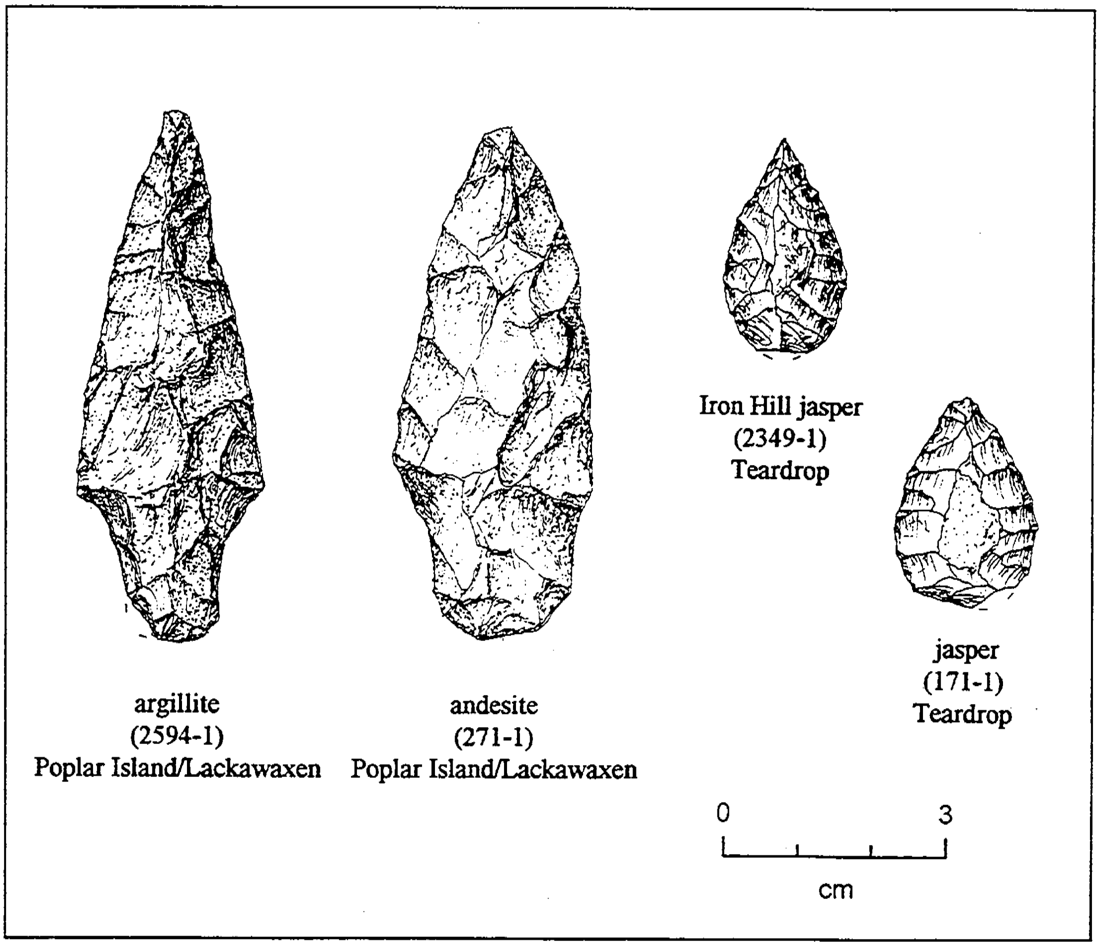

Figure 49. Woodland I Stemmed and Teardrop Projectile Points

Ceramics

Aboriginally manufactured ceramics were also recovered from the Lums Pond site in plow zone contexts and in intact deposits, particularly in association with the features in Area 2. The ceramics identified in the Lums Pond site were further demonstration of the extent of Woodland I period occupation of the site. However, few sherds were recovered overall. They occurred in a relatively poor state of preservation, mainly consisting of small pieces which could not be confidently placed into specific type categories. The ceramics identified in the plow zone were from chronologically mixed contexts, hence they of little assistance in delineating specific areas of occupation.

Nonetheless, most of the shell-tempered sherds, generally considered to be representative of the Woodland II Townsend series, occurred in Area 3 along with the largest proportion of Woodland II triangular points.

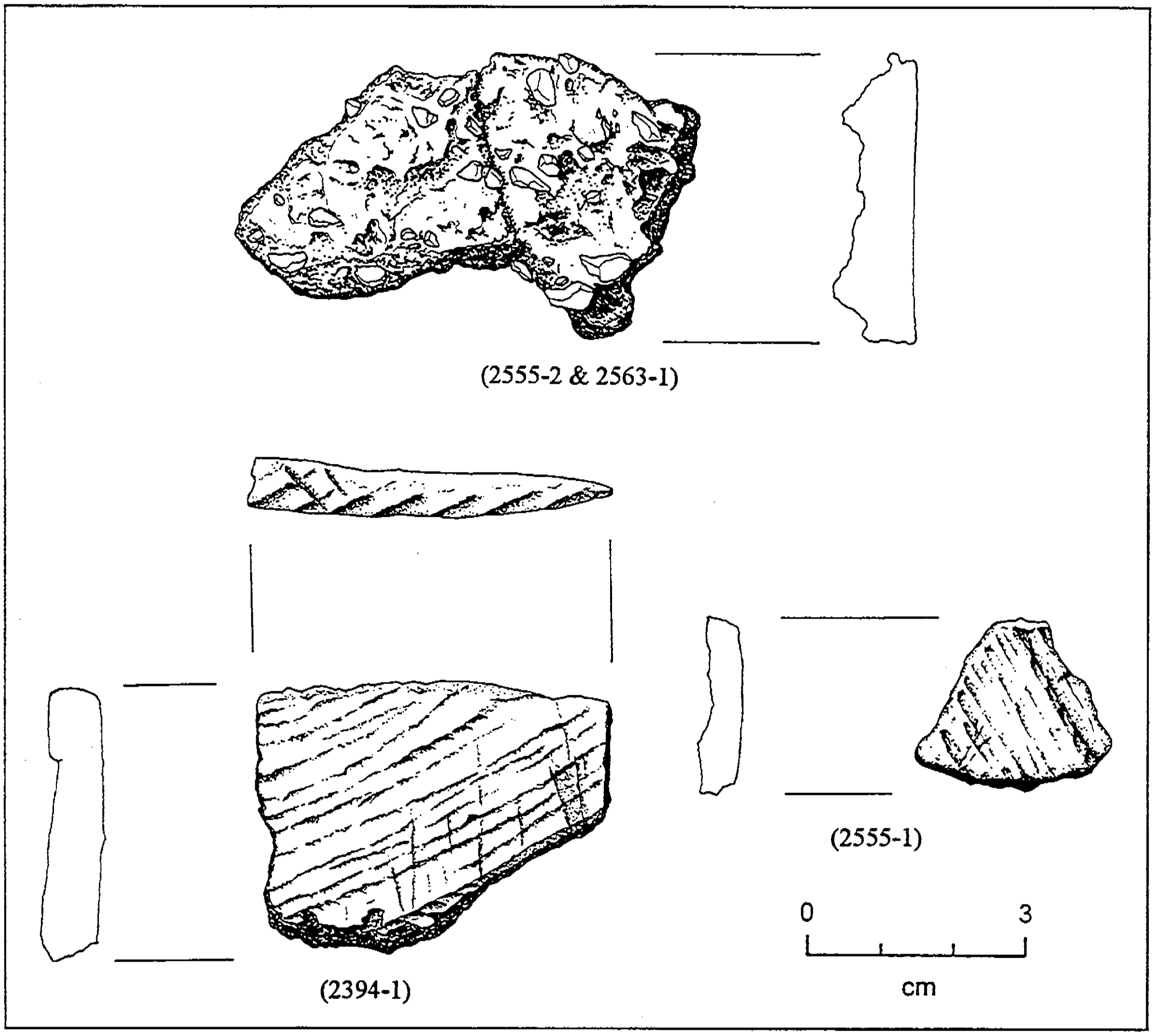

Figure 50. Sample of Experimental Ceramics Recovered from Pit Features

More significant ceramic evidence was recovered from the pit features in Area 2 (Figure 50). The majority of the sherds from these proveniences were schist tempered. Given their fragmentary condition, the sherds could not be confidently typed, other than to identify them as "experimental" wares (Cara Blume, personal communication, 1996). Experimental wares in Delaware have been defined as a series of types representing a period of evolving technology, when there were few established manufacturing traditions and various tempers, vessel shapes, manufacturing methods, and surface treatments were experimented with (Wise 1975; Custer 1989). However, the presence of early ceramics in the features further bolstered the Woodland I radiocarbon dates, and showed that the sand-tempered and schist-tempered types date to about 2802 BP (852 BC). The Lums Pond ceramics were thus consistent technologically with experimental wares, and the radiometric dates from the site helped to confirm the chronological position of the wares in the Woodland I.

Geochemical Signatures

Geochemistry may be used to provide estimates of the relative age of archaeological deposits, thereby supporting radiocarbon and artifact style dating methods. The degree to which phosphate is present in a deposit, ranging from weak to stronger chemically bound forms, may be taken as a signature of time when compared across a number of proveniences. Older deposits tend to contain more concentrated phosphate than younger deposits and thus may be differentiated from them on a relative basis. The similarity of the phosphate prints from the pit features in Area 2 suggested that the pits were contemporaneous, in agreement with radiocarbon determinations from the features. Further evidence for relative dating came from analysis of Feature 10. Variations in phosphate prints suggested a chronological difference between Feature 10 and the pit cluster to the east. In addition, phosphate data from samples throughout the feature implied that, unlike the smaller pits in the cluster, Feature 10 had been exposed over a period of time and had infilled slowly.

Environmental Setting

Paleoenvironmental settings may be reconstructed using a number of lines of evidence, including application of geoarchaeological and botanical techniques. Historic and contemporary land use accounts indicate that Lums Pond and its vicinity have been extensively modified, leading to significant changes from former surfaces, topography, and hydrology. Given this, geoarchaeological study of Lums Pond was initiated to place the archaeological assemblages at the site in proper context with respect to ancient landscapes. Botanical and geochemical analyses were also conducted in order to examine the extent to which former plant communities and vegetative settings could be determined. Once the former landscape and environment at Lums Pond was reconstructed, comparisons were made with established environmental sequences from other locations in the High Coastal Plain zone.

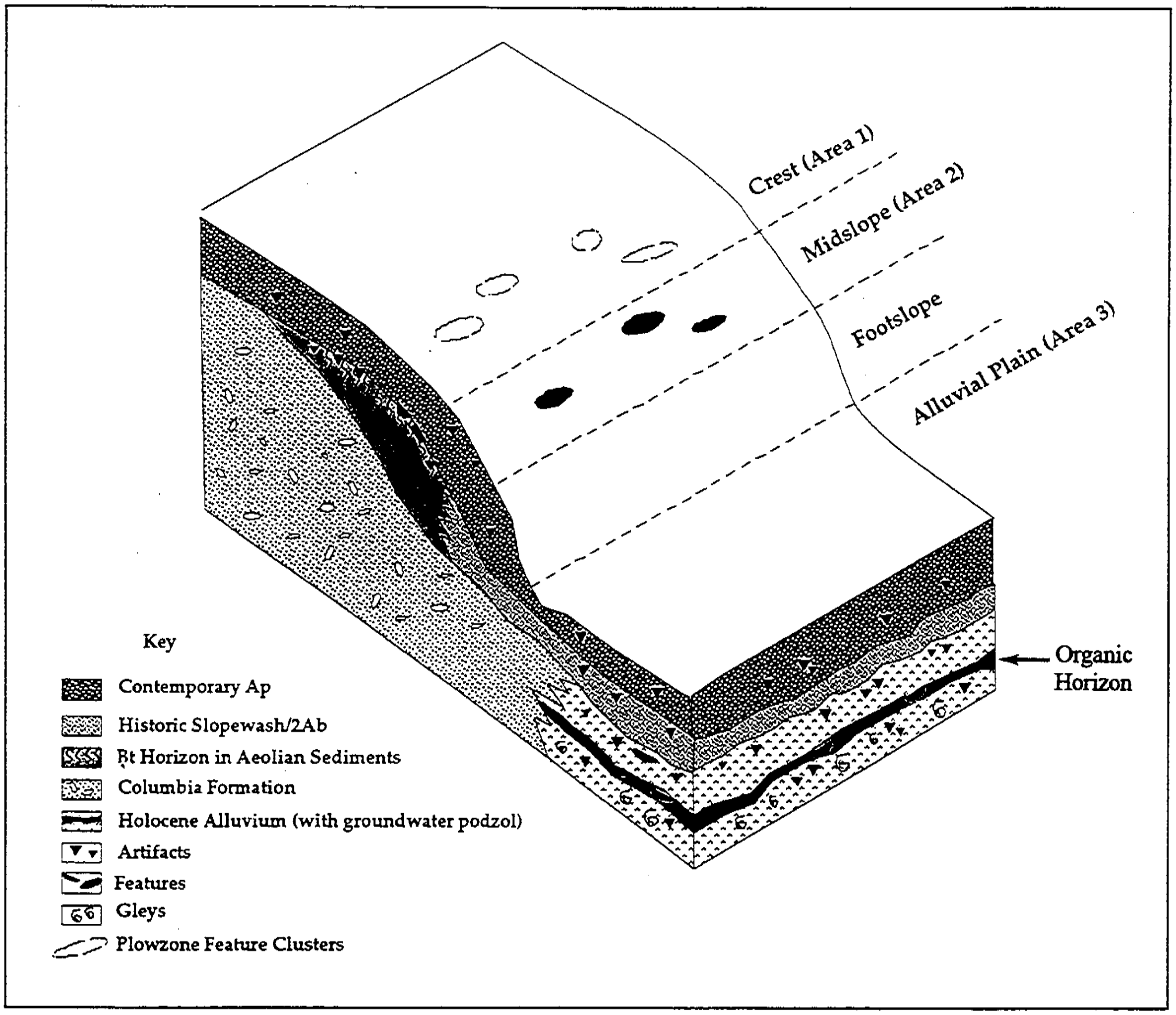

Figure 51. Three-Dimensional Rendering of the Lums Pond Landscape

Lums Pond

Geoarchaeological field work and laboratory analysis indicated that each of the areas within the Lums Pond site corresponded to different landscape segments (Figure 51). Based on geoarchaeological research, a model of site formation was established (Figure 52-53). Evidence of a former environment is preserved at the base of the landscape which dates to around 10,000 years ago before prehistoric occupation of the area.

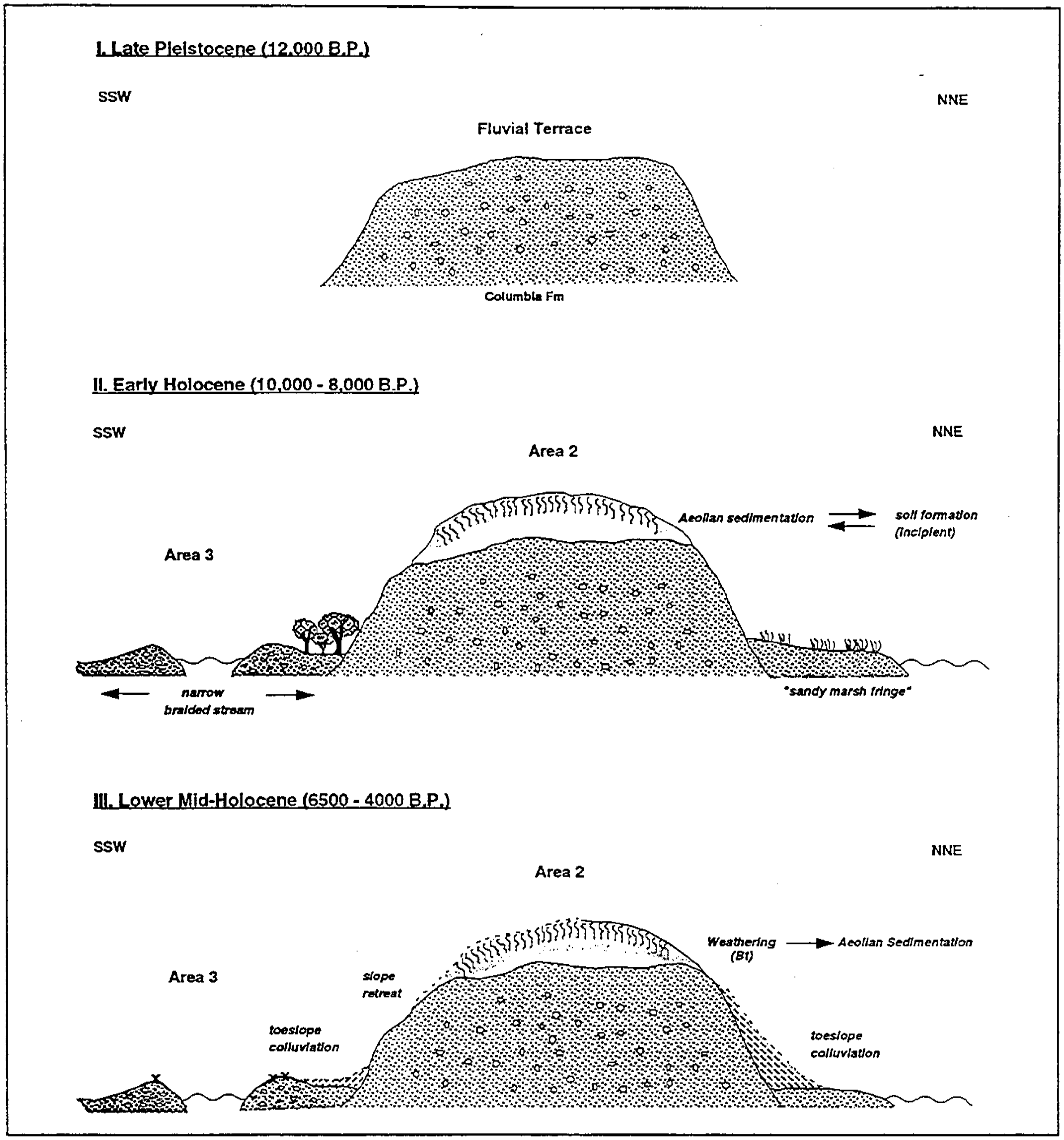

Figure 52. Lums Pond Site Formation Model

The most ancient deposits signal a braided stream environment in which watercourses were adjusting to changes in flow at the end of the glacial period. Relatively high energy stream environments dominated the Lums Pond vicinity prior to 5,000 years ago, a situation that prevented settlement, or preservation of its evidence, near stream margins. As a consequence, Paleo-Indian and primary Archaic deposits were absent at the Lums Pond site. During the Middle Holocene, around 5,000 years ago, the landscape stabilized, and primary deposits developed, correlating with the first evidence for prehistoric occupation of the site. At this time a clayey soil capped by wind borne sediments was forming on the Columbia Formation sands of the Pleistocene landscape. Area 1, the highest portion of the landscape, contained artifact assemblages within a plow zone, consisting in part of these weathered, wind deposited sediments. Below this plowed sediment in Area 2 were of a series of pit features that were intrusive into weathered midslope soils. The sediments along the midslope are the remnant of surfaces that have been stripped by accelerated hillslope retreat, which eventually reformed on top of the stream laid deposits of Area 3. The preservation of the Area 2 feature assemblages was a consequence of the thickness of the soil horizons there and the clayey nature of the soil which tends to impede erosion.

On the lower floodplain surfaces, in Area 3, the braided stream environment gave way to a meandering stream around 5,000 years ago. Point bars, or gravel beds, were laid down in bends in the watercourse, providing unstable surfaces that were irregularly occupied by prehistoric populations. During the Woodland I, the area was extensively utilized and stream-laid floodplain deposits developed. Peak occupations here were during the Woodland I, around 3331 BP, represented by Stratum D, and the Woodland II, at about 431 BP, represented by Stratum C. Clusters of prehistoric artifacts were contained in thin, stream laid deposits, minimally disturbed by stream borne overflow or post-burial processes. Within horizons some superimposition of activity areas may have been possible due to slow rates of burial. The Woodland II deposits represented more sustained surfaces which formed as the depositional rates stabilized. However, thick or deeply stratified occupations did not emerge along the floodplain. Where previously stream dynamism had been the dominant agent forcing a dispersed settlement pattern across the project area, rising groundwater levels began to affect localized drainage patterns and the capability of the low-lying terrain to support long-term and repeated occupations. The Lums Pond floodplain exhibited different potential for archaeological preservation in comparison with higher order floodplains, where deeper vertical sequences are more likely to seal in evidence of occupations. Area 3, in contrast, is an example of a low-order stream environment in which stratified prehistoric deposits were preserved in thin layers.

Finally, recent alterations to the landscape have partially recontoured the terrain. Slope erosion, accelerated over the past 200 years by land clearing and cultivation, have spread a thick mantle of slope washed deposits over the lower edge of the site in Area 3.

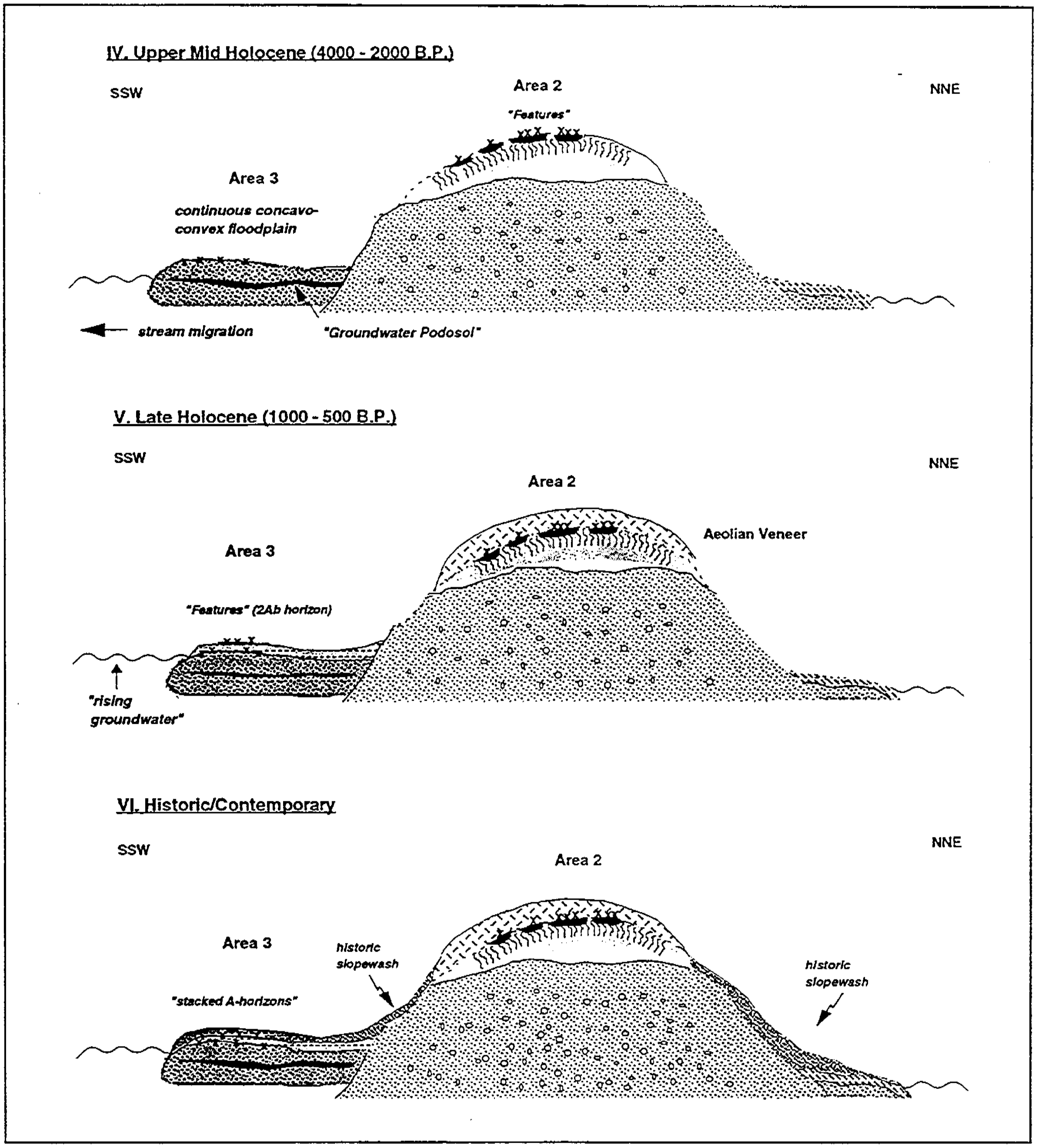

Figure 53. Lums Pond Site Formation Model

Paleovegetation at Lums Pond

Analysis of archaeobotanical remains recovered from the site provided supplementary information about the vegetative cover at Lums Pond during site occupation. Charred wood from prehistoric features and levels furnished direct indication of the surrounding environment. Research into environmental conditions during the period has suggested that oak was a dominant component of the tree community. Data from the Lums Pond features indicated that the main component of the forest cover in the vicinity of the site was in fact oak. The oak stands would have been supplemented with hickory trees along with other species adapted to wet, alluvial soils. Thickets and cleared areas were probably found along actively eroding stream banks or in marshy and low lying, waterlogged areas.

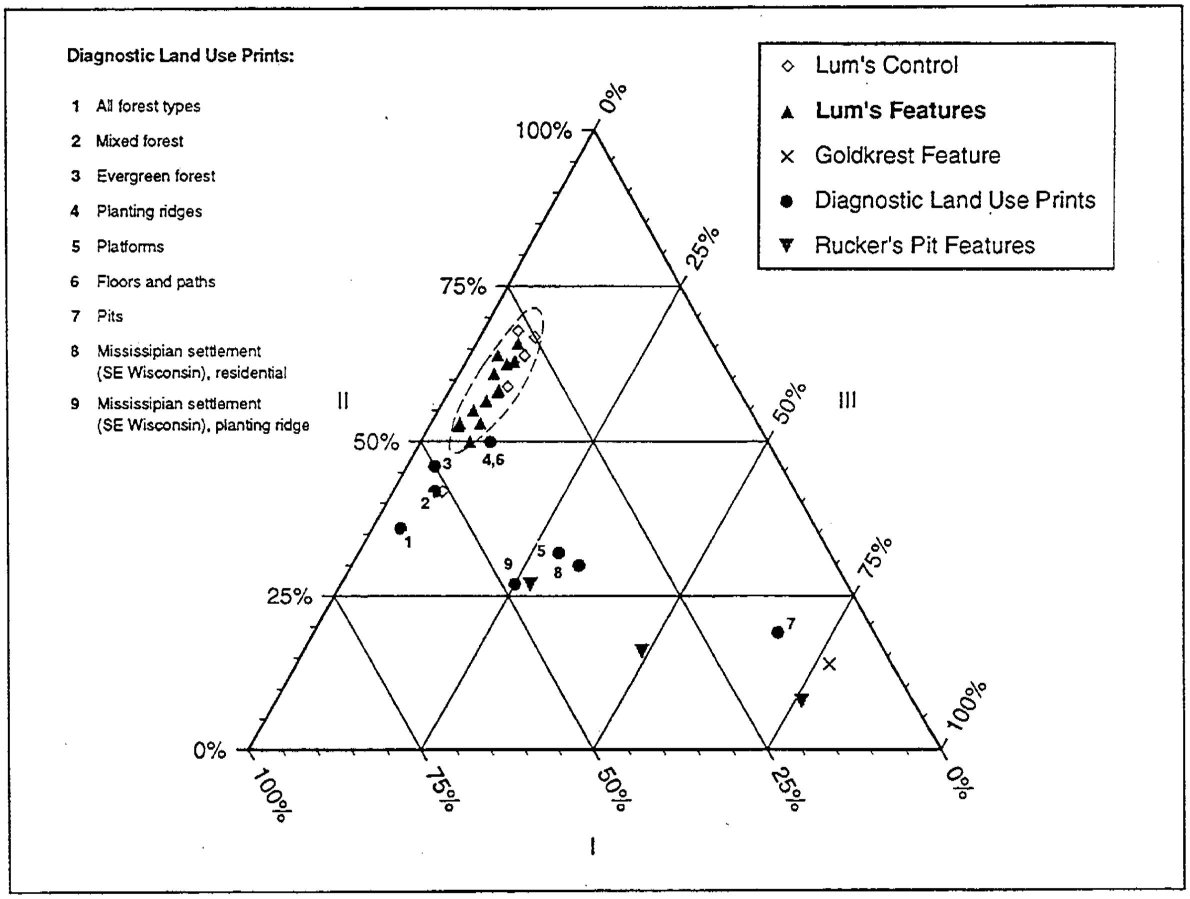

Figure 54. Land Use Prints Based on Phosphate Geochemistry

The geochemical analyses further supplemented the macrobotanical evidence. The chemical signatures indicated the closest matches with diagnostic patterns characterized as "evergreen forest," "planting ridges," and "floors and paths" (Figure 54). The evergreen forest pattern is consistent with the present arboreal setting of the site and the local paleovegetation reconstructions (Kellogg and Custer 1994). The signatures referred to as planting ridges and floors-and-paths have been interpreted as indicators of land clearance (Schuldenrein 1995). Small clearings at Lums Pond would have been present around the main habitation areas, such as is represented in Area 2, where activities occurred around pits and along pathways leading to different use areas. Grasses and weedy plants such as huckleberry and mint, as identified in macrobotanical samples, would have flourished in these open areas. The positive identification of deer protein on stone tools is also consistent with this reconstruction, since deer are browsers that feed on the understory of a mixed woodland-open habitat environment.

Regional Correlations

Reconstructions of paleoenvironmental sequences have been conducted on a regional scale across the Coastal Plain of Delaware. Many of these data sets show a high degree of diversity, evidence of the complexity of the formation of the Coastal Plain, where estuarine and continental processes interact. In effect, recurrent and comprehensive sequences have been difficult to establish across the region, thus there is no widely recognized measure of regional paleoclimatic patterns and associated geomorphic responses and preservation contexts.

The extent of local paleoenvironmental variability is noted most prominently in a recent compilation (Kellogg and Custer 1994), based on independent palynological, hydrological, and ethnobotanic studies along a 40 km segment of the eastern flank of Delaware's mid-drainage divide. The research centered on upstream and central segments of the Appoquinimink, Smyrna, Leipsic, and St. Jones drainages, all of which empty into the Delaware Bay. Geomorphological and pollen studies have also been undertaken upstream of the St. Jones in conjunction with excavations at Blueberry Hill (Heite and Blume 1995). While all these locations are within 50 kms of Lums Pond, certain environmental conditions varied greatly between the areas. The incursion of tidal or estuary settings differed dramatically across the region, varying from 2000 BP at St. Jones to 500 BP at Leipsic. Direct comparison is further complicated by the location of Lums Pond at the northern edge of the Coastal Plain, effectively on the margin of the Piedmont, where different underlying topographic, hydrographic, and geological variables control stratigraphy and sedimentation.

Lums Pond was compared to sequences established for Bay Basin settings, tidal rivers, and to the environments recorded at Blueberry Hill. It was only at Blueberry Hill that a variety of component microenvironments analogous to Lums Pond were recorded. The paleoenvironmental significance of the upland aeolian contexts with the alluvial stratigraphy of the St. Jones floodplain was recognized. The Bay Basin settings are most similar to Lums Pond with respect to general physiography because these are the only locales situated on the drainage divide within the High Coastal Plain. The most common manifestation in the geomorphic cycles of all four locations is the interval of erosion recorded 8-10,000 years ago. Realignment of drainages subsequent to the melting of the ice sheets and the resultant massive discharges from glaciers resulted in widespread resculpting of the landscape. High energy stream sediments are recognized at all locations. The erosional cycle is consistent with the inferred transition to a progressively warmer and drier climate. In the more northern locales, Lums Pond and Bay Basins, the dynamic stream pattern persists to 6000 BP, while more quiet, ponded settings appear to emerge in lower elevations to the south, central tidal rivers and Blueberry Hill. During the Early Holocene at Lums Pond and Blueberry Hill, analogous settings are registered, indicating the onset of initial deflation followed by a weathering phase. Initiation of the accretion regime at St. Jones is paralleled by the appearance of the braided stream at Lums about 7000 BP. The transition from a meandering stream at Lums at about 5000 BP reflects the delay in sea level rise in the northern High Coastal Plain settings.

By the Middle Holocene (after 6000 BP), the depositional sequences are considerably more varied across the region. This correlates with the higher degree of stratigraphic resolution accompanying depositional cycles across the Coastal Plain. A stabilization cycle is registered at 6000-3000 BP. Inter-site comparisons indicate upland locations witnessed soil formation, although Blueberry Hill data may suggest renewed weathering, while Lums records sustained evolution of a deep profile. Evidence for ponded habitats and seasonally moister settings is indicated in stabilized floodplains. At Lums Pond the fining of sediments indicates slowed sedimentation where evidence points to appearance of groundwater rising. The Late Holocene (after 3000 BP) is signaled by the long term emergence of groundwater settling at Lums Pond. Since Lums Pond is in the highest and most interior setting of the locations, it may be inferred that aquatic biomes, typically flanking tidal streams, were finally pervasive everywhere across the Coastal Plain. Climatic data converge to a cooler and moister pulse between 3000-2000 BP (Stuiver et al. 1995). Thereafter, accelerated organic sedimentation and tidal transgression mark the culmination of the Late Holocene environment, registering complex aquatic and ponded settings.

Technology

Artifact Types and Lithic Assemblage Formation

The artifacts from Lums Pond were classified into discrete categories allowing for studies of site function. As summarized in the artifact assemblage analysis in Chapter VII, a variety of chipped stone artifact classes were found in the Woodland I deposits including formal types (e.g., projectile points, bifaces) and debitage (e.g., flakes, chips, cores).

The Woodland I assemblages from Areas 1 and 3 were similar enough in composition to allow comparison. In both areas, flakes predominated, although in lesser percentages in Area 3. The dominance of flakes in Area 1 is in accordance with the interpretation that the area represents one or more reduction areas for stone tool manufacture. The Area 3 assemblage displayed a larger range of artifact types, leading to the conclusion that a wider range of activities occurred in this area. The presence of fire-cracked rock in Area 3 also provided spatial information showing that lithic reduction activities and burned features occurred together.

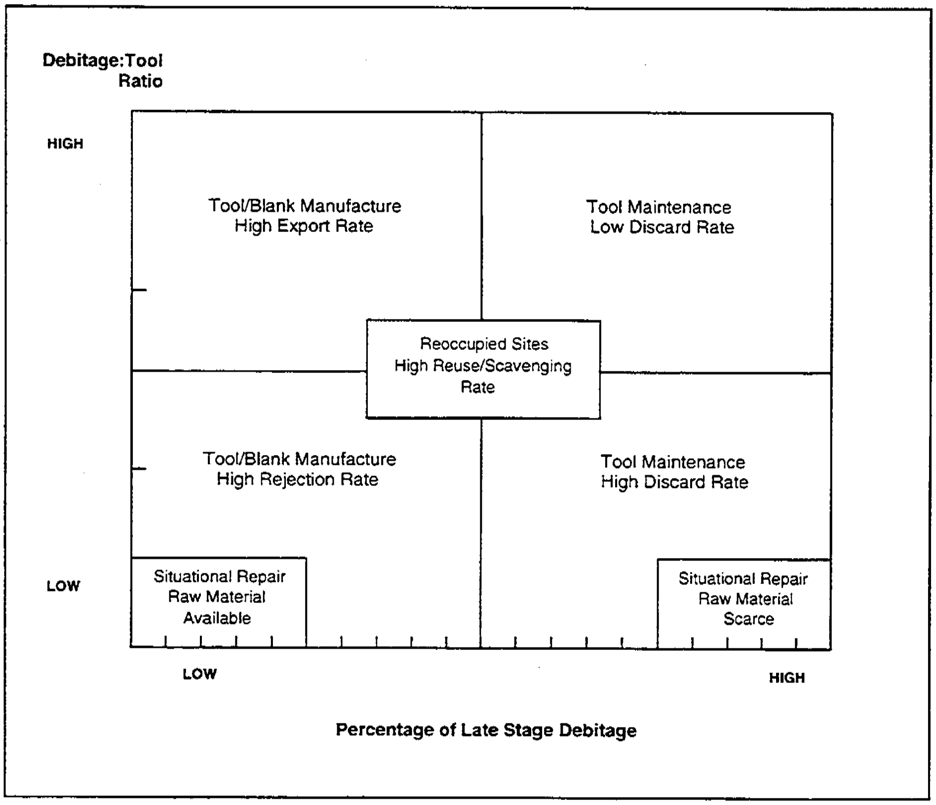

Figure 55. Lithic Assemblage Formation Model (after Magne 1989:figure 1)

Magne (1989) proposed a model of lithic assemblage formation to assess aspects of prehistoric site function. The model plots debitage-to-tool ratios against the frequency of occurrence of late stage reduction debitage (Figure 55). The analysis primarily discriminates between high rates of curation and maintenance on the one hand, and expedient or situational tool production on the other. Key to the interpretation is the accurate and reliable discrimination of late stage debitage. It should be emphasized that the model is schematic, and has not been tested with wide ranging data sets, thus its application is still largely relative.

At Lums Pond, assemblage variation was different in each area of the site, hence the data were analyzed separately to examine tool assemblage formation and duration. The Lums Pond data set was plotted within the assemblage formation model. All three areas fell near the center of the diagram, where the variables described sites that were repeatedly occupied, with high reuse and scavenging rates (Figure 56). In general, the classification agrees with what would be expected from a site which was not specialized in use, as would be indicated at the high and low extremes within the model on both x and y axes. The classification is somewhat problematic since other lines of evidence did not suggest that the Lums Pond site was heavily or repeatedly reoccupied. Yet there was evidence for overlapping activity areas (as shown by refits in Area 3). Moreover, geomorphological analysis indicated that depositional rates were not high, and thus individual occupations may not have been quickly buried and separated.

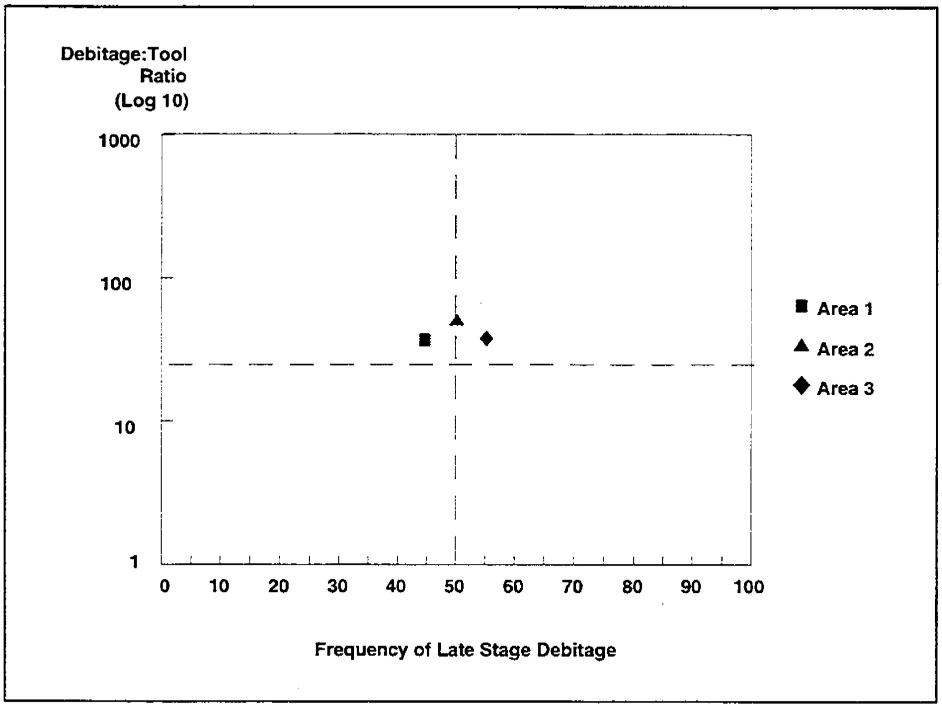

Figure 56. Debitage:Tool Ratio

Another interesting comparison that may be conducted is analysis of the relationship between the number of tools occurring at a site and the length of occupation that is implied. The analysis is based in the theory that while late stage debitage will accumulate with extended site use, its proportion in the total assemblage will diminish with the increased use and discard of formal tools. The ratio of tools to debitage becomes a relative measure of the duration of site use. For the analysis, tool counts from the three areas at the Lums Pond site were plotted against debitage percentages (Figure 57). The Lums Pond data showed that in the relative terms implied by the chart the three areas differed substantially from one another. The shortest span of time was implied in the Area 2 (Block D) data. It is possible that this area saw comparatively few episodes of use, as suggested by the non-overlapping pit features in the area. In contrast, the Area 1 distribution showed a more elevated tool count relative to late stage debitage. This finding does not necessarily conflict with the plow zone data including both reduction clusters and fire-cracked rock clusters from the area. The Area 3 distribution showed the highest proportion of tools, implying the longest length of site occupation among the three areas. This is a plausible inference given the evidence of reoccupation and the slow rate of burial on the floodplain.

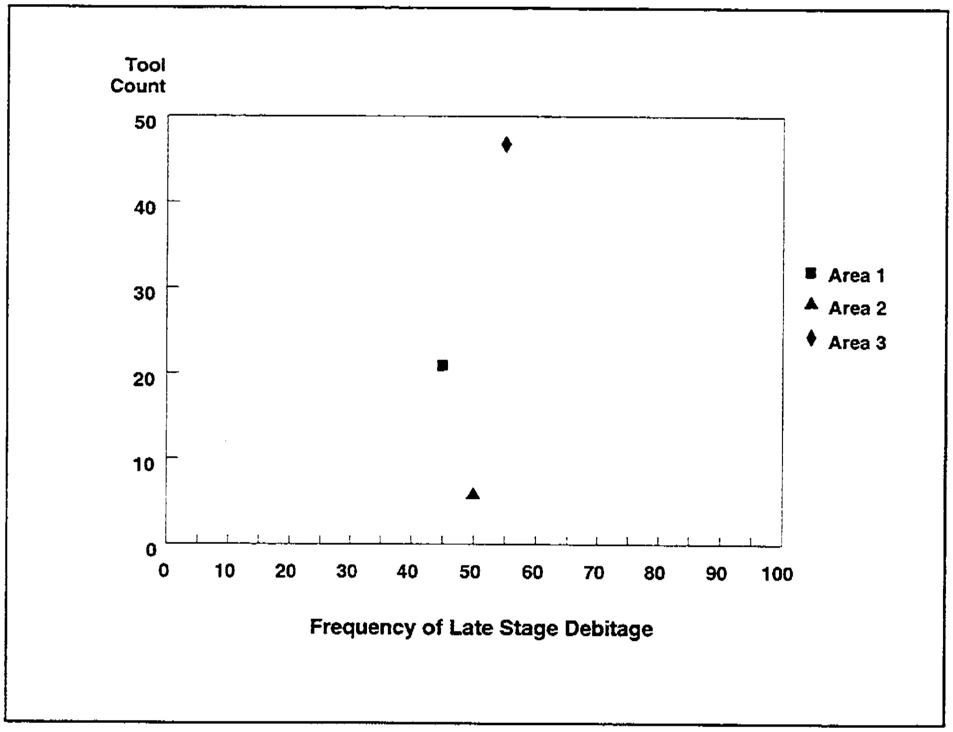

Figure 57. Tool Count vs. Debitage, Occupation Span

In sum, the lithic assemblage formation model and the occupation span model suggested some degree of site reuse and reoccupation. Other analyses indicated that while reoccupation probably did occur, there were no dense deposits or overlapping, and non-discriminate artifact distribution patterns implying repeated and intensive reuse. These data substantiate ethnoarchaeological observations and site formation studies indicating that neither stratigraphic levels nor horizontal areas within an archaeological site should be considered the unaltered remains of episodes of prehistoric activities. The residues of different occupations may be deposited on the same surface, while site activities and functions may completely change between occupations. This provides a caution in attempting to categorize or typologize sites from gross patterning.

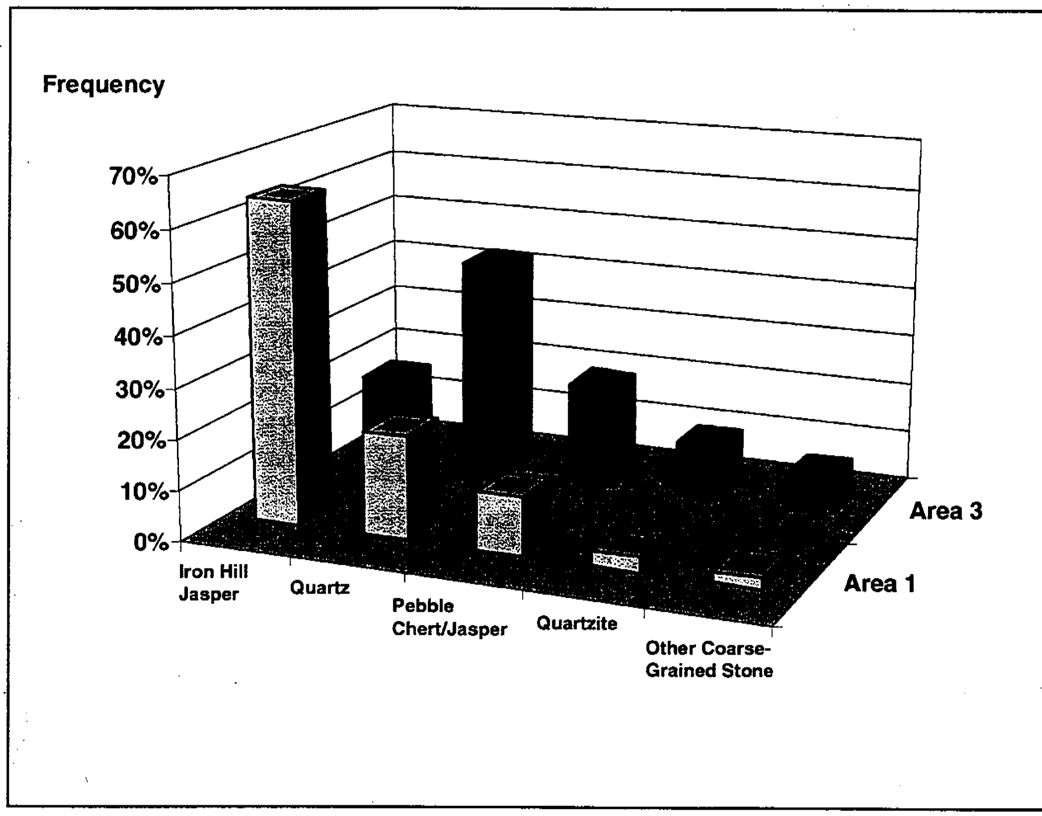

Figure 58. Comparison of Raw Materials in Woodland I Assemblages in Areas 1 and 3

Raw Materials and Reduction Techniques

In Area 1, the predominant stone material was Iron Hill jasper, as shown in Figure 58. Considerably less quartz was present, along with small quantities of pebble chert and jasper, quartzite and other coarse-grained materials such as argillite, andesite, and rhyolite. In contrast, quartz was the predominant raw material in Area 3, followed by pebble chert and jasper, Iron Hill jasper, quartzite and other coarse-grained materials. The variation in the materials directly reflected the specialized nature of the tool manufacturing activity conducted in Area 1, where a small workshop was located in which partially made bifaces were brought from the nearby jasper quarry at Iron Hill for further shaping and finishing. A wider range of manufacturing activity and materials were in evidence in Area 3.

The Lums Pond raw material data vary somewhat compared to other nearby sites. Several kilometers north of Lums Pond, at the Brennan site (Watson and Riley 1994), the lithic assemblage consisted of almost solely of Iron Hill jasper (98 percent of the total), reflecting an even more specialized tool production locale. At Wrangle Hill (Custer et al. 1995), another specialized production assemblage was characterized by a large proportion of ironstone. And in the Clyde Farm Complex assemblages of the Snapp Site, chert and jasper were the predominant raw materials, comprising 40 percent each of the total, with lesser percentages of quartz (11 percent), quartzite (6 percent), and other stone types making up the remainder (Custer and Silber 1995:155). Not only do some raw materials vary, but also the percentages are quite different, demonstrating variability in stone tool selection and reduction.

Multiple analyses of the Lums Pond artifact data set indicated that stages in manufacturing sequences could be identified. The clearest indications came from examination of the Iron Hill jaspers, which were likely brought to the site as partially completed artifacts. Figure 59 illustrates a typical reduction sequence, beginning with efforts at obtaining the raw stone and following through a number of steps to the completion of the finished artifact. An arrow indicates the point in the sequence represented by the manufacturing debris observed at Lums Pond. Inferences about the manufacturing activities at the site were borne out by study of both the bifaces and the flaking debris. In Area 1, for example, the Iron Hill jasper flaking debris was smaller and cortical pieces were fewer compared to raw material types such as quartz, that appeared to have been used in a greater range of production, as indicated in the figure. Flake platform characteristics, including the presence of remnant bifacial edges, also indicated more complexity. In Area 3, substantial amount of Iron Hill jasper was recovered among the flaking debris, yet there were few bifaces of the material, implying that the flakes were largely related to maintenance or the resharpening of tools, and were not associated with the full range of reduction. Size distribution data, and in particular, weight distributions, lent some support to this conclusion.

In a comparison of the Iron Hill jasper assemblage from Lums Pond with two other Woodland I sites, Brennan (Watson and Riley 1994) and Paradise Lane (Riley et al. 1994), variations were noted in flake attributes that suggested differences in knapping activities. The Lums assemblage contained more small flakes and broken flakes, as well as flakes with more dorsal flake scar complexity and remnant bifacial platforms. These findings supported an inference that the Lums Pond assemblage resulted from a later biface reduction sequence than did material from the other sites.

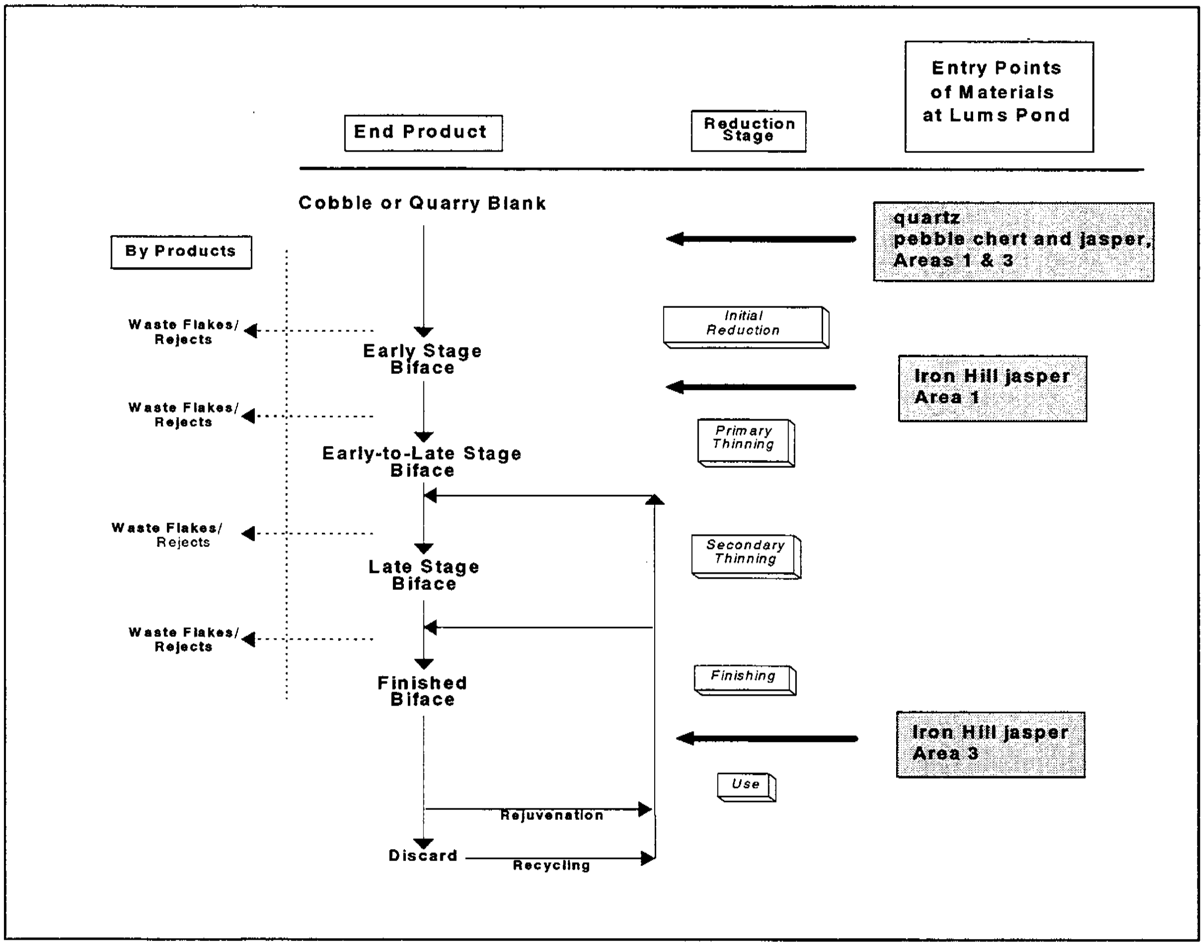

Figure 59. Stone Tool Manufacturing Processes at Lums Pond

Stone tool manufacturing experiments conducted during the project provided informative comparisons with the Lums Pond archaeological artifacts. Jasper was procured from quarry sources in northern Delaware and a number of stone tool reduction experiments were performed (Plates 30 and 31). The experiments showed that the material selected and transported to Lums Pond was of a generally high quality compared to the potential range of material witnessed in the Northern Delaware outcrops, and thus it was clear that the site inhabitants were careful in selecting jaspers with good flaking properties (Plate 32). Generally missing was the large mass of material that is produced during the knapping of poor and medium grade jasper (Plate 33). This order of material was common at sites along the fringes of the quarries, such as the Iron Hill East site (Lothrop et al. 1987; Petraglia and Knepper 1995). The Lums Pond jasper artifacts often displayed tightly bonded, homogenous structure, and definable flaking attributes. Occasionally artifacts displayed grainy structure, containing slight, but well-bonded bands of brown and yellow inclusions. Although unflawed jasper is present in the Northern

Delaware quarries and at Lums Pond, the purest forms are rare, outshadowed by the far more common moderate to low grade grainy pieces with inclusions and fracture lines. The experiments demonstrated that prehistoric knappers would have tested materials, probably shaping the materials somewhat at the quarries before carrying them away. It was also clear that reduction was often well-planned, designed to work around any visible flaws or fracture planes to successfully manufacture tools. Unplanned manufacturing errors also likely occurred, however, as the presence of refitted broken jasper bifaces at the site indicated. The abundance of generally high grade flaking debris in Area 1 of Lums Pond indicated that some tools were likely successfully manufactured in this spot and transported away. Most interesting is that Area 1 does contain some discarded jasper bifaces. The discard of the bifaces may be tied, in part, to the grade of the materials, since most of the discards showed grainy structure. The conclusions reached about knapping strategies at the Lums Pond site were very similar to the findings at the Brennan site, situated on a stream just to the west (Watson and Riley 1994). At the Brennan site, the large amount of jasper debitage recovered suggested the reduction of prepared cores and bifaces. The majority of the recovered bifaces were early stage forms that had been rejected during the manufacturing process, while others were brought to the site directly from Iron Hill and Chestnut Hill as later stage forms. As at Lums Pond, these more finished bifaces were reduced further at the site, possibly made into projectile points and carried away.

Plate 30. Jasper Being Procured for Experiments

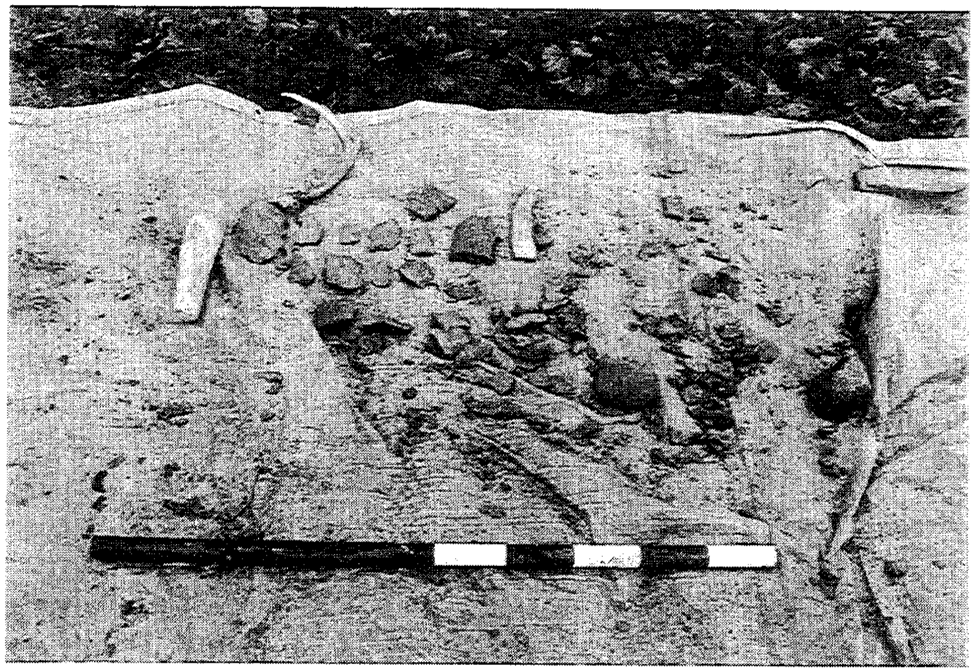

Plate 31. Antler and Hammerstone Percussors and Chipping Debris Resulting from Jasper Experiments

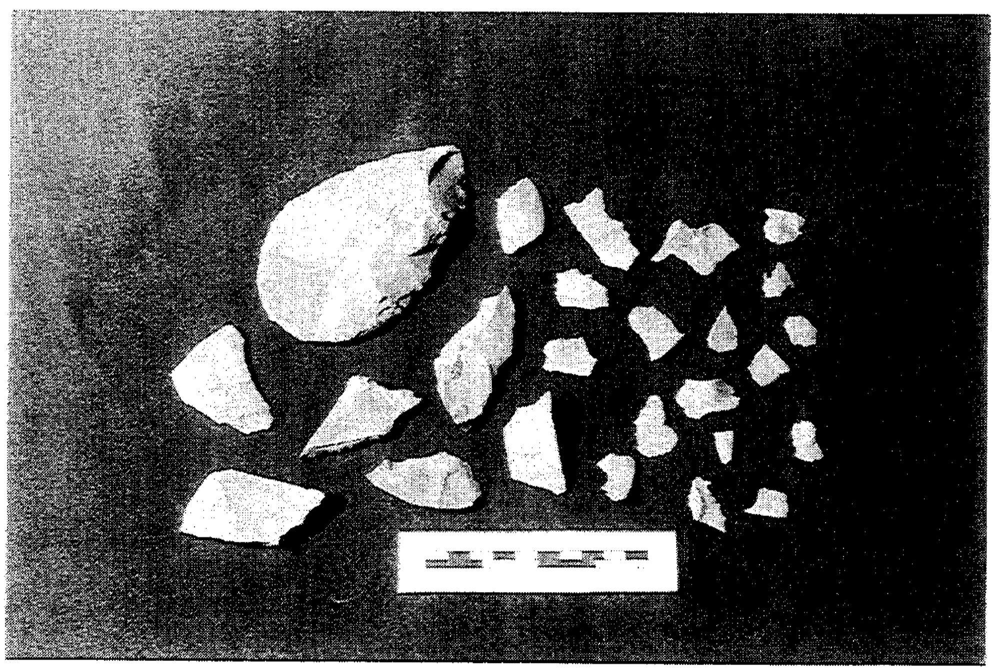

Plate 32. Jasper Experiment Showing Production of Biface and Flaking Debris

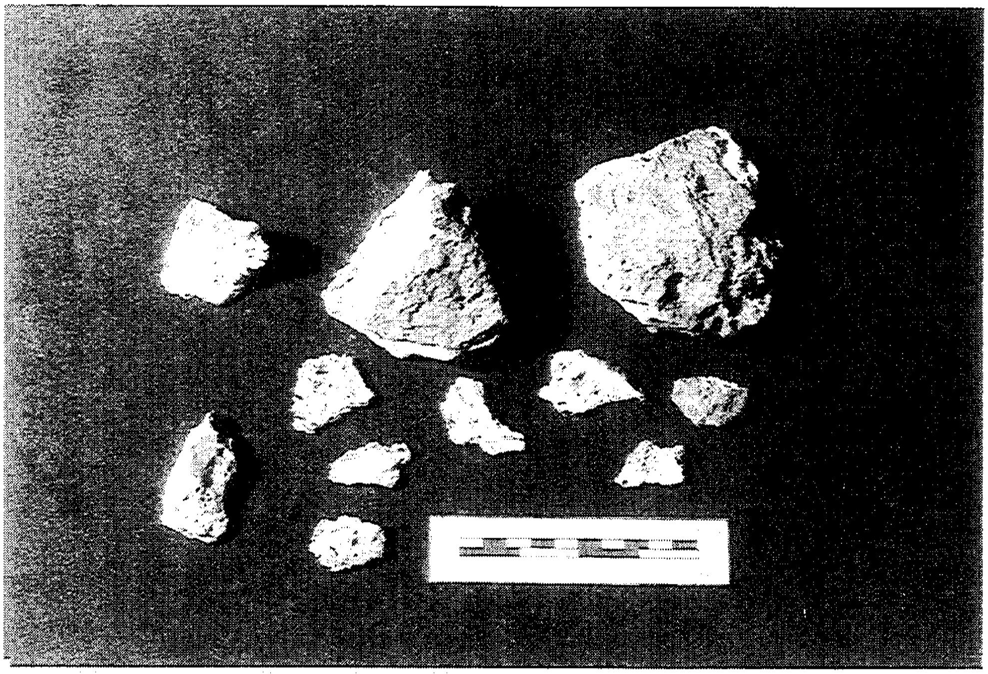

Plate 33. Jasper Grades Showing Poor Flaking Characteristics

There was evidence to show that the Lums Pond inhabitants selected small clasts, including pebbles, to obtain sharp edges for tools, using either on the pebble or the flake byproducts. Pebbles and cobbles are common in the Lums Pond vicinity, especially along streams and in the Columbia Formation soils forming the basal sediments of the site. Given the small size of these clasts, it would have been extremely difficult to fracture the pieces using freehand percussion. An easier and more efficient way was through the use of the bipolar technique. The best direct evidence for use of bipolar percussion was derived from the refitting project. Here several artifact sets consisted of flakes refit to the original clast, reforming whole or nearly whole pebbles (Figure 60). The refit evidence was supported by analytic evidence from the archaeological assemblages. Cortical frequency and flake-size distribution data suggested that quartz and other raw materials such as chert and some jaspers originated from pebbles and were less often associated with biface manufacture. Crushed platforms, which are a common result of bipolar reduction, were more frequent on quartz and chert. Many of pebble chert and jasper cores and quartz cores had evidence of bipolar flaking, and there was also evidence throughout the assemblage for the testing and rejection pebbles and cobbles of poor quality material. A trend toward the use of local pebble and cobble sources during the Woodland I period was also seen at the Snapp site, where similar artifact assemblages were recovered (Custer and Silber 1995). Information from Lums Pond thus reinforces inferences developed from other regional locations about material economics in the Woodland I, by demonstrating the use of a wide range of stone sources for tool manufacture, but a general concentration on locally collected pebbles and cobbles.

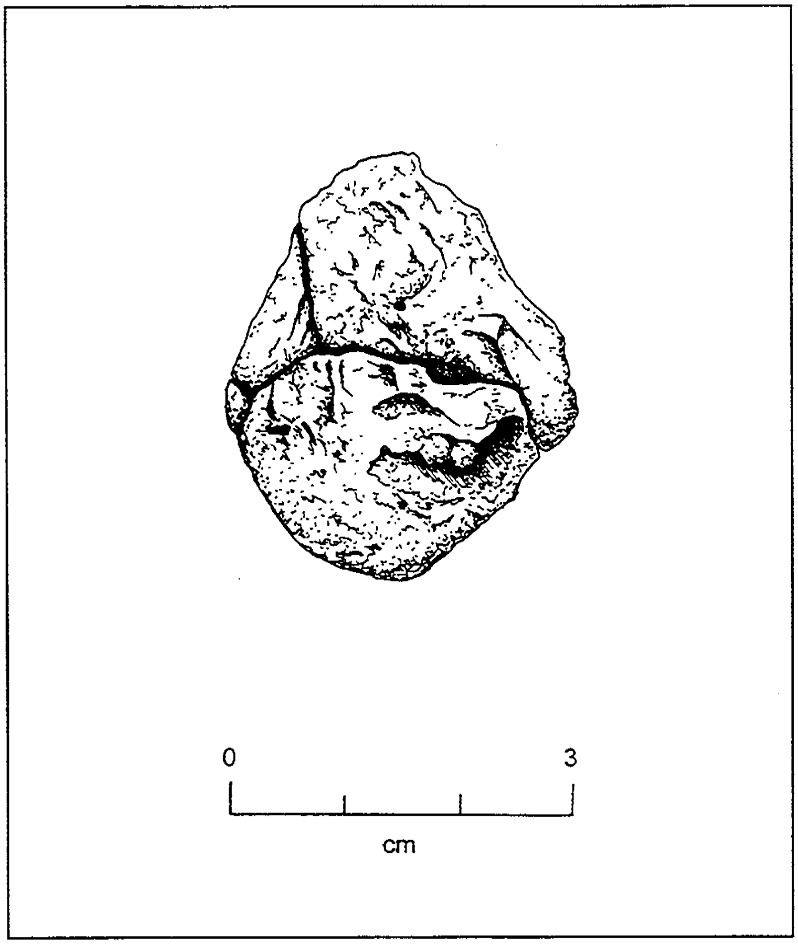

Figure 60. Refit Bipolar Pebble

Intra-Site Settlement Patterns

Shovel testing conducted as the first part of the investigation of prehistoric occupation at Lums Pond showed that artifacts were clustered or concentrated in specific areas within the site (Figure 61). The survey and testing program ended with the recognition of three main areas of site activity, labeled Areas 1-3. Not coincidentally, these three areas lay along the unnamed stream at the south edge of the site and overlooking the swampy areas bordering the stream.

Area 1

Despite the effects of plowing, clusters of artifacts were preserved in Area 1 that were interpreted to be remnants of human activities. The shovel test data indicated that the area contained two main artifact concentrations (Figure 62). A large proportion of the lithic debris recovered from the excavations consisted of Iron Hill jasper. The frequency was significantly greater than in other parts of the site, suggesting the presence of a specialized work area.

Data recovery excavations focused on the western concentration, based on the occurrence of higher artifact counts and apparent concentrations of stone materials. Spatial analysis indicated the presence of individual knapping episodes. Iron Hill jasper debris was concentrated in the southeast portion of the block with a more scattered distribution in the northwest. Horizontal distributions indicated that the quartz varied from the Iron Hill jasper, the greatest concentration being centered south and west of the main jasper concentration. These data suggested separate reduction areas for the different raw material types. Diagnostic artifacts recovered from the block consisted of several Woodland I period projectile points, two of which were manufactured from Iron Hill jasper.

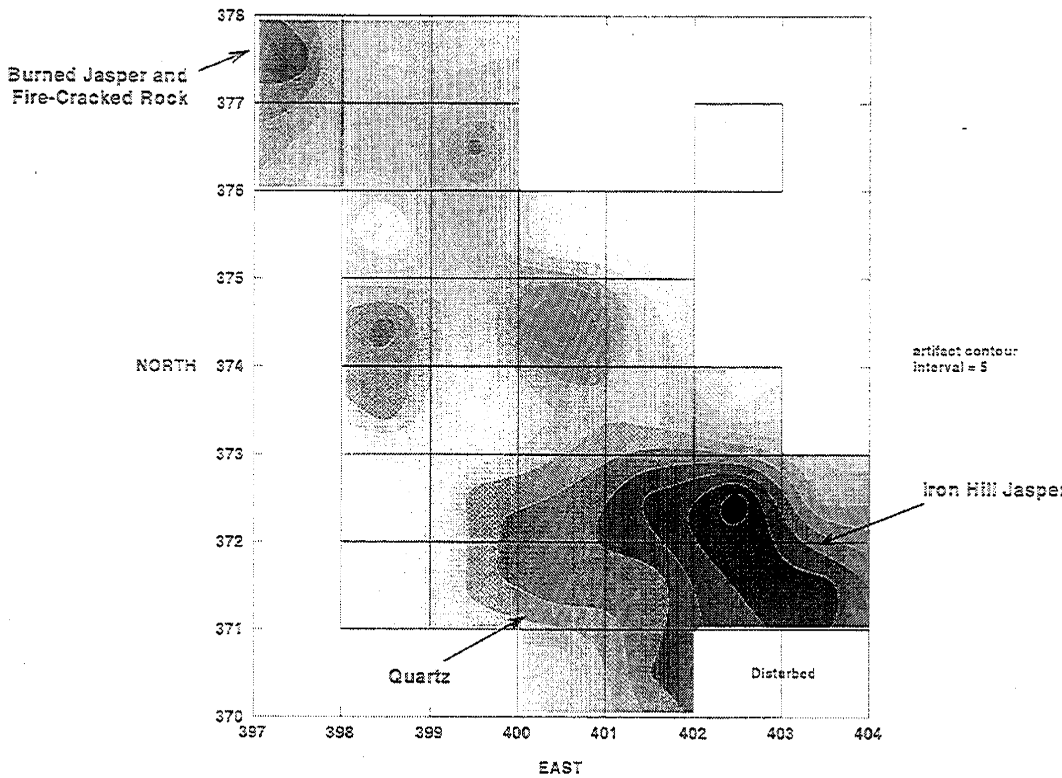

Figure 62. Artifact Concentrations in Area 1 Block

Area 2

Area 2 contained evidence for prehistoric activities that set it apart from other portions of the site. Chronologically, radiocarbon data and temporally diagnostic artifacts pointed to site use during the Woodland I. Area 2 contained a high number of long-bladed, stemmed projectile points, typically classified as Poplar Island/Lackawaxen or Bare Island points. Teardrop points and experimental ceramics of the Woodland I were also identified.

Two main areas of activity were identified, separated by a filled in seasonal stream. The two most intensive clusters lay in the eastern block in contrast to the western block, where artifact counts were low and distributions more sporadic. The most striking aspect of the excavations in Area 2 were the dense concentration of non-overlapping pits, the morphology and function of which are discussed below. Maps of the spatial distribution of fire-cracked rock in the plow zone relative to these features indicated some association. Clusters of fire-cracked rock were identified, suggesting the presence of hearths in immediate association with the pits (Figure 63).

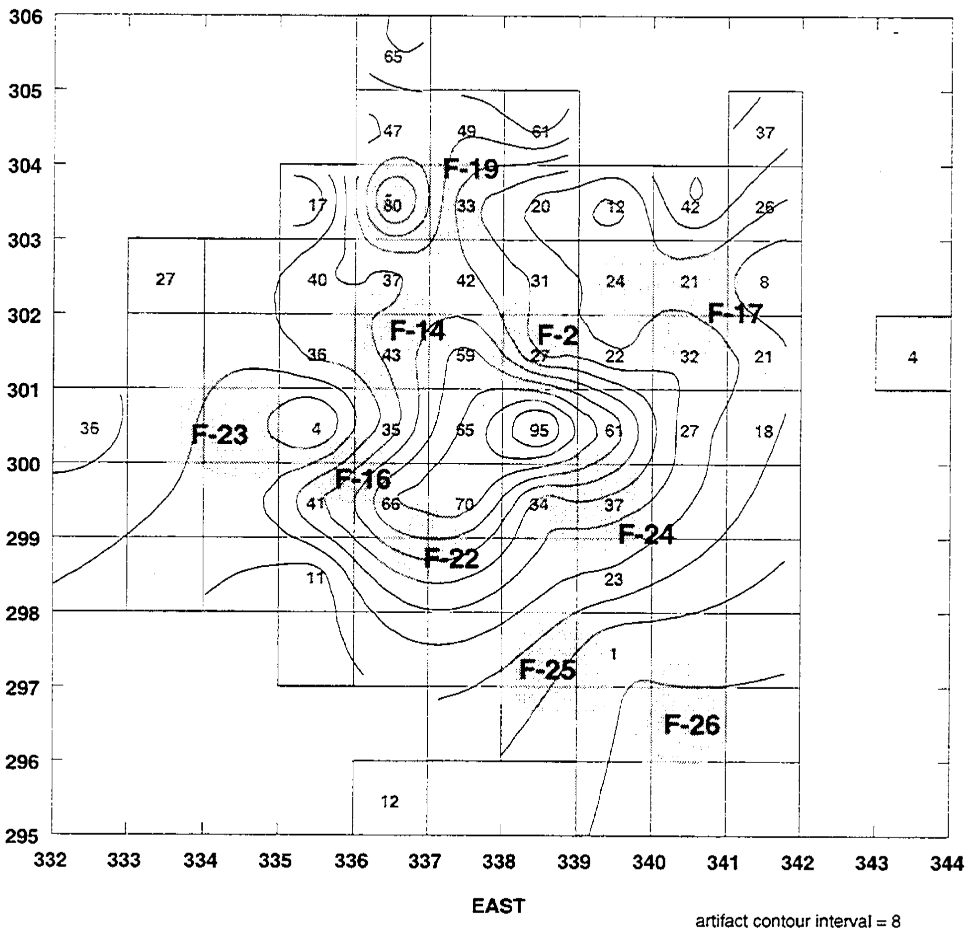

Figure 63. Pit Features in Area 2 and Fire-Cracked Rock Clustering

In terms of the spatial distribution of artifacts from intact sub-plow zone contexts, some concentration was evident in quartz, pebble cryptocrystalline lithics, and ironstone in Block D on the north edge of the area. Analysis of the spatial distributions by size indicated that large and small flakes could be differentiated. The ironstone concentration made up most of the smallest debris whereas larger flakes were distributed in separate zones. These distributions argue for the presence of small lithic manufacturing areas.

Area 2 Feature Morphology

Feature analysis at Lums Pond focused on the series of pits found in Area 2. The radiocarbon dates convincingly argue for contemporaneity among the features, with an average date of 2802 BP (852 BC). In spite of their proximity, there was a general lack of physical overlap, such as might be expected if they had been excavated a different times, with later pits cutting through existing pit outlines.

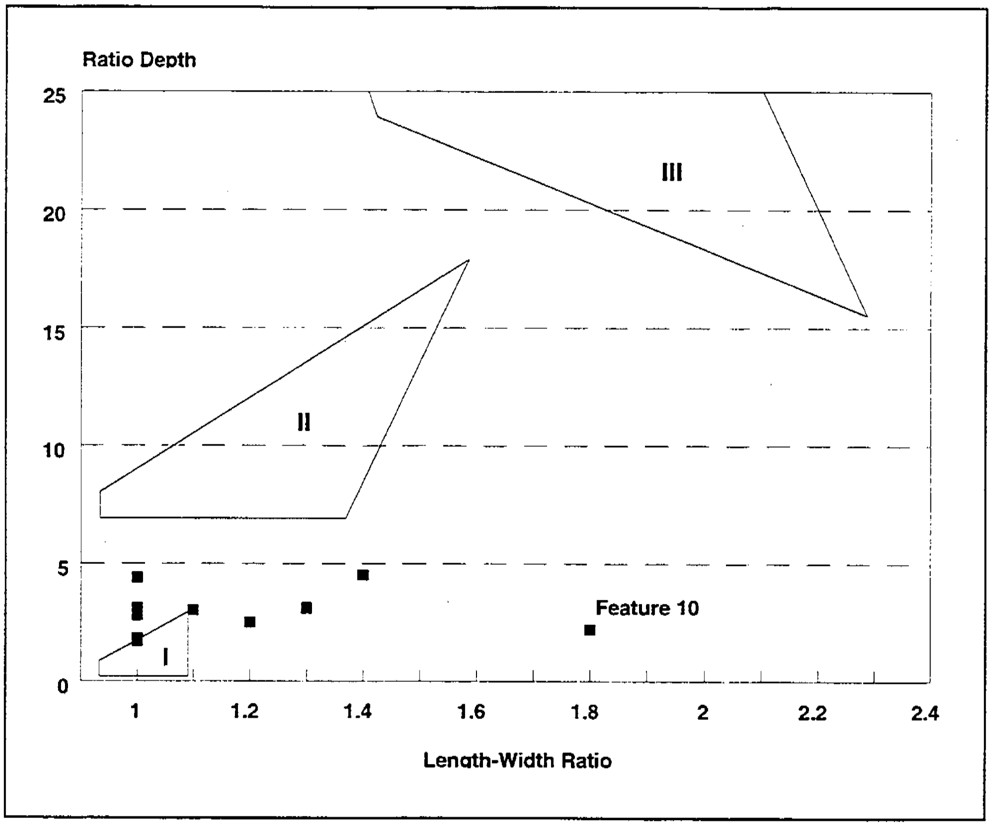

Figure 64. Dimensional Proportions of Lums Pond Features (dots) in Relation to Feature Categories (polygons I-III) from Fisher Farm. Note that Lums Pond Features Share Similarities with Deep and Round Feature I Types from Fisher Farm, but the Lums Features are Slightly More Elliptical (Greater Length-Width Ratio)

The morphological study consisted of the description of the size and shape of the excavated features, analysis of feature contents, and correlation of the compiled variables. Comparison of dimensional proportions was initiated to examine how the Lums features compared to other measured and reported morphological forms. One relatively simple technique that provides a degree of intersite comparative data is the examination of scatterplots based on a series of dimensional ratios.

The Lums Pond features were compared to feature from Fisher Farm, a Late Woodland (Woodland II) village site in Pennsylvania (Hatch and Stevenson 1980). At that site, features were grouped analytically on the basis of shape. The groups are shown as numbered clusters in Figure 64, which also displays the Lums Pond features as individual points plotted on the same dimensional scale. Cluster I features at Fisher Farm were round in plan and proportionately deep; Cluster II features were oval and relatively shallow; and Cluster III were large, elongated and shallow. The Lums Pond features showed some correspondence with Cluster I features from Fisher Farm. The Lums Pond features were round in opening and relatively deep. There was a greater range in the opening shapes compared to Fisher Farm, with a few showing slightly elliptical in shape (1.3 to 1.4 length-width ratio). Feature 10, located in Block E of Area 2, was distinguished from the Block C, Area 2 pit features, clearly showing different shape parameters, and probably indicating a different function (refer to Plate 3 for block locations). The Lums Pond pit features showed some correspondence with the round and deep Category I features from Fisher Farm, although there was a greater range in the Lums pits, being slightly more elliptical in their openings.

To further examine morphology, the Lums Pond features were compared to those from Cabin Run, a Late Woodland (Woodland II) site in Virginia (Snyder and Fehr 1984). The Cabin Run features were grouped into three types on the basis of absolute, rather than proportional dimensions: Cluster I had deep profiles relative to opening size; Cluster II had large surface dimensions with shallower depths; and Cluster III had variable surface widths and shallow depths. The groups are illustrated Figure 65, with the Lums Pond features plotted individually on the same axes. In comparison, several of the Lums Pond features fell near or within the reported range of Cluster I types at Cabin Run, which were generally identified as storage or refuse pits.

The morphological comparisons suggested both correspondence and variability between the Woodland I features at Lums Pond and those documented at the two later village sites. The types of activity conducted at the villages may have been comparable in terms of general resource processing and storage, yet sufficiently different from those at Lums Pond, both in scope and intensity, to leave different feature patterns. Thus the study of feature morphology, while not consistently revealing specific feature function, can be an effective descriptive tool which can demonstrate gross differentiation at the site level.

In light of comparisons with Woodland II village sites, mention should be made of a series of deep pits found at the Delaware Park site (Thomas 1981). In this Woodland I and II site a variety of feature types were identified, among them, a group of features described as silo-shaped pits (Type A), which were relatively deep in relation to their surface, with vertical sidewalls and flat bottoms. Others were also silo-shaped pits (Type D), but these features were not as deep and walls were slightly wider at the base. While the Delaware Park features share some general shape similarities with the Lums Pond pits, the pits are different enough to indicate some variation, particularly in terms of overall size. The variation may be a consequence of length of site habitation, since the Delaware Park occupations appeared more substantial. Thus the deep pits may have been more formalized and better constructed.

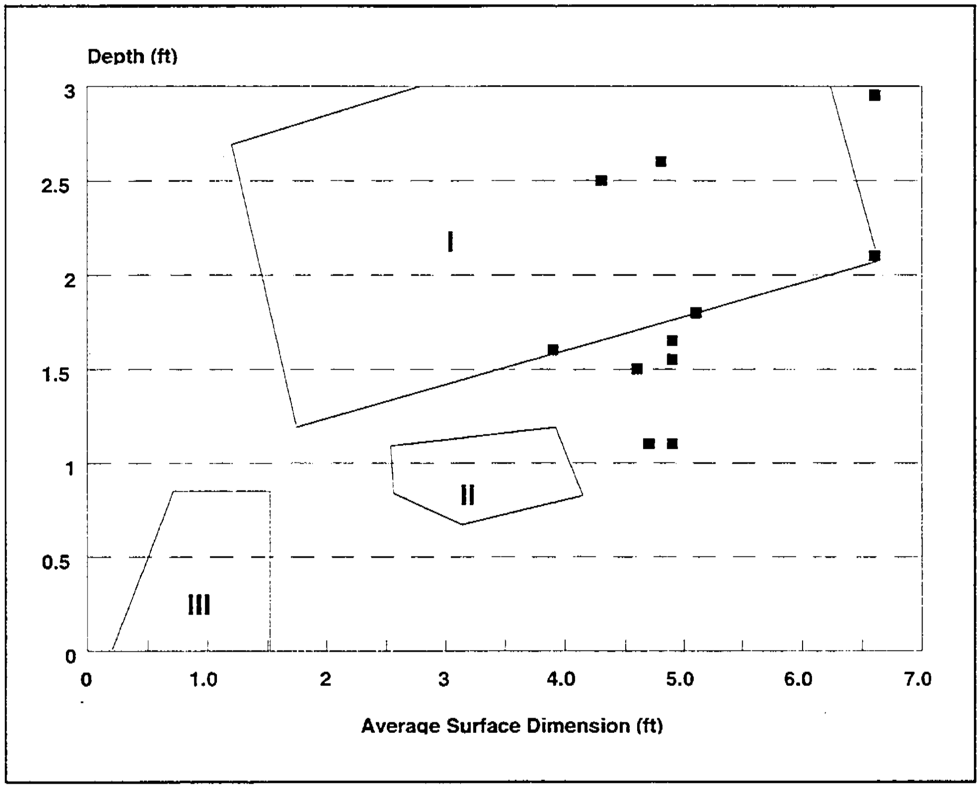

Figure 65. Dimensional Proportions of Lums Pond Features (dots) in Relation to Feature Categories (polygons I-III) from Cabin Run. Note that the Lums Pond Features Overlap with the Deep and Wide Category III Features from Cabin Run

Area 2 Feature Function

The morphological feature analysis was aimed at accurately describing size and shape characteristics, allowing for comparisons to various site types, and thus helping to elucidate functional variability. Most of the Lums Pond pits were straight-sided and relatively deep in relation to surface opening, or roughly silo-shaped. All had been excavated into the coarse sandy subsoil, perhaps for drainage. Morphological evidence suggested that the original function of the pits was for storage.

Stratigraphic, artifactual, and ecofactual data resulting from analysis of the contents of the pits argue for similar formation processes, and imply secondary deposition after use as storage containers (Table 31). In general, the pits appeared to have infilled quickly, as their general forms were preserved and their contents were generally similar. The artifacts found in the pits would have been disposed of from the living surfaces (Figure 66). Fragments of fire-cracked rock in the pits were of the same general size, mostly consisting of highly fragmented and small debris. The implication is that the fills were similar in origin, and further, that deposition was secondary. Moreover, with the possible exception of Feature 14, there was no evidence for in situ burning in the pits, even in Feature 19, which contained the most abundant evidence for fire-cracked rock. Feature 19 was also representative of secondary deposition, but its contents differed from the other pits. The lenses of debris, greater concentration of charcoal, and higher artifact counts suggested clean up and dumping of refuse. Geochemical data also convincingly argued that the pit fills were of a similar nature, consistent with the interpretation of a single function and secondary deposition. The geochemical data varied significantly from prints diagnostic of extensive activity surfaces or middens that imply repeatedly occupied, long duration sites. The activities in Area 2, as indicated by pit fill, consisted of specific tasks, likely of limited duration.

	Shape	Primary Use	Secondary Use
Feature 2	silo	storage	disposal
Feature 14	basin	roasting pit, hearth	none
Feature 16	silo	storage	disposal
Feature 17	silo	storage	disposal
Feature 19	silo	storage	disposal
Feature 22	silo	storage	disposal
Feature 23	silo	storage	disposal
Feature 24	silo	storage	disposal
Feature 25	silo	storage	disposal
Feature 26	silo	storage	disposal

Table 31. Lums Pond Area 2, Feature Functions

While none of the pits preserved large amounts of organic material, carbon was present and occasionally charred macrobotanical remains. The macrobotanical evidence from various pits was redundant indicating consistent use of oak, probably as a fuel, and exploitation of nuts, including hickory and acorn. Artifact contents were also similar, arguing that the debris resulted from a uniform set of activities. Many of the pits contained flakes, chips, bifaces, and ceramics, but with little significant differentiation in the patterns of occurrence. While some of the lithic material showed signs of burning, there was likewise no patterning to suggest activity variation. Chronological data, including radiocarbon determinations and diagnostic projectile points and ceramics, were consistent enough to argue for contemporaneity.

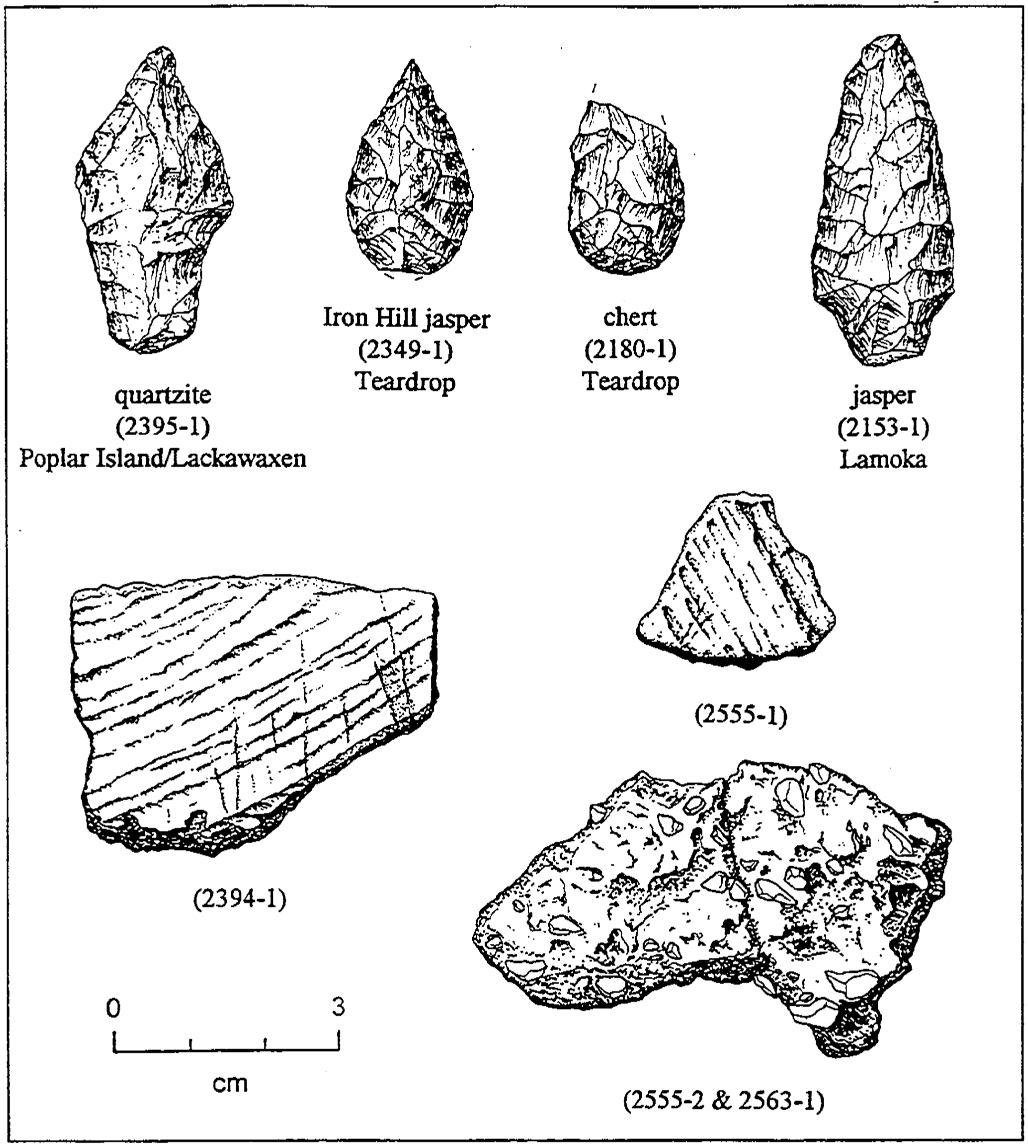

Figure 66. Artifacts Recovered from Pit Features in Area 2

Feature 14 was dissimilar from the rest of the features in shape and presumably function. It was shallower, basin shaped, and contained more charcoal and concentrations of fire-cracked rock than most of the other, straight-sided pits. Based on its shape and contents, it likely served as a hearth or roasting pit.

In sum, the pits represented a tightly controlled set of activities occurring during a brief period of time. It appeared that the features were originally used as storage pits.

Material would presumably have been stored in them during winter months, with the pits being opened and emptied in the late winter and early spring. Fire-related activities appeared to have occurred in the vicinity of the pits, suggesting immediate processing of the contents of the features. Oak was gathered as a fuel source. Geochemical data argued against major, long-duration site activities that would have left signs of dense subsistence debris. Instead, use of the area was probably short term and perhaps specialized. The processing and consumption of hickory and acorn nuts may have been among the activities that were performed in this area. After the pits were emptied, they were filled with debris from the nearby area, and eventually the site was abandoned.

Area 3

The survey and testing program showed that Area 3 was an additional area of discrete prehistoric activity, situated closest to the stream bank. Testing showed that two main areas of artifact concentration were present in intact sediments, and data recovery excavations, labeled Block A and Block B, focused on these locations.

Block A

In Block A, two stratigraphic levels, Stratum C and Stratum D/E, contained the main evidence of prehistoric activity. These deposits were dated by radiocarbon and artifact types to the Woodland II and Woodland I periods respectively. In Stratum C, two artifact clusters were identified. One consisted mainly of pebble flaking debris, including flakes and chips of quartz and pebble chert. The other cluster was concentrated to the north, and contained quartz debris alone. While little fire-cracked rock was present, there was evidence of clustering along one edge of the block.

Stratum D/E was the main artifact bearing level. Two main artifact concentrations were present in Stratum D/E, one dense cluster identified in the northeast and a second in the southwest corner of the block. Fire-cracked rock was more prevalent in the artifact concentration in the northeast. Breakdown by raw materials showed that quartz and Iron Hill jasper were present in both areas, with counts higher in the northeast. This contrasted with pebble cryptocrystalline materials and quartzite, which were more heavily concentrated in the southwestern area. Some correspondence was also noted between fire-cracked rock and burned jaspers, thus suggesting the possibility of heat treatment associated with tool manufacture. However, refitting information showed that some of the artifacts may have been unintentionally burned.

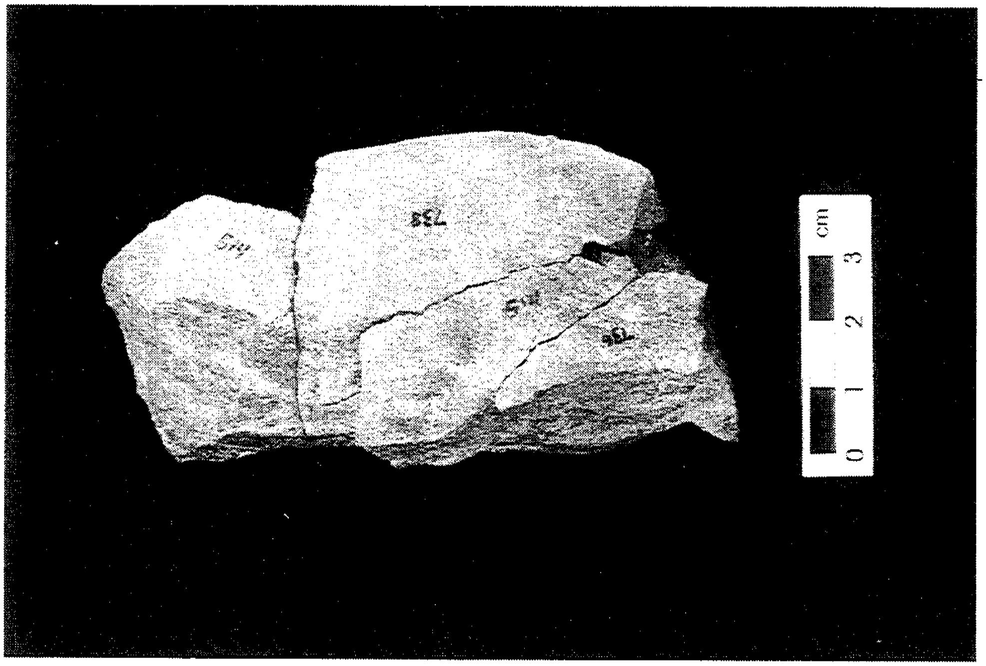

Plate 34. Refit Fire-Cracked Rock from Block A, Area 3 (Group 3a)

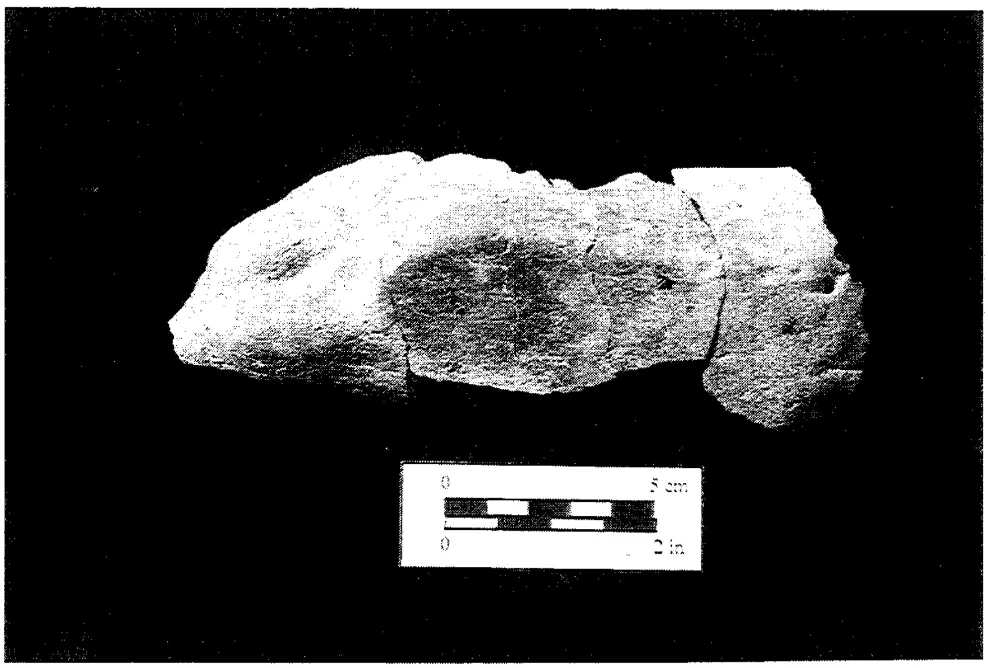

Plate 35. Refit Fire-Cracked Rock from Block A, Area 3 (Group 4a)

Data resulting from the refitting analysis was found to be useful when overlaid on the general artifact distribution plots. The refits of fire-cracked rock (Plates 34 and 35) showed a close correspondence with the spatial clusters (Figure 67). The locations of chipped stone refits similarly correlated with general artifact concentrations (Figure 68). It appeared then, that the refits confirmed the validity of the artifact concentrations that were delineated by the spatial analysis. The general separation seen in the chipped stone and fire-cracked rock refits supported the contention that the fire-cracked rock and stone artifact assemblages were real, and that different activity areas might be present. Horizontal spatial divergences of refits may be the result of re-use of occupation surfaces. For instance, if the interpretation is correct that some artifacts were unintentionally burned during re-use, it may be surmised that some horizontal differences are the result of additional activities which would have reshuffled artifacts through processes such as trampling. Thus, cultural processes may account for artifact clustering as well as redistributions and separations.

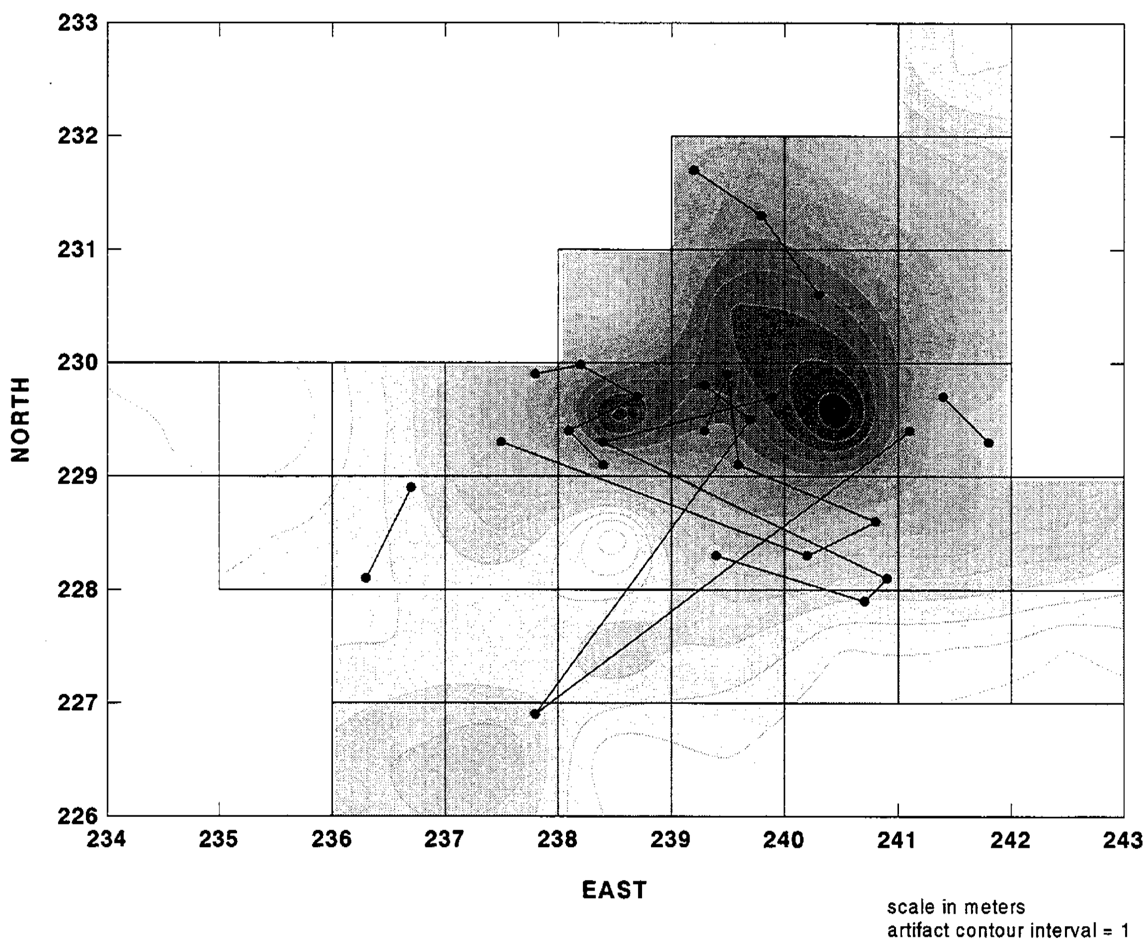

Figure 67. Fire-Cracked Rock Clusters and Refits

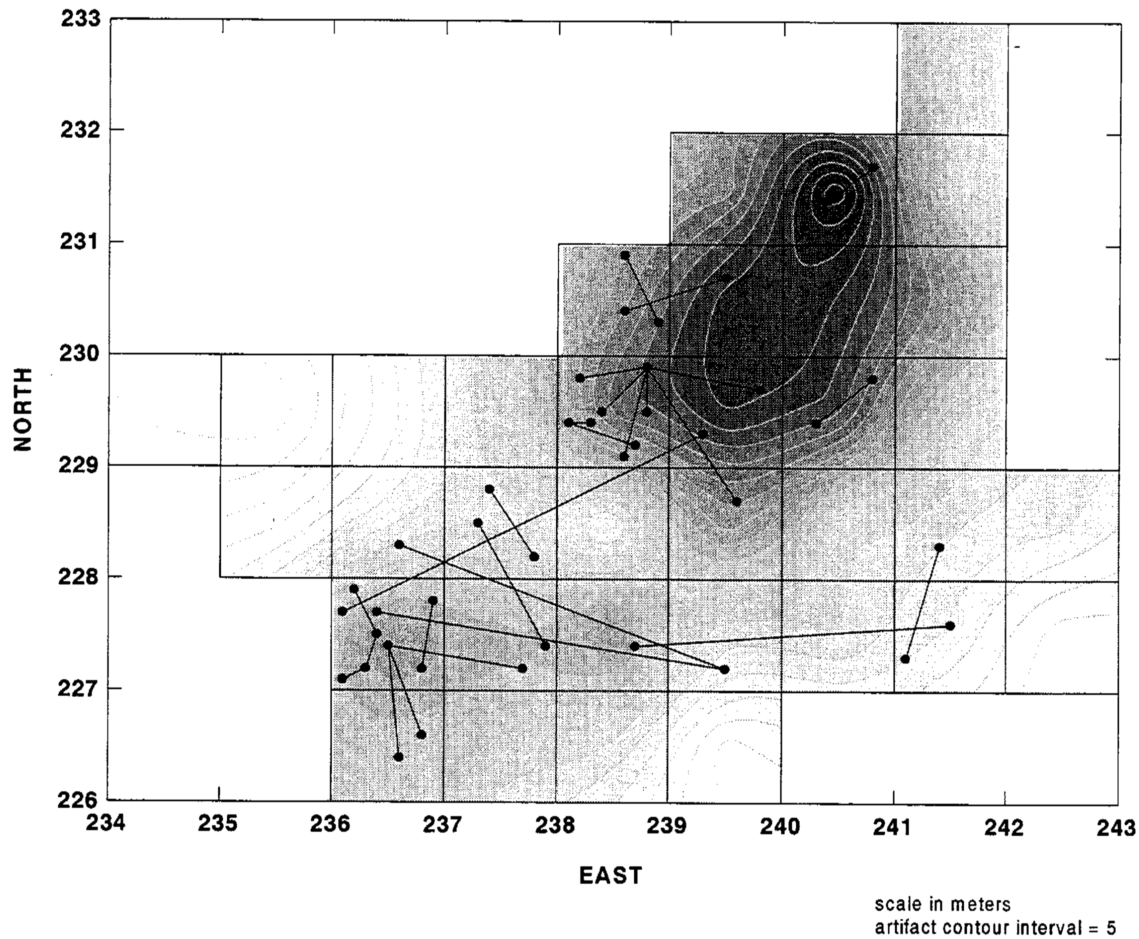

Figure 68. Artifact Cluster and Refits

Block B

Two distinct episodes of deposition were also recorded in Block B, and they appeared to be directly associated with those in Block A. The deposits were Stratum C and Stratum D/E, dating to the Woodland II and the Woodland I. In Stratum C, a distinct cluster of material was identified in the central portion of the excavation block. The majority of the cluster was made up of fire-cracked rock, with the remainder consisting of flaking debris of quartz and pebble chert. Analysis suggested that the artifact cluster represented the remnants of a localized lithic reduction area with a small hearth nearby.

In Stratum D/E, two artifact concentrations could be defined, one in the southwest portion of the block and the other near the center (Figure 69). There were differing proportions of fire-cracked rock and chips in the two areas, and raw material differences were also identified. The spatial variations in the chipped stone were interpreted as

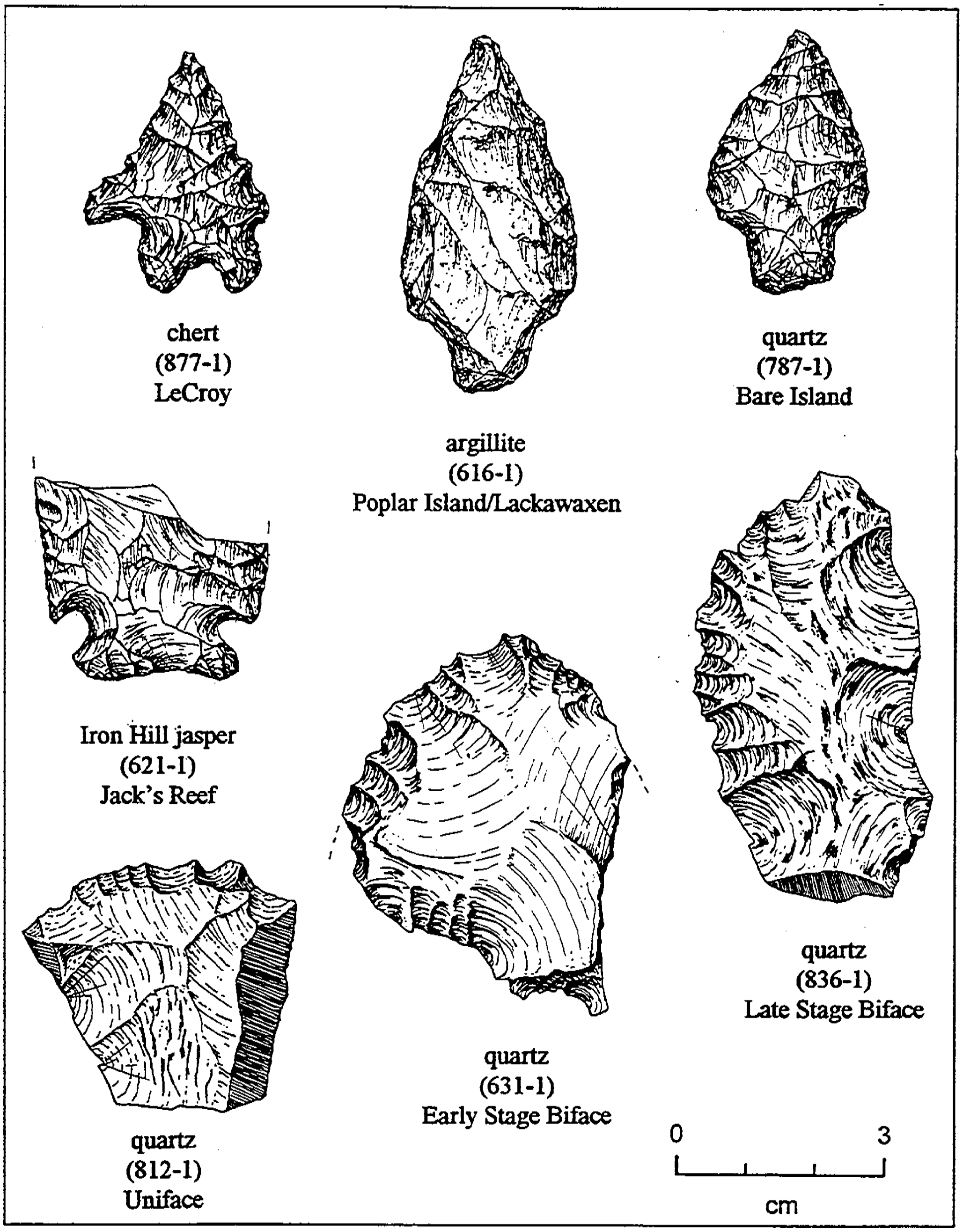

Figure 69. Artifacts Recovered from Block B, Stratum D/E

isolated jasper and quartz knapping debris. Refit data again confirmed the results of the by indicating that refitted fire-cracked rock fragments were confined to the units in the central part of the block in which fire-cracked rock was concentrated.

Vertical Patterns

Upon excavation of Area 3, artifact assemblages were found in buried contexts of up to a meter in depth. The uppermost levels, Strata A and B, consisted of a mix of historic and prehistoric artifacts. Geomorphological analysis clearly showed that the depth of these horizons was the result of erosion generated in the midslope portions of the site, and thus some of the artifacts had been redeposited. Various analyses, including close stratigraphic inspection, showed that Strata C through E were prehistoric deposits. Radiocarbon dating helped to sort the ages of the deposits, with assays from Stratum C having a mean date of 431 BP (1519 AD) and assays from Stratum D a mean date of 3331 BP (1381 BC). Spatial analyses of the vertical patterns were also aided by artifact distribution analysis and refitting.

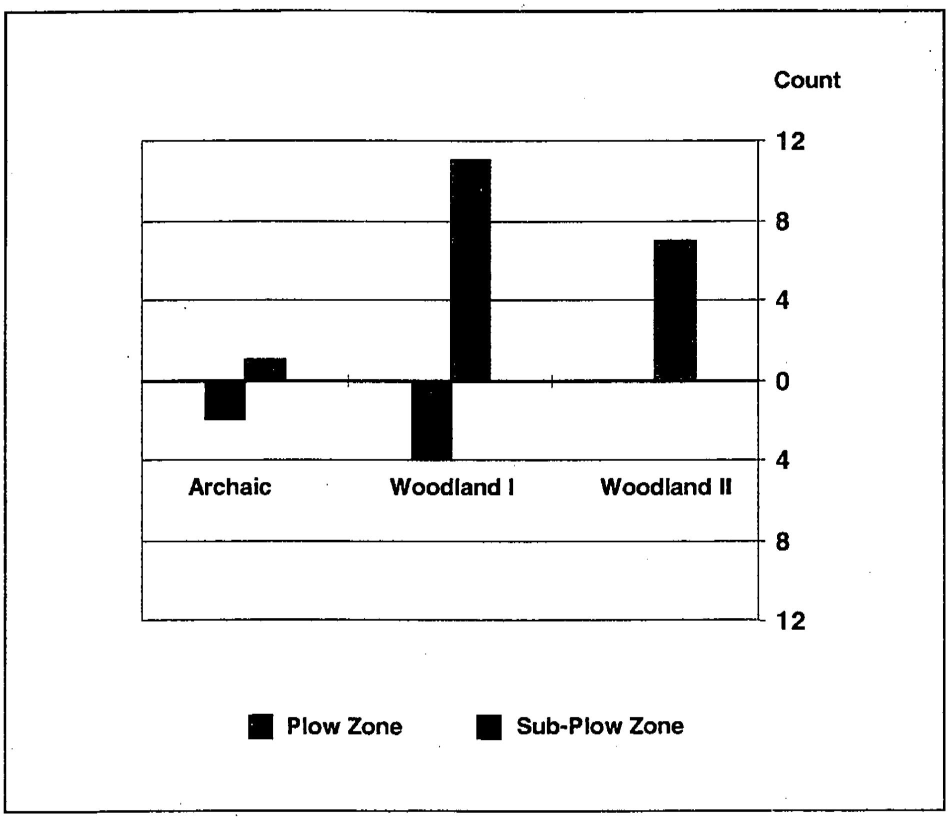

Figure 70. Vertical Proveniences of Temporally Diagnostic Projectile Points in Area 3

The proveniences of temporally diagnostic projectile points in Area 3 were plotted (Figure 70). A clear trend is evident in which earlier types occurred more frequently in sub-plow zone context and later types in the plow zone. The chart implied a relatively straightforward stratigraphic sequence, with all of the Woodland II period points occurring in the plow zone, and truncation of the original profile causing Woodland I and II points to co-occur together. It should be noted that the few finds of Archaic points are, in actuality, the result of re-sharpening and re-use by Woodland I inhabitants.

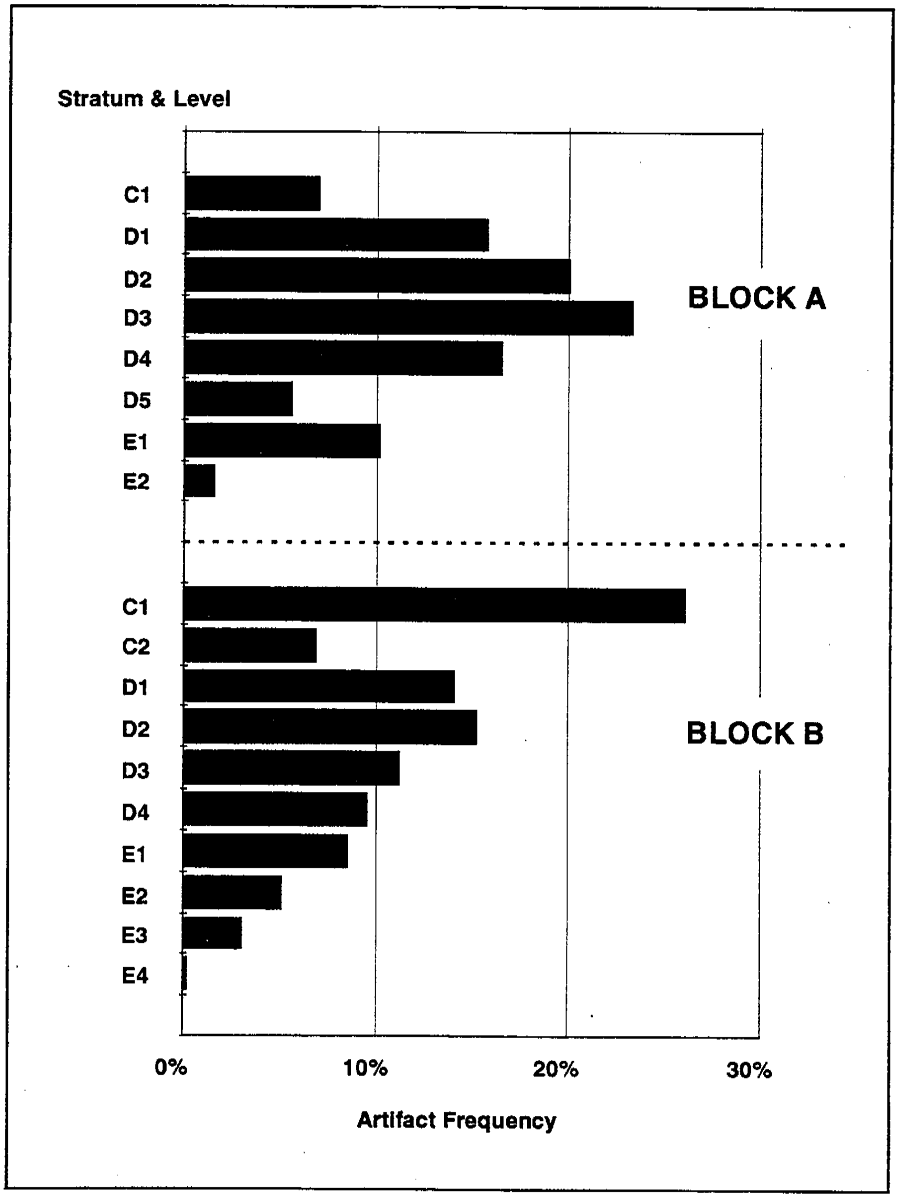

Figure 71. Vertical Frequency Distribution of Artifacts in Sub-Plow Zone Deposits in Block A and Block B

To examine differences among Strata C-E, vertical frequency distributions were plotted. Artifact frequencies showed variation among strata, with obvious peaks in Stratum D of Block A and Stratum C of Block B (Figure 71). In strata with multiple 10 cm levels, there were highs and lows of artifact counts, implying potential vertical migrations. However, there was little evidence for artifact size variation observed, based on the relationship between artifact weight and depth of occurrence. The analysis indicated a lack of sorting by natural processes. In sum, frequency distributions and size sorting data implied that deposition occurred within a comparatively restricted zone in each stratum with some potential mixing among levels and interfaces between strata.

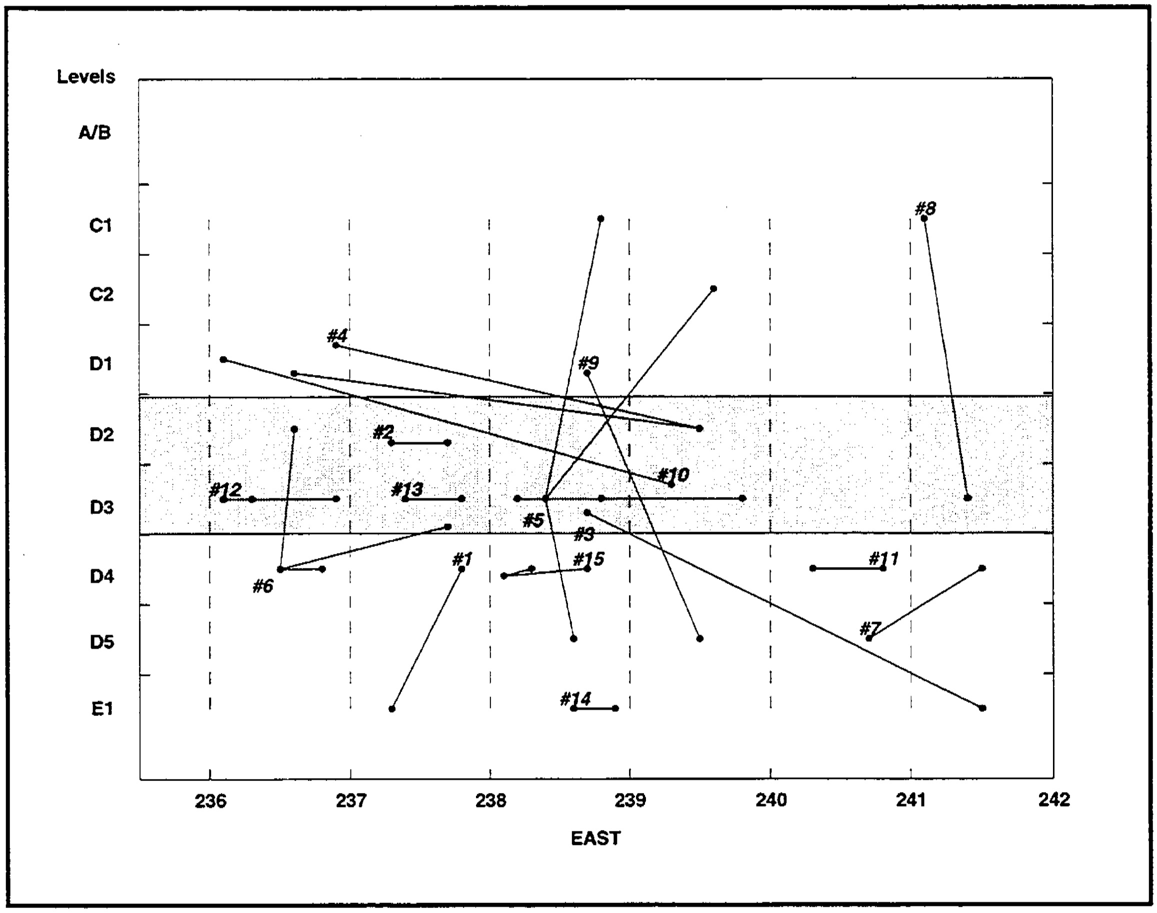

Figure 72. Vertical Distribution of Refits

The refitting of lithic artifacts and fire-cracked rock in Area 3 aided in determining the relative integrity of strata. Refits within individual stratum designations showed that these were in fact distinguishable prehistoric units of analysis, according well with the artifact frequency information. The refitting information also indicated the re-use of certain surfaces and it suggested that in some cases, strata preserved lenses of material still in their original cultural positions. However, while individual groups of refits suggested this was the case, it could not be demonstrated that levels were the result of individual occupations due to evidence for vertical separation of artifacts after burial (Figure 72). Refits commonly ranged across vertical levels and sometimes strata (although fire-cracked rock, the heavier items, ranged less distance vertically then chipped stone refits). Overall, the refits implied that the most useful units of analysis are stratum designations and not levels. A similar situation and argument was made from a set of buried sites in southern Delaware (Blume 1995). At these sites, vertical separations were observed as a consequence of natural processes, but it was also argued, that based on artifact frequencies and depth, depositional integrity was generally maintained, allowing for some level of behavioral analysis. Based on this vertical refitting evidence, the Lums Pond analysis was geared towards the proper units of behavioral analysis, combining artifacts in levels ranging in Stratum C and Strata D and E. While postdepositional vertical transformations were recorded, the refitting project showed that most artifacts of the Woodland I were cofined to Stratum D/E and only a few ranged into Stratum C (probably upheaved upward in the profile as seen in the reassembled sets). This data clearly shows that analysts must fully consider the degree to which natural processes have influenced horizontal and vertical patterns.

Subsistence

Charred hickory nutshell fragments were recovered from three pit features and from several stratigraphic levels at the site. Hickory has been considered to be among the most important nutmeats used by Native American populations at the time of European contact (Reidhead 1981). In support of ethnographic information, hickory shells have been found to be the most common nutshell fragments recovered at prehistoric sites in the east (LeeDecker and Holt 1991). Hickory would have been a highly efficient source of food inhabitants of the Lums Pond site. Hickories are usually found in groves, particularly along stream margins, and thus the nuts would have been relatively easy to gather. Although the yield of each hickory tree reportedly may vary on a 1-to-3 year cycle, once identified, a stand of hickories can represented a fairly abundant and consistent resource (Keene 1981). Considering the relative frequency of occurrence of hickory shell fragments at Lums Pond, the harvesting and processing of the nut was probably a major focus of activity. Water from the nearby stream could have been used as a flotation device to separate meat from shell after crushing. The meat would then have been boiled to extract oils that could be used immediately or stored. The processing of hickory nuts has been documented in similar contexts at several other regional sites, such as the Bryan site on the Upper Delaware River (Kinsey 1975), a site in the Abbott's Farm Complex in New Jersey (Cavallo 1987), Lower Black's Eddy on the Middle Delaware (Kingsley et al. 1991), the Kettle Creek site on a tributary of the West Branch of the Susquehanna (Petraglia and Knepper 1994), and the Connoquenessing site in the Upper Ohio Valley (Knepper and Petraglia 1996).

In addition to hickory, charred acorn shell fragments were found in several Woodland I contexts at the site. It is possible that acorn represented part of the prehistoric diet as well. Ethnographic reports have noted that acorns were a valued source of food. However, the acorn fragments could also be incidental, as oak was the predominant wood charcoal identified in the pits.

Charred seeds were also recovered from the Lums Pond occupations. The Lums Pond samples contained evidence for use of mint (*Lamiaceae*) and huckleberry (*Gaylusscaia*). Both of these plants were used ethnographically. The huckleberry shrub yields blue or black berries that ripen from July through September. Huckleberries may be eaten fresh, cooked, or dried and stored for future use. Mints are known to be used as food, flavorings, scents, and medicines in ethnographic contexts. These plants may be found in dry or moist ground in woods, thickets and clearings, and they may be associated with open or disturbed areas. Some researchers have suggested that such areas would have been limited in the so-called virgin forest of the Middle Atlantic and the Northeast (Keene 1981). Yet geochemical analysis at Lums Pond supported the inference of clearings near the site, suggesting that environments suitable for plants such as mint and huckeberry were present in the area. As clearing increased from disturbances such as fire (of natural or human origin) or flooding, such plants would have had additional opportunities for colonization and thus may have become part of the prehistoric diet. As cultural alteration of the landscape increased with the development and spread of horticulture, more disturbed habitats would have become available for weed plants, and probably not coincidentally, a rise in the incidence of weed and grass seed is generally recorded throughout the Woodland period (Asch and Asch 1977).

In addition to nuts and plants, it would be anticipated that Woodland I groups would have made extensive use of terrestrial animals. However, no faunal remains were recovered at Lums Pond, probably due acidic soil conditions. As a consequence, analyses were conducted in an attempt to determine if organic residues were indeed present on stone tools, and if so, whether the animal types exploited could be identified. The organic residue analysis of stone tools was successful, showing that some tools did preserve signs of animal protein along their surfaces. One stone artifact, a jasper uniface, showed convincing evidence of the presence of deer protein, clearly indicating that this species was utilized. While the findings of the study were limited, they did provide important evidence that a range of animal proteins may be in fact recognized with relative certainty given sufficient analytical effort.

Regional Settlement Patterns

The Woodland I period in Delaware is characterized as a time period which witnessed the stabilization of riverine and estuarine environments. These environments would have supported significant and seasonally predictable populations of shellfish and anadromous fish (Custer 1986). The generally increased size and complexity of settlements along rivers and estuaries during this period suggests a trend toward sedentism as well as organized strategies for resource acquisition. In spring and summer months groups may have coalesced into large base camps situated along major streams, like St. Georges Creek, where anadromous fish were harvested. During the fall and winter months, smaller base camps would have been occupied along inland tributaries. More transient, special purpose camps, for the harvesting or procurement of specific resources were used to support the base camp occupations. Recently it has been proposed that individual families rarely joined together into large "macro-band" camps (Custer 1994). In this perspective, riverine base camps, such as those identified at Leipsic, Snapp, and Pollack, would be considered the product of repeated use by individual nuclear families, and the accumulations and large size of the sites could be considered the result of re-occupations. In contrast, sites traditionally labeled as "micro-band" base camps, characterized by fewer artifacts and smaller sizes, could be considered short-duration sites that were not repeatedly revisited.

Lums Pond, situated along a tributary of St. Georges Creek, conforms to expectations about limited duration, so-called "micro-band" base camps. While there was much evidence for Woodland I occupation across the site, each of the individual areas within the site appeared to have been short duration deposits representing separate episodes of site use. The distinct separation of the site areas seen as a result of survey and testing strongly indicated that different zones existed, which likely comprised separate occupations and activities which occurred along the margins of the stream and its wetlands. The radiocarbon data clearly show that Area 2 and Area 3 were occupied at different times, separated by some 500 years. The relatively low artifact densities found in each of the three areas also indicated limited activity sets. Moreover, the similar dates and the lack of overlap of pit features in Area 2 also strongly argued for short-term, contemporaneous use rather than long term activity or re-occupation.

Recent models have been formulated which suggest the geographic range of Clyde Farm Complex territories (Custer and Silber 1995:193, figure 104). The identification of rhyolite and argillite artifacts from the Snapp Site suggested that Clyde Farm influences stretched from St. Georges Creek to southeastern Pennsylvania and from northern Maryland through much of southern New Jersey. This territory is much larger than ranges normally identified by regional archaeologists, but it is considered well within a normal hunter-gatherer mobility pattern (Custer and Silber 1995: 193). The jasper characterization study at Lums Pond was conducted to examine the distances that groups may have traveled to obtain good quality knapping material. The chemical analysis of jasper artifacts from Lums Pond indicated multiple sources, extending from Northern Delaware, Eastern Maryland, and Pennsylvania (Figure 73). Most of the evidence suggested however that the great majority of the Lums Pond material was derived from the jasper quarries in Northern Delaware, particularly in the vicinity of Chestnut Hill and Iron Hill. The jasper from the Brennan site, a temporary quarry workshop site located just west of Lums Pond, was also considered to derive from the Northern Delaware sources based on visual analysis (Watson and Riley 1994). Yet the chemical data also suggested that some of the Lums Pond jasper artifacts were derived from the Amtrak (Iron Hill Cut Quarry) and Heath Farm Complex sources, both in eastern Maryland, and from distances as far north as the Middle Delaware and Susquehanna River valleys in Pennsylvania. This finding lends support to the Clyde Farm Complex model, indicating that the territorial range of Woodland I groups probably extended well to the north and west into many areas of the Piedmont and beyond.

Conclusion

The archaeological investigations carried out at the Lums Pond site represent intensive, systematic research, the results of which have added substantially to the current state of understanding of prehistoric activity for sites located in New Castle County. Data recovered from plow zone and intact stratigraphic contexts provided information relative to the periods of site occupation and to site function. Recovery of data from feature proveniences provided additional information concerning site use, subsistence practices, and paleoenvironmental conditions. Considering the amount and quality of the data recovered, mitigation of the Lums Pond site is held to have been successfully accomplished. Specific goals of the Lums Pond data recovery were to obtain information on prehistoric chronology, settlement, subsistence, and technology. A considerable amount of chronological and functional data was recovered concerning occupations during the Woodland I. The Lums Pond data recovery project clearly indicated the functional difference between the types of sites that may be expected on the St. Georges Creek and its tributaries. Excavations of Lums Pond therefore supplied detailed information about a certain site type. The retrieval of significant data from Lums Pond has indicated that systematic excavation of temporary locales is productive and essential if a full picture of aboriginal settlement pattern is desired.

Insights Gained and Future Prospects

Most archaeological reports end with a discussion concerning what was learned from the investigations. During the course of the Lums Pond work, Kevin Cunningham, DelDOT archaeologist, asked Parsons Engineering Science to evaluate the relative importance of our field work and laboratory analyses. This research appraisal was considered a challenge, presenting us with the opportunity to reflect upon what we consider to be the areas of most productive future research and the areas that may have less prospect for providing useful information.

Picture of the Woodland I

A basic and legitimate question that may be posed at the conclusion of the Lums Pond investigations is what did we truly learn about the Woodland I? At first glance, it appears that much of the recovered data set and material culture conforms to published reconstructions of the time period (Custer 1989, 1994). And, it is true that much work has been conducted on Woodland I sites, particularly in northern Delaware, allowing for development of models of Clyde Farm Complex chronology, settlement, subsistence, and technology. However, while some perceptive models have been advanced, much of the information has been obtained from older artifact collections while behavioral reconstructions are oftentimes placed on a general rather than specific level. In this sense, the Lums Pond investigations fulfilled a level of much needed archaeological research. The Lums Pond investigations may be viewed as an accomplishment in obtaining a modern, high quality data set. The application of specialized analyses to the collections further elucidated aspects of prehistory, providing relatively unique information, and delimiting new avenues of research.

Moreover, the Lums Pond investigations have added specific details to what we know about a particular time and place. The Lums Pond data provided detailed information about the Clyde Farm Complex on the upper reaches of the High Coastal Plain. Few intensive excavations have been performed on similar sites, with the exception of Woodland I sites such as Snapp and Brennan. However, the investigations also showed that while some similarities may be drawn between Lums and the Snapp and Brennan sites, the interpretations are different enough to indicate that archaeologists have not reached a level of redundancy in pattern recognition studies or research findings. The following subsections will attempt to document that many alternative ways of scientific inquiry remain to be applied to prehistoric sites in Delaware, and much detailed information about prehistoric adaptation is yet to be derived.

The Survey and Testing Strategy

Recent ethnoarchaeological studies show that aboriginal peoples tend to occupy large areas during any single site occupation (e.g., O'Connell 1987). This suggests that if archaeologists wish to understand the layout of aboriginal settlements, large areas must be examined. Many of the surveys and excavations performed in Delaware are in fact useful for showing the spatial layout of prehistoric sites (e.g., Custer and Silber 1995; Custer et al. 1996). In many other cases, archaeologists have confined themselves to small areas, such as may be of little use in discerning site structure. The sampling design employed during the Lums Pond field investigations succeeded in showing the distribution of artifact assemblages, stratigraphic deposits, and features over a broad area.

The Lums Pond survey was conducted over a proposed wetland mitigation area. In contrast to projects limited to right-of-way corridors, the shape of the mitigation pond allowed archaeologists to work over a laterally extensive area. Use of systematic shovel testing confirmed the location of the previously identified site and further, delineated areas of artifact concentration. More intensive shovel testing within each of these zones defined the horizontal limits of the concentrations. Based on these findings, test units were excavated, examining the varieties of stratigraphic deposition which were present across the area. These initial excavations indicated the locations of artifacts in plow zone and subsurface contexts. The field work performed during evaluative testing of the site was conducted in stages. After initial test unit excavation was conducted, additional units were placed in areas where plow zone concentrations were identified or where artifacts or features had been identified in subsurface contexts. This two stage approach and flexibility in testing was a critical factor in isolating artifact distribution patterns of interest, providing effective evaluation of deposits before committing to more intensive mitigation. Computer-aided mapping and preliminary artifact analyses concurrent with evaluative testing were also used effectively to direct testing in areas of interest. The coordinated geomorphological investigation undertaken during the testing phase of the archaeological investigations was critical in making proper management decisions about site integrity and the potential for identifying deposits which might be useful as paleoenvironmental indicators. On-site consultation with archaeologists from DelDOT, the Delaware SHPO, and Delaware Department of Parks and Recreation allowed for effective communication of testing results and the development of an appropriate excavation strategy. Thus, a broad area investigation, flexibility in field testing, and in-field decision making with all parties involved allowed for the implementation of a successful program of testing and evaluation and the elaboration of effective treatment strategies for the resources identified.

The results of the Lums Pond testing strategy suggest that such a process should be continued for other, similar investigations, since adequate knowledge of overall site structure is often not available from the evaluation stage of an archaeological investigation. Contemporary economics may often dictate the amount of effort put into the testing phase of a project. While the horizontal and vertical limits of the site may be defined at the end of testing, the site's internal structure is often not fully delineated, making the design of an efficient and productive mitigation plan impractical. While the testing phase of work may be more intensive in such a strategy, it may provide long-term savings to agencies by avoiding unnecessary mitigations and more precisely directing those mitigations that are conducted.

Staged Mitigation

As in the testing phase of field investigations, data recovery was staged, allowing again for flexibility in the size and placement of block excavations. In this investigation, the first stage of the mitigation was aimed at further refining an understanding of site structure and deposits, whereas the second stage had a goal of fully investigating patterns of greatest interest. Sampling in the first stage provided a larger probabilistic sample of each area than was generated by testing. This increased definition of the distribution of cultural material across the site and directed the focus of more intensive, Stage 2 investigations. Thus, data recovery excavations occurred only in areas with the most productive signs of behavioral patterning. The staged mitigation provided a means of increasing the efficiency of the data recovery process by clarifying site structure during the course of the investigations. While archaeologists should indeed provide explicit field designs for testing and mitigation samples, the Lums Pond field work indicates that flexibility is important, and that no single strategy or sampling method should be considered superior to another. In many cases, this will depend on the local circumstances of site conditions, preservation, internal structure, and deposition.

One drawback identified in the Stage 1 fieldwork at Lums Pond should be noted. In retrospect, it is felt that one-meter square test units did not represent the most efficient means of exposing subsoil for evidence of features. Mechanical removal of the plow zone, a process that has been effectively used at sites in the region, was not practical at Lums Pond given the nature of the landform in Area 2, an area characterized by sandy sediments and a heavy vegetation cover. Units measuring 1-x-2 or 2-x-2 meters would have been more useful, especially considering the known problems involved in recognizing the subtle nature of feature fill in the northern Delaware region. Here the excavation of Feature 24 is a case in point. Feature 24 went unseen in a 1-x-1 meter unit by a number of supervisory and field archaeologists until several contiguous units were opened in the vicinity. While larger units would be desirable to clarify the nature of deposits in such situations, the field strategy should be designed for particular circumstances. A greater field effort is obviously required to accommodate a greater number of excavation units, and costs may become a necessary management consideration. As a result, the testing strategies directing such work need to be carefully designed and applied to local circumstances. In parallel situations to Lums Pond that show many site-wide clusters of subsoil features, compromise may be needed between additional work in areas of particular interest and a reduction in the overall number of locations to be intensively investigated.

Settlement Patterns

Site typologies based on size of artifact distributions and artifact densities have been developed and used extensively in Delaware. With recent, large-scale excavations at sites such as Snapp, Leipsic, and Pollack, the validity of the concept of "macro-band" sites during the Woodland I has been questioned (Custer 1994). Questions have been raised mainly based on differences in material culture and the distributions of features. The mitigations clearly show that assessing and establishing site contemporaneity is critical since site parameters of size and density may be the result of single or multiple occupations. While material culture and site structural characteristics have suggested that site typologies should be re-evaluated due to evidence for reoccupations, further support for these notions could come from more precise dating. Unfortunately, at these same sites a battery of radiocarbon dates that would have allowed a refined assessment of the relative ages among deposits or features were not available. For instance, although emphasis was laid on assessing site contemporaneity and dating artifact assemblages at the Snapp site, which was inferred to be a repeatedly reoccupied locale, only 4 radiocarbon samples were obtained (Custer and Silber 1995: 103), 2 of which corresponded with artifact types, one of which was partially confirmatory, and the fourth was considered inaccurate. Similarly, only 6 radiocarbon dates were obtained from the Leipsic site, another large and repeatedly reoccupied site (Custer et al. 1996). As a consequence, these studies show that archaeologists should not only excavate broad areas, showing the relationship among deposits and features, but they should apply more refined chronological indices to establish relative ages.

In light of these studies, establishing the relationship among areas within Lums Pond was considered essential in examining contemporaneity. In this respect, the wide aerial extent of the excavations and the application of multiple radiocarbon dates was useful. The Lums analyses eventually verified that Woodland I intra-site areas could be isolated. Radiocarbon dating showed that these areas were not contemporaneous, the deposits of Area 2 and Area 3 separated by some 500 years. An erroneous conclusion based solely on the similar Woodland I material culture recovered from each area may have been that the Lums Pond occupations were much larger in extent then was the case. The Lums data therefore shows that archaeologists should collect refined chronological information to evaluate contemporaneity within sites before they are typed based on site size and density. More refined chronological estimates within sites will allow for an assessment of whether distributions are the result of limited duration episodes or repeated re-occupations by small to large groups.

Jasper Characterization and Territories

An aim of archaeological research is to establish the potential territorial range of prehistoric populations. Hypotheses have been advanced concerning the range of the Clyde Farm Complex (Custer 1994; Custer and Silber 1995). This model is based on perceived movement of groups as inferred from the distribution of lithic raw materials. A jasper characterization study was conducted at Lums Pond with the aim assessing the potential wandering range of the inhabitants of the site. The Lums Pond analysis relied on both visual and chemical studies to examine the Clyde Farm territorial range, distinguishing itself from the argillite and rhyolite distribution studies which were visually based identifications. The chemical analyses of jasper provided a higher level of confidence in assigning lithic artifacts to their sources. If strong patterning could be shown in chemical signatures among jasper quarries and artifacts, it was hoped that archaeologists would have a way to scientifically establish relationships. The Lums Pond analysis strongly suggested that distinctions between jasper quarries in Pennsylvania and Delaware could be distinguished. Furthermore, it was suggested that sources within Delaware could be isolated from one another. Clearly, then, the scientific study of the jaspers appears to support intuitive notions about the extent of Clyde Farm territorial range to the north. These findings are potentially exciting, suggesting that with additional analysis, great accuracy may be placed in defining aboriginal ranges. While this study appears to confirm the range hypothesized for the Clyde Farm Complex, it would be interesting to examine jaspers from other sites, such as those in southern Delaware, presumed to be the Barker's Landing territory. Jasper characterization may test the model suggesting relationships between the groups or it may suggest revisions. While great strides were made in the Lums Pond jasper characterization study, it must be emphasized that it was a pilot study. Additional samples must be collected from quarries and sites to further test and bolster the visual and chemical findings. If the Lums Pond patterns can be confirmed with other scientific studies, characterization applications can play a central role in Delaware and Middle Atlantic settlement studies, providing verification and proof of prehistoric distributions.

Chronological Indicators

Archaeologists often rely on the recovery of distinctive styles of projectile points to estimate the relative age of prehistoric deposits (see Petraglia and Knepper 1996). This approach was useful in understanding the relative chronology of Lums Pond. In addition to the material culture study, the application of a large number of radiocarbon dates was considered critical in assessing and refining site chronology. In application of radiocarbon dating at Lums, effort was put into verifying the utility of single dates, hence multiple samples, totaling 20, were submitted from certain contexts. Based on multiple samples, some dates were in fact considered to be reliable estimates (e.g., Area 2 pit features) whereas others were rejected (e.g., Area 3 stratigraphic levels) due to discordant results, as to be expected in radiocarbon dating and in contexts showing signs of disturbance. As a consequence, the Lums Pond radiocarbon sampling strategy was considered worth the relative expense since greater accuracy was derived. In this sense, it is argued that caution should be exercised in reliance on single dates derived from any level, feature, or site area without supplementary or confirmatory information. The application of radiocarbon dates in different site areas within Lums nicely confirmed the chronological difference between areas. This would not have been possible with artifact styles alone. In fact, the radiocarbon dates provided information to suggest that the few Archaic points situated in Woodland I deposits were scavenged and reused items. The Lums Pond sampling design suggests that more than a few radiocarbon dates are necessary for confidently assessing age and vital to any discussion of intra-site contemporaneity.

Landscape Formation

Great progress has been made in understanding the paleoenvironmental setting of prehistoric sites in Delaware (e.g., Kellogg and Custer 1994; Heite and Blume 1995). These studies have allowed for the development of detailed reconstructions of environments and showed the relationship of changes in local environments with settlement patterns. While these studies have been extremely useful, it is generally agreed that much additional research in Delaware remains to be conducted along similar lines. In a comparison of the inferred environments of Lums Pond with the published data sets from bay basin settings, the central Delaware tidal rivers, and from Blueberry Hill, some general trends in landscape history were apparent. However, enough local variability was also indicated to suggest that a variety of detailed local studies were needed. As a consequence, environmental and landscape reconstructions from Delaware are both spatially and chronologically variable, indicating that prehistoric adaptations could be associated with these trends. While the geoarchaeological investigations were satisfying in highlighting landscape variability across Delaware environments and sites, the reconstructions must be treated as tentative as limited paleoenvironmental sampling of discrete microenvironments is yet to be conducted. Moreover, the Lums Pond analysis will need to be supplemented by more detailed sedimentological and interdisciplinary approaches from other sites.

The comprehensive geomorphological and geoarchaeological approach taken to the Lums Pond site was considered to be relatively unique in approach. The Lums Pond study attempted to examine the stratigraphic and geomorphological records from the perspective of the interaction of human populations with the landscape. In general, the main goals of the Lums Pond study were to address the vertical and lateral reconstructions of the landscape and human use through time and to compare the results with earth science oriented approaches previously undertaken in Delaware. More specifically, the geoarchaeological study was concerned with site formation, the significance and patterning of cultural residues, the logistics of site selection and landform, and the preservation of the archaeological record in certain sediments and soils. In this respect the Lums Pond approach contrasts somewhat with previous geomorphological studies which tend to emphasize reconstruction of landscape histories and soil weathering, leaving the archaeologists to interpret human and landscape elements. To our knowledge, this kind of approach in not normally undertaken in prehistoric research in Delaware, thus we would argue additional studies of the type undertaken at Lums Pond are needed.

Wood, Nuts, and Seeds

Botanical recovery is of use to archaeologists in inferring potential environments and subsistence practices. The Lums Pond botanical analysis recovered both uncharred and charred nuts and seeds. As in other contexts, the unburned specimens were considered unreliable indicators of a prehistoric origin, due to mixing by taphonomic processes. Therefore only charred specimens from relatively reliable, sealed contexts were used to infer prehistoric association at Lums. Although even charred specimens have been called into question as solely prehistoric, this was not considered to be a factor at Lums where contexts did not show any historic intrusions. To verify prehistoric association in future excavations, radiocarbon dating of charred nuts or seed could be conducted.

The strategy for submitting the Lums Pond macrobotanical samples for study was considered effective, yielding solid and cost-effective returns for archaeological analysis. The macrobotanical samples were submitted in a staged approach. The goal of the first submission was to examine if flotation produced useful results. The first set of samples was picked from reliable contexts (i.e., those that showed integrity and minimal signs of disturbance). The samples were mostly from the pit features in Area 2 and a few were selected from the stratigraphic levels in Area 2. The first set of samples indeed turned out to be productive, providing charred specimens in each sample. However, the first set of samples showed some apparent redundancies among the pits, with identification of oak and hickory nuts. The several Area 3 samples indicated that charred seeds were present. Given this situation, several other samples were submitted from Area 3 to examine if redundant information would be provided and several samples were submitted from Area

2 to examine if additional charred seeds could be recovered. The second set of samples provided very similar results compared to the first set. Although the two staged approach took more time for analysis, the strategy was considered worthwhile. The first set of samples verified charred specimens were preserved, suggesting the need to conduct further study. The second set of submissions bolstered and confirmed the paleobotanical information previously obtained.

The Lums Pond analysis suggests that with careful selection practices, good results may be obtained and a high level of confidence may be placed on the results. Of the 12 samples submitted for flotation, all 12 samples yielded charred specimens of use for prehistoric interpretation. The high return rate is probably due to the purposeful submission of samples from organic contexts or from sealed contexts with the potential for preserved organics. The Lums Pond botanical analysis confirms the utility of submitting samples in a staged approach and it also suggests useful information may be derived from samples if they are carefully selected. Future botanical studies in Delaware may benefit from a similar practice.

Describing Stone Tools

A repertoire of stone tool attributes were taken on the Lums Pond data set. A large number of descriptive attributes were obtained, including artifact types, raw material types, weight, percent cortex, flake size, flake platform characteristics, and scar counts (see Laboratory procedures for the full range of attributes taken). In designing the attributes taken at Lums Pond, it was considered important to create a data set which could be compared to other Delaware sites. This was conducted with some degree of success; for instance, the Iron Hill jaspers among several sites were compared, implying differences in reduction stages. While direct comparisons could sometimes be made, certain stone tool attributes were broken down further than normally found in other reports. For instance, while the UDCAR reports note presence or absence in certain attribute fields, the Lums Pond analysis stratified certain fields to obtain more detailed information. Instead of only noting whether cortex was present or absent or if a flake platform was prepared or not, percentages and sizes were recorded on the Lums Pond data set, assumed to be of more use in determining the method and stage of lithic reduction.

Instead of cataloguing all lithics comprehensively, a degree of economy was exercised in analyzing the Lums Pond data set. Comprehensive attribute cataloguing was not deemed necessary on account of the variation in the contexts in which artifacts were identified. That is, it was not considered worthwhile to take comprehensive measurements on flake attributes from certain plow zone contexts as these were in mixed and disturbed settings. On the other hand, where plow zone contexts were considered chronologically controlled (i.e., Area 1) or where subsurface contexts were considered reliable, additional attribute analyses were conducted. This had the overall effect of providing accuracy in inferring reduction techniques used at particular times and areas within the site and it also eliminated the need to conduct cataloguing in certain contexts which do not merit such an approach, thereby controlling laboratory expenses.

Jasper Quality

The jasper reduction experiments were conducted to provide further insight into raw material quality and usability. In this case the jasper reduction experiment was supplementary to an overall appraisal of the inherent qualities of jasper found regionally. The reduction experiments showed real differences in the various inherent qualities of the Iron Hill, Chestnut Hill, and Amtrak (Iron Hill Cut Quarry) site jaspers. The experiments confirmed some intuitive notions about the quality of jasper and notions about how artifacts would be tested and formed at quarries. The study also indicated that the Lums Pond jaspers, especially those derived from Area 1, were among the best raw material types likely to be found and selected at the northern Delaware sources. While the experiments were useful, allowing for a more refined understanding of the jaspers, a main drawback in assessing fracture and raw material quality was that observations were not quantified and thus impressionistic. A more controlled, and quantified approach could be designed, but the experiments clearly showed that such a study would have to be conducted on a large range of individual knapping experiments, which would be time consuming and potentially costly. This does not mean that such an approach would not be of use, however.

Mapping Clusters

An effective tool applied to the Lums Pond data set was computer generated mapping. The use of computer aided contour plots helped to visually show where clusters could be identified, potentially the remnants of prehistoric activities. Spatial plotting techniques have indeed been used with some degree of success at other Delaware sites (e.g., Custer et al. 1996; LeeDecker et al. 1996). A main difference in the Lums Pond application appears to be the degree and depth to which this technique was used in examining site patterning. In the Lums analysis, large and small areas were examined in a comprehensive fashion and multiple distribution analyses were conducted in an attempt to discern patterns.

A large number of computer plots at various scales were mapped at Lums Pond to show where artifact distributions could be considered patterned or clustered. The use of computer generated maps allowed for the processing of the data set in a multitude of ways, examining distributions of artifacts by number, type, raw material, and sizes. The exploratory spatial analyses were especially useful in identifying latent features, that is clusters that were not immediately obvious in field work. Latent features were identified in both plow zone contexts and in subsurface contexts. The computer mapping in plow zone contexts was effective, isolating jasper and quartz reduction areas in Area 1 and revealing the presence of fire-cracked rock distributions in Area 2, situated above and near the pit features. The plotting procedure confirmed the presence of remnant prehistoric activity areas in such disturbed contexts. The computer maps also showed that Area 3 clusters existed, and that both reduction areas and fire-cracked rock concentrations were present and spatially separated, despite evidence for disturbance by natural factors. Of importance in confirming their behavioral attribution, refitting showed some degree of correspondence.

While the spatial mapping procedures are of great benefit in examining distributions, it should be recognized that certain factors and choices may enter into the visual displays. For instance, all visual displays were based on the one-meter unit as the most refined level of analysis. A grid pattern may not necessarily correlate with actual prehistoric distributions, hence spatial differences may be anticipated. Furthermore, choices may enter into how many levels or how many strata are used in mapping procedures, perhaps having nothing to do with any isolated or single prehistoric occupation. As a result, while mapping devices may appear to be highly useful in discriminating patterning, archaeologists must also be conscious of the fact that choices enter into how data is entered and visually displayed. As long as analysts describe how displays and interpretations are formulated, critical appraisals will be possible.

Features and Formation Processes

The feature analysis at Lums Pond provides some useful avenues for describing archaeological patterns and for assessing formation processes. The morphology and content of the Lums Pond features were fully described so that analysts may be able to make cross-comparisons with findings from other sites. Current summary lists of feature types as described in many reports are often not enough to make inter-site comparisons and assess cultural functions. Moreover, with the emerging debate on feature formation in Delaware, full description of features is considered necessary to evaluate formation processes. It is currently difficult to compare the morphology of the Lums features with those presented in recent site reports such as at Snapp and Leipsic (Custer and Silber

1995; Custer et al. 1996). In these reports summary information and feature typology is only presented. The lack of reporting of individual feature sizes, contents, and volumetrics is clearly needed. Because these variables are not reported, the Lums feature data set can not be directly compared to other sites (e.g., as in scatterplots shown in conclusions above).

In addition to describing the morphology and contents of features, several in-depth analyses were performed of the Lums Pond data set to further support inferences concerning function. In this respect, the Area 2 feature types were distinguished from Feature 10, situated in the western zone of Area 2. In the field there was some degree of consternation as to whether Feature 10 should be considered natural or cultural. The feature was unique in size and shape, and it was wide and deep, steeply sloping walls and a basin shaped bottom. It contained few artifacts, none of which were temporally diagnostic. Stratigraphic inspection indicated that rodent burrows had disturbed the fill. It was felt that the cultural-natural attribution could not be resolved by visual inspection alone, hence special analyses were performed in the hopes that distinctions could be made compared to the pit features. A radiocarbon sample was returned from the feature fill to indicate that it dated to 1150 BP, not related to any other reliable feature date or deposit in the site. Geochemical analysis showed that Feature 10 could be discriminated from the pits in the eastern zone of Area 2. The geochemical analysis also showed phosphate variation between the upper and bottom parts of the feature, supporting the notion of infilling through time, not purely the result of cultural activity and formation. In sum, all available evidence showed that Feature 10 was unique in its formation. The combined analyses strongly implied that the feature was likely a natural pit (e.g., tree throw, burrow) which slowly infilled with both natural and cultural debris, and probably subsequently disturbed by burrowing.

The approach taken to the features at Lums Pond and the findings of the special analyses have implications regarding the question of feature types and cultural attributions recently coming forth in the Delaware literature (e.g., Custer and Silber 1995; Custer et al. 1996). Debate continues on whether or not the D-shaped or kidney-shaped features represent pithouses or natural disturbances, or a combination of both. Since some level of skepticism has been raised about cultural attributions of various features, these need to be carefully re-evaluated and analyzed in terms of formation processes. The Lums Pond analysis suggests that field observations or morphological assessments alone will not resolve the natural-cultural arguments. Rather, rigorous description and analytical studies are clearly needed to address, clarify, and resolve lingering questions. Delaware studies which wish to reconstruct the formation of features and patterning would clearly benefit from the application of site formation approaches (e.g., Schiffer 1987; Waters 1992; Goldberg et al. 1993).

Reassembling Sites

Artifact refitting has been shown to be of use in examining stone tool reduction techniques, spatial distributions, and assessing horizontal and vertical integrity (Custer and Watson 1985; Carr 1986; Petraglia 1993, 1995; LeeDecker et al. 1996). The refitting project performed on Lums Pond was extremely useful, either supplementing findings from other analyses or providing unique information.

The refitting project performed at Lums Pond showed that the bipolar technique was utilized by the site inhabitants. The refits showed the importance of cobble reduction and in several cases it showed the sequence of flake removals within reduction sets. This information confirmed the use of bipolar and percussion techniques as inferred in the stone tool attribute study. The refits demonstrated that early stage reduction techniques were operative, but some flake refits also showed that late stage reduction of bifaces was performed.

The refitting project was of extreme value in assessing horizontal and vertical patterning within the site. The refits were useful in isolating clusters of chipped stone and fire-cracked rock, showing the relationship among these, and providing unique and supplementary information to the Area 3 spatial analyses. The refits showed that a number of raw material clusters identified in computer aided maps were in fact related, for example, connections were made within jasper clusters in Area 1 and chert and quartzite clusters in Area 3. The most dramatic findings of the refits was in the vertical separation among pieces, sometimes crossing levels and strata. This evidence clearly showed that assemblages could not be naively assumed to all be related to one another. Vertical differences according to object size (i.e., chipped stone vs. fire-cracked rock) showed that artifact mobilization varied, indicating that large objects were relatively stable whereas the smallest artifacts had a greater ability to move upwards and downwards in the profile. While vertical transformations were shown, the refits also demonstrated that isolated horizontal and vertical patterns existed, supporting interpretation of depositional integrity.

The Lums Pond refitting project had a great bearing on an understanding of stratigraphy and subsurface patterning. The Lums Pond study confirms the findings of other recent studies in Delaware which suggest that artifact mobilization in buried, sandy substrates is more common than previously recognized (Blume 1995; LeeDecker et al. 1996). Of importance in all these studies, various lines of evidence showed that certain stratigraphic and artifact patterning were the result of human activities, hence deposits could still be temporally ordered despite disturbances. These studies reinforce the notion that buried deposits can not be taken as either solely pristine or as badly disturbed. Rather, various degrees of cultural and natural contributions are anticipated in different geomorphic and sedimentary settings in Delaware and it will be up to archaeologists to sort these out.

The Lums Pond refitting project was not attempted on all objects; rather certain areas and distributions were targeted, hence choices were made according to research questions. The refitting began with a goal to reconstruct reduction sets in Area 1, concentrating on the jasper clusters. While a few refits were obtained, the analysis was somewhat disappointing here in that a greater number of mends were not made. The reason for this appears to relate to certain cultural factors. Refitting was difficult since cortical material was removed at quarry sources and at Lums bifaces and cores were likely carried away. This meant that the Area 1 debris was mainly the intervening reduction debris, hence outer cortical pieces and inner cores were lacking, helpful in mending lithic objects. The Area 3 refitting project was more of a success in mending different chipped stone raw materials and fire-cracked rock. In Area 3 refitting was easier because of visual distinctiveness of material, the presence of cores and flakes, and the presence of clusters of artifacts. Thus, when similar conditions are met at other Delaware sites, refitting will likely be as successful.

Blood from Stones

A new and exciting research area in archaeology is the examination of organic residues on stone tools. Archaeologists have recently discovered that the edges of stone tools may preserve blood or organic residues that help to determine artifact function and animal or species used. Archaeologists working in the Middle Atlantic region have recently applied specific techniques to examine blood residues (e.g., Custer et al. 1988; Petraglia et al. 1996). The University of Delaware archaeological program has routinely applied blood residue studies, examining whether hemoglobin on artifacts were present and whether tools were used in game procurement or processing. Overall, however, while these studies have shown positive signs of blood on tools, the scientific techniques have not progressed, and the determinations have not been useful for functional determinations. For instance, 680 artifacts from Leipsic provided negative results (Custer et al. 1996). Of examination of 110 tools from Snapp, 2 provided positive results, with only faint signatures, rendering the analysis unreliable (Custer and Silber 1995). At Pollack, 967 samples were analyzed, and only 3 had positive results (Custer et al. 1996), indicating the two unretouched flakes were used for cutting and scraping for processing game animals or fish, and the point tip came into contact with flesh of targets. Of other

Delaware studies, residue analysis was performed at the Two Guys site (LeeDecker et al. 1996). Here, a stratified approach was taken, first subjecting the artifacts to the hemoglobin tests and then to CIEP analysis. Of 186 artifacts tested to chem-strip analysis, 7 were positive. These 7, together with another 43 specimens, were submitted for CIEP analysis. Of the 50 artifacts tested, 11 produced results to a variety of animal types. Most interesting, the correspondence between the two tests was low, with only 1 of the 7 original artifacts testing positive. A general conclusion of the Two Guys study was that the hemoglobin tests were not an effective method for deriving positive results whereas CIEP produces more positive and more specific results.

Most recently, many organic residue studies in archaeology are undergoing reappraisal and critique (e.g., Fiedel 1996; Fullagar et al. 1996). A conclusion of many of the debates occurring on the national and international scene indicate that while encouraging, blood residue studies should be cautiously applied and their analytical value remains incompletely understood. Given this research background, the Lums Pond organic residue was designed to help resolve whether blood was indeed present and whether specific techniques could be developed to definitely prove species of origin. The study was also performed to scientifically examine the reliability of techniques and whether contaminants could give false positive reactions. Of the 100 artifacts analyzed as part of the Lums Pond study, the great majority were negative suggesting that preserved blood will be difficult to identify. However, while a small percentage, the presence of protein on eight tools was heartening, suggesting there is value in pursuing organic residue studies. Of the tools with sufficient protein, five could be further analyzed, one convincingly testing positive to deer. In a separate analysis of the artifacts, many tested positive to deer or horse, the latter an inappropriate animal for prehistoric stone tools. This suggests that cross-reactions with animals is possible and false positives may be derived in employing standard and non-sensitive blood residue techniques such as CIEP and ELISA. As a consequence, the Lums Pond study demonstrated that current methodologies in blood residue analysis in the national archaeological literature must be critically evaluated. However, the study was also encouraging, strongly showing that prehistoric blood was indeed preserved on stone tools, and further, that particular species could be identified. Given archaeologists desire to obtain blood residues from stone tools, this study indicates that much more research is needed before laboratories are used for standard processing of samples. The Lums Pond study was extremely laborious and it had the benefit of using national research laboratories. Unfortunately, for archaeologists practicing in Delaware, few laboratories are equipped to conduct a similar level of organic residue research.

The conclusion that must be reached from the Lums Pond findings is that many previously applied organic residue techniques are suspect, and confirmatory studies must be conducted to offer valid proofs. The Lums Pond analysis indicate that blood residue analyses should not be routinely applied as if certain techniques undoubtedly elucidate tool functions. Rather, blood residue research must concentrate on affirming methods, and effort should be placed on conducting independent tests and experimentation to verify results. If blood residue tests are to be performed on archaeological sites in Delaware, archaeologists must carefully select their techniques, control collections, and consider the role and effects of various natural and cultural contributions in artifact histories and site formation. The euphoria of finding blood on stones must now be replaced with clearly designed questions about elements of prehistoric adaptation (e.g., study of environments, species exploited, tool function), and scientific studies to prove organic residues are incontrovertibly prehistoric in origin.

Final Conclusion

The archaeological investigations performed at Lums Pond represent a program of intensive and systematic research, undertaken to further the current state of our understanding of prehistoric adaptation in the upper reaches of the upper reaches of the High Coastal Plain of Delaware. Geomorphological and geoarchaeological reconstructions showed the correspondence of landscapes and occupation areas. Data recovered from plow zone and sub-plow zone contexts comprised an important and representative sample of the artifactual material from the site, providing information relative to the periods of occupation, site use, and activity zonation. Chronological data from analysis of temporally diagnostic materials were confirmed by absolute age estimates returned from radiocarbon dated features and strata. Recovery of macrobotanical material from features and stratigraphic levels provided data concerning site use, subsistence practices, and aspects of the paleoenvironment. Stone tool analyses and spatial pattern recognition studies elucidated the nature of prehistoric activity. All available evidence pointed to a series of short-term and temporary occupations.

Comparison to previous work in the vicinity of Lums Pond indicates some general conformity with descriptions of Woodland I and Clyde Farm Complex sites. However, a number of detailed studies indicate that there is some degree of variety to be found among sites both in their material and spatial formation. The investigations at Lums Pond, beginning with systematic survey, and continuing through evaluative testing to mitigation, have shown that significant data can be obtained from these type of locales. The investigations of the Lums Pond site were geared toward extracting the maximum feasible amount of information from the existing archaeological record. A comprehensive analytical program was undertaken which resulted in analysis beyond the level of descriptive summary. Similar work in various microenvironmental settings will hopefully reaffirm the validity of the approach undertaken at Lums Pond.