Appendix B: Muller's Discussion of Features 3 and 6 and the Issue of Potential Pithouses

***Note*:** The following text is extracted from Rutgers University's unfinished draft report, and consists of Dr. Raymond Muller's chemical analysis of soils and discussion of potential pithouses. The text is reproduced here as close to the original version as possible; all necessary changes and/or omissions—made in regard to context and clarification—appear in brackets. In cases of differing usage between this text and the report text to which it is appended (for example, "pit house" and "pithouse," respectively), differently constructed terms are denoted (*sic*) only in their first appearance. In an effort to avoid excessive interruption, all editorial disagreements are not indicated. An incomplete reference list is provided here; in-text citations not fully detailed in the reference list are presented in brackets. These citations will be fully spelled out in the final version of this draft report.

Hypothesized Pit House [*sic*] Features

[T]he absence of organic staining and scarcity of artifacts and hearths within the suspected prehistoric pit house features at the Gabor Site raised several questions regarding how they might have formed…

Analysis of Features 3 and 6

[T]here soil features, interpreted as the remnants of prehistoric Native American semi-subterranean "pit houses," were present in the underlying B-horizon [*sic*] within the open area of the site (Hoseth and Seidel 1994: 3). The upper portions of these features had been disturbed or truncated by agricultural activity that created the plowzone.

Feature 3. According to Hoseth and Seidel's (1994) Phase II report, this oval to kidney-shaped feature['s]… yellow brown to gray soil also contained charcoal. The feature measured 3.7 m x 1.6 m in plan view and extended to a depth of 0.5 and was slightly deeper in its northern half. No diagnostic artifacts were found in the fill but its southern half yielded numerous flakes that corresponded with the high concentration of flakes found in the plowzone immediately above the feature. A total of 131 flakes, a flake tool, 1 early stage biface, and several pieces of fire-cracked rock were recovered from the feature fill.

[T]wo presumed post molds [*sic*] (Phase II Features 8 and 10) were found in association along with a rodent burrow (Phase II Feature 7). The presence of these smaller "post" features in close proximity with Feature 3 suggested to Hoseth and Seidel (1994: 43) that Feature 3 "may have been part of an enclosed house structure similar to the house feature identified at the Snapp Site (Custer and Silber 1994)."

Feature 6. Prior to the mechanical removal of the plowzone during Phase III, we uncovered another curious soil feature that was designated as Feature 6 by UDCAR. The feature fill lacked the dark organic staining that one might expect in a domestic feature of this sort. Instead, it consisted of a relatively loose, yellowish-brown clayey loam that was slightly lighter in color and finer in texture than the more compact and gravelly, reddish-brown silty clay matrix. Furthermore, in plan view, the subtle difference in the color of the fill made it nearly impossible to distinguish from the surrounding soil in which it occurred. Excavation of a section of Feature

6 revealed that it was shallow, lacked any internal stratified layers, and contained less gravel than the surrounding soil. No post molds were associated [with this feature] and only a few pieces of thermally fractured rocks and flake debris were found within it.

Several other D-shaped or kidney-shaped soil anomalies of this type were subsequently discovered after the plowzone in the field had been mechanically stripped. These anomalies were similar to the Phase II features identified by UDCAR in the characteristics of their soils, lack of organic staining and internal stratigraphy, an absence or [scarcity] of artifacts, and a total absence of post molds and internal features such as hearths or rock clusters.

Phosphorus Analysis

To test the multiple hypotheses for the formation of the soil features, Muller conducted a spectrophotometric analysis of total phosphorus on soils from the Gabor Site. Phosphorus is an important indicator of human occupation used by archaeologists. Phosphorus is present in humans as calcium phosphate (CaPO4) in bones, ATP (Adenosine Tri Phosphate) in cells, and lipid phosphates in and on cell walls. Phosphorus is concentrated in urine, feces, meat, and especially bones, thus making this element an important indicator of areas of prehistoric human occupation. Because phosphorus is virtually immobile in the soil (except in pedogenic time), it accumulates in areas of human occupation above the background level of natural soil phosphorus. Total phosphorus analysis was performed to avoid the problem of differences in solubility of various phosphorus compounds. Phosphorus content will form a distinctive vertical profile over time, so samples were collected from the same depth to avoid differences produced by sample depth.

The undisturbed rock cluster in the unplowed forested area of the site provided a test location for an evaluation of phosphorus content. A total of ninety samples were collected in and around the rock cluster and in the adjacent control area of the forest where no artifacts or cultural features were found. The mean P-content [phosphorus content] around the rock cluster was 705 parts per million (ppm) while the control area had a mean P-content of 601 ppm. The higher concentration around the rock cluster is indicative of human occupation.

While significant, the P-content is not greatly higher from that of the control area suggesting that human use of the wooded site area was low. This interpretation is supported by the relatively low density and variety of artifacts and features and the presence of small, isolated activity areas. Unfortunately, the annual addition of phosphorus-rich commercial fertilizers to the cultivated field precludes comparisons between it and the wooded sector of the site.

Fifteen additional paired soil samples were collected from one of the hypothesized pit house features (Feature 6). For each sample collected from within a feature, another was collected at the same depth outside the feature. If a feature was a product of human use, the P-content should be higher inside the feature. However, in this case, the mean P-content was higher outside the feature. Mean phosphorus content was 627 ppm inside the feature but a higher mean value of 742 was obtained outside the feature. The difference in P-content inside and outside the feature can be explained by pedogenic processes.

During the overturning of a tree, the E-horizon was forced downward to a depth below the plowzone. Because the E-horizon is a zone of leaching, it would be expected to be lower in phosphorus. Phosphorus content in a vertical sequence of samples collected in the unplowed forested area showed phosphorus depletion in the intact E-horizon at depths of 15 to 25 centimeters. The lighter color of the feature is not found in the surrounding soil because outside the tree-throw depression, the E-horizon would be mixed with the A-horizon by plowing. The lighter-colored sediment is present near the surface in the unplowed, wooded area. The phosphorus content indicates that Feature 6 was not produced by humans.

The Potential Role of Tree Removal

In addition to the natural felling of trees by wind action, the deliberate removal of trees for the clearing of agricultural lands during early and later historic times could also have resulted in the creation of features that mimic the size and stratigraphy of some pit houses reported in southern Delaware. This more recent cultural source of soil disturbance was initially suggested by our discovery of a large metal pulley in Feature 16 in the southwestern portion of the plowed field that abutted with the woodline.

This feature was encountered during the closing days of Phase III after the plowzone had been removed from the surface of the field. At first its overall shape in plan view at the top of the B-horizon closely resembled the prehistoric pit house feature reported by Griffith and Artusy (1975) in southern Delaware at the Poplar Thicket Site (7S-G-22). Although two sherds of a glazed, historic redware vessel were found in the upper portion of the first level of Feature 16, the presence of chert chipping debris suggested that the feature might be prehistoric Native American in origin or that the feature was created during the European Contact period. The discovery of several large post molds adjacent to Feature 16 also raised our hopes that this idea might prove correct.

Although prehistoric artifacts, including some large ceramic sherds, continued to be found within the feature fill, these speculations quickly faded when the neck and handle of a glazed redware vessel were discovered. At Ron Thomas' urging, we showed these vessel sherds to Betty Cousins, an expert in historic ceramics who was employed by Mr. Thomas. After examining the specimens, she identified them as the remains of a late eighteenth century to early nineteenth century redware bottle sherds, far too recent for even the Contact period.

The metal pulley found in the fill was, at first, very puzzling. The senior author [of the Rutgers' report] began searching the literature and questioning several historic archaeological colleagues familiar with nineteenth century farming techniques. Eventually, David Zmoda, a historic archaeologist with the New Jersey Department of Transportation, suggested that the pulley might have been farming related. Shortly after, he produced a book on farm development techniques, published in 1910, in which the author, Hays, discusses and illustrates various methods by which tree stumps were removed during the nineteenth century:

> A block and tackle applied by means of a capstan, is much used to multiply horse and steam power. The capstan, fastened to one or more strong stumps by means of guy

> chains or cables, is the main feature of some of the most practical stump pullers in use… [Hays 1910: 20].

As the accompanying illustration from Hay's book shows, the pulley recovered from Feature 16 is very similar to those shown in the drawing of the capstan or tree-puller. Furthermore, Hays' descriptions of the treatments of stumps prior to their removal by use of a capstan is also revealing and seems to explain the charred tree roots and stratified layers of ash, charcoal-rich soil, and fill in the feature.

> Some stumps may be partially burned by boring a hole from the top of the stump down diagonally through the side, pouring kerosene into this slowly, so as to saturate the walls of the hole, and then applying a match. The hole serves as a chimney to give draft to the fire, which causes the stump to burn… But the more frequent use of fire in removing stumps is to cover them with brush and waste timber and burn part of the stump while burning the other wood. Remaining portions, as large roots, may then be dislodged by pulling them with the stump puller… [Hays 1910: 123].

Hays' descriptions of the treatment of different tree species is also informative:

> The species of tree is also a most influential factor in the cost of clearing lands. The poplar stump, for example, is soft, easily broken, and not large, and may be removed when green with comparatively little trouble… The white pine, on the other hand, grows large, has very extensive though not deeply penetrating roots. It is solid, its wood is full of pitch, which serves as a preservative, and it will remain for a generation and still be hard to remove…
>
> Some hickories and oaks develop large stumps with strong tap roots, holding them very firmly to the soil. The wood will last, in the case of the oaks almost as long as the white pine stumps [Hays 1910: 124 – 125].

Discussion of Results and Recommendations

Our interpretations should not be viewed as an attempt to establish the false dichotomy that soil features of this kind must either be pit houses *or* tree throws. Rather, when investigating soil features of the type found at the Gabor Site, we believe researchers should be working with multiple modes of formation in mind and, using a comprehensive set of analytical tools, evaluate which possible method(s) of formation is responsible for the creation of the features on a site by site basis.

What we do know, however, is that the soil features in question are found on archaeological sites. For each site, the literature and our own research suggest that the realm of possible processes responsible for the formation of these features can be characterized as a continuum that includes: 100% pit house features, to pit houses and tree-throw features, to pit houses disturbed by tree throw[s], to tree throw[s] used as shelters, and, finally, 100% tree-throw features.

Our investigation shows that tree throw[s] can produce features analogous to those thought to be pit houses. Both disturbed and undisturbed areas in Delaware provide an opportunity to compare the two theories of formation. Soil phosphorus distribution is an important indicator of human occupation at sites and for defining the physical boundaries of sites. Soil phosphorus analysis, along with other soil characteristics and archaeological evidence, allowed us to evaluate the two hypotheses and develop a continuum of possible formation processes.

There is no doubt that some of the pit house features reported in northern Delaware were created by prehistoric Native Americans. However, preliminary background research revealed that the hypothesized pit houses features at the Gabor Site and several other sites in northern Delaware also share many similarities with published descriptions of natural tree throws. For example, as Waters (1992: 307) pointed out, particles of soil and artifacts adhering to the root plate fall back into the depression or collect on the mound adjacent to the depression. The repeated overturning of the soil mantle of sites can also concentrate "a veneer of stones at the surface" [Wood and Johnson 1978: 556]. Of particular importance is the shape of the pits or depressions left by the root plate. These include "ovoid" or "crescentic pits" and the formation of "two small pits on either side of the mound" [Schaetzl et al. 1990: 278 – 279]. These descriptions sound extremely similar to some of the "Type 6" features reported from the Snapp Site and feature types from other northern sites.

Observation of a cluster of several large tree throws in the wetlands associated with the nearby Paradise Lane Site (7NC-D-125) adjacent to Red Mill Road [was] also informative. Although these trees were located in a moist environment, rather than an upland setting, the water-filled depressions left by the upheaval of the root plates were "D-shaped" and "crescent-shaped" and of similar diameters [relative] to many reported pit house features.

More recently, Muller et al. [1997] examined tree throws at two interior upland sites in southern New Jersey. One area is in the Cape May National Wildlife Refuge (CMNWR) in Cape May County. This complex of sites is being excavated as part of an archaeological field school by Rutgers University and Richard Stockton College. The second area is the Stockton campus in Pomona.

On the wooded upland portion of the CMNWR, tree throws disturbed soils to a depth of 140 cm. Data for a cluster of twenty tree throws on the Stockton campus showed an average disturbance depth of 105 cm and a disturbed width of 134 cm. Importantly, these disturbances were not caused by unusually large trees. The average tree age was slightly over 57 years while their diameter (DBH) was only 30 cm. [B]imodal tree fall direction indicated that [these trees] were blown over by northeast or northwest winds, most likely during the winter. The trees were in various stages of decomposition indicating that no single catastrophic storm caused the blow overs… The tree growth form and loose, sandy soil conditions, which allow the trees to pivot around a central point underground, most likely caused the tree throw[s] rather than a severe wind storm.

Tree-throw disturbance is more frequent in the vicinity of archaeological sites than in uncut forested areas. The association of tree-throw depressions with archaeological sites is enhanced by the clearing of land for villages or fields. Trees along the edges of forests, or in exposed

locations, develop different root structure than trees in more sheltered situations. Trees in exposed areas develop a wind-firm, pyramid-shaped trunk and root structure, while sheltered interior trees have a more cylindrical structure. With clearing, the interior trees are exposed to greater wind velocities and increased turbulence. As noted by Kimmins [1997], windthrow [*sic*] is far more common adjacent to clear-cut areas than in uncut areas.

Many researchers have noted that tree throw is far more common in shallow and/or wet soils, such as those examined near the Paradise Lane Site in Delaware. Pitch pine develops different root morphology depending on its position in the landscape. In wet areas, its root system is shallow and broad while in well-drained, upland areas the roots are thick and long. Field research at both Kimbles Beach and the Stockton campus sites indicates that tree throw is common in upland positions.

One of the tree throws examined in the CMNWR showed soil disturbances to a depth of 1.4 meters. Significantly, this upland tree throw also showed rotation of the light-colored E-horizon to a depth well below any plowzone and jumbled soil horizons such as the presence of dark, organic matter around the perimeter of the rotated block.

After analyzing the phosphorus samples from the Gabor Site, it became apparent that a typology of phosphorus profiles from a variety of sites was needed to better understand the use of phosphorus for tree throw versus pit house depression analysis. As a result, samples were collected from a variety of locations at both the CMNWR and the Stockton campus. The samples were taken from areas that were both disturbed and undisturbed by tree throws and from archaeological and non-archaeological sites.

At the CMNWR, a vertical sequence of samples was collected at several control points located away from artifact finds or recent tree throws. This sequence showed a high phosphorus content near the surface which rapidly dropped off in the underlying B-horizon. The increase in phosphorus at a depth of 90 cm is associated with the 2B-horizon of a truncated paleosol.

A paired sequence of phosphorus analysis near a tree throw showed an interesting divergence of phosphorus distribution. The undisturbed soil had a profile similar to the one above. The profile from soil disturbed by tree throw shows an entirely different distribution. Higher phosphorus content at the base probably indicates the accumulation of leaves and other organic matter in the base of the depression when it was filled.

Muller et al. [1997] also wanted to examine the lateral distribution of phosphorus. With normal soil formation processes, phosphorus content at a consistent depth within a small area should be similar. This graph shows the wide range of phosphorus content in the area affected by tree throw. This could be a useful diagnostic characteristic for determining the presence of old tree-throw disturbances.

Phosphorus analysis of tree-throw areas on the Stockton campus showed a pattern similar to that in the CMNWR. Samples were collected from the disturbed soils of tree throws and from nearly undisturbed control areas. In the undisturbed profile, phosphorus was concentrated near the

surface and increased again in the truncated 2B-horizon of a paleosol. The disturbed profile once more showed a high phosphorus content at the base of the pit.

While the idea of developing a typology of phosphorus profiles between areas disturbed and undisturbed by tree throw appears to be achievable, the comparison with an archaeological site proved less successful. At Kimble's Beach in the CMNWR, our major site is located in the middle of a tight cluster of modern homes. To make matters worse, the site was beneath an old septic system drainfield. This rendered phosphorus analysis useless. We have not yet found a major prehistoric occupation site in undeveloped areas of the Refuge. The artifact distribution at locations where phosphorus was analyzed was indicative of very low occupational intensity. Thus, the phosphorus content did not rise above the background levels found in the soil.
It is expected that phosphorus distribution in a pit house would have a high concentration at the occupation level, then drop off rapidly below that level. Phosphorus content above the occupation level would vary depending on the sequence of habitations and the nature of the fill. At the present time, the phosphorus distribution in a [given] Native American pit house is a [matter of] conjecture.

While intriguing, these findings are, of course, very preliminary and additional research will be required to more adequately test the hypothesis. Given the inordinate numbers of pit features reported on archaeological sites in northern Delaware we recommend that future archaeological investigations should involve geomorphological and chemical analysis of feature and non-feature soils collected during Phase III fieldwork, and the excavation of modern tree throws in both upland and lowland settings.

References

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